ECONOMIES OF FARM SIZE IN THE CARMAN AREA OF MANITOBA

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ABSTRACT

The central objectives of this study were to determine whether there is a functional relationship between the size of the farm firm and its unit cost; to ascertain what is the optimum size of the farm firm; and to determine whether the family farm is consistent with the optimum size of firm in agriculture.

In this study improved acreage and volume of output were used as criteria of farm size. Data from the records of 41 crop farms in the Carman Area of Manitoba were used in the empirical analysis. Synthetic budgeting and regression analysis were the techniques used in estimating the relationship between the size of farm firm and its unit cost, as well as in determining the optimum size of the farm firm.

The results of this study show that where improved acreage is the criterion of size, the optimum size of farm firm is 883 acres. On the other hand, where volume of output is the criterion, the optimum size farm produces approximately $34,000. worth of output. This study also indicates that the family farm is consistent with the optimum size of firm in agriculture.

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INTRODUCTION

Economies of farm size is an issue that has been a subject of considerable debate in the Province of Manitoba. Lengthy discussions have continued with very little knowledge of the cost economies that exist in agriculture. Some aspects of the economies of farm size are suggested in the trend towards consolidation of farms evident in this Province since 1931. The trend suggests that cost economies are realized on larger farms, and that low incomes are earned on farms that are too small. However, it does not give any indication of what is the optimum size of farm firm in agriculture.

There is need for information relating to the real nature of cost economies that can be realized on different sizes of farms, and also of the size of farm unit which would allow for maximum farming efficiency. This type of information can be very useful to extension specialists in making their farm management recommendations. It would facilitate a more effective administration of credit policies. Indications of the economies of farm size would also aid policy makers in planning for a sound and progressive agricultural industry.

In the present decade, long-term planning assumes a more significant role in the strategy of economic development. Farms must, therefore, tend to be of optimum size if agriculture is to continue to play its role in the economic growth of this Province.

The family farm is the basic socio-economic unit in agriculture. As such, information relating to economies of farm size should be centered around the family farm. It should indicate whether the family farm can be preserved in its present form, or whether its destruction is implicit in the technological revolution in agriculture. Information should also indicate whether the long-term interests of the Province can best be served by other than family type farms. In effect, it should suggest specifically whether the family farm is consistent with the optimum size of firm in agriculture.

This study uses volume of production and improved acreage as criteria of farm size. Its specific objectives are fourfold: firstly, it aims to determine whether a functional relationship exists between the size of the farm firm and its unit cost; secondly, to determine the nature of the relationship in terms of the optimum size farm; thirdly, to determine whether the family farm is inconsistent with the optimum size of firm in agriculture; and fourthly, to determine why some farms have lagged behind in the overall process of adjustment.

In this study, the methods of synthetic budgeting and regression analysis have been used in estimating the cost economies that are associated with different sizes of farms. The conceptual and empirical problems, that were encountered in measuring some of the crucial variables, made the isolation of actual cost economies a very difficult task. The estimates derived in this study however, can provide a basis for effective planning of the agricultural industry.

CHAPTER II

NATURE AND SCOPE OF THE PROBLEM

There is uncertainty regarding the cost economies that are associated with different sizes of farms in the Province of Manitoba. This has resulted in inconsistencies and contradictions in strategic areas of farm policy both at the level of government, and among farm organizations in the Province. In this chapter, an examination will be made of the confusion that has clouded understanding of the nature of the problem of economies of farm size.

The Manitoba Farmers' Union has described the family farm as being "the most efficient unit in terms not only of production, but also in terms of soil conservation and human and sociological values"[1]. Yet, the Union immediately suggests that the family farm is in danger of being liquidated by large scale units. In view of this, it is urged that "preservation of the family farm must be the prime object of any national policy worthy of its name"[2].

The logic employed here is inconsistent. If the

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[1]Manitoba Farmers' Union brief to the candidates of the Manitoba election of December 14, 1962, p.2.

[2]National Farmers' Union brief to the Federal Cabinet, January 31, 1962, p.2.

family farm is the most efficient producing unit, it is not clear why there is any need for its protection. On the other hand, if the plea for protection is pursued to its logical conclusion, then the implication here is that the family farm is less efficient than alternative types of units. As such, it is obvious that the Union is asking government to preserve inefficiency in agriculture.

Many people claim that the destruction of the family farm is implicit in the technological revolution in agriculture. Hence, they argue that the revolution must be tailored to suit the needs of the family farm, rather than family farm adjusting itself to the revolution. In this connection, the National Farmers' Union has stated:

> We reject the widely propagated thesis that technology and efficiency demand the removal of the majority of farm families from the land. We do not subscribe to the theory that the activities and institutions of men are determined solely by technology and economics regardless of human and social values, but hold that technological development can and must be adjusted to serve human, social and economic needs of men.[3]

The implication in this argument is that the family farm can be preserved in its present form. This is an untenable proposition. Society has made tremendous outlays in research in agriculture so that the industry can make the optimum use of its resources. Research has given direction to the technical changes that are necessary to

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[3] Ibid.

achieve this goal. It would be irrational, and a contradiction of policy, if society were now to deny itself the fruits of research by ignoring the adjustments that are indicated for the survival of the family farm. Clearly the Farmers' Union also holds that the economic aspect of the family farm is sub-ordinate to its sociological aspects.

Contrary to the proposition now advanced by the Farmers' Union, adjustment to technological change does not necessarily mean abandonment of the family farm. Indeed, the motive in adjusting to the forces of change is to strengthen, and not to weaken the position of the family farm.

The technological revolution in agriculture, and the adjustments that it indicates for strengthening the family farm have often been mis-interpreted. The following statement by the Manitoba Farmers' Union illustrates this point:

> The exodus of farm people to our urban centres is continuing and is not in the best interest of all concerned. Although we may agree that to some extent there is room for this development in certain areas, we wish to re-affirm that, in our frank opinion, the present conditions are not eliminating the so-called "inefficient" farm operators (often referred to by economists and others), but instead are draining off mostly those farmers in the age group, who because of their initiative and education can readily apply themselves in other industries[4].

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[4]Manitoba Farmers' Union brief to the Manitoba Cabinet, January 12, 1959, p.3.

The inference in this statement is that it is the more efficient farmers, who because of their education and initiative, are abandoning their farms. If this is so, then the implication here is that it is the less efficient farms that are expanding in size. This is a dubious proposition, which is not borne out by empirical evidence.

It has also been argued that the most effective means of achieving prosperity in agriculture is through a system of parity prices for farm products.[5] Parity prices are frequently short-run devices for bridging the gap between farm and non-farm incomes. As such, they are inadequate substitutes for the long-run adjustments that are indicated by the technological revolution for an efficient organization of the agricultural industry. This is evident in the fact that after more than a decade of parity prices for farm products, the measure of prosperity envisaged by the Union has not been forthcoming.

There is little doubt therefore, that the greatest danger confronting the family farm is the prevailing philosophy that the family unit can and should be preserved in its present form. In this connection, Professor Gilson has warned:

> The fatal weakness of this philosophy is the fact that the technological revolution in agriculture soon outmodes the <u>status quo</u>. it

[5]Manitoba Farmers' Union brief to the Manitoba Cabinet, January 23, 1962, p.9.

> must be recognized that the production firm in agriculture, more so than in any other industry, is in a continuous state of flux. This may not be desirable, but it is certainly inevitable[6].

The inference to be drawn from the fears expressed for the ultimate fate of the family farm is that there are many large scale or 'factory-type' farm units in Manitoba. Contrary to this belief, there are actually very few of such units in this Province. Indications are that the most serious threat facing the majority of the prevailing farms in the Province during the next decade will not be factory farms as such. The real threat will be the larger and more efficient family farm making full use of modern techniques and business management.

The average capital investment for all farms in Canada in 1961 was $27,383. However, this ranged from $122,570 for the 9,507 largest commercial farms in Canada, to $17,098 for the 94,256 smallest commercial farms (Table I). The average amount of capital per farm in Manitoba in 1960 was $35,398.

The majority of government credit agencies have set maximum limits to the amount of credit that will be given to any one farmer. The motive in setting these limits was to preserve the family farm. As an example, it may be

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[6] J.C. Gilson, Strengthening the Family Farm, Faculty of Agriculture and Home Economics, Winnipeg, Technical Bulletin, No. 6, April 1962, p.24.

TABLE I

CAPITAL STRUCTURE OF DIFFERENT CLASSES OF FARMS, CANADA 1961

Type of Farm	Number of Farms		Average Capital per Farm
	Number	Percent of Total	$
Commercial farms classified according to value of products sold			
Over $25,000	9,507	2.0	122,570
$15,000 - 24,999	14,411	3.0	73,175
10,000 - 14,999	25,923	5.4	54,906
5,000 - 9,999	90,419	18.8	37,925
3,750 - 4,999	49,754	10.4	27,782
2,500 - 3,749	69,023	14.4	22,597
1,200 - 2,499	94,256	19.6	17,098
All commercial farms	353,293	73.6	32,908
Small scale farms			
Part-time farms	37,645	7.8	12,100
Other small scale farms	45,301	9.4	11,365
Residential and other small farms	43,850	9.1	10,516
Institutional farms	815	-	139,719
Total other farms	127,610	26.4	12,109
Total all farms	480,293	100	27,383

Source: Dominion Bureau of Statistics, Census of Canada, 1961, (Ottawa: Queen's Printer and Controller of Stationery, 1961).

noted that Part III of the Federal Farm Credit Act limits the amount of any one loan to $27,000.

If capital investment is considered as the criterion of farm size, then this limit indicates that at the time it was set, a farm with an investment of $27,000 plus operator's initial equity capital was considered an efficient size unit. There is no indication, however, that this was the optimum size farm. It appears that this limit was arbitrarily set in an attempt to ensure that the available credit was spread over as many family farms as possible.

There is now a growing number of farms whose capacity to use credit goes well beyond the maximum limit of $27,000. It is clear therefore, that greater injections of capital and a re-organization of farms will be required in the near future. The ceiling that will be put on the amount of credit available to any one farmer should depend upon the capital requirements of the optimum size of farm firm in agriculture. In this connection Gilson has stated that:

> Whether, of course, government sponsored loans of $40,000 to $50,000, with a 40 or 50 year repayment period should be made available to Canadian farmers is a question which we expect to see debated before too long. Loans of this size, while not inconsistent with the needs of larger family farms or greater production efficiency in agriculture, will no

> doubt be questioned by the supporters of the smaller family units. It should be an interesting debate.[7]

In recognition of the problems inherent in the current situation relative to available farm credit, the government has just amended Parts II and III of the Farm Credit Act. The amendments now raise the limits on borrowing capital for a single farm enterprise from $27,000 to $55,000.[8] While these limits seem to be more realistic in terms of present costs of financing economic farms, it is not clear whether they are sufficiently high to enable the majority of family farms in this Province to attain the optimum size. In order to resolve this problem, it is necessary that the optimum size of farm be first determined, and an assessment made of the capital requirements on this size of farm.

Classical economic theory holds that there are three phases or distinct periods in the growth of a firm. As the firm increases the scale of its plant in the first phase, net economies of scale are obtained, because the fixed cost is spread over a larger volume of output. However, a phase in its growth is soon reached where a proportional increase in inputs is followed by a proportional

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[7] J.C. Gilson, Farm Credit-The Current Situation in Canada, A paper presented to the Fifth National Farm and Business Forum, Winnipeg, March 19, 1964. p.4.

[8] Canadian Federation of Agriculture Bulletin, Vol. 13, No. 5, July, 1964.

increase in output. The firm, therefore, obtains net constant returns to scale. Finally, in the third phase further expansion causes net diseconomies of scale. It has been explained by theoretical economists that the firm experiences net diseconomies because of the limitations of the efficiency of management.

The postulates of the theory of the firm outlined above are, at best, useful hypotheses. As such, they must be subjected to empirical verification, before they are accepted as explanations of economic phenomena in the real world.

Agreement is far from unanimous among economists regarding the tenets of the theory of the firm on this score. There are many different shades of opinion on the subject. Over the last decade, there has developed quite a controversy in the literature regarding the problem of economies of scale. The arguments and an evaluation thereof will be presented in a later section of this study dealing specifically with the theory of the firm.

It is pertinent to point out however that economists do not accept all the postulates of the theory of the firm. While some have accepted theorems relating to increasing and constant returns to scale, they claim that in the real world the firm can expand without obtaining diseconomies of scale. The implication of this argument raises some interesting questions about certain other aspects of economic theory. If this argument is sound, then it implies that the number of firms in the industry and the optimum size of firm are indeterminate. It also denies that there are limitations to the efficiency of management.

Some studies, to be reviewed in Chapter IV have been made in which research workers attempted to determine whether a relationship exists between the size of the farm firm and its unit cost. While functional relationships have been established, these studies did not incorporate specifically the family farm as the central point of the investigation. The family farm is the basic socio-economic unit in agriculture. If research is to suggest the nature of adjustment necessary for economic efficiency in the agricultural industry, the family farm must occupy the pivotal point in the empirical investigation. Inasmuch as this has not yet been done, the problems of the nature of the cost-economies and the adjustments needed in the industry have not yet been fully determined.

From the above discussion, it is evident that there is uncertainty, doubt, skepticism and apprehension as to the cost-economies that exist in the real world. Controversies and lengthy discussions have developed and persisted but the problem is still un-resolved. There exists, therefore, an urgent need for empirical verification of the propositions of economic theory, and other postulates relating to the problem of economies of farm size. This is imperative if information is to be obtained regarding the nature of cost-economies that exist in the real world.

The problematic situation dictates that empirical research should be undertaken to suggest answers to the specific problems that are formulated as follows:

1. Is there any functional relationship between the size of the farm firm and cost per unit of output?

2. If there is, then,

(a) what is the nature of the relationship?

(b) what is the optimum size of farm firm?

(c) what is the combination of resources on the optimum size farm firm?

(d) why have some farm firms lagged behind?, i.e. why is there a "gap" between the existing use of resources and the empirical optimum? and,

3. What are the explanations for the co-existence of both small and large farms in a competitive industry such as agriculture?

4. Is the family farm inconsistent with the optimum size of firm in agriculture?

Studies in cost-economies can therefore be very useful. They could be used to evaluate the extent of, and the real reasons for, the income disparity at both the macro and micro levels. They could attempt to explain why one group of farms is successful, while the other group struggles for existence. These studies could suggest some of the reasons why some farmers find it easy to, while others fail to make adjustment to technological progress. They could also indicate the types of, and the magnitude of the adjustment needed on these farms for their survival.

When the nature of the adjustments have been determined, studies in cost-economies could then indicate whether the industry, as presently organized, can effectively make these adjustments. Where it is obvious that it cannot, they could suggest the policy changes that are necessary in order that the required adjustments could be made. Research could also throw some light on the economic and sociological implications of these adjustments.

One of the central aims of research on cost-economies would be to determine whether family farms are necessarily less efficient than other types of producing units[9]. Where it is indicated that they are, research may suggest whether the long-run interests of a nation would

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[9]Dr. J.C. Gilson has distinguished five types of producing units in Canada, viz., (1) the family farm, (2) the subsistence farm, (3) the family type of corporation which involves several members of the same family, (4) the non-family type of corporation called the factory farm and (5) the chain, or multiple unit, type of farming. Vide: J.C. Gilson, Strengthening the Farm Firm, Technical Bulletin No. 2, Department of Agricultural Economics and Farm Management, University of Manitoba, Winnipeg, 1960, pp. 4-5.

best be served by other than the family type of farm. It may also suggest the types of policies that should be aimed at attaining these objectives.

Having made a decision regarding the specific form of structural organization, research would give direction to farm credit policy aimed at realizing pre-set goals. If for example, research indicates that the large group of less successful farms falls short of the optimum size of firm, education and credit policies could be tailored to meet the needs of those farmers, who have the incentive and ability to manage larger size units.

It appears that stimulation of incentives and a flexible credit policy are vital forces in the creation of larger size units, where this is oonsidered consistent with optimum resource-use. The creation of larger units have several social and economic ramifications. In the short-run period, there would be an acceleration of the process in which machinery would be substituted for labour. Redundant farm labour would have to seek employment in the secondary or tertiary sectors of the economy. This indicates that the economy should be expanding and at a level of full employment in order that the surplus labour could be absorbed.

When the whole transition is viewed in terms of its long-run effects, there are several other facets of the problems with which policy makers will be faced. Acquisition of the cost-economies of the nature envisaged will definitely enhance the productivity of the resources utilized in agriculture. The effect of this will be an appreciable increase in the total output of the farm sector. The implication of this would be that a more vigorous search must be made abroad for marketing outlets for Canadian farm products.

CHAPTER III

THEORETICAL FRAMEWORK

Theory of the Firm

The theory of the firm furnishes the necessary background for an analysis of the problem. It constitutes the theoretical foundation upon which this investigation is made. It also suggests some very useful hypotheses for empirical verification. An examination will now be made of the basic tenets of theory relating to economies of scale in order to study their implications for the family farm.

A firm is defined as a technical production unit, which converts inputs into outputs. The conversion, however, is subject to the technical attributes of the production function. In this regard, therefore, it is logical to view the firm as a decision-making unit. The owner of the firm, the entrepreneur, assumes the risk for the management decisions of the firm relating to problems of what to produce, how much to produce and how to produce i.e. what technology to use in production.

An input is an ingredient of production. It may be a good or service. Normally, it requires a combination of many inputs to produce a single output. The input may be either fixed or variable in the short-run[1]. In this period a fixed input is necessary for production, but its quantity does not vary with the level of production. Costs in this input are incurred regardless of the short-run income maximising decisions of the firm. The amount of the variable input varies directly with the level of production.

Nevertheless, given a sufficiently long period of time, all inputs are variable. Inputs that are, therefore, fixed for one time period are necessarily variable for a longer period. It is obvious then that any distinction between fixed and variable inputs is at best temporal.

Costs associated with the variable factor are called "variable or direct costs", and those associated with the fixed factors are referred to as "fixed costs". Viner has pointed out that:

> fixed costs are fixed only in their aggregate amounts and vary with output in their amount per unit, while "direct costs" are variable in their aggregate amount as output varies, as well as, ordinarily at least, in their amount per unit.[2]

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[1]Jacob Viner has defined the short-run as a "period which is long enough to permit of any desired change of output technologically possible without altering the scale of plant, but which is not long enough to permit of any adjustment of scale of plant". Vide Jacob Viner, "Cost Curves and Supply Curves", Readings in Price Theory, American Economic Association London, W.C.1., 1960, p.202.

[2]*Ibid*., pp. 202-203.

The Anatomy of the Firm

In any given production situation, the firm faces three basic production problems via: (a) what to produce, (b) how much to produce and (c) how to produce. The forces which influence an entrepreneur's decisions in solving these problems may be classified into four main groups on the basis of their origin. These are:(1) "the demand conditions for finished goods and services existing on the market; (2) the technical knowledge of different combinations possible in producing these goods and services from available productive services; (3) the supply conditions of productive services, (4) the supply conditions of capital funds"[3].

The demand conditions for finished goods and services inform the entrepreneur about the products that can be sold on the market. To the individual business firm the demand for its output appears as a series of possible price quantity combinations, whose extent and character depend on the firm's market position. It should be noted, however, that as the production process requires time and the firm's production has to be planned in advance, it is actually not the demand itself, as it appears in the market, but the entrepreneur's anticipation of this demand at the date of planning, that represents the production determining force.

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[3]Sune Carlson, A Study on the Pure Theory of Production, (New York: Kelley and Millman, Inc., 1956), p.6.

If the demand conditions indicate to the entrepreneur what goods and services may be expected to be sold on the market, technical knowledge or the "state of the arts" will indicate to him how these goods and services may be produced. It is obvious, however, that unforeseen changes in the technical processes that occur after the planning date frequently have no effect on the firm's production.

The supply of productive services, like the demand for finished goods and services, appears to the individual firm as a series of price-quantity combinations. However, as was noted in the case of the demand conditions for the firm's output, it is really not the service supply actually prevailing at any particular date, but the entrepreneur's anticipation of this service supply, that represents the production determining factor.

The supply of capital funds for a particular productive activity is determined by two sets of circumstances: (a) those regulating the total supply of capital to the business firm, and (b) those regulating the investment of funds in other activities. This becomes obvious when it is remembered that the firm's total capital is equal to the sum of its own capital and its borrowed funds. It is also clear that with given anticipations in regard to the supply of capital, the capital that is devoted to a particular activity will be determined by the rate of return the firm expects from the activity, and the expected rate of return from outside investments.

The above elucidation of the four factors, which aid the entrepreneur in making his decision on the problems of (1) what to produce, (2) how much to produce and (3) how to produce, is intended primarily to invite attention to the crucial role that "expectation" plays in both the factor and products markets.

The Production Function

The question of how to produce is a technical problem. A production function is a mathematical expression of the physical input-output ratios. Carlson defines it as "the relationship between the variable productive services and the output under the assumption that the plant remains constant"[4]. If the quantity of output is denoted by (Y), the quantities of variable productive services, (n) in number, by $X_1 \cdots X_n$ and the fixed factor by X_0, we write

$$Y = f(X_0, X_1, X_2 \cdots X_n) \quad . \quad . \quad . \quad . \quad (1)$$

This is our production function. Carlson has pointed out that, if we want the production function to give only one value for the output from a given service combination, the function must be so defined that it expresses the maximum product obtainable from the combination at the existing state of technical knowledge. Hence, the purely technical

[4] *Ibid*. p.14.

maximization problem may be said to be solved by the very definition of the production function. The implication of the definition of the production function is that the technical organization of the resource inputs may vary when the service combinations and output vary. The central point here is that once a particular production function is selected, it is impossible to obtain a higher level of output than that dictated by the function. The function therefore sets out the technical limitations of production. For every resource combination there exists only one optimal organization and only one maximum output. A technical change, on the other hand, implies that the optimal organization and maximum output for the same resource combination have changed.

Two analytical concepts, which will greatly facilitate the study of the production function, will now be introduced. These are (a) marginal productivity and (b) the function coefficient.

(a) Marginal productivity

As was noted above, the production function was given by

$$Y = f(X_0, X_1, X_2 \cdots X_n)$$

Now we want to look at the effect on output of varying the input X_1. The partial derivative of the production function with respect to the resource input X_1 is expressed as

$$\frac{\partial Y}{\partial X_1} = \frac{\partial f}{\partial X_1}(X_0, X_1 X_2 \cdots X_n) \equiv Q_{X_1},$$

which will be referred to as the marginal physical productivity of the resource input X_1. The differential product $dY_{(X_1)}$ which is obtained from an increment of X_1 while the other inputs remain constant is expressed as

$$dY_{(X_1)} = Q_{X_1}\, dX_1$$

This is commonly referred to as the marginal physical product of X_1. It is therefore evident that if the increment is equal to unity, then the marginal product and the marginal productivity are the same.

Carlson states that "any infinitesimal variation of the productive services may be thought of as an aggregate of individual service variations"[5]. Hence the change in output produced by an arbitrary but infinitesimal service variation may be written as the sum of the marginal products of the individual services. Consequently, total marginal physical product may be expressed as

$$dY = Q_{X_1}\, dX_1 + Q_{X_2}\, dX_2 + \cdots + Q_{X_n} dX_n \quad . \quad . \quad (2)$$

(b) Function coefficient

In view of the fact that the quantity of output does or does not vary in proportion to a proportional change

[5]Carlson, Ibid., p.16.

in all resources, the production under consideration is said to yield constant or variable proportional returns. The concept of the production function coefficient or elasticity of production is used as a scale of measure of proportional return. Elasticity of production may be defined as the relative change in output associated with a relative change in input. Expressed mathematically

$E = \dfrac{\frac{dY}{Y}}{\frac{dX}{X}}$ where E denotes elasticity. If it is assumed that $\frac{dX}{X} = m$, then $E = \dfrac{\frac{dY}{Y}}{m}$. Hence, the change in output i.e. dY caused by the proportional increments of resources can be derived as follows:

$$E = \frac{dY}{Ym}$$

$$EY = \frac{dY}{m}$$

Since by previous definition

$$dY = Q_{X_1}\, dX_1 + Q_{X_2}\, dX_2 + \cdots + Q_{X_n} dX_n, \text{ then}$$

$$EY = \frac{Q_{X_1} dX_1}{dX_1/X_1} + \frac{Q_{X_2} dX_2}{dX_2/X_2} + \cdots + X\frac{Q_{X_n} dX_n}{dX_n/X_n}$$

$$EY = \frac{Q_{X_1} dX_1 X_1}{dX_1} + \frac{Q_{X_2} dX_2}{dX_2} + \cdots + \frac{Q_{X_n} dX_n X_n}{dX_n}$$

$$E = Q_{X_1} X_1 + Q_{X_2} X_2 + \quad + Q_{X_n} X_n \quad . \quad . \quad . \quad . \quad (3)$$

Hence E is the function coefficient or the elasticity of production.

The Production Diagram

If the production function is of the form $Y = f(X_1\ X_2)$ i.e. there are only two variable inputs, this may be represented by a surface in a three dimensional diagram as in Figure 1 below:

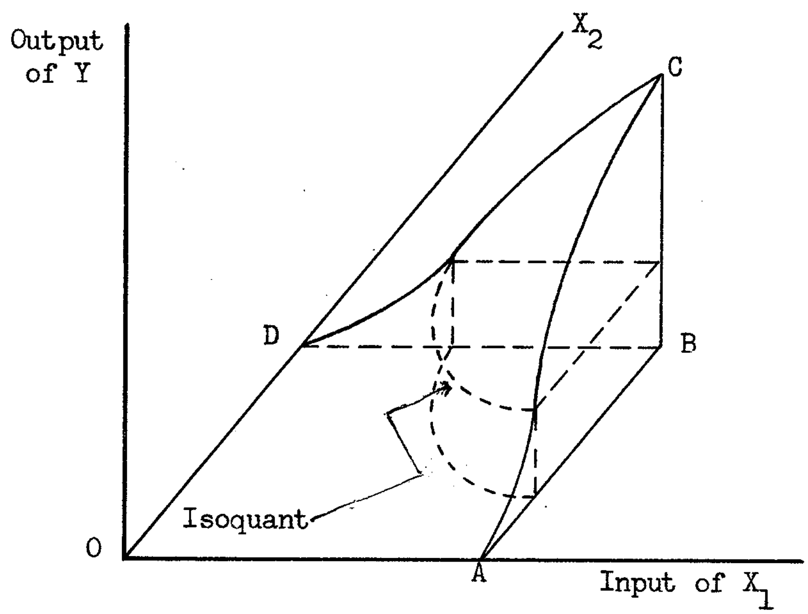

Figure 1 : Production Surface

The resource inputs are plotted on the base axis X_1 and X_2, and the vertical axis gives the maximum output corresponding to the combination of services on the base plane. Thus the surface OACD represents the locus of the output of all possible resource combinations. When one of the inputs is kept constant, e.g. X_1 at quantity OA, the output is shown to increase with the amount of the other input along the curve AC. The rate of change of this curve, that is, the partial rate of change of the output with respect to X_1, is the graphic representation of the marginal productivity of X_2 for a value of X_1 equal to OA. Similarly, the slope of the curve DC represents the marginal productivity of X_1 when X_2 is equal to OD.

If the production function is of the form $Y = f(X_1/X_0\ X_2 \cdots X_n)$, it may be represented diagramatically as shown in Figure 2 below:

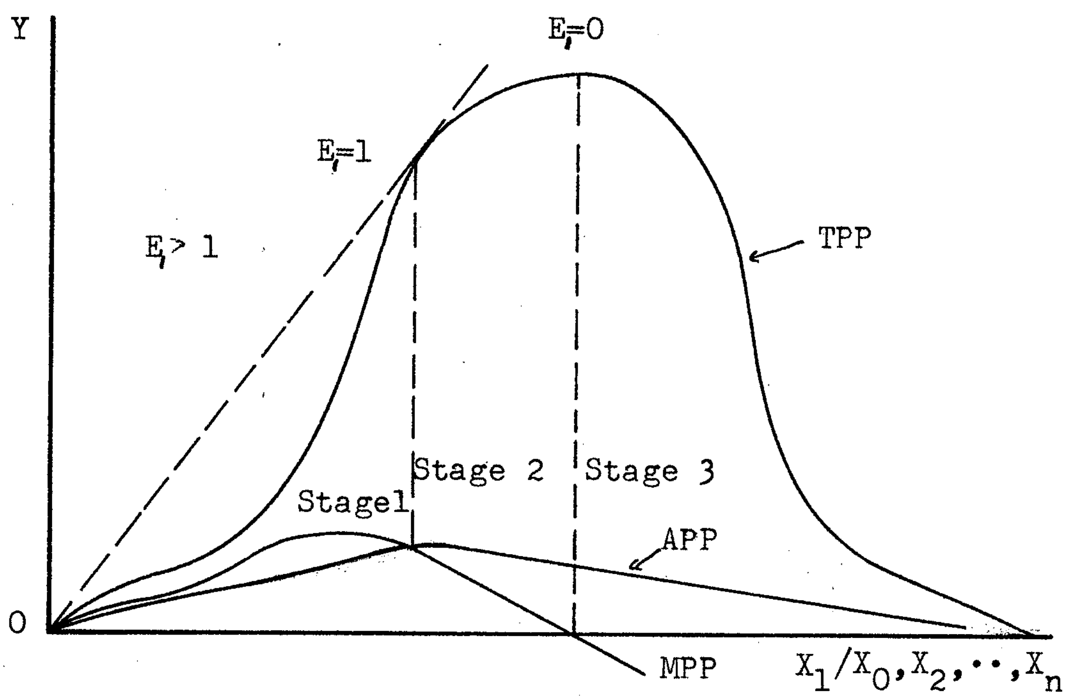

Figure 2 : Production Function

In this diagram TPP means total physical product, APP means average physical product and MPP means marginal physical product. This diagram illustrates that the total physical output varies in magnitude through three distinct stages. The production function, therefore, adheres the Law of Diminishing Returns[6].

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[6]The Law of Diminishing Returns states that with a fixed amount of anyone factor of production successive increases in the amounts of other factors will after a point yield a diminishing increment of the product. Vide Joan Robinson, Economics of Imperfect Competition, (London: Mac Millan & Co., Limited, 1946), p.330.

While the law as stated above probably brings out its main attributes it is not as precise as may be desirable. Perhaps the most precise statement of the law was made by J.M. Cassels thus:

> If, without change in the methods of production (in the sense explained above) successive physical units of one factor of production were added to a fixed physical quantity of another factor (or a constant combination of other factors) the total physical output obtained would vary in magnitude through three distinct phases:
>
> 1. In the first phase, it would increase, for a time at an increasing absolute rate and then at a decreasing absolute rate, but always at a percentage rate greater than the rate of increase of the variable factor, until the final point in this phase was reached at which its rate of increase was exactly equal to the rate of increase of that factor.
>
> 2. In the second phase, it would continue to increase, but at a decreasing absolute rate and at a percentage rate always less than that of the variable factor, until the final point of this phase was reached where the maximum output was attained.
>
> 3. In the third phase, it would decrease, possibly for a time at an increasing absolute rate but probably through most of this phase at a decreasing rate, until the final point was reached at which the product was reduced to zero.

A stimulating treatment of the motive behind this re-statement of the law can be read in Cassel's paper: "On the Law of Variable Proportions" published in the American Economic Associations': Readings in the Theory of Income Distribution. pp. 103-117. However it is to be pointed out that the law could be stated in terms of marginal or average products obtained from varying a factor but it would prove difficult to declineate the three phases when either the marginal or average product alone is used.

The Isoquants

An isoquant depicts the different combinations of two factors to produce a given level of output. It is generated from the production function as is seen below. The production function given by the engineers was expressed as hereunder

$$Y = f(X_0, X_1, X_2 \cdots X_n)$$

Let X_1 and X_2 be two variable inputs. The function for the isoquant can be expressed as follows:

$$Y_0 = f(X_1, X_2).$$

From the production function, therefore, we can generate a family of isoquants. The isoquants are sometimes circular in nature as the contours of a hill. The circles at the base of the hill are relatively large because of the broad base of the hill, whereas those at the top of the hill are relatively smaller in as much as the top of the hill is narrower than its base. A part of an isoquant has already been illustrated in Figure 1.

The characteristics of a family of isoquants are now illustrated in Figure 3. X_1 and X_2 are two variable resources. TPP represents the total product curve. A,B,C,D, E and F represent a family of six (6) isoquants each of which represent different levels of output obtained from the different combinations of X_1 and X_2. Since the production function is technically efficient, and in as much as the isoquants are derived from the production function, then each isoquant is technically efficient.

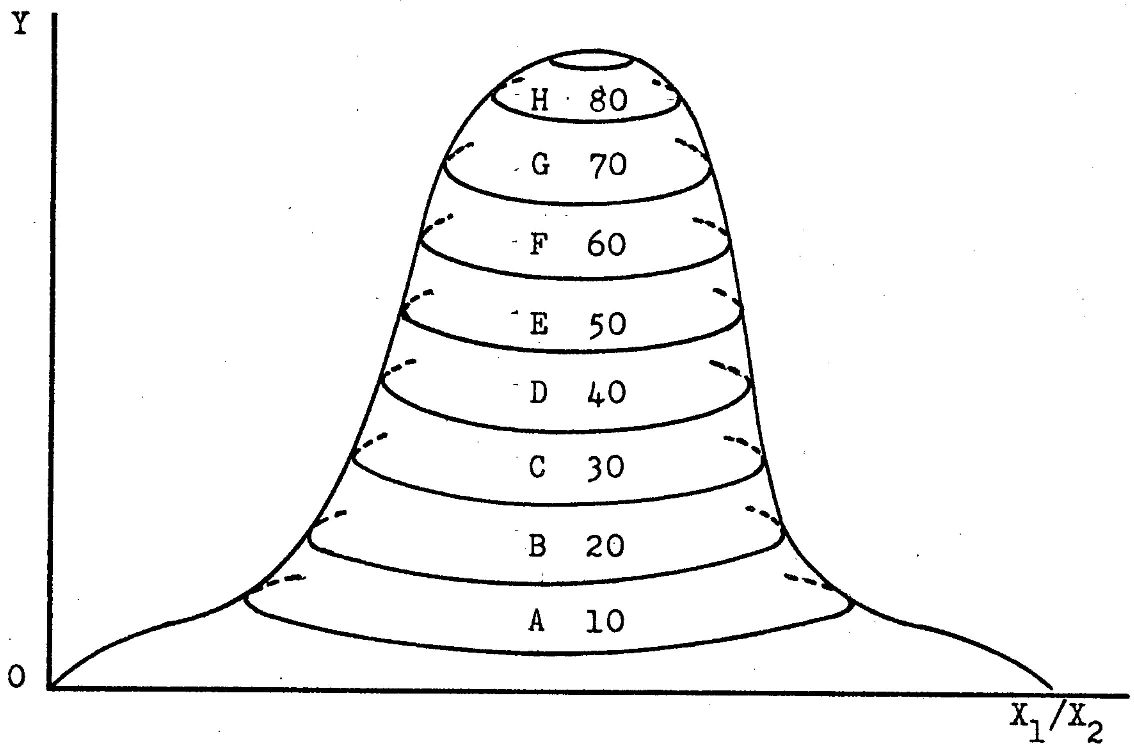

Figure 3 : Production Function and Family of Isoquants

Our interest lies mainly in a particular part of the contour, i.e. the rational area of the family of isoquants.

<u>Method to Deduce the Relevant Area</u>

Draw in the circular isoquants. Then draw a line tangent to each isoquant such that each line is parallel to the vertical axis. Join the points of tangencies. Then draw a line tangent to each isoquant such that each line is parallel to the horizontal axis. Join the points of tangencies. The area AZB traces out the relevant portion of the isoquants. It is now to be noted that the relevant areas of the isoquants in Figure 4 are convex to the origin. The implication of this convexity of the isoquants is that there is diminishing marginal rates of substitution. AZ and BZ are two ridge lines. On the ridge line BZ, $Q_{X_1} = 0$ and on the

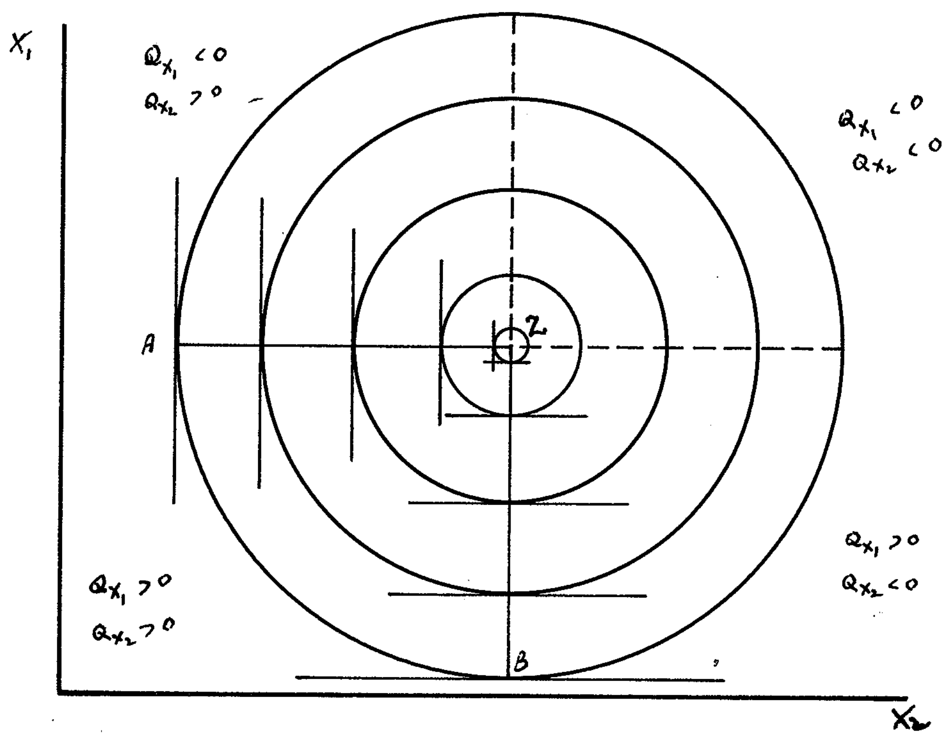

Figure 4 : Derivation of Relevant Sections of Isoquants

ridge line AZ, $Q_{X_2} = 0$.

Having derived the isoquants, we can now draw only the relevant area as shown in Figure 5.

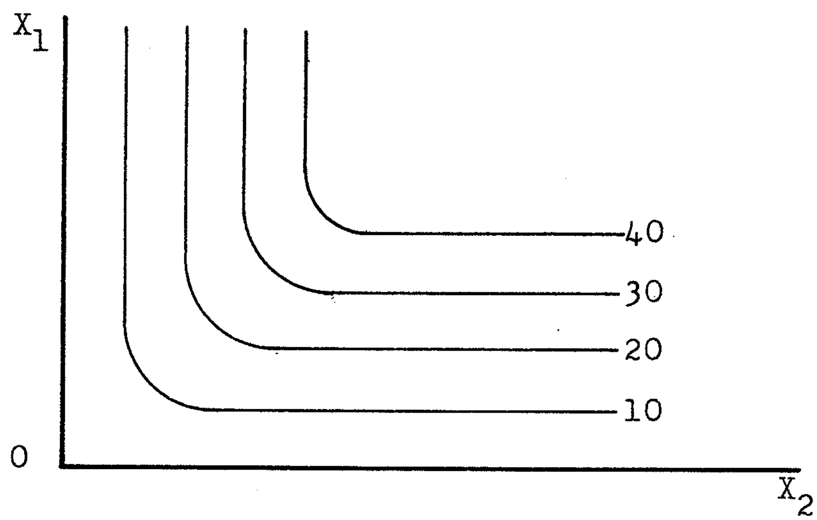

Figure 5: Family of Isoquants

The isoquant tells us the nature of the production function as shown in Figure 6.

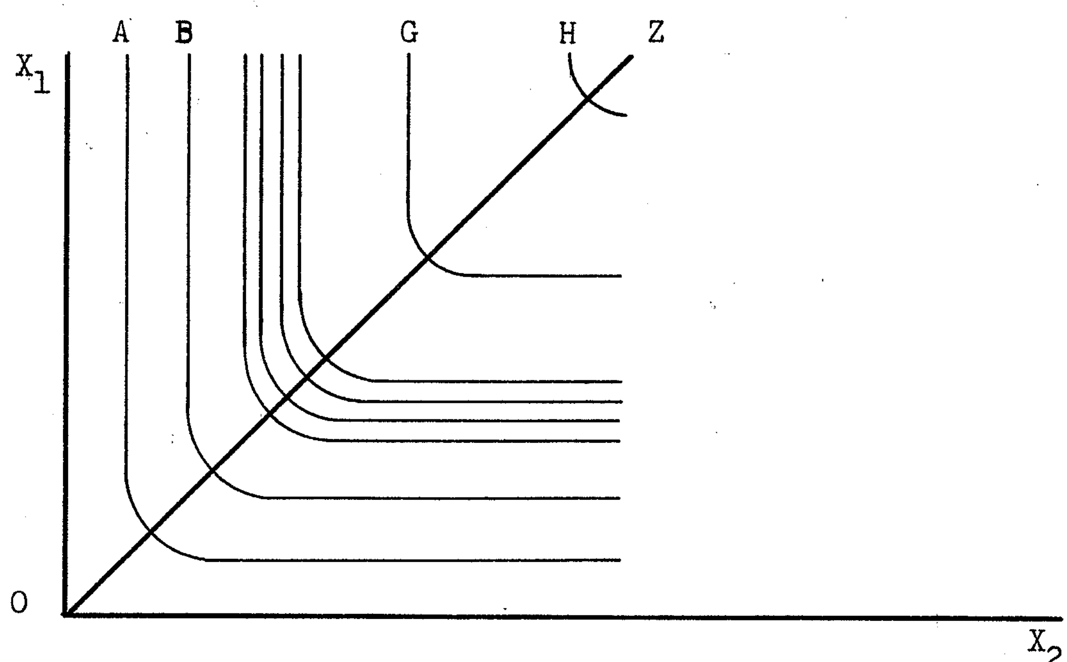

Figure 6 : Scale Line

Cost of Production Analysis

In the first part of this chapter we examined the physical relations between input and output, in which we considered the conditions for physical efficiency within the firm. The examination enabled us to review the principles of production, that provided a foundation for an analysis of the cost of production. The central objective in the present analysis is to examine the conditions that will allow the firm to attain economic efficiency.

The methodological approach to the problems outlined above involves specific answers to the questions listed below:

(1) In what proportions should the variable factors be combined to produce a given rate of output in order to attain economic efficiency?

(2) What principle should be followed to alter these proportions for different rates of output? and

(3) What should be the profit-maximizing rate of output.

To give a specific answer to the first question above, it is obviously necessary that the factor market be introduced into the analysis. In the previous section to this chapter the function for the isoquant was given by

$$Y_0 = f(X_1 X_2) \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Given this isoquant, the problem now to be resolved is "how can the firm attain economic efficiency"? The approach to this problem involves the determination of the slope of the isoquant $Y_0 = f(X_1 X_2)$

We have already shown that

$$dY_0 = Q_{X_1} dX_1 + Q_{X_2} dX_2 + \cdots + Q_{X_n} dX_n$$

$$dY_0 = Q_{X_1} dX_1 + Q_{X_2} dX_2$$

The concept of the isoquant indicates that the level of output is a constant. Hence since the derivative of a constant is zero,

$$dY_0 = 0$$

$$0 = Q_{X_1} dX_1 + Q_{X_2} dX_2$$

$$Q_{X_1} dX_1 = - Q_{X_2} dX_2$$

$$\frac{dX_1}{dX_2} = - \frac{Q_{X_2}}{Q_{X_1}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

which is the slope of the isoquant or the marginal rate of substitution of X_1 for X_2.

Having derived the slope of the isoquant, it is now left to derive the slope of the isocost function. It is at this point that the resource market is introduced. Let it be assumed that the price of (X_1) be given by q_1 and the price of (X_2) be given by (q_2). We now want to determine the effect on total outlay if an additional unit of X_1 is purchased. The total cost of X_1 is given by

$$TC_{X_1} = q_1 X_1$$

$$\frac{dTC_{X_1}}{dX_1} = q_1 \frac{dX_1}{dX_1} + X_1 \frac{dq_1}{dX_1}$$

$$\frac{dTC_{X_1}}{dX_1} = q_1 + \frac{dq_1}{dX_1} X_1$$

We will introduce here the concept of "<u>price flexibility of a factor.</u>"

$$\text{Price Flexibility} = \frac{\text{Relative change in Price}}{\text{Relative change in amount purchased}}$$

$$\text{Price Flexibility} = \frac{dq_1}{q_1} \Big/ \frac{dX_1}{X_1} = \frac{dq_1}{q_1} \cdot \frac{X_1}{dX_1}$$

$$\text{Price Flexibility} = \frac{dq_1}{dX_1} \frac{X_1}{q_1} = \lambda_{X_1}$$

$$\frac{dTC_{X_1}}{dX_1} = q_1 + X_1 \frac{dq_1}{dX_1}$$

We can now multiply and divide both sides by (q_1) and still maintain the quality of the expression:

$$\frac{dTC_{X_1}}{dX_1} = q_1 \frac{q_1}{q_1} + X_1 \frac{dq_1}{dX_1} \frac{q_1}{q_1}$$

$$= q_1 + \frac{X_1}{q_1} \frac{dq_1}{dX_1} q_1$$

Since $\lambda_{X_1} = \frac{X_1}{q_1} \frac{dq_1}{dX_1}$

Then $\frac{dTC_{X_1}}{dX_1} = q_1 + (\lambda_{X_1})q_1$

$$\frac{dTC_{X_1}}{dX_1} = q_1(1 + \lambda_{X_1}) \equiv C_1$$

which is the <u>Marginal Unit Cost</u> of factor X_1.

By following a similar procedure

$$TC_{X_2} = q_2X_2$$

$$\frac{dTC_{X_2}}{dX_2} = q_2(1 + \lambda_{X_2}) \equiv C_2$$

which is the Marginal Unit Cost of factor X_2

$$TC_{X_1X_2} = q_1X_1 + q_2X_2$$

$$dTC_{X_1X_2} = (dTC_{X_1})dX_1 + (dTC_{X_2})dX_2$$

Since total outlay in an isocost is a constant, and the derivative of a constant is zero

$$0 = q_1(1 + \lambda_{X_1})dX_1 + q_2(1 + \lambda_{X_2})dX_2,$$

$$q_1(1 + \lambda_{X_1})dX_1 = - q_2(1 + \lambda_{X_2})dX_2,$$

and $\frac{dX_1}{dX_2} = - \frac{q_2(1 + \lambda_{X_2})}{q_1(1 + \lambda_{X_1})}$. . . (6), which is the slope of the isocost, which depicts the negative of the ratio of factor prices.

At equilibrium, the slope of the isoquant is equal to the slope of the isocost.

(i) Slope of Isoquant was given by: $\frac{dX_1}{dX_2} = -\frac{Q_{X_2}}{Q_{X_1}}$

(ii) Slope of Isocost is given by: $\frac{dX_1}{dX_2} = -\frac{q_2(1 + \lambda_{X_2})}{q_1(1 + \lambda_{X_1})}$

$$\frac{dX_1}{dX_2} = \frac{Q_{X_2}}{Q_{X_1}} = \frac{q_2(1 + \lambda_{X_2})}{q_1(1 + \lambda_{X_1})} = \frac{C_2}{C_1}$$

Hence $\frac{Q_{X_2}}{Q_{X_1}} = \frac{C_2}{C_1}$ . . . . (7)

This expression at (7) above is the optimum condition, i.e., the necessary and sufficient conditions for economic efficiency. From the foregoing, it is clear that on the expansion path, the ratios of the marginal physical productivities of factor inputs is equal to the ratios of their respective marginal unit costs. Some text books state that the necessary and sufficient condition for economic efficiency is where the marginal physical productivities of factor inputs is equal to the inverse of their price ratios. This is the case only under perfect competition.

The analysis so far has given us sufficient tools that enable us to attempt answers to questions (i) and (ii) on page (33). From the isoquant-isocost approach to production it was noted that to produce a given level of output at minimum cost, the firm operates at the point where the slope of the isoquant is equal to the slope of the isocost, i.e. where the marginal rates of factor substitution is equated to the inverse of the price ratios ($MRS_{X_1X_2} = q_{X_1}/q_{X_2}$). This concept is illustrated graphically below:

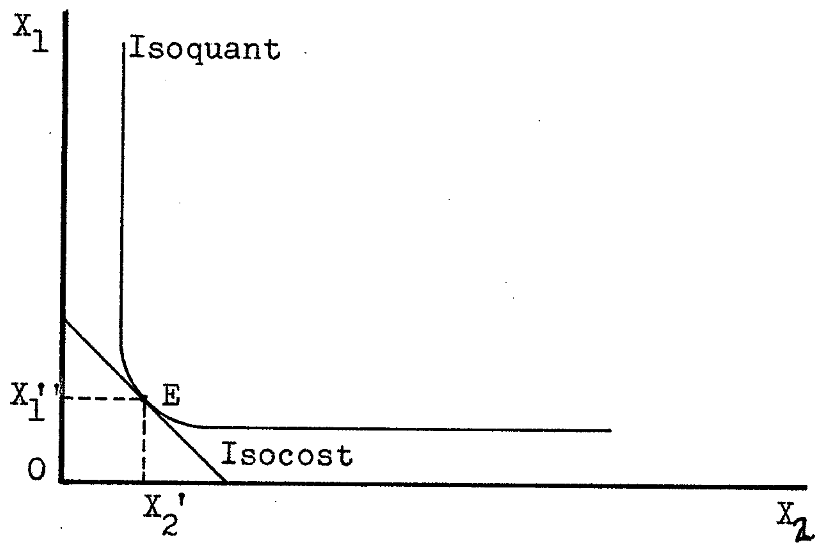

Figure 7 : Isoquant and Isocost

Hence in producing the level of the output indicated by the isoquant, the firm operates at the point E on the isoquant whose slope at that point is equal to the slope of the isocost at that same point. The firm will, therefore, use a combination of OX_1' of X_1 and OX_2' of X_2. By our previous definition, the point E lies on the expansion path. The first condition of economic efficiency indicates that to produce a given level of output at minimum cost, the firm can combine the factors given by a point on the expansion path.

Hence, to find the optimum factor combination for a given level of output the firm must vary the factor proportion along the isoquant until it hits a point on its expansion path. The expansion path is the locus of the points of optimum factor combinations for producing different levels of output. Expressed mathematically, it may be defined as the locus of points where

$$\frac{q_1(1 + \lambda_{X_1})}{Q_{X_1}} = \frac{q_2(1 + \lambda_{X_2})}{Q_{X_2}} = \cdots = \frac{q_n(1 + \lambda_{X_n})}{Q_{X_n}}$$

The principle to be followed in altering the factor proportions for different rates of output is that to vary the rates of output, the firm must vary the factor proportions along the expansion path.

It is to be pointed out that the path which an entrepreneur follows in expanding the amount of resource inputs may not be consistent with true scale relationships. This is a common characteristic of farm production. True scale relationships are obtained only when all resources are increased in the same proportions. This is depicted in Figure 8.

If the inputs of X_1 and X_2 are both doubled, then the relationship expressed represents a true scale relationship. However, if X_1 is increased by 20 per cent, whereas X_2 is increased by 80 per cent, then the relationship expressed is a hybrid of a true change in scale and a change

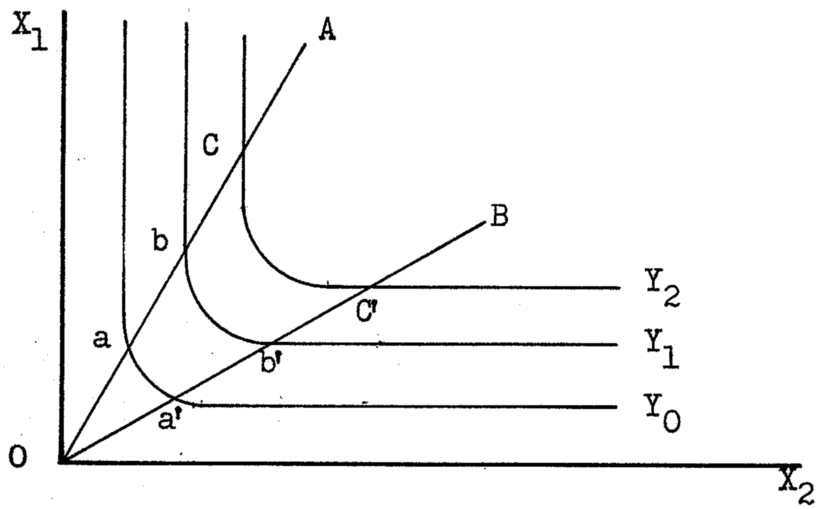

Figure 8 : Scale Lines in Relation to Substitution Co-efficients

in the proportion of factors used. True scale relationships are represented by the lines OA and OB, which are not only linear, but pass through the origin. In this connection Heady has pointed out that:

> A "true" scale line represents the path by which a farmer should expand the use of his resources only under one condition: the slope of successive isoquants must be the same at each point where they are intersected by a given scale line[7].

Obviously, the relative marginal physical productivities of two resources must not change along the scale line, if the expansion of the business unit is to be achieved through increasing the use of resources in the same proportions. Where the relative resource productivities

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[7]E.O.Heady, "Relationship of Scale Analysis to Productivity Analysis", Resource Productivity, Returns to Scale, and Farm Size, (Ames: Iowa State College Press, 1956), p.86.

change as they are utilized in greater quantities, it is clear then that the firm's expansion path cannot be along a scale line. This is illustrated in Figure 9 below:

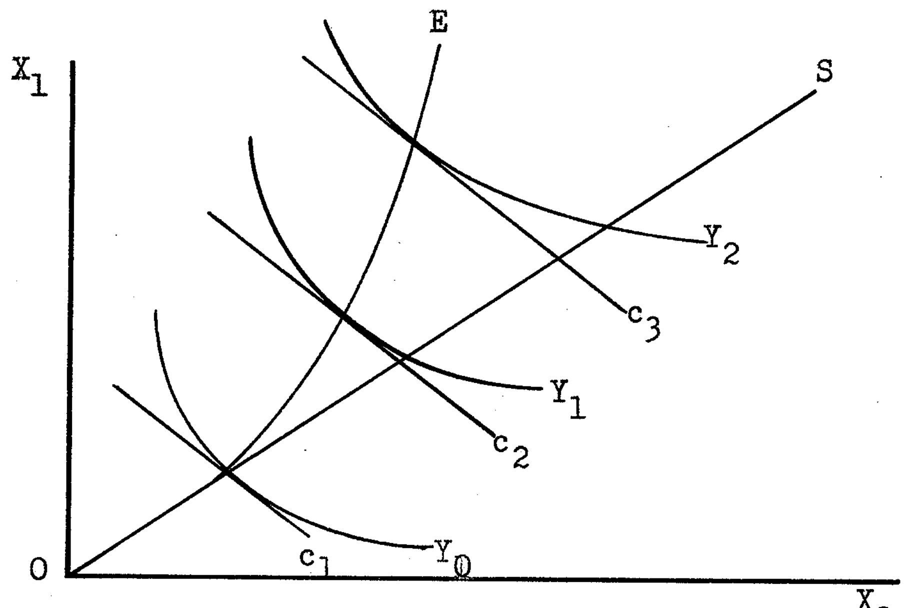

Figure 9 : The Firm's Expansion Path and Scale Line

The lines C_1, C_2, and C_3 are isocost lines; Y_0, Y_1, and Y_2 are three isoquants; OS is the scale line, and OE is the firm's expansion path, which depicts the path through which resources should be combined as the firm expands the volume of its output.

The expansion path has been defined above as the locus of the points of equality of marginal unit costs and marginal physical productivity ratios. It is left to be proven, however, that on the expansion path the firm minimizes its cost in producing a given level of output. This will now be proven. Let X_1 and X_2 be two inputs and let k be the fixed factor. Let C represent total cost, and q be price of factor input.

$$C = q_1X_1 + q_2X_2 + k_c$$

$$CY_0 = q_1X_1 + q_2X_2 + k_c$$

$$q_1X_1 = CY_0 - q_2X_2 - k_c$$

$$X_1 = \frac{CY_0 - q_2X_2 - k_c}{q_1}$$

$$\frac{dX_1}{dX_2} = 0 - \frac{q_2}{q_1} - 0$$

$$\frac{dX_1}{dX_2} = -\frac{q_2}{q_1}$$ which is the slope of the isocost function.

$$Y_0 = f(X_0X_1X_2)$$

$$X_1 = f_1(Y_0X_0X_2)$$

$$\frac{dX_1}{dX_2} = \frac{df}{dX_2}(Y_0X_0X_2)$$

Substituting

$X_1 = f_1(Y_0X_0X_2)$ in the cost function $(Y_0 = q_1X_1 + qX_2 + k_c$

$$CY_0 = q_1\ f(Y_0X_0X_2) + q_2X_2 + k_c$$

$$\frac{dCY_0}{dX_2} = q_1 \frac{df}{dX_2}(Y_0X_0X_2) + q_2$$

To minimize the above expression we set to zero.

$$q_1 \frac{df}{dX_2}(Y_0X_0X_2) + q_2 = 0$$

$$\frac{df}{dX_2}(Y_0X_0X_2)q_1 = - q_2$$

$$\frac{df}{dX_2}(Y_0X_0X_2) = \frac{q_2}{q_1}$$

We have just shown that

$$\frac{df}{dX_2}(Y_0X_0X_2) = \frac{dX_1}{dX_2}$$

$$\frac{dX_1}{dX_2} = \frac{df}{dX_2}(Y_0X_0X_2) = \frac{Q_{X_2}}{Q_{X_1}}$$

Hence $\frac{dX_1}{dX_2} = \frac{Q_{X_2}}{Q_{X_1}}$ which is the slope of the isoquant.

Having derived the expansion path and proven that it depicts the locus of the points of least-cost combinations of factor inputs, we can now derive from the expansion path the cost functions of the firm. The expansion path of the firm is given by the line OR in Figure 10.

Figure 11 illustrates a major source of growth in the relative productivity of labour and capital. Y_0, Y_1, and Y_2 are three isoquants depicting equal increments in the output of the firm from its labour and capital production function. If the entrepreneur were to increase only one resource, there will be a decline in both its marginal and average physical productivity. Where, for example, capital is increased by the quantities denoted along the line C_2e,

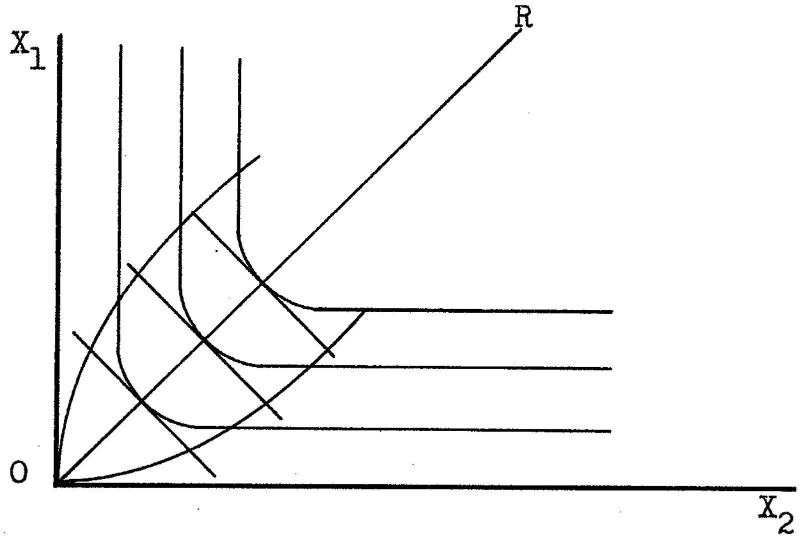

Figure 10 : The Firm's Expansion Path

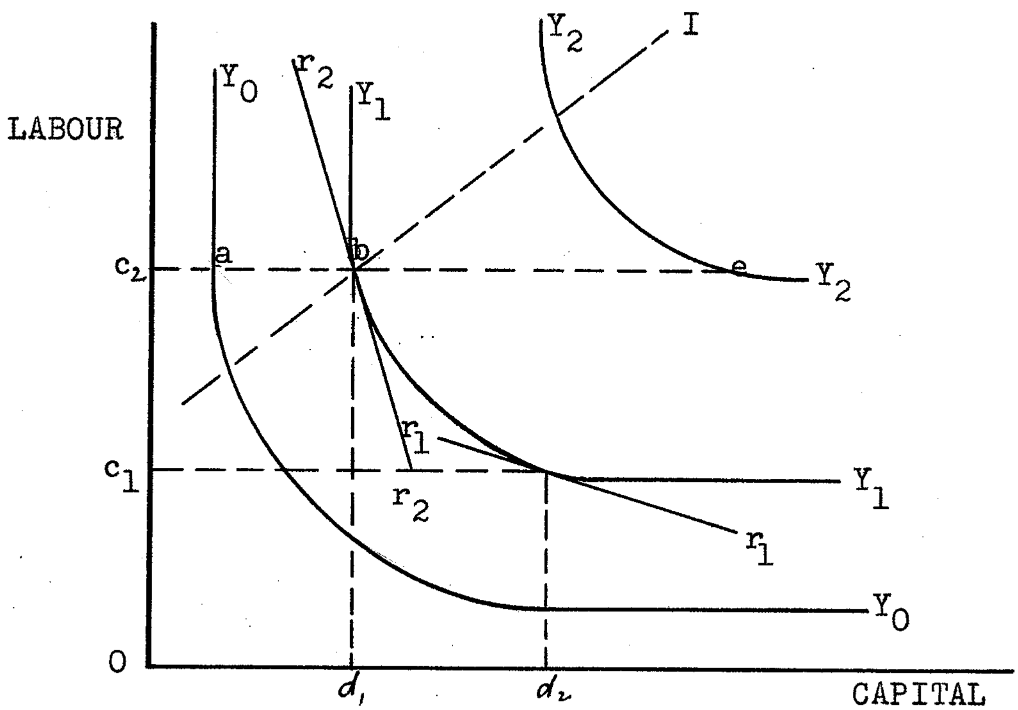

Figure 11 : Effects of Factor Substitution on Resource Productivity

its marginal productivity declines along the isoquants inasmuch as $\frac{\Delta Y}{be} < \frac{\Delta Y}{cb}$ where Δ Y is the constant marginal output. If he increases his capital input, while holding the labour input constant at OC_2, then the average physical productivity will rise from Y_0/OC_2 to Y_1/OC_2, and then to Y_3/OC_2. The marginal physical productivity of labour will also increase. This, however, depends upon the attributes of the particular production function[8].

A change of this nature, with the input of labour being held constant, is a characteristic of agriculture where the supply of labour input may be limited to the size of the farm family. Many farmers do not contemplate expansion of the size of their operations, which makes it necessary to engage hired help. This is considered by some farmers as an encroachment on the privacy of their homes and family.

There is, however, another kind of change which may be associated with a change in the factor/product price ratio, and/or the factor/factor price ratio. Any change in the factor price ratio which favours the use of more capital such as that depicted by the slope of the isocost line C_1 as compared to r_2, would theoretically cause a shift in

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[8]E.O. Heady and L.G. Tweeten, Resource Demand and Structure of the Agricultural Industry, (Ames: Iowa State University Press, 1963), pp. 29-30.

resource combination for output at the Y_1 level, from OC_2 of labour and Od_1 of capital.

This shift will result in a decline in the average physical productivity of capital from Y_1/Od_1 to Y_1/Od_2 for capital. The productivity of labour, however, will increase from Y_1/OC_2 to Y_1/OC_1. The implication of this is that the substitution effect has obviously dominated the expansion effect, the net result of which is an increase in the productivity of labour and as a decrease in the productivity of capital.

Along the expansion path the conditions given under obtains:

$$\frac{q_1(1 + \lambda_{X_1})}{Q_{X_1}} = \frac{q_2(1 + \lambda_{X_2})}{Q_{X_2}} = \frac{q_3(1 + \lambda_{X_3})}{Q_{X_3}} = \cdots = \frac{q_n(1 + \lambda_{X_n})}{Q_{X_n}}$$

Let $$\frac{q_1(1 + \lambda_{X_1})}{Q_{X_1}} = \frac{q_2(1 + \lambda_{X_2})}{Q_{X_2}} = \cdots = \frac{q_n(1 + \lambda_{X_n})}{Q_{X_n}} \equiv \beta$$

Each point in the expansion path defines least-cost combinations. Let TVC be total variable cost.

$$TVC = X_1q_1 + X_2q_2 + \cdots + X_1q_n \equiv \sum_{k=1}^{n} q_kX_k$$

It is clear from the above that the assumption is that firms are operating in the expansion path.

Since $$\frac{q_1(1 + \lambda_{X_1})}{Q_{X_1}} = \frac{q_2(1 + \lambda_{X_2})}{Q_{X_2}} = \cdots = \frac{q_n(1 + \quad X_n)}{Q_{X_n}} \equiv \beta$$

then $q_k(1 + \lambda_{X_k}) = Q_{X_k}$

$$TVC = X_1 q_1 + X_2 q_2 + \cdots + X_n q_n = \sum_{k=1}^{n} q_k X_k$$

$$\frac{dTVC}{dY} = \frac{\partial (X_1 q_1)}{\partial X_1} \frac{dX_1}{dY} + \cdots + \frac{\partial (X_n q_n)}{\partial X_n} \frac{dX_n}{dY} = \sum_{k=1}^{n} \frac{\partial (X_k q_k)}{\partial X_k} \frac{dX_k}{dY}$$

$$= q_1(1 + \lambda_{X_1}) \frac{dX_1}{dY} + \cdots + q_n(1 + \lambda_{X_n}) \frac{dX_n}{dY}$$

$$= \sum_{k=1}^{n} \frac{C_k dX_k}{dY}$$

where $C_k = q_k(1 + \lambda_{X_k}) = Q_{X_k}$

Then $\frac{dTVC}{dY} = \sum_{k=1}^{n} \frac{Q_{Y_k} dX_k}{dY}$

$$\frac{dTVC}{dY} = \frac{Q_{Y_k} dX_k}{dY}$$

By a previous definition we had shown that

$$dY = Q_{X_k} dX_k$$

$$\frac{dTVC}{dY} = \beta \frac{dY}{dY} = \beta$$

Hence,

$\frac{dTVC}{dY} = \beta =$ MC which is equivalent to the <u>marginal cost of the firm</u>.

We have therefore arrived at what we started with i.e.

$$\frac{q_1(1 + \lambda_{X_1})}{Q_{X_1}} + \cdots + \frac{q_n(1 + \lambda_{X_n})}{Q_{X_n}} \equiv \beta$$

Now since TVC $= \sum_{k=1}^{n} q_k X_k$

$$AVC = \sum_{k=1}^{n} q_k X_k / Y$$

We have already proven that $\frac{q_1}{Q_1} = \beta$

From this expression then $q_1 = Q_1$. If we assume a perfect factor market and a homogeneous production function then,

$$AVC = \frac{\sum_{k=1}^{n} Q_k X_k}{Y}$$

$$Q_k X_k = E \cdot Y$$

$$AVC = \frac{\sum_{k=1}^{n} Q_k X_k}{Y} = \frac{\beta \ YE}{Y}$$

$$AVC = \beta \ E \equiv CE \text{ where C is marginal cost.}$$

$$TVC = C \ E \ Y.$$

Having developed these concepts, we can now look at some of the relationships between the AVC, MC and elasticity. Before examining these relationships, it is proposed to define the concept of "cost flexibility". This term may be defined as a relative change in cost divided by a relative change in output. If the cost flexibility is denoted by λ_c, then expressed mathematically

$$\lambda_c = \frac{\frac{dc}{c}}{\frac{dY}{Y}} = \frac{dc}{c} \frac{Y}{dY}$$

An examination of some of the relationships referred to above can now be made from Figure 12.

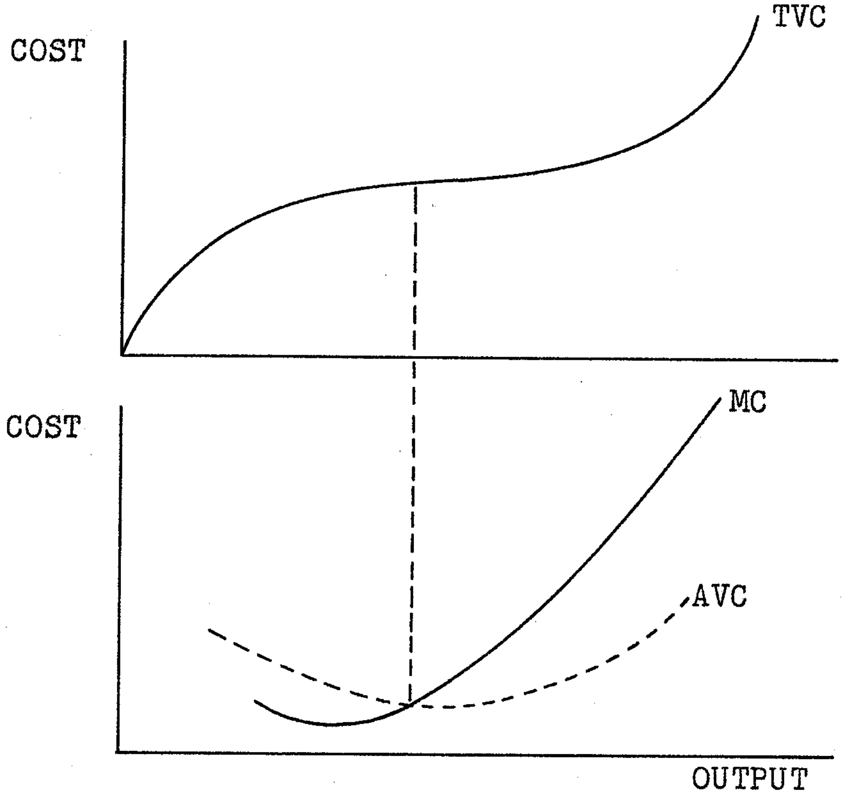

Figure 12 : The Firm's Cost Curves

From this figure, it is noted that

where E $>$ 1 then AVC $>$ MC
E $<$ 1 then AVC $<$ MC and
E $=$ 1 then AVC $=$ MC.

Up to this point, we have only examined the condition for cost minimization for a given level of output. It is obvious, therefore, that on the basis of the theory developed thus far, we cannot really say anything regarding the optimum level of output. Our next task is to examine the criteria for the profit-maximizing rate of output. The central aim of the following analysis would be the determination of the maximum rate of output given a specific demand function.

We shall examine a perfect competition model. In the previous analysis we examined the assumptions of pure competition in the factor market. We shall now carry out a similar examination for perfect competition in the product market. The assumptions involve the following:-

(i) Homogeneous Product, i.e. there is no difference in quality, form or appeal to prospective buyers.

(ii) Perfect knowledge to all buyers and sellers as to the current and future terms of trade. Buyers and sellers are randomly paired.

(iii) There is ease of entry into and exit from the market.

(iv) The number of firms and size of the largest firm in relation to the aggregate amount sold are such that variations in output by individual firms have no perceptible effect on product prices which remain fixed.

Notations used in the model

q = price of input factor	TC = total cost
X = amount of input factor	c = cost
p = price of product	Y = amount of product
R = total revenue	π = total profit

We will also assume that:

(p) and (Y) are both variable, and

(q_1) and (q_2) are both constant.

The specifications of the model are as follows:

(a) $p = p(Y)$ (b) $R = h(p,Y)$

(c) $R = h_1(Y)$ (d) $R = p.Y.$

(e) $c = f(X_0 X_1 X_2)$ (f) $TC = X_1 q_1 + X_2 q_2 + kC$

(g)
$$\pi = R - TC$$
$$\pi = (p.Y) - (X_1 q_1 + X_2 q_2 + kc)$$
$$\pi = p.Y - X_1 q_1 - X_2 q_2 - kc$$
$$\frac{d\pi}{dY} = \frac{p.dY + Ydp}{dY} - \frac{X_1 dq_1 + dX_1}{dY} - \frac{X_2 dq_2 + q_2 dX_2}{dY} - 0$$

By assumption

(q_1) and (q_2) are constants

$$dq_1 = 0$$
$$dq_2 = 0$$

$$\frac{d}{dY} = (p. + \frac{Ydp}{dY}) - (\frac{q_1 dX_1}{dY}) - (\frac{q_2 dX_2}{dY})$$

To maximize $d\pi/dY$ we set it to zero

$$(p. + Y\frac{dp}{dY}) - (q_1 \frac{dX_1}{dY}) - (\frac{q_2 dX_2}{dY}) = 0$$

$$(p. + Y\frac{dp}{dY}) = (q\frac{dX_1}{dY} + \frac{q_2 dX_2}{dY})$$

Multiply and divide L.H.S. by p.

$$(\frac{p}{p})p + (\frac{Y}{p}\frac{dp}{dY})p = p + (\frac{dp}{dY}\frac{Y}{p})\,p$$

Since by previous definition $= \frac{dp}{dY}\frac{Y}{p}$

L.H.S. $= p + \lambda p = p(1 + \lambda)$ which is equivalent to the firm's Marginal Revenue.

$$p(1 + \lambda) = \frac{dX_1}{dY} q_1 + \frac{dX_2}{dY} q_2$$

By previous definition it is obvious that

(a) $(\frac{dX_1}{dY} q_1) = MC_{X_1}$ and

(b) $(\frac{dX_2}{dY} q_2) = MC_{X_2}$

Hence L.H.S. is the firm's Marginal Cost, i.e.

$$p(1 + \lambda) = \frac{dX_1}{dY} q_1 + \frac{dX_2}{dY} q_2$$

Marginal Revenue = Marginal Cost.

From this analysis it may be concluded that under perfect competition the optimum rate of output is that rate of output where marginal revenue is equal to marginal cost. The rate of output also defines the short-run optimum factor combination.

$$MR = p = MC = \frac{q_1(1 + \lambda_{X_1})}{Q_{X_1}} = \cdots = \frac{q_n(1 + \lambda_{X_n})}{Q_{X_n}}$$

The conclusions in this portion of our analysis may be summarized in Figure 13.

The Average Total Cost curve can now be isolated for particular study. It is a second degree curve which declines first, levels off, and then increases as output is expanded. This is shown in Figure 14.

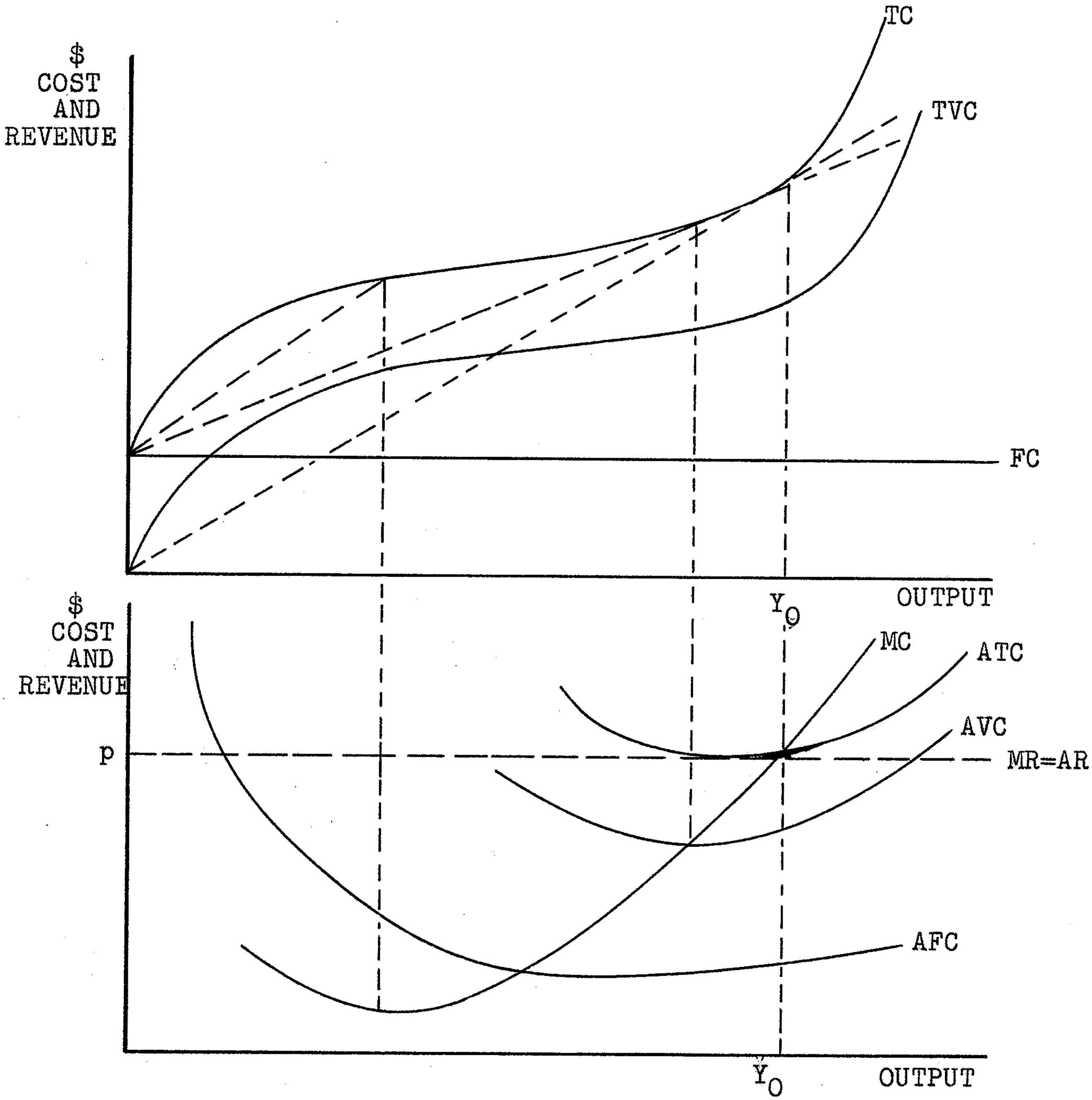

Figure 13 : Relationship Between the Firm's Cost and Revenue Curves

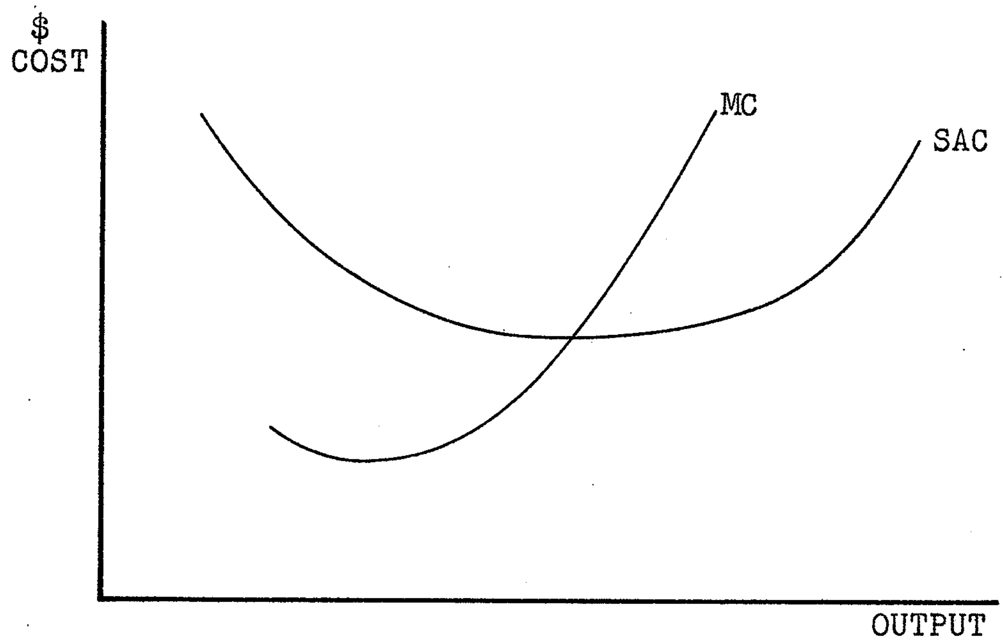

Figure 14 : Marginal Cost and Short-run Average Cost Curves

The short-run average cost function depicts the size of plant, which the firm utilizes, during a specific time period when the entrepreneur cannot feasibly change the size of the plant. The reason for this may be that a large proportion of the resources used may be fixed in quantity and hence a large percentage of the total cost may be fixed. This is particularly so in the case of a particular year's operations which had been planned in some previous period. The short-run average cost function may also be viewed as showing the average cost incurred in producing a unit of output, given the size of the plant, at a particular point of time.

In its early phases, the SAC function is negatively sloped i.e. it declines. This is so because the size of plant being fixed in the short run and the fixed costs, which constitute the greater portion of the total cost is spread over a greater volume of output. Cost per unit of output declines. The slope of the SAC curve declines and then levels off. However, in the next phase, the SAC function becomes positively sloped i.e. it increases because the size of plant being fixed - the universal law of diminishing returns comes into play.

In the next time period, the experience gained in the previous period and expectations regarding future events may dictate adjustments within the structure of the firm which entail an increase in the size or scale of plant. The fixed cost is also adjusted to complement the size of plant. The SAC function in this time period assumes the same shape as the SAC curve in the earlier period. The difference between the two curves lies in their relative position and the scale phenomena they depict. The SAC(2) function depicts the scale of plant built in the subsequent period, and the SAC(1) shows the scale or size of plant built initially. The point is the scale of plant built in the subsequent period, is larger than that built initially. The SAC(2) therefore takes up a position lower than to the right of SAC(1). The optimum point on the SAC(2) indicates that with this larger scale of plant, the firm can now produce its output at a low per unit average cost.

In the light of experience and expectations the firm will continue to make structural adjustments requiring a larger size plant and adjustments in fixed costs in each ensuing period. These enable the firm to produce its output at a lower per unit average cost up to a point where further expansion in the size of plant results in the average per unit cost decreasing at a diminishing rate. With expansion beyond this size of plant the average per unit cost becomes a constant. The next phase in the expansion in the size of plant results in an increase in the average cost per unit of output.

The long-run or planning curve is then derived as an envelope of the series of short-run average cost curves. In Figure 15 the discrete case of five short-run average cost curves is considered.

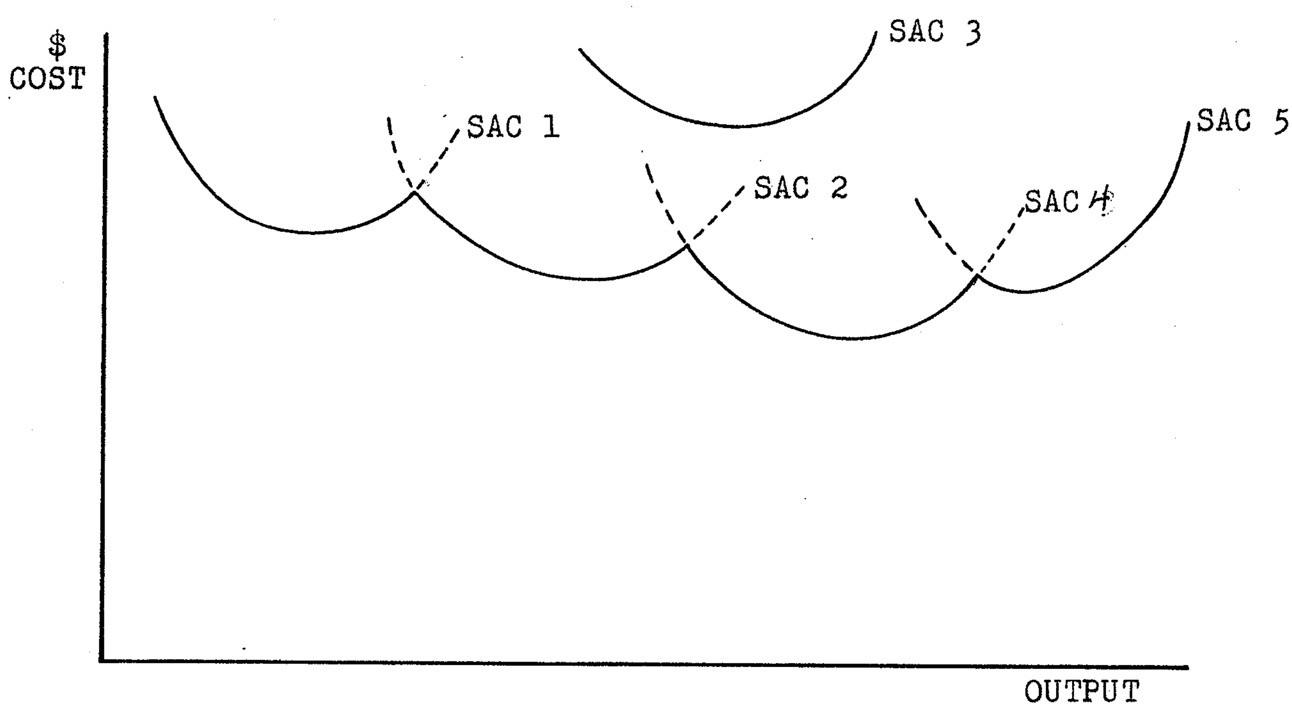

Figure 15 : Derivation of the Planning Curve (Discrete Case)

The solid line portions of the SAC curves (1), (2), (4) and (5) constitute the long-run planning curve. Although the SAC(3) does not form part of the planning curve, it is not without significance. This curve cannot be excluded from the analysis on the grounds that it is above the planning curve, since it is not known at the outset where the planning curve will fall. Chamberlin has pointed out that to draw in the SAC(3) as has been done "clarifies the manner in which the planning curve was derived". He has also claimed that such a curve might have been built under some previously established long-run optimum[9].

Each SAC function represents the short-run average cost curve for a given size of plant. In the long-run the firm can elect to build any one of the possible sizes of plant or it can feasibly shift for one size of plant to another. In so doing, however, the decision will be based on past experiences and future expectations. The size of plant that the firm builds may vary with, and depend upon, the long-run output per unit of time that it is decided to produce. It is assumed, however, that whatever the volume of output is decided upon, the firm will operate at the average per unit cost that is lowest for that output.

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[9] E.H. Chamberlin, Towards a More General Theory of Value, (New York: Oxford University Press, 1957), p. 186.

The LAC or planning curve is composed of very small segments of the series of SAC curves. It therefore depicts the least possible cost per unit of producing the various levels of output when the firm has had the time to build the desirable size of plant.

In the long-run a firm can build an infinite number of possible scales of plant. To each scale of plant, there exists another that is either infinitesimally larger or smaller. This is the continuous case. Here also the long-run planning curve is depicted as an envelope of all possible short-run average cost curves. This is illustrated in Figure 16. Leftwich has stated that:

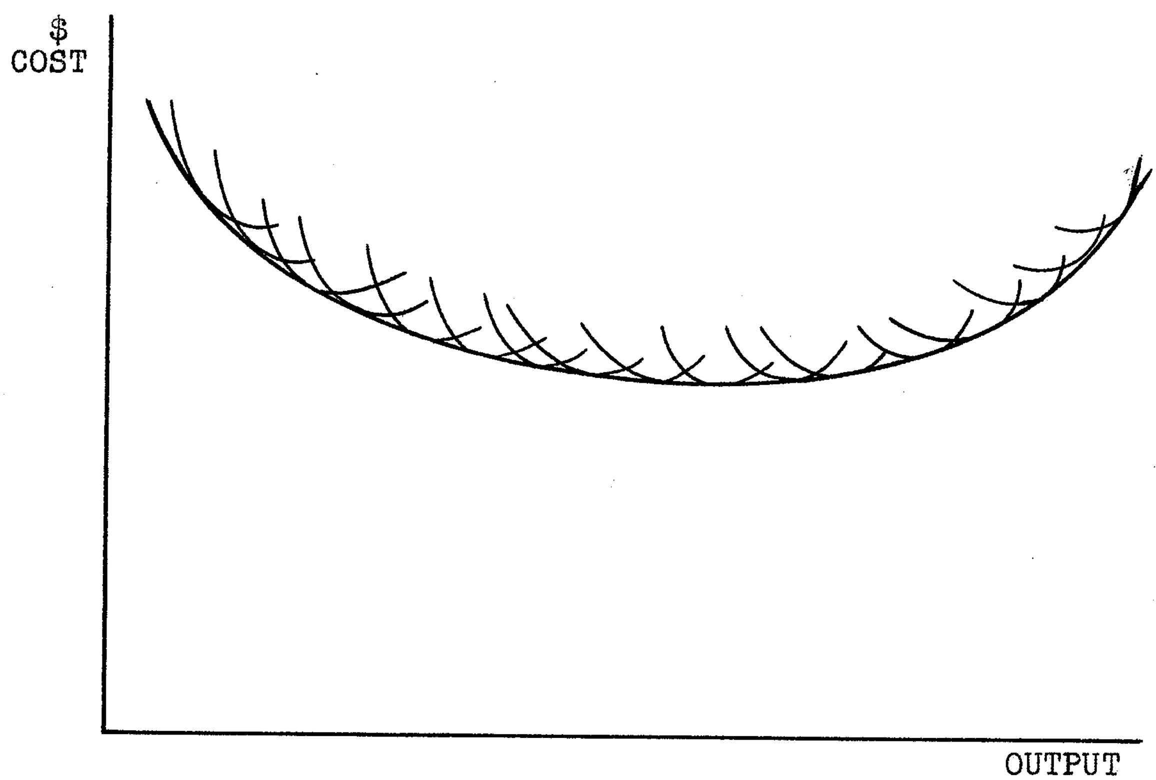

Figure 16 : Derivation of the Planning Curve (Continuous Case)

> Since the long-run average cost curve is made up of very small segments of the various SAC curves, it can be considered just tangent to all possible SAC representing the different scales of plant which the firm conceivably could build. Mathematically it is called an "envelope curve" to the SAC curves[10].

The proposition of the analysis thus far is that the long-run planning curve is U-shaped. It is now left to examine the reasons for this. In the long-run the firm can augment its volume of output by utilizing a larger size plant. Where the planning curve declines with an increase in output (increasing returns to size or economies of size), this indicates that the larger size plant is more efficient than the smaller plant. That this is the case can be seen in the case of the SAC's (1) to (4) of Figure 15. However, an expansion in the size of the firm beyond the size of plant (4) indicates that a larger size plant is less efficient in that the planning curve becomes positively sloped as output increases (decreasing returns to size or diseconomies of size).

A classical debate[11], regarding the explanations for the behavorial pattern of the planning curve, is that of Chamberlin vs. Stigler, Kaldor, Lerner, and Knight. It

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[10]R.H. Leftwich, The Price System and Resource Allocation, (New York: Rhinehart & Company, Inc., Fourth Edition, 1958), pp. 150-151.

[11]E.H. Chamberlin, *op. cit.*, pp. 169-212.

is not proposed to present the entire arguments of both parties here. This has adequately been done in the literature. However, some of the salient points of the debate and the implications thereof will now be presented below:

The parties agreed in principle that both economies of scale and diseconomies of scale occur simultaneously throughout the entire range of the planning function. Over the declining phase of the curve, the forces that make for economies are greater than those for diseconomies of scale. Along the rising portion of the curve the forces that cause diseconomies are greater than those that enhance economies of scale. At the minimum point of the curve the opposing forces are in a state of equilibrium.

However, their major disagreement is in the explanations advanced for the rising and falling portions of the curve. Firstly, the propositions relating to the declining portion of the curve will be examined. Stigler _et.al._ attempt to explain the falling portion of the curve in terms of the "imperfect divisibility" of factors. This proposition holds that factors of production can be obtained only in discrete units. In view of this, it is felt that the optimum proportions of factors is obtained when the total amount of factors used is large. The inference to be deduced from this proposition is that

> ...the relative inefficiency of small scale production is explained merely as a matter of

> failure to achieve the optimum proportions. With perfect divisibility, it is argued, they could be realized by sub-division of any aggregate, no matter how small, and economies of scale would be non existent. Large economies are explained by imperfect divisibility[12].

A more subtle implication that emerges from this hypothesis is that, where factors are perfectly divisible, economies of scale would be non-existent. To this extent, the hypothesis assumes away the problem that initiated the inquiry.

Chamberlin points out that the fundamental fault with this proposition is that it neglects to consider the effect of divisibility upon efficiency. He asserts that indivisibilities play no part whatever in explaining economies of scale. He also opines that even though all factors are perfectly divisible, efficiency remains a function of size[13].

Chamberlin views the long-run planning curve as the joint result of factor proportions, and the aggregate amount of factors used i.e. scale of plant. He hypothesises that the curve declines for two reasons viz:

> (1) increased specialization, made possible in general by the fact that the aggregate of resources is larger, and (2) qualitatively different and technologically more efficient units or factors, particularly machinery, made possible by a wise selection from among the

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[12]*Ibid.*, p. 176.

[13]*Ibid.*, p. 186.

greater range of technical possibilities opened up by greater resources[14].

There is however an inconclusive debate among theoretical economists regarding the reasons for the behavioral pattern of the planning curve beyond its minimal point. Does the curve rise? If it does, then what are the forces that cause it to rise? These are some of the questions that comprise the subject matter of the debate.

Most economists agree that the curve rises beyond its minimal point. Kaldor[15] explicitly argues that the long-run planning curve rises beyond its minimum point because of the law of diminishing returns. He argues that the entrepreneur has three distinct managerial functions viz: (i) uncertainty-bearing, (ii) supervision and (iii) co-ordination. He holds that uncertainty-bearing and supervision are variable factors but maintains that the co-ordinating function is a fixed factor. In support of this classification, Kaldor argues that co-ordination involves a single brain. To him, there is always a top co-ordinator. With this criterion that co-ordination is a fixed factor, the planning curve must rise because of the operation of the law of diminishing returns. The criterion that the co-ordinating function being a fixed factor is critical to Kaldor's

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[14] Ibid., p.176.

[15] N. Kaldor, "The Equilibrium of the Firm" Economic Journal, Vol. XLIV, March 1934, pp. 60-76.

hypothesis in that his whole analysis stands or falls on the acceptability of the criterion.

Chamberlin disagrees with Kaldor: He holds that "entrepreneurship, however defined, appears to be variable". In support of this stand he has argued that:

> ...if a particular entrepreneur does not wish to expand it (entrepreneurship) in his own firm because he does not want to share with others certain functions which he performs, then the size of this firm will be limited by his ability to perform these functions, or by his available capital and borrowing ability, or by both, after the manner of the plant curve analysis[16].

In Chamberlin's world, then, all factors in the envelope curve are variable in the longrun. The rise in the curve beyond the minimal point cannot be explained in terms of a fixed factor. He claims that the curve takes an upward course beyond the minimal point "because of the greater complexity of the producing unit as it grows in size, leading to increased difficulties of co-ordination and management"[17].

Kalecki maintains that "with a given amount of owned capital an individual entrepreneur may extend his borrowings only at progressively higher rates of interest as illustrated by the higher rate on second as compared with first mortgages, etc"[18].

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[16] E.H. Chamberlin, op.cit., p.188.

[17] Ibid., p.190.

[18] Ibid., vide footnote, p.188.

In this connection, it is to be pointed out that the theory of capital gives ample reasons to believe that the firm does not borrow indefinitely, in that there is some scale of operations which has the least cost[19]. The firm borrows up to the point where the rate of interest is equal to the marginal value product of capital. This equilibrium position is illustrated in Figure 17. If the firm can borrow

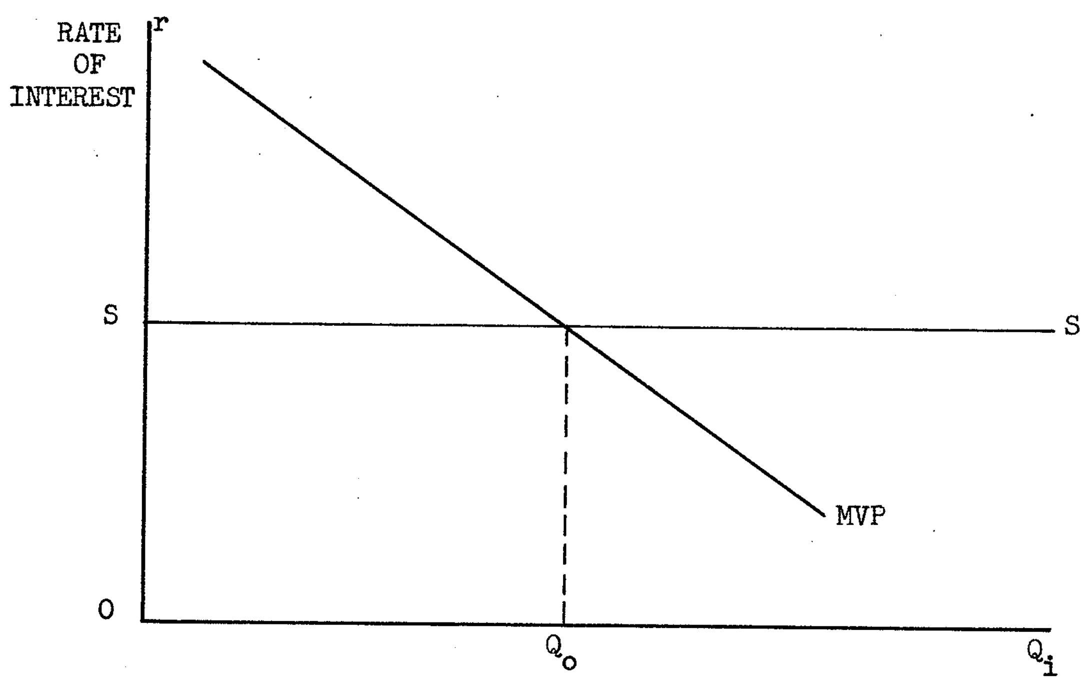

Figure 17 : Equilibrium Position of the Firm with Unlimited Capital Supply

capital whose supply is given by SS, the firm will borrow the quantity given by OQ_o. Hence, the firm will never borrow indefinitely. The amount borrowed will depend on the rate of interest and the marginal value product of capital.

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[19]A.P. Lerner, Economics of Control, (New York: The Macmillan Company, 1944), pp. 323-345.

The scale of operation, which has the least cost in this model is given by OQ_o. In this model, however, entrepreneurship is limited in supply, and hence the size of the firm is limited by the entrepreneur.

Scitovsky rejects this thesis. He does not really believe that there is some scale of operation which gives the least cost. He also rejects diminishing returns to scale as reason why the firm does not expand indefinitely. Scitovsky affirms that it is only in the short-run that the phenomenon of diminishing returns to scale becomes operative. He believes that the firm does not expand indefinitely because capital is a limiting factor in that the supply of funds is not elastic. This is the only explanation he accepts. In Scitovsky's world, therefore, one seeks to maximize the return on capital. He concludes that the entrepreneur's human limitations cannot limit the size of the firm because none of the entrepreneur's task is such that it cannot be delegated and divided among several production managers[20].

The long-run "optimum size" of plant can be defined as the most efficient of all the sizes of plant (in terms of per unit cost of output), which the firm can realistically

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[20] J. Scitovsky, Welfare and Competition, (Chicago, Illinois: Richard D. Irwin, Inc., 1951), Chapter IX, pp. 189-228.

build in the long-run. It can also be described as the size of plant with a SAC function tangent to the planning curve at the minimum points of both. This is illustrated by the size of firm SAC in Figure 18.

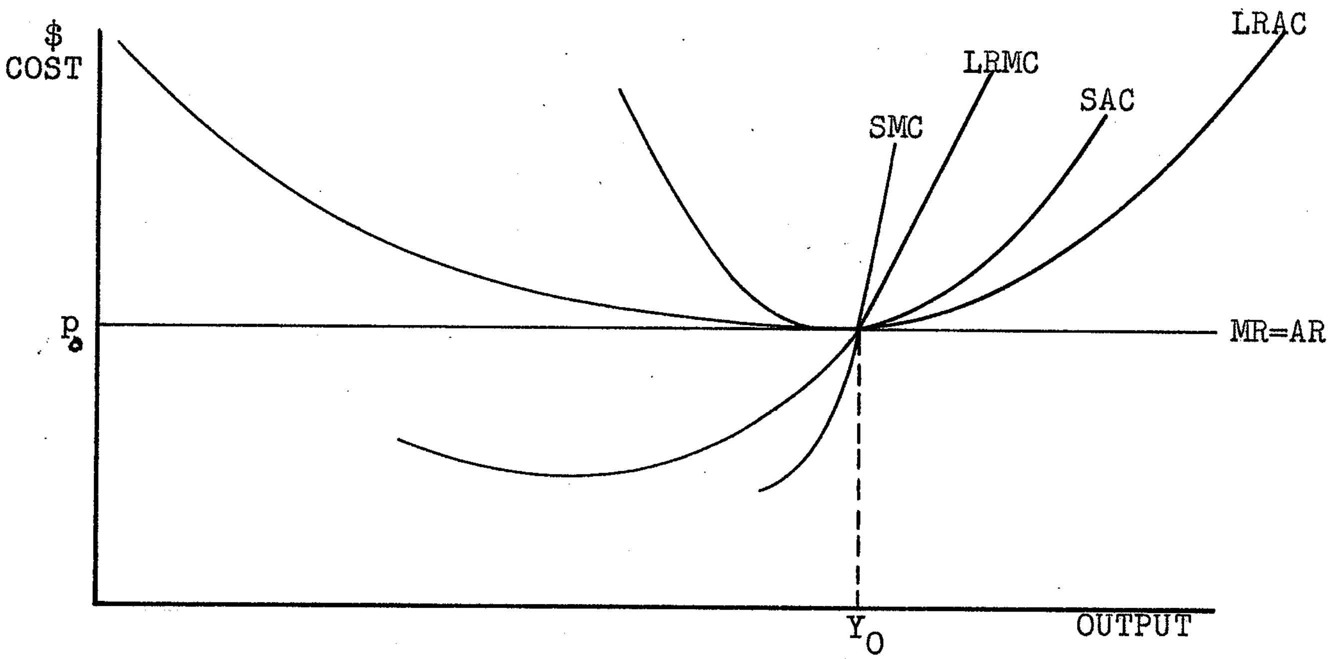

Figure 18 : Long-run Equilibrium

Figure 18 indicates that the long-run equilibrium of the industry is established at price p_o. The optimum scale of firm is depicted by SAC. Theoretically, the firm is said to be in equilibrium vis-à-vis the other firms in the industry. No incentive exists for firms to either leave or enter the industry. All resources are earning a return equivalent to what they could earn in alternative employments. This is a very static concept. However, the equilibrium becomes very unstable, when viewed in terms of the dynamic nature of the industry in the real world.

Leftwich has observed that:

> As a practical matter, long-run equilibrium is never likely to be achieved in an industry. It is a will-o-the-wisp which industries forever chase but never catch. Before an industry can reach equilibrium, conditions defining the equilibrium position change. Demand for the product changes or cost of production change as a result of resource price changes or changes in techniques of production. Thus the chase goes on toward a new equilibrium position. The long-run (and other) equilibrium concepts are important, however, because they show as the motivation for and the direction of the chase. Additionally, they show us how the chase works towards (in most cases) solution of the economic problem[21].

There is a final point to be clarified in this treatment of the theory of the firm. It is the desire to distinguish between the internal economies of large scale production from the economies resulting from the spreading of the overhead costs. Internal economies of large-scale production are essentially a long-run phenomenon dependent upon appropriate adjustments of scale of plant to each successive output. Economies resulting from spreading of overhead are short-run phenomenon. In the long-run there are no technologically fixed or overhead costs.

This examination of the theory of the firm indicates that there are some useful theorems in economic theory, which are suggestive of the nature of phenomena in the real world as these relate to the particular problem that initiated this

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[21] R.H. Leftwich, The Price System and Resource Allocation, Revised Edition, (Toronto: Holt, Rhinehart and Winston, 1963), p. 185.

study. However, these theorems are a deductive set of propositions derived by the rules of logic from basic postulates. Since alternative theorems are possible, the mere application of economic logic is an insufficient condition for the attainment of a practical solution to the problem under investigation[22]. There is need, therefore, for empirical verification of the postulates of economic theory before they can be accepted as explanations of phenomena in the real world.

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[22] E.O. Heady, Economics of Agricultural Production and Resource Use, (Englewood Cliffs, N.J., Prentice-Hall, Inc., 1957), pp. 14-15.

CHAPTER IV

REVIEW OF STUDIES RELATING TO THE PROBLEM

The trend towards consolidation of farms evident in Canada since 1931 has posed many problem areas for research. One of the most important, from the point of view of resource efficiency, is to determine what relationship exists between the size of the firm and its unit cost. Merely obtaining this information, however, does not resolve the issue. It is just the first stage in solving the central problem. The crucial function of research lies in the interpretation of the derived relationship in terms of the position of the family farm.

The family farm is the basic socio-economic unit in agriculture. As such, research work on the problem of the economies of farm size should be centered around the family farm. Most investigations in this direction, however, have not explicitly dealt with the problem in terms of the position of the family farm. Hence, the probable implications of their results for the family farm are not quite clear. These studies for example have not specifically indicated whether the family farm is consistent with the optimum size of firm in agriculture.

It is the thesis of this review that the short-comings of previous studies noted above have contributed in a large measure to the meagre progress that has been made on the problem. Consequently, very little is known of the real cost economies associated with farms of different sizes. As a consequence of this, farm management specialists lack empirical evidence, that would enable them to suggest to the individual farmers the specific adjustments in farm size that could be made.

Notwithstanding this basic shortcoming of previous studies, an appraisal will now be made of the conceptual and methodological frameworks employed in investigating the problem of farm size. In studies of this nature it is necessary to differentiate between cost economies associated farm size and economies of scale. The former are the decreases in unit cost associated with a non-proportional increase in resource inputs. This is also viewed as spreading the overhead costs. The latter are the decreases in unit cost associated with a proportional increase of all resource inputs. Hence real scale relationships are possible only where all resource inputs are increased in the same proportion. In farming, entrepreneurs do not increase their resource inputs in a manner consistent with real scale relationship. To this extent, the concept of an "economy of scale" curve is not truly pertinent to actual farm situation. A more realistic terminology would be the "planning" curve, which has more relevance to farm production economies. Most studies on problems of farm size have neglected to make clear this distinction; and have so contributed to some of the existing confusion on this score.

What has commonly been referred to as the "economy of scale" curve is indeed the locus of the lowest average costs that is attainable with variation in the volume of output, or size of farm. More important than this, however, is that it depicts the levels of cost that are obtainable from different sizes of farms "when operations are organized as efficiently as possible under given conditions."[1] This conception and the failure to differentiate between "economies of scale" and "economies of farm size," have contributed to the confusion in the literature.

The long-run average cost curve is referred to as the economy of scale curve.[2] Another writer has stated that the long run average cost curve can be looked upon as a "planning curve."[3] At the theoretical level these conceptions are both logical and consistent. However, at the empirical

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[1]R.G. Bressler, Jr., "Research Determination of Economies of Scale." Journal of Farm Economics, Vol. 27, 1945, p.526. Also, R.O. Olson "Review and Appraisal of Methods in Studying Farm Size," Resource Productivity, Returns to Scale and Farm Size, edited by E.O. Heady, et. al, 1956, p.53.

[2]R.H. Leftwich, The Price System and Resource Allocation, (Toronto: Holt, Rhinehart and Winston, 1963), pp. 155-156.

[3]E.O. Heady, Economics of Agricultural Production and Resource Use, (Englewood Cliffs, N.J., Prentice Hall, Inc., 1957), p. 367.

level, the planning curve need not always be the same thing as the long-run average cost curve. Whether or not they are the same depends entirely on the empirical method used in developing them.

The failure of some studies to recognize the need for a distinction here has added further confusion to an understanding of the cost economies that exist in farming. To illustrate the confusion created thereby, an examination will be made of a planning curve derived through budgeting method by Fellows and Engel at the University of Connecticut[4]. This will be compared with the long-run average cost curve developed through the use of the regression method by Heady, McKee and Haver at Iowa State College[5].

Fellows and Engel used the budgeting method to develop four short-run average cost curves. On accomplishing this, the long-run planning curve was then drawn tangent to the short-run cost curves as illustrated in Figure 19.

Heady *et al* used the method of regression analysis to develop the long-run average cost curve, which is shown in Figure 20.

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[4] I.F. Fellows and N.E. Engel, *Economic Effects of Alternative Organizations on Large Dairy Farms*, University of Connecticut, Bulletin 354, 1960.

[5] E.O. Heady, Deen E. McKee and C.B. Haver, *Farm Size Adjustments in Iowa and Cost Economies in Crop Production for Farms of Different Sizes*, Agricultural Experiment Station, Iowa State College, Research Bulletin 428, May, 1955.

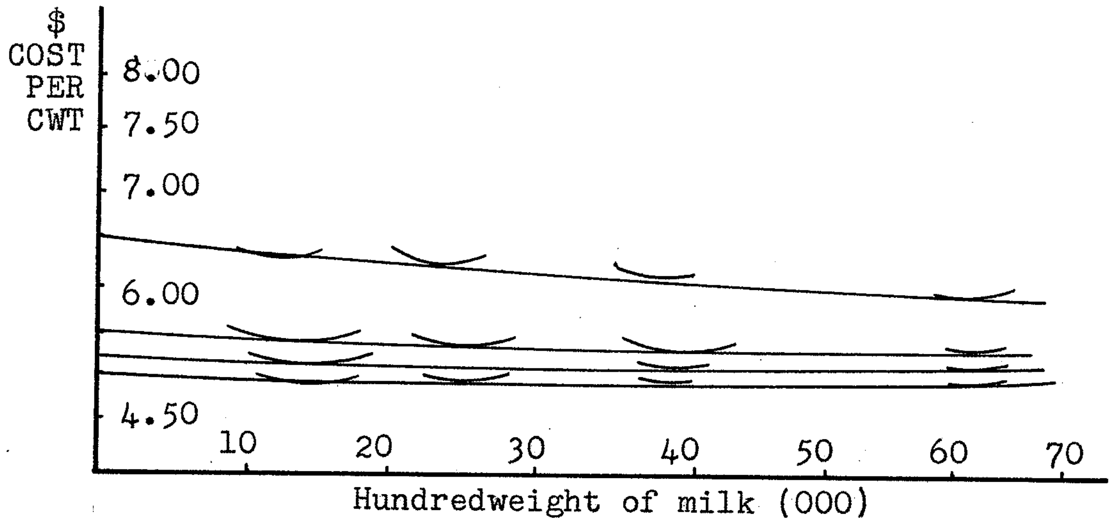

Figure 19 : Planning Curves for Four Selected Forage and Replacement Programs

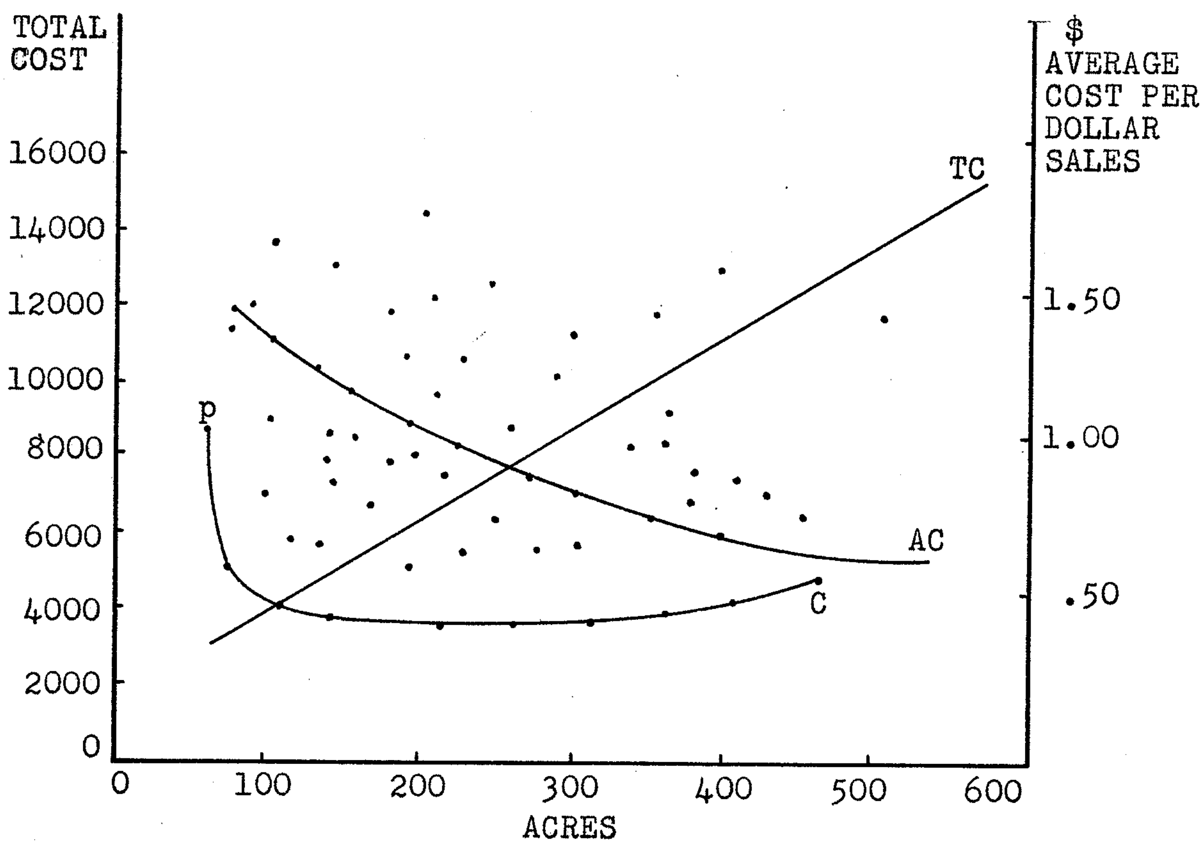

Figure 20 : Total Costs and Average Cost per $1 Gross Sales for Farm Sample

That the planning curve developed by Fellows and Engel is the same as the long-run average cost curve is conceptually and empirically, undisputable. To this extent both concepts are synonymous. Clearly the same interpretation cannot be given to the long-run average cost curve developed by Heady et al. The AC curve developed by them is inconsistent with the characteristics of a planning curve. As such, it is not the relevant curve to be used as the logical basis for intelligent farm planning. It does not realistically indicate the whole spectrum of cost economies associated with farms of different sizes.

The average cost curve presented in the scatter diagram depicts the average relationship between the size of farm and the average cost per dollar of sales. Interpretation and/or use of the AC curve as the planning curve in this particular model arises from a failure to differentiate between (a) changes in per unit cost associated with a more effective utilization of existing farm resources; and (b) changes in cost arising out of changes in the size of the farm firm. Since each cost and acreage point depict a farm of a particular size and proportion of excess capacity, it is merely by pure chance it may approximate the level of the planning curve[6].

The planning curve depicts the locus of the minimum

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[6] R.C. Bressler, op. cit., pp. 528-529.

per unit cost points that is attained with the different sizes of farms. This average cost curve as derived by Heady et al, indicates unit costs above the minimum points that define the planning function. A more realistic method of approximating the planning curve would be to fit an envelope curve to the minimum cost points of the scatter as shown by the line PC in Figure 20. The curve PC depicts the locus of the minimum cost farms and as such it is a more realistic approximation of the planning curve insofar as it includes only the farms of different sizes that are efficiently managed and operated at close to full capacity. The curve PC is more consistent with the definition of the planning curve, and as such, it is the relevant curve for intelligent farm planning.

There are several variables that influence the unit cost on farms. These include the level of capacity at which farms are operated, the level of management, external economies etc. In order to be able to measure the effects of differences in farm size on unit cost, all farms in the sample should be homogeneous, or reasonably so, in all characteristics except for the differences in size.

Conceptual and empirical difficulties, relating to measurement of both management and farm capacity, pose critical pitfalls to any attempt to isolate the effects of the size variable on unit cost. Economies that are external to the farm arise out of its cooperation with other farms in such matters as bulk buying etc. They can also arise out of the proximity of the firm to the resource markets. Very few studies have so far been able to normalise these variables. In this particular regard, the function depicting the relationship between farms of different sizes and unit cost may well be a hybrid.

Another reason for the negligible progress made on the problem of farm size stems from the source of the data used in the empirical phase of investigation. Several studies[7] have used census data to test their hypotheses. Some of these studies have very little empirical content, and contain more descriptions of such aspects as average size of farm by area, kinds of farming etc. Hence, they have not really concerned themselves with the real issues involved. In addition thereto, there are many pitfalls inherent in using census data. It is very doubtful whether a homogeneous sample can be obtained from census data. The reason for this point of view lies in the fact that census data contain considerable intra stratum variations in both the system of farming and the efficiency with which resources are utilized. As such, conclusions derived from such studies

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[7]As examples vide. (a) J.D.Black, R.H. Allen, and O.A. Negaard, "The Scale of Agricultural Production in the United States", Quarterly Journal of Economics, May 1939; (b) L.J. Ducoff and M.J. Hagood, Differentials in Productivity and in Farm Income of Agricultural Workers by Size of Enterprise and by Regions, U.S.D.A. Report (Mimeo.), 1944; and (c) K.L. Bachman and R.W. Jones, Sizes of Farms in the United States, U.S.D.A., Technical Bulletin, 1019, July,1950.

have limited utility in providing the specific kind of information, that could suggest the nature of adjustment in size required at the individual farm level.

Some studies have based the empirical phase of the investigation on data acquired through detailed farm survey and/or farm account data. The procedure adopted was that of categorizing farms into many classes. Then for each class or stratum, the average cost per unit of output is calculated. It is obvious that this method involves several conceptual and empirical difficulties that may well result in the development of a 'mongrel' planning curve.

Some studies have established empirically that the planning curve is U-shaped as postulated in the theory of the firm. Others have developed planning curves that slope downwards quite rapidly as the size of farm increase, but beyond a certain size the curves assume an almost horizontal shape.[8] Scoville used the budgeting technique to estimate the long-run planning curve. Scoville's analytic model assumed that there is no limitation to the efficiency of management, i.e. it is continually variable in both the short and long-run periods. This is a rather questionable proposition in that there is the very distinct possibility,

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[8] For examples, see: O.J. Scoville, Relationship Between Size of Farm and Utilization of Machinery, Equipment and Labor on Nebraska Corn-Livestock Farms, U.S.D.A. Technical Bulletin No. 1037, September 1951, pp. 29-31.

that in the long-run diseconomies of size can accrue to the farm, because of the inability of the entrepreneur to co-ordinate the separate units of a larger farm.

The implications of Scoville's planning curve is that (a) the number of farms, and (b) the optimum size of farm indeterminate. When the results of this study are viewed in terms of the propositions of economic theory, the results of other studies on the problem, and the competitive nature of the agricultural industry, the nature of the planning curve obtained by Scoville depicts a unique development.

The budgeting method employed by Scoville, Fellows et al, and the engineering approach used by French, Sammet, Boles and Bressler at California[9] are effective in showing the level of efficiency obtainable for different sizes of farm under the idealized conditions which their models assume. However, these models seem to have limited utility in estimating the cost economies associated with any group

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[9]B.C. French, et al., "Economic Efficiency in Plant Operations with Special Reference to Marketing of California Pears", Hilgardia, Vol. 24, No. 19, (Berkeley: Agricultural Experiment Station, University of California, July 1956), pp. 543-579.

J.N. Boles, "Economies of Scale for Evaporated Milk Plants in California", Hilgardia, Vol. 27, No. 21, (Berkeley: Agricultural Experiment Station, University of California, October, 1958), pp. 621-700.

R.G. Bressler, Economies of Scale in the Operation of Country Milk Plants with Special Reference to New England, (Boston: New England Research Council on Marketing and Food Supply, 1948).

of farms, especially when the models are appraised in terms of risk and uncertainty, adjustment opportunities and the inherent individual capabilities of different farmers.

Recently, some studies have used the method of production functions to indicate the scale phenomena that exist in agriculture. In this approach, the Cobb-Douglas production function is the one most frequently employed. This model requires, for ease of manipulation, the aggregation of rather heterogeneous inputs into supposedly homogeneous categories. For example tractors, trucks, etc., are all grouped as one item-capital.

When properly handled, the Cobb-Douglas production function provides estimates of the marginal productivities of each input category. It does not, however, indicate the productivity of the individual input within each category, which is of real concern to the individual farmer. This production function also provides estimates of the true economies of scale in terms of the categories of inputs indicated. However, it does not allow for the whole spectrum of cost economies and diseconomies of the planning curve. It shows either increasing, decreasing, or constant returns to scale but not all three. At best, it can be said that the production function method indicates the nature of the scale phenomena, but it does not illustrate the entire picture.

The Cobb-Douglas production function approach to the problem of farm size indicates the nature of the returns to scale[10]. If the sum of the elasticities of production of all the factor inputs amounts to less than one, there are diminishing returns to scale. If the sum of the elasticities is greater than one there are increasing returns to scale. If the sum of the elasticities equals one, then there are constant returns to scale.

There are two pitfalls in the production function approach to study the problem of economies of farm size. The nature of the Cobb-Douglas production function allows for a proportional increase in all resource inputs used. It, therefore, enables the research worker to study the scale phenomena that exist in the real world. However, the path which a farmer generally follows in expanding the quantity of resources used is inconsistent with true scale relationships. The normal characteristics of farm production are that farm operators increase their resource inputs in a dis-

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[10]For examples, see: J.C. Gilson, Productivity of Farm Resources in the Carman Area of Manitoba, Faculty of Agriculture and Home Economies, University of Manitoba Technical Bulletin No. 1, September, 1959; Ludwig Auer, Productivity of Resources on Farms in the New Dale-Hamiota Area of Manitoba, Master's thesis presented to the Faculty of Graduate Studies and Research, University of Manitoba, 1958; W. Darcovich, "The Use of Production Functions in the Study of Resource Productivity in Some Beef Producing Areas of Alberta," The Economic Annalist, Vol. XXVIII, No. 4, August 1958, pp. 85-93.

proportional manner. In view of this, the resulting cost economies do not show the effects of scale of operations. They depict the savings in cost that are associated with the differences in the size of farm business. The Cobb-Douglas production function approach therefore has a limited application as an analytical technique for investigating the problem of economies of farm size.

This review of some studies on the problem of farm size does not exhaust all approaches, that have hitherto been made to resolve the problem. Clearly there is a medley of subtle conceptual methodological, and empirical problems to be considered in any attempt to investigate the problem. These difficulties do not make the determination of the problem any less urgent. The problem presents an intellectually challenging area for scientific investigation.

Peston of the London School of Economics opines that

> ...the current state of the theoretical approach (or approaches) to scale is such that the laws which are formulated are either in principle not capable of being related to data, or are so vague in this respect that it is impossible to test them[11].

He also holds that in view of the foregoing, it is impossible

[11] M.H. Peston, "Returns to Scale," Oxford Economic Papers, New Series, Volume 12, (Oxford at the Clarendon Press, 1960), p. 133.

to determine what "scale phenomena" will appear in the real world. While the whole spectrum of intricate problems as seen above is recognized (incidentally the motive of research is problem-solution), researchers have developed some models, inspite of Peston, which have been used to test empirically the propositions of economic theory insofar as they relate to the cost economies in agriculture. The task now left to present research workers, is to clarify the concepts, and refine the models used by earlier workers who blazed the trail.

CHAPTER V

CONCEPTUAL FRAMEWORK

1. Hypotheses

Emanating from the problematic situation, the postulates of economic theory, and the studies just reviewed are the following hypotheses:

1. There exists a functional relationship between the cost per unit of output, and the size of the farm firm[1].

2. The size of the farm firm is limited by two types of forces or a combination of both viz: (a) forces that are internal to the firm such as incentive, management etc., and (b) forces that are external to the firm such as risk, uncertainty, capital rationing, leasing and tenure arrangements.

3. The family farm is consistent with the optimum size of firm in agriculture.

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[1]The 1961 Canadian Census of Agriculture has defined a farm as an agricultural holding of one acre or more with sales of agricultural products during the past 12 months of $50.00 or more". However, it has been stipulated that "All farms (except "Institutional farms, etc") with a total value of agricultural products sold of $1,200 or more were classified as commercial farms". Institutional farms etc., are experimental farms, community pastures, Indian reserves and farms operated by institutions regardless of the amount of sales of agricultural products.

These hypotheses are advanced as conjectures in explanation of phenomena that exist in agriculture. It is the central objective of this study therefore to attempt an empirical verification of these hypotheses in order to determine whether or not they describe the real nature of things.

In developing the concepts for this study, the procedure will be to survey, examine and critically evaluate the interpretations given by authoritative sources. Then where necessary, modifications will be made that are consistent with the objectives of this study.

2. Concept of the "Family Farm"

It has been stated that... "Almost all the farms in Canada are still family farms, mechanically operated with little hired help"[2]. An exhaustive search has failed, however, to produce from the same source a definition or some notion of what is its conception of a family farm. Surely, the diverse policy problems regarding the family farm would require different definitions as indicated by the specific purposes under consideration. A prior condition, that must be established before the number of family farms can meaningfully be estimated, is that some clear-cut and workable definition must be attempted. Similarly, before this study

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[2]Dominion Bureau of Statistics, Canada Year Book, 1960, (Ottawa: Queen's Printer and Controller of Stationery, 1960), p.435.

can objectively determine whether the family farm is consistent with the optimum size of firm in agriculture, it must set out in precise terms its conception of the family farm.

E. O. Heady holds that"....The term 'family farm' has no specific meaning in respect to size or scale relationships in agriculture"[3]. He explains that:

> ...Many people have supplied a definition of the family farm, there are as many definitions as there are special interest groups. The term has great economic-political appeal, and if an individual, economic group, or political party wishes to win the majority favor of farm people, it need only espouse the cause of the family farm... In their varied definitions of the family farm many people, including agricultural economists, imply that it is the most efficient producing unit; then they immediately suggest that it is in danger of being liquidated by large-scale units. The logic employed here is inconsistent...[4]

He then proceeded to point out that:

> Other definitions suggest that the family farm is one in which (1) all management is provided by the farm family, (2) more than half the labor is provided by the family, and (3) returns on resources are as great as might be earned in alternative employments[5].

Heady concluded that:

> ...This definition also implies that, in terms of general equilibrium analysis, the family farm is the most efficient producing unit. Accordingly,

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[3]E.O. Heady, <u>Economics of Agricultural Production and Resource Use</u>, (Englewood Cliffs, N.J., Prentice-Hall Inc., 1957), p. 379.

[4]<u>Ibid</u>. [5]<u>Ibid</u>., p.380

> there is no basis for the further suggestion (and one which almost always follows) that "the family farm is in dire danger of being eliminated by sinister forces[6].

Heady's motive in the excerpts quoted above is to point out the ambiguity of the term "family farm". In view of its scope and flexibility, Heady exhorts writers to state precisely their conception of the term when they are writing on the subject. He feels that this chore is crucial, and hence necessary if one is to be clear on the context in which the term is used. Heady, therefore, has not lapsed into error by making any out-of-context definition of the term. This is deliberate in view of his earlier stand - that the term "has no specific meaning in respect to size or scale relationships in agriculture".

Heady's contribution on this score lies in the fact that he recognizes that the term "family farm" has tremendous scope and implications. These may be political, social, economic or even philosophical. He leaves the chore to the writer to explain the concept and the context in which it is made. So the problem remains.

The definition of the family farm given by Joseph Ackerman and Marshall Harris is based on the following three criteria:

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[6] _Ibid_.

> 1. The entrepreneurial function is vested in the farm family.
>
> 2. The human effort required to operate the farm provided by the farm family with the addition of such supplementary labor as may be necessary, either for seasonal peak loads or during the developmental and transitorial stages in the family itself. (The amount of such regular outside labor should not provide a total labor force in excess of that to be found in the family of 'normal' size in the community).
>
> 3. A farm large enough, in terms of land, capital, modern technology, and other resources, to employ the labour resources of the farm family efficiently[7].

In a treatment of the social role that the family farm is expected to play, R. Schickele has designated three basic criteria that the family farm would have to meet in order to play such a role:

> 1. Freedom of managerial control, which is necessary for the farmer to exercise entrepreneurship and develop his managerial capacities.
>
> 2. Reliance upon the farmer's and his family's labor for a substantial part of the farm's labor requirements, so that workmanship is cultivated and no clear-cut separation of labor and management becomes established.
>
> 3. Adequate amount of land and capital resources, so that the farm can yield sufficient income to provide the family with an acceptable standard of living[8].

Schickele's third criterion tends to impose a lower limit on

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[7]J. Ackerman and M. Harris, "Family Farm Policy", (Chicago: University of Chicago Press, 1947), p.389, cited by Rainer Schickele, Agricultural Policy Farm Programs and National Welfare, (New York: McGraw-Hill Book Company, Inc., 1954), p. 330.

[8]*Ibid.*

the size of farm firm that can be classified as a family farm. His definition requires that the farm be large enough to enjoy an "acceptable standard" of living. In the criteria as set out by Ackerman and Harris, the emphasis is shifted to an efficient employment of family labour resources. The essence of the two concepts reveals no real conflict in relation to their meaning insofar as economic efficiency is reflected, in part, in income. However, there is a basic inconsistency in the two criteria in relation to their implications for agricultural policy. Within the framework of family farm policy, the emphasis in Schickele's criterion is on income distribution, whereas with Ackerman and Harris the emphasis is on production efficiency. Where for instance, a farmer's labour resources are efficiently utilized, but his net income is inadequate to allow his family an "acceptable standard" of living, the farm would not meet Schickele's third criterion. It would most certainly meet the Ackerman and Harris' criteria.

Schickele's third criterion is crucial to his definition, which implies that he uses acreage and investment as criteria for farm size. A full discussion on the limitations and pitfalls in using these as criteria for farm size will be made below. The term "adequate amount" is latently ambiguous in view of the relativity in the use of the concept. In effect, it has no specific meaning, and hence there could be as many interpretations of this term as there are points of view on the topic. The term "acceptable standard" leaves tremendous scope for subjective interpretation. The fault in Schickele's criterion lies in its inadequacy of definitive precision in the terms used.

A more serious limitation in Schickele's criterion is that an "adequate amount" of land and capital - whatever this means - does not in itself guarantee a higher level of income that would accrue to a farmer with less. A combination of an "adequate amount" of land and capital, with sheer inattention to efficiency in resource use, could result in the farm family diminishing its capital assets to sustain itself. In the long-run this could lead to bankruptcy. Hence, each definition by itself is inadequate. Together they display greater merit.

T. W. Schultz has stated that:

> ... the concept of the family farm has been vague and ambiguous to say the least. There has been much meandering over the years in public effort intended to give support to it[9].

In his view:

> ... The way to achieve a workable definition is to examine the technical, political, social and economic characteristics of the family farm and tie the definition to those characteristics which

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[9]T. W. Schultz, Production and Welfare of Agriculture, (New York: MacMillan Company, 1950), p. 30.

> appear to be most important to its success. On the technical side, it is fairly evident that modern techniques and practices in farming are not restricted narrowly to any particular form of farm organization whether co-operative, partnership, co-operative, or individual entrepreneurship vested in the family farm. It is also true that existing political and legal institutions are sufficiently flexible to accomodate alternative forms of organization and from this it would follow that the salient features of the family farm are not to be found in this sphere[10].

Schultz holds that in as much as there is such freedom of choice in the technical and political-legal spheres, one must turn to the social and economic characteristics of the family farm for a definition. He holds that:

> ... In economic analysis the farm, regardless of the type of organization that exists, is a firm. As such it is a decision-making unit of production, vested with the entrepreneurial function which involves the organization and management of the farm combining land (nature), labor and capital and taking certain economic risks in the process[11].

He points out, however that the conception of the family farm need not carry certain implications as discussed below:

> ... It does not, for one, carry with it the implication that the family farm must own all the property (land and capital) and provide at all times all the labor that is employed on the farm. Nor does it mean that the size of the farm must necessarily expand and shrink with the family circle[12].

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[10] *Ibid.*, p.31.

[11] *Ibid.*

[12] *Ibid.*

Schultz holds that there is no family farm unless the entrepreneurial function resides in the farm family. In addition to this stipulation, he considers that the farm should consist of enough land and capital to absorb efficiently the labour of such members of the farm family as may depend upon it for a livelihood. Conversely, the farm should consist of no more land and capital than can be operated by the farm family or by a family of normal size in the community[13].

The concept of the family farm as envisaged by Schultz is formulated on the following three criteria:

(i) The entrepreneurial function is vested in the farm family.

(ii) The human effort required to operate the family farm is provided by the farm family with the addition of supplementary labor as may be necessary, either for seasonal peak loads or during developmental and transitional stages in the family itself.

(iii) A farm large enough (in terms of land, capital, modern technology, and other resources) to use "efficiently" the efforts of the members of the family who are employed on the farm.

Schultz's criteria are identical to those of Ackerman and Harris. However Schultz holds that all farms that entail

[13] Ibid., p.33.

share cropping, consist of certain types of tenants or operate under contract agreement which, in effect, impair the essentials of entrepreneurship, do not meet Schultz criteria. As such he does not consider them family farms. Plantations and farms that depend wholly upon hired labour are not classified as family farms. To Schultz, part-time farmers should also be excluded[14].

The implications inherent in Schultz's definition of the family farm are obviously very many. Recognition and examination of some of these will now be made. The three criteria tend to impose an upper limit on the size (regardless of what criterion is used as farm size) of farm firm that can legitimately be classified as a family farm.

It was noted earlier that almost all the farms in Canada are family-farms, the exception being the Indian reserves, institutional farms etc. It was also pointed out that the concept of the family farm envisaged by the Dominion Bureau of Statistics was not clear. However, it is clear that if the Schultz's definition was applied to the farm organization in Canada, a major segment of the agricultural industry would be excluded from the category of family farms. This type of test could have several implications relative to farm policy in Canada.

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[14]*Ibid.*

A Royal Commission on Agriculture and Rural Life in Saskatchewan reported that: on the criterial accepted for the family farm, only 43 percent of the farms in that Province met these criteria. Hence 57 percent were excluded. The report stated thus:

> It is clear that by far the greatest proportion of Saskatchewan farms that do not meet the requirements for family farm status fail because of inadequate resources. A much smaller group is disqualified on account of large size or too many resources to be handled by a farm family[15].

In dealing with the types of firms in agriculture and their implications, J.C. Gilson has pointed out that:

> While there are several different types of production firm in agriculture, the single proprietorship is the predominant firm at the present time. Ownership and management control, as well as the required labor for the business are generally identified with one person or family. This is what most people have in mind when they refer to the family farm in Canada[16].

He has added that while there are probably as many definitions of the family farm as there are points of view on the topic, one of the most commonly accepted definitions is the following:

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[15]Royal Commission on Agriculture and Rural Life, Land Tenure, Report No. 5, Government of Saskatchewan, 1955, p.23.

[16]J.C. Gilson, Strengthening the Farm Firm, Department of Agricultural Economics and Farm Management, Winnipeg, Bulletin No. 6, 1962, p.4.

(1) The farm operator makes all or most of the managerial decisions,

(2) The farmer and members of his family supply most of the labor needed,

(3) The available resources are sufficient to provide the family with at least an adequate, minimum standard of living,

(4) Tenure is reasonably secure for the operator and his family.[17]

In examining some of the implications of the definition, Gilson has pointed out that the first and second criteria tend to impose an upper limit, while the third criterion places a lower limit, on the size of firm that will qualify as a family farm. The fourth criterion allows the tenant operated farm to qualify as a family farm, provided that the condition for "reasonable security" of tenure is met.

As noted earlier Schultz's criteria suggested that "certain types" tenancy arrangements, which violate the essentials of entrepreneurship, do not qualify as family farms. There are several types of tenancy arrangements. Inasmuch as Schultz did not stipulate the specific types of tenancy referred to, it is difficult to determine whether his definition is at variance with that cited by Gilson.

Another definition suggests the following eight criteria:

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[17] *Ibid.*

1) On which emphasis is placed on farming as a way of life, as on its economic returns.

2) On which management is vested primarily in the family that lives and operates the farm.

3) On which most of the labor is contributed by the family.

4) Which will provide for full and efficient use of all of the land, labor and capital invested in the enterprise.

5) Which, from the total farm and family enterprise will make possible for all the people on the farm to have adequate (a) diet, clothing and housing; (b) health facilities; (c) educational opportunity for children and adults, (d) recreational and social facilities, (e) religious opportunities and activities, and (f) security for old age.

6) Which, in exchange for things purchased, will provide food, fibres, and other products needed for domestic consumption and export.

7) Which will fully conserve and restore the physical resources of the farm, including soil, forest, and water, as well as farm equipment.

8) Which will develop the human resources, particularly the operator's family, but also the other families that work directly on the farm.[18]

The conception of the family farm envisaged in this study requires that the entrepreneurial function remains vested in the farm family. Whenever vertical integration, contract production, or any other consideration impels the farm family to compromise its control of the management function,

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[18]A Protestant Program for the Family Farm, assembled at Biblical Institute, Evanston, Illinois, March, 1948. Cited in Timmons and Murray, "Land Problems and policies", Iowa State College Press, 1950, p. 206. ff. Cited in J.C. Gilson, Strengthening the Farm Firm, Department of Agricultural Economics, Winnipeg, Bulletin No. 6, 1962, p. 54.

the farm violates the conception of the family farm.

Ackerman, Harris and Schickele's third criterion, that the farm be large enough, in terms of land, capital, modern technology and other resources is ambiguous. It assumes that acreage and amount of investment are acceptable criteria for farm size. These criteria are couched in limitations and weaknesses as will be seen later on in this chapter. The writers leave it to the reader's imagination to decide how large is 'large enough'. They have also neglected to reconcile the need for 'large enough' size, with the existence of possibilities for intensification of resource use. It need hardly be pointed out that where excess capacity exist, the farm firm can more efficiently increase productivity and income through greater intensification rather than the acquisition of more resources. In a similar light, more intensive resource use can be as effective in fully using farm labour as acquiring more resources. This conception of the family farm would amend Ackerman, Harris and Schikele's third criterion to read. "Net farm family income is such that it can provide the farm family concerned with the minimum standard of living that it could accept".

Schultz' criteria hold that the farm should not consist of more land and capital than can be operated by the farm family, or a family of normal size in the community. The implication here is that, having accepted one of the several criteria for farm size, it should not grow faster than the size of the farm family. This tends to impose a lower and an upper limit on the size of the family farm. In an era where machinery is substituted for labour, this criterion is obsolete and hence invalid.

There is an implication inherent in this criterion that is more critical than the one just examined. This is that where the size of the family ceases to grow for one reason or another the size of the farm firm should also cease to grow even though distinct possibilities exist for gains in cost economies through an expansion of its size. In this respect, the criterion is unrealistic.

This conception refuses to concede that any limitations be imposed on the size of the family farm. In fact, this study aims to determine whether the family farm is consistent with the optimum size of firm in agriculture. It is a basic tenet of this investigation, therefore, that the farm firm should seek to expand its size towards the point where the cost per unit of output tends to a minimum.

Where the type of expansion discussed above is indicated and tenancy of one form or another is the one means of achieving this goal, the conception of the family farm requires that tenancy should be reasonably secure. This is imperative if long term planning is to be formulated and executed.

This study conceptualises that with a given level of technology and at a specific time period, there exists an optimum size of firm. Time, however, is never static. Technology in this era is a dynamic concept. Planning is a continuous process through time. With the progress of time and technology, therefore, the "optimum size" farm firm becomes elusive and unattainable. The farm firm aspires continually towards an ideal that is very elusive because of the dynamic nature of time and technology. In the process of its aspirations the farm firm has the need to make adjustment with each change in the state of the arts. In its conception of the family farm, therefore, this study envisages a philosophical, social and institutional framework which will allow the farm firm to make the adjustments demanded by the progress of technology.

Finally, the conception of the family farm envisages an economic framework in which a large degree of competition prevails in agricultural industry. The farm firm should not be so large as to exercise monopoly power in the commodities and/or resource markets.

With this conceptual framework, an attempt can now be made to set out in precise terms the definition of the family farm envisaged in this study. The family farm is a firm in which:

(i) the entrepreneurial function remains vested in the farm family,

(ii) the net family farm income is such that it provides the family concerned with at least the minimum standard of living that it would accept. The term "adequate standard of living" is viewed as being ambiguous. It is a subjective concept which would vary from family to family;

(iii) no artificial limit is imposed on the amount of resources land and capital - that the firm should utilize and no arbitrary ceiling is placed on its growth. The market forces are the sole arbiter of ultimate size;

(iv) the philosophical, social and institutional framework is such that it permits the firm, during the urge for growth to effect the necessary adjustments to technological change;

(v) the economic framework ensures a high degree of competition in the farm sector, so that the firm does not exercise monopoly power in the commodities and/or the resource markets; and

(vi) tenancy, where necessary, is secure,

(vii) the farm family provides most of the labour inputs.

3. Criteria of Farm Size

The problem of farm size is a controversial issue of long standing in agricultural economics. The literature abounds with lengthy debates on the advantages and/or the disadvantages of large and small farms. The farm entrepreneur and the person responsible for farm policy are fundamentally interested in the size of unit that would allow for efficiency of operation in terms of resource use, and an acceptable standard of living to the farm family.

However, quite a large number of people continue to debate such issues as whether factory farms will eventually force the family farm out of existence. Others are involved in such controversies as whether or not the family farm is necessarily less efficient than large size farms.

Answers to these questions necessarily depend on the nature of cost economies that are associated with farms of different sizes. Investigation of such cost economies renders it necessary that the meaning of farm size be explicitly stated. It is also worthwhile to examine the implications of some of the criteria of farm size.

Several measures of farm size have been used in farm management studies. These are farm acreage, gross farm output or total income, total or net capital investment, number of man-equivalents, and total productive man-work units. An appraisal will now be made of these criteria with a view to an evaluation of their limitations in terms of the objectives of this study.

More often than not farm size in crop production is measured on the basis of acreage, which may further be broken down into four sub-criteria. These are farm area, crop area, crop acreage area, and area devoted to one or two of the dominant types of crops.

In using the sub-criterion based on farm area, the entire land area operated by the farmer is included. It is composed of the sum of owned and rented land subtracted from the land area rented to others. Farm area consists of the farmstead area, woodlands, pasture and crop lands[19]. In this measure of farm size problems necessarily arise in those cases where differences in the quality of land exist on the same farm. It is worthwhile in such situations to normalize the farm lands on the basis of some standard ratios such as: (x) acres of woodland or (y) acres of pasture land may be equated to an acre of cropland.

The portion of farm area which is used specifically for growing crops is called the crop area. The total area actually sown in crops in a particular year is called the crop acreage area. It is therefore distinct from the crop area all of which may not be grown in crops during a particular year.

The acreage criterion, however, is not an indicator of the real volume of business, which is also affected by the level of intensification, pattern of land use, crop yields, rates of fertilizer application and the particular rotation system. As such it may conceal the effects of these other variables.

This measure of farm size may also tend to overemphasize the effects of mechanization on cost economies

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[19] W.Y. Yang, Methods of Farm Management Investigations for Improving Farm Productivity, (Rome: Food and Agricultural Organization of the United Nation, Agricultural Development Paper No. 64, 1958), p.59.

that are associated with farms of different sizes. In this case, it may cloud the effects of other relevant variables. The investigation may therefore assume the form of a study in the cost economies associated with machinery use on different sizes of farms. Hence the criterion may associate cost economies essentially with machinery use, which may not be the crucial variable in the realization of cost economies.

The acreage criterion is, therefore, inadequate since it considers only the land input. By itself, it fails to consider the differences in the amounts of the other resources, labour and capital and the differences in the levels of management used by other farms with similar acreage. In effect then, although the acreages between farms may be fixed there are differences in the levels of intensification that must be recognized. This is particularly important in problems relating to cost economies associated with farms of different sizes. In measuring the effects of differences in size on cost economies - the sampling units must be reasonably homogeneous.

Another facet of the limitations to the acreage criterion is that one farm may be big in terms of acreage, whereas another may be bigger in terms of capital, labour and the quantity of output produced.

Often a crop farm will be big in terms of acreage while another neighbouring will actually use more labour and capital. Farms which use large amounts of capital and a small acreage of land are said to be intensive units; size or volume of output may be increased by intensification on a given area. Farms which use large acreages relative to labour and capital are said to be extensive units; size and volume of business may be increased by acreage expansion. Many types of farming are of an intensive nature and use much labour and capital even though their acreage is relatively small. Hence since expansion in volume of output can come either through intensification or extension - land input i.e. acreage is not a sufficient measure of farm size.

While the foregoing facets of the problem impair the effectiveness of acreage as a measure of farm size, this does not mean that its use is altogether meaningless. Research work on problems of farm sizes and its associated cost economies can improve the utility of the acreage criterion through a process of normalization. The soil in a particular district is normally classified into several types. In the Carman area of Manitoba, for example, the soils are classified into Types I, II and III. The investigation can therefore be concentrated on a particular soil type in order to increase the homogeneity of the group of farms under study. Homogeneity of the farms can also be improved by standardizing the crop rotations during the particular year.

Where soil type and rotation systems have been homogeneized - there remain the problems of the differences in the level of management and differences in the level of intensification on the fixed factors of the group of farms. Through the use of the synthetic budgeting method - the problem of differences in management can be dealt with. In this method the budgeting coefficients can be derived from the operations of a single farm, and as such does not entail a different management. This process will be developed further in Chapter VII.

The problem of differences in intensification nevertheless still remains. No conceptual or empirical framework has so far been formulated to deal with this problem. This may be partially because no real measure of excess capacity at the farm level have been developed.

Because of the inadequacies of measures of excess capacity at the farm level, and because of the complex conceptual empirical problems involved no attempt has been made in this study to solve this problem. Hence cost economies may be attributed to either differences in farm size or differences in the levels of intensification.

However, this particular variable becomes a powerful tool in explaining the differences in cost economies where these exist on farms of the same size, where all other variables are reasonably homogeneous. Farms with greater cost economies where all variables, except for intensification, are homogeneous will indicate to those with less the nature of the internal adjustments that are necessary so as to obtain greater cost economies through intensification on the fixed factors. In other words, more scope may exist for greater cost economies through intensification rather than through expansion of size.

Apart from the fluctuations occasioned by the vagaries of the weather, gross farm output is a good criterion of farm size. There is a close association between the volume of farm output, and the total amount of resources used irrespective of whether the proportions are high in terms of capital, land or labour.

The criterion adequately reflects the real volume of farm business. It is therefore a realistic measure of farm size. Quite unlike the acreage criterion, this measure indicates the effects on cost economies of all the relevant variables that are associated with the volume of business.

In those cases where the farm firms produce several crop products, output can be measured in dollar sales in order that they can be aggregated. They can also be normalized in terms of the dominant crop.

As this criterion emphasizes the production side of the farm business, it may conceal the effects of some of the associated variables such as labour costs etc. The measure is largely affected by acreage, yields, and prices which may need to be adjusted for comparisons with other farms.

Nevertheless, it is a superior criterion of farm size to the acreage criterion in that it does not possess all the pitfalls of the latter. There is some definite functional relationship between acreage and output assuming that yields per acre and intensity of land use are relatively uniform. Hence, where the relevant variables are reasonably standardized this criterion has great usefulness in studying the cost economies that are associated with different size farms.

The plausibility of the total or net capital investment criterion depends to a large extent on the real valuation of all farm capital assets. This emphasizes the need for comparable and consistent standards of capital valuation. However, the efficiency of this criterion is seriously impaired by the conceptual, theoretical and empirical difficulties involved in valuating capital assets.

Capital may be classified as monoperiodic or polyperiodic resources. The former are those that are essentially transformed into a product during a single production period. Polyperiodic capital resources are those that are transformed into a product over a number of production periods. Hence, the input of such resources consist of annual depreciation of machinery, equipment and buildings; and interest on investment on capital.

Durable assets such as machinery and equipment constitute a stock resource which gives rise to a flow of input services over the life of an asset. Therefore, the inputs of capital items for a particular production period must be considered as rates or flows where the real input is the use or service of the capital good. This creates a real difficulty in setting prices for the services of the capital inputs, which are not consumed during a single production period.

The other dimension of this problem is the fact that depreciation consists of a time component i.e. exposure to the elements; and a use component i.e. wear and tear that are associated with actual use. In addition thereto, an interaction exists between repair costs and the magnitude of the time and use depreciation. By continually incurring repair and maintenance costs, probably at an increasing rate through time, the life span of a durable asset may be extended almost indefinitely. The net result of this is that there exists no objective way of linking particular units of inputs with particular units of output. All that can realistically be said is that all the inputs of the durable factor are jointly responsible for the whole stream of output over time. Costs of durable assets do not therefore have much significance in the short-run.

Measurement of the flow of services as a depreciation rate is necessarily based on an arbitrary criterion. As such it may be quite unsatisfactory. Equipment is composed of several items, all of which depreciate at rates of characteristically their own. Most of these rates are determined in an arbitrary manner; and therefore fail to depict true situations. The rates so used are not the result of a desire to be arbitrary, but rather of the difficulties involved in establishing more realistic rates.

The depreciation rates selected are based on the expected useful life of the piece of equipment. If it is anticipated that the asset will last for twenty five years, a depreciation rate of 4 percent is considered appropriate. But obviously, it is difficult to foretell what will be the length of the useful life of the particular asset. It has already been pointed out that the length of the useful life of an asset depends upon the care in its upkeep and maintenance. Even in cases where a reasonable estimate of physical deterioration and useful life can be made, technological progress will introduce elements of obsolesence that will render predictions very difficult, if not impossible to make.

Some of the farms that are investigated in this study were over-capitalized. In order to make efficient use of labour and capital a considerable amount of custom work was undertaken during the production period under review. These were features of a large proportion of the farms in the group, which utilized large units of machinery and equipment in order to enhance the timely sowing and harvesting operations. The use of larger machinery enabled farmers to minimize losses in crop product through belated sowing and/or tardy harvesting. The farmers were able to complete these chores in a minimum time and so were able to undertake custom work. Other farms in the group, especially those with a large custom work bill may be considered under-capitalized on the basis of this criterion.

Farms, that are over-capitalized, have a considerable amount of excess or unused capacity. As such, this feature distorts the real size of business where the criterion of net or total capital investment is used as a measure of farm size. Farms, that are under-capitalized - especially those that employ a great deal of custom work, do not really reflect their potential size in terms of quantity of machinery used. It is evident, therefore, that where some farms in a group are over-capitalized whereas others are under-capitalized, this renders comparisons very untenable. In a study where it is desired to isolate the effect of farm size in cost economies, it is necessary to have all the other variables, that affect cost economies, reasonably homogeneous. Where the amount of excess capacity affects cost economies, it becomes very difficult to isolate the effect of size.

In view of the conceptual and empirical problems relating to depreciation and the problems of excess capacity; this study rejects the adoption of the net or total investment criterion as a measure of farm size.

The usefulness of the "number of man-equivalents" criterion is limited to comparing farm sizes of the same degree of labour efficiency and mechanization. It is considered that this criterion will be ineffective in this study since quite a disparity exists in the groups of farms in labour efficiency, and the extent of mechanization. The latter problem has already been examined.

The total productive man-work units criterion is based on the normal labour requirements of the farm. It represents a standard day, normally about eight to ten hours, of productive work by an adult male, or the equivalent, that is required for growing crops and other farm chores. This criterion may be useful in making inter-farm comparisons where the difference in the level of mechanization among a group of farms is not too great. In the farms used in this analysis the disparities were too great for this criterion to be effective.

This survey of the different measures of farm size indicates that each criterion has its own merits, and place where it can effectively be used. Therefore, the choice of a particular criterion depends upon the objectives of the investigation.

In this study the "gross volume of product" and "improved acreage" criteria are used as measures of farm size. As had been explained earlier - the volume of farm output criterion is a realistic measure of farm size inasmuch as it adequately reflects the real volume of farm business. Also, the 'acreage' criterion possesses some unique features that well adapts it to the particular objectives of this study.

CHAPTER VI

SOURCE AND NATURE OF DATA USED IN EMPIRICAL ANALYSIS

Another controversial issue in agricultural economics research is the source, nature and method of collecting data for the empirical verification of hypothesis in farm production studies. Historically, research workers used data that were compiled from censuses, surveys, judgement and purposive samples. More recently, researchers have been using data obtained from the records of farm accounting associations, such as the Carman District Farm Business Association, and the Western Manitoba Farm Business Association[1].

The crux of the issue lies in the limited scope for inductive generalization in cases where conclusions are based on non-random sample survey data. Research workers are fully aware that random sampling increases the scope of the inferences of their investigations. There are, however, some commendable features in the data compiled from associa-

[1] The Carman District Farm Business Association is a voluntary association of farmers in the Carman area of Manitoba. It was organized in the spring of 1957 with 70 members. The Western Manitoba Farm Business Association is also a voluntary association of farmers in the Neepawa-Minnedosa-Hamiota-Miniota area of Manitoba. The purpose of the two Associations is to co-operate in farm management research with the Department of Agricultural Economics, University of Manitoba.

tion records. Perhaps, the most important is that it allows the research worker to obtain a continuous picture through time of the processes of growth in the size of the farms.

This is indeed a significant consideration that can hardly be overlooked in the search for a solution to the particular problem which initiated this study. Research, once it has started, proceeds along a continuum. There is no end since knowledge is never complete. Time and experience may render old ideas invalid. It may also become necessary to re-assess traditional approaches and explanations of economic and social phenomena.

There can be no one-for-all answers to the problem of farm size. The dynamic nature of technical innovations in agriculture may render invalid tomorrow a size of farm that is considered the optimum today. This makes it necessary that this investigation be followed up by subsequent ones, in order that there could be a continuing re-appraisal of the solutions in the light of subsequent changes that may occur.

The records of the farm associations possess decided advantages, which strongly recommend their use in this study, over random sample survey data. The data from the records of the Carman District Farm Business Association will specifically be used in testing the hypotheses of this investigation. The implications in the use of this kind of data will now be examined, in order to evaluate its limitations on the conclusions that arise from this study.

Statisticians idealize the use of data procured from random sample surveys since this type of sampling provides an objective basis for generalization, and a mathematical framework within which the probability of error and variation can logically be determined. However, it is the thesis of this study that each method has its own place and merit. As such, each may be considered appropriate for a specific purpose. It is further held that where one method has limited applicability, another method comes into its own. One method may also indicate where another may effectively be applied. For these reasons it is considered futile to debate the superiority of one method over the other in farm production studies.

The report on the Canadian Census of Agriculture indicates that in 1961 there were 43,306 farms in the Province of Manitoba[2]. In that year there were 70 farms in the Carman District Farm Business Association[3], which constitutes .16 per cent of the Provincial total.

The interpretation of the results of the analysis, and the implications arising therefrom are of particular

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[2]Dominion Bureau of Statistics, 1961 Census of Canada Agriculture, Manitoba, (Ottawa: Queen's Printer and Controller of Stationery, 1963), p.1-1.

[3]Department of Agricultural Economics and Farm Management, 1961 Annual Report, Carman District Farm Business Association, (Winnipeg: Faculty of Agriculture and Home Economics, University of Manitoba, Winnipeg, 1962), p.i.

interest to farmers in the specific areas studied, to persons engaged in extension work, to credit agencies, and to institutions that furnish farm machinery and other farm equipment. Sustained studies of this type develop measures and standards, which serve as criteria on which analyses and improvements in the performances of farm business can realistically be made. This is undoubtedly essential to a progressive and healthy agricultural industry.

Having regard to the objectives just outlined, the group of farms in the association lays no apriori claim to be representative of the population. The term "population" is used here in the statistical sense, denoting the total number of the estimated 43,306 farms in the Province of Manitoba. The farms that joined the Associations have done so by choice rather than by selection. This being the case, the question now arises as to whether the group of associating farm constitutes, in its own right, a sample in the statistical sense. The answer to this question lies in the conception of a sample. Webster's dictionary defines a sample as being a "part or piece taken or shown as representative of the whole group." On this criterion, the associating group of farms is not a sample, since it has no pretensions of being representative of the population.

The basic assumptions upon which the theory of sampling rests apply both to the way the sample is obtained and to the material sampled. With respect to the material sampled, the assumption is that there exists a large universe of items subject to more or less uniform conditions. It is also assumed that throughout the universe the individual items vary among themselves in response to the same causes, and with the same amount of variability. With respect to the selection of the sample, the values must be so selected that the selection or occurrence of one item in the sample is independent of the selection of any other item. The implication of this specific assumption is that the population is normally distributed. The second assumption is that the successive items in the sample are not selected from different portions of the universe in regular order. They are simply chosen at random so that the chance of the occurrence of any particular value is the same with each successive observation in the sample. The third assumption is that the sample is not picked from one portion of the universe, but that the observations are scattered throughout the universe by purely chance selection.

The definition of a sample, and the assumptions just outlined render it untenable to assert that the group of associating farms constitute a sample in the statistical sense. The group lays no claim to randomness or independence. Therefore, it can best be viewed as constituting a special case that is designed in no way to be representative of the population. Hence, for all practical purposes the analysis, classification and interpretation of data from accounting associations can realistically be interpreted as the case study method.

Alfred Marshall, who utilized the case study method in his monumental contributions in the field of economic theory, has defined the case study method as "the intensive study of all the details of the domestic life of a few carefully chosen families[4]." He claims that at its best, it is the best of all methods, but he warns however, that in ordinary hands it is likely to suggest more untrustworthy general conclusions than those obtained by the more extensive statistical method. To work well, Marshall suggests that the case study method requires a rare combination of judgement in selecting cases, and of insight and sympathy in interpreting them.

The intensive character of the case study method renders it practical to examine and investigate only a small number of cases with the depth, thoroughness and perception necessary. Quite a great deal of time must be spent in adequately analyzing a single case. The justification for this lies in the fact that it is only through an exhaustive study that new relationships can be discovered and accurately analyzed. It is obvious that each individual case has characteristics which can logically be regarded as typical

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[4]Alfred Marshall, Principles of Economics, Eighth Edition, (London: Macmillan Company, 1959), p.116.

of a larger number of cases.

The case study method is distinct in itself as a method. However, it bears a direct relationship to the other technical methods. Elmer holds that the case method and the statistical method are independent and complementary. He states that:

> The statistical method points out the existence of repetitious units, which may show the presence of a desirable or undesirable situation. The case method on the other hand calls attention to problems to which the statistical method may be applied, and on the other hand may follow a statistical conclusion by a comprehensive analysis of the particular phenomenon which has been shown statistically to be a repetitious unit[5].

The continuing nature of the case history developed since the Associations were formed is a veritable pioneering effort that constitutes a research laboratory for farm production studies. The case description based on such data is always a true record of what occurs in the particular instances. This attribute is in direct contrast to the central characteristics of the random sample survey method when generalization, except in those instances when all the cases are included, is only an abstract approximation. Where the latter method is used, definiteness and precision of detail must to some extent be sacrificed to the more inclusive view of statistical generalization.

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[5] E. Elmer, Social Research, (New York: Prentice Hall Inc., 1939), pp. 122-123.

Intensive examination, analysis and interpretation of the Associations' records may be compared roughly to the use of the microscope and/or the laboratory experiment of the experimental method. In this manner, the farm firm is studied in its entirety. Its behaviour can then be investigated when placed alongside other units possessing similar attributes. The behaviour of the farm firm can also be studied under changing environmental conditions. These aspects of scientific research imposes a serious limitation on the use and effectiveness of the random sample survey method.

Use of the Associations' data for farm production studies provides a continuous picture through time of the growth of the business within a given social, economic and political environment. The records provide the life history of the individual farms, and furnishes all possible desirable data regarding the farms studied. They enable the investigator to derive therefrom a unified coherent concept concerning the part played by complex influences in determining the character and experiences of the farm firm its existence as a unified entity.

Whereas data collected through random surveys have limited use where sociological, psychological and institutional problems are involved, the use of the Association data comes into its own. The records are comprehensive, introspective, and reflective. They reveal the inner private life of the farm firm in terms of the fundamental motives or attitudes of the entrepreneur, and social structures that call such attitudes into existence. One of the hypotheses of this study suggests that managerial incentive is one of the variables that affect the size of farm. In testing this hypothesis, the personal nature of the information required suggests that a sociological and psychological study of each farmer's personality is necessary. The case study method lends itself better than the alternative methods to obtaining this type of data.

The Associations' records therefore enhance the penetration, thoroughness, depth, comprehensiveness and intensification in the analytical approach designed to isolate and study problems, and to indicate the areas where further empirical research is necessary. By their use, repetitions of situations, meanings and responses may be noted, and adapted for comparative purposes in forming generalization where possible.

It is to be emphasized that generalization based on analyses of the Associations' records is dangerous. As was indicated earlier this was really not the intention in the formation of the Association. Research based on these records has no real claim to be a basis for inductive generalizations. However, where and whenever this is attempted such inferences are based upon an intimate knowledge of the situation, and of the habits and attitudes of the persons and units inter-acting.

It is now necessary to examine the reasons that render it illogical, if not impossible, to generalize on the basis of the conclusions derived from an analysis of the Associations' records. The subjective data gathered by this method of analysis does not lend itself to quantitative check. Much of the data represent atypical cases. Random sampling is neglected and generalizations may be false. The records are open to errors of perception, judgement and unconscious bias with a special tendency to over emphasize the unusual. On completion of an exhaustive study of the various phases of the few cases, there may be the tendency to generalize. However, inspite of the mass of data analyzed in the few cases, generalizations may be exceedingly dangerous. These can be viewed as mere conjectures or trial hypotheses to be subjected to more extensive empirical verification. The great pitfalls in the use of the Associations' records for farm production studies, from the statistical point of view, are the lack of statistical objectivity in the observations and recording of the material, and the informality and subjectivity of any generalizations attempted.

The motive in using data from random sample surveys in farm production studies is to have an objective basis on which inductive generalization can be made for the entire population. This method attempts to abstract certain attributes common to all farms in the random sample, and then it analyses variations in these and associations between them. The rationale here is that if a sufficiently large number of random samples is taken, this would increase the probability that the estimated population parameter will more closely approximate the true value.

The random sample survey method, through the use of statistics, attempts to project the formation of significant judgements into "no man's land" i.e beyond the limits where a complete count is impracticable. In so doing, this method relies heavily on what is referred to in mathematics and statistics as the "law of regularity." This law holds that "a moderately large number of items chosen at random from among a very large group are almost sure, on the average, to have the characteristic of the larger group[6]." There is no implication in this law however, that the resemblance between the sample and the population will be perfect.

The assumptions upon which the theory of random sampling is based impose the most crucial limitations on the usefulness and effectiveness of the method. These assumptions have already been examined above. The other sources of error which can impair the reliability of the

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[6]H. Jerome, Statistical Methods, (New York: Harper and Brothers, 1924), pp. 13-23.

random sample survey method are the incidence of inadequate or inaccurate data, mechanical mistakes and unsound interpretations. It is also a one-shot approach to which no follow-up work may ensue.

This method is not equipped to deal with the non-quantitative aspects of farm family living. It is a poor predictive tool in that it allows for the rise of new variables. It is also in-effective in dealing with unique phenomenon in social life, and has limited applicability in discovering or isolating new things in farming.

It is in these specific areas that the case study method, through use of the Associations' records, is very effective, It offers tremendous scope for the study of qualitative problems in farm production studies. Another positive use of the method lies in its dexterity in formulating or suggesting trial hypotheses in the exploratory stages of research. It is fallacious, therefore, to argue that the random sample survey method is superior to the case study approach. Each has its specific function, merit and place in the continuum envisaged in the scientific method. The two approaches are not competitive. They are complementary to each other.

It is to be reiterated that the case study method is not intended for use as a basis for generalization in farm production studies. Its role is essentially problem identification and problem solution through further research. Most of the problems encountered in its use do not lie in the limitations of the method perse. They emanate from a fundamental misconception of the nature, the attributes and the scope of the method. Little wonder that Alfred Marshall warned that in unskilled hands the case study method is "likely to suggest more untrustworthy general conclusions than those obtained by the more extensive statistical method."

CHAPTER VII

ANALYTICAL METHODS

The analytical techniques that have been used most widely in estimating the cost economies curve are synthetic budgeting, regression analysis and mathematical programming.

In order to determine the effects of farm size on cost economies or dis-economies, it is necessary to standardize all the variables, except size, that affect cost economies. These variables are soil type; crop combination; the external forces which influence the operation of the farms; management and the level of capacity utilized.

Several conceptual and empirical problems arise in an attempt to standardize these variables. However, the extent of these difficulties depends upon the particular analytical technique employed in approximating the cost economies curve. In this study synthetic budgeting and regression analyses have been used in estimating the curve.

The Method of Budgeting Analysis

This method involves the estimation of the short-run average cost curves for the various strata of farm sizes, and then fitting the planning curve as an envelope of the series of cost curves.

This study is based on those farms in the Carman

District Farm Business Association that fall within the soil type I classification. From this group of farms, those on which seventy five to one hundred per cent of gross current receipts were derived from crop production were classified as crop farms. On this criterion forty one such farms were selected for this study.

These farms were then stratified according to their acreage. This is presented in Table II below.

TABLE II

STRATIFICATION OF FARMS

Stratum	Acreage Interval	No. of Farms
I	< 299	4
II	300 - 399	9
III	400 - 599	15
IV	600 - 799	10
V	800 - 999	1
VI	> 1000	2
Total No. of Farms		41

The acreage intervals were so selected in order that there would be a quarter-section, a half-section, a three-quarter-section and a whole-section farm within each interval. This is the most realistic method of setting the intervals, since operators normally tend to increase the size of their farms by quarter-sections if this is available.

The farms selected for study in the budgetary analysis derived from 95 per cent - 100 per cent of their gross current receipts from crop production. An adjustment had to be made in their expenditures for services that are not associated with crop production. Such services include outlay on custom work off the farm and/or livestock production. This involved the segregation of joint costs. The adjustment in total expenditure were made on the basis of the percentage of current receipts that were derived from sources other than crop production. This criterion may be considered arbitrary, but no better method is available for segregating joint costs.

This method of selection minimized the problems that were encountered in allocating joint costs between crop and livestock enterprises on the same farm. However, it was improbable that the farms selected will be exactly one quarter-section, a half-section and so on in size. The sizes of the farms that were selected are presented in Table III.

The problem was then to estimate average cost curves for the farms in the various strata. One farm was selected from each stratum on which crop production constituted nearest to or one hundred per cent of gross current receipts. The input-output coefficients of this farm were used to synthesize the cost curves for the farms in the particular stratum.

TABLE III

CHARACTERISTICS OF CROP FARMS TO BE USED IN THE BUDGETING ANALYSIS

Stratum	Acreage Interval	Acreage of Particular Farm Selected	Crop Production as a Percentage of Current Receipts
I	< 299	160	95%
II	300 - 399	320	96
III	400 - 599	560	99
IV	600 - 799	708	100
V	800 - 999	893	100
VI	>1,000	1,190	96

This method guaranteed the homogeneity of the variables within the stratum. It represents a departure from the conventional technique of deriving the cost curves from coefficients that are averages over all stratum farms. The conventional method is beset by too many conceptual and statistical limitations that seriously impair its utility in this study. Some of these difficulties are the measurement and aggregation of management and capacity variables.

These two variables have considerable effects on the cost-economies or dis-economies which accrue to the farm firm. No objective method has been developed for quantifying these variables. It is, therefore, difficult to either standardize or measure them. Many studies ignore the effects of these variables[1]. Others assume that they are constants over all the farms in the stratum. Such approaches to the problem are difficult to justify in terms of the real world. They necessarily cause the resulting cost function to be a mongrel. More important than this is the fact that it will be illogical to assert that estimated cost-economies are due to the differences in the size of farms. Savings in cost may well be attributable to farm size, management or the level of capacity at which farms are operated; or some combination of these three variables. In any attempt to study the effects of farm size, it is necessary therefore to isolate the effects of the other variables.

This is exactly what the particular model developed in this study attempts to accomplish. The model is also more consistent with the fundamental requirements of homogeneity than can be claimed for the conventional technique.

The heterogeneity of the variables between strata makes it untenable to assert that the planning curve depicts the cost-economies and dis-economies that are associated with different farm sizes alone. The implications of the assumption of continuity, which is implicit in the planning curve, are that there are changes in the variables as farm size changes.

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[1]For an example, see W. Darcovich, "The Use of Production Functions in the Study of Resource Productivity in Some Beef Producing Areas of Alberta", The Economic Annalist, Vol. XXVIII, No. 4, August 1958, p.93.

In estimating the planning curve, the problem is to ensure as far as possible, that the variables are reasonably homogeneous. The model, which has been developed for dealing with this particular problem, groups the relevant variables into six categories. These are soil type; external forces that influence the operations of the business; resource inputs; crop combination; level of farm capacity and management.

Homogeneity of soil type presents no problem since only crop farms of soil type I classification in the Carman District are included in this study. There are no differences in the external forces that influence the operations of the farm firms in this particular group.

On the selected group of farms there were grown various combinations of wheat, oats, flax, sunflowers, barley, peas, buckwheat, sugar beets and hayseed. The distribution of crop combination on the six farms is shown in Table IV.

In terms of the acreage devoted to it and of gross farm receipts, wheat is by far the most predominant crop. This is followed by oats, and then flax. Except for the isolated cases, where a little peas, buckwheat, meadow fescue seed, sugar beets or barley are cultivated, the rotational systems in terms of the major crops are reasonably homogeneous.

Several conceptual problems are encountered in

TABLE IV

DISTRIBUTION OF CROP COMBINATION ON THE SIX FARMS
USED IN THE BUDGETARY ANALYSIS

Crops	No. of Farms Producing
1. Wheat	6 farms
2. Oats	6 "
3. Flax	5 "
4. Hay	4 "
5. Sunflowers	3 "
6. Peas	1 "
7. Buckwheat	1 "
8. Meadow fescue seed	1 "
9. Sugar beets	1 "
10. Barley	1 "

any attempt to normalize the level of capacity of farm operation. It has proven very difficult to find a universally acceptable conception of farm capacity. It was also difficult to find an objective measure of it. This may well be the reason why studies on problems of farm size have neglected it. However, it definitely affects the cost economies that are associated with different sizes of farms.

Farm capacity may be defined as the maximum production potential of a producing unit of a given size or with a given quantity of resources. On this definition, the problem then arises as to how best this variable may meaningfully be quantified. In effect, how may the capacity of the farm firm be objectively measured? In asserting that a quarter-section farm has a certain level of capacity is an arbitrary judgement, which may be devoid of empirical content. Surely, the capacity of a farm depends upon the particular resource combination, which varies between farms. It is clear then to obtain a measure of the capacity of the farm firm, it is necessary to know the quantity of each resource used land, labour, capital and management. Hence, the total capacity of the producing unit is the sum of the capacities of the individual resources utilized.

The problem resolves itself into the determination of the capacity of a unit of land, a unit of labour, a unit of capital and a unit of management. Crop yields per acre are not really known. The productive capacity of a hired hand per workday depends on several variables among which are health, education, incentive, initiative, age and sex. It seems dubious whether a precise mesurement of this resource can be made.

Capital may either be as polyperiodic and monoperiodic in farms. Durable capital assets give rise to a flow of services over many production periods. This makes it difficult to measure the capacity of a unit of capital in a specific production period such as is the case in this study. No method exists that makes it possible to obtain an objective measurement of the management variable. It is not possible therefore to quantify the capacity of an operator in his role as manager.

Even if it were possible to devise realistic measurements of the capacities of the resource inputs, problems of aggregation may seriously impair the reliability of the final estimate of farm capacity. The existence of these intricate problems makes it necessary that some alternative indicators of capacity be used in this study.

Theoretically, it is postulated that farm firms on the planning curve are operated at optimum capacity. In the empirical estimation of this curve the difficulties, that have just been examined, make it untenable to assert that the theoretical postulate holds true. Clearly, the exact position of the planning curve in the real world could hardly be empirically derived. However, it can be asserted with some measure of certainty that the estimate of the planning curve that is empirically desired represents at least the lowest upper bound of the position of the real planning curve.

It is not a critical limitation to this study if the farms along the estimated planning curve are not operated at optimum capacity. What is more desirable from the point of view of the homogeneity requirement is that the level of capacity over all farms should be reasonably uniform.

In this study, the intensity of land use and machinery investment per improved acre were adopted as indicators of the level of capacity at which the farms are operated. The choice of these variables assumes that they give some indication of the intensity with which the farms are operated. Intensity of land use is defined as the ratio of the number of crop work units to the number of improved acres, i.e.

$$\text{Intensity of land use} = \frac{\text{Number of crop work units}}{\text{Number of improved acres}}$$

These characteristics of the farms are presented in Table V.

On the basis of the criterion of intensity of land use it can be asserted that the group of farms are reasonably homogeneous. Except for some small differences on the second and sixth farms they are also reasonably homogeneous with respect to the criterion based on machinery investment per improved acre.

TABLE V

SOME MEASURES OF THE LEVEL OF CAPACITY OF THE GROUP OF FARMS

Farm No	Farm Size (acres)	Number of Improved Acres	Percentage Crop Farm	Intensity of Land Use	Machinery Investment Per Improved Acre
1	160	155	95	.377	$ 32
2	320	308	96	.412	20
3	560	502	99	.405	35
4	708	658	100	.426	35
5	893	883	100	.421	32
6	1,190	1,160	96	.465	26

With regard to the management variable it is necessary to distinguish between homogeneity in terms of the quality, and homogeneity in terms of the quantity of the input of this factor. In theory the quality of management is assumed to be homogeneous over the different sizes of farms, However, it is implausible, both theoretically and empirically, to require that the quantity of the management input be kept constant over all sizes of farms. Quantity of management refers to the amount of co-ordinating duties which the single operator performs.

An assumption that the quantity of management should be constant over all sizes of farms, implies irrationality on the part of entrepreneurs. Surely, this is inconsistent with the conception of the planning curve. The implications of this assumption may be pursued further. If an operator has a quarter-section farm on which he spends an eight-hour work day to accomplish his chores. By implication, if he were to increase the size of his farm to a half-section, then he will need a sixteen-hour work day to accomplish his chores. Similarly, he will need a twenty-four hour work day and a thirty-two hour work day to complete his daily chores on a three-quarter and a full-section farm respectively. If the implications of this assumption are pursued further, the farmer will either work himself to death or the chores will remain undone. Alternatively, he may have to hire a man for each new quarter-section of land that is added to the initial size of the farm unit.

Clearly, entrepreneurs do not operate their farms in this fashion. As the size of the unit increases the operator necessarily assumes more duties both in terms of his functions as a source of farm labour, and in his role as the co-ordinator. While it may be possible for him to hire extra labour or substitute machinery for labour as the size of the unit expands, it may be undesirable for many reasons to delegate some of the additional co-ordinating duties to one of the hired hands.

As the size of the farm increases the operator makes better use of his own labour resources and managerial skill. This results in decreasing cost per unit of output.

However, further expansion of size causes the managerial responsibilities to become more complex and exacting. With this may be associated the constant per unit cost that results.

There is a very definite limit to the human potential in terms of its skill and dexterity in the use of resources. Some operators recognize this fact and others do not. Expansion of the farm to a size that is beyond the capabilities of the operator results in increasing cost per unit of output. Greater net savings in unit cost may be a very distinct possibility on a larger size farm. However, some farmers prefer to operate efficiently the size of unit which is consistent with their managerial potential.

The operator of the five hundred and sixty acre farm which was selected from the third stratum illustrates the case in point. In terms of resource used, this operator is imaginative and efficient. By comparison with other farmers around him, his achievements are so outstanding that, without prior knowledge of his philosophy, an enthusiastic extension specialist may recommend an expansion in the size of the farm. This farmer maintains that his unit is of the correct size, which his capabilities would allow him to operate efficiently. He feels then any further expansion will most certainly result in higher unit costs.

The operator does not want to have any hired hands on the farm. Expansion in farm size will necessitate the hiring of extra help who must be provided with board. This operator regards the farm as his home. He maintains that having hired hands on the farm will be compromising the privacy of his home and family.

In the budgetary model used in estimating the farm's short-run average cost function, inputs were divided into fixed and variable categories. The former includes general overhead such as insurance, taxes, interest on debt etc., depreciation on buildings, machinery and equipment; interest on investment, and the operator's labour. The variable inputs include hired labour; the cost of operating farm machinery and equipment; crop costs such as fertilizer inputs, seed and other crop costs; repair and maintenance of machinery and equipment; and miscellaneous inputs.

The criterion of farm size in the budgetary analysis is the volume of production in dollar value. Farm acreage in the short-run production period will be fixed. Increasing the size of business therefore, involves stepping up production on a fixed number of acres. This can be accomplished by cultivating crops on acreage normally devoted to summer fallow; increased use of fertilizer; second crops, and taking crops off stubble.

This is exactly what farmers in the Carman area are doing in order that they may achieve some of the short-run gains from the increases in wheat price caused by huge sales to Communist countries. Their actions can best be studied in the model outlined below:

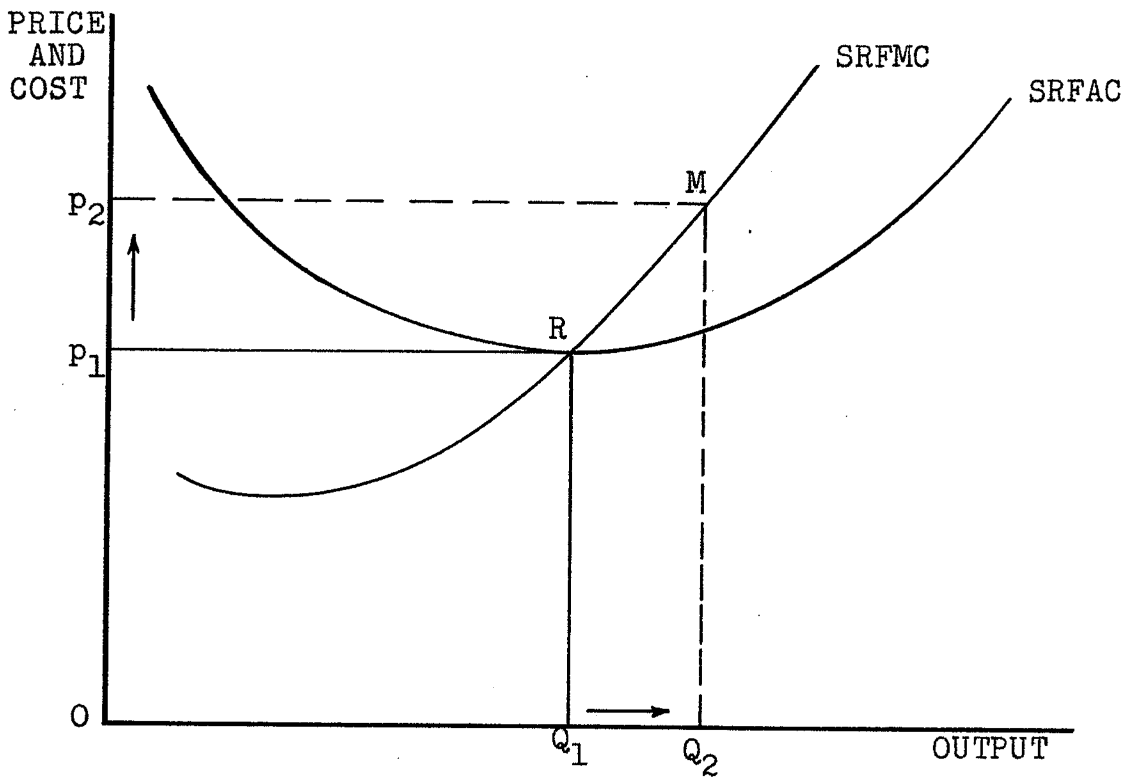

Figure 21 : Short-run Increases in Output Stimulated by Higher Price Per Unit of Output

Prior to the large sale of Canadian wheat to the Communist countries, let it be assumed that the farm price per bushel of wheat was p_1 and the amount produced by the operator was Q_1. The income from the sale of wheat was the area given by p_1RQ_1O. The huge sales of wheat abroad has caused an increase in the demand for Canadian wheat, thus resulting in a short-run rise in price to p_2. Farmers are now stepping up their production from Q_1 to Q_2 through intensification in their fixed resources so as to capture the short-run gains from the increase in price. They are now using more fertilizer on their fields. Land that was normally in summer fallow is currently being used in wheat production. With these measures their incomes are now given by the area p_2MQ_2O. The increase in income is given by the area $p_1p_2Q_1Q_2$.

The response of crop yields to increases in the application of fertilizer adheres to the law of diminishing returns[2]. The relationships can be depicted in Figure 22. Associated with the phenomenon of diminishing marginal productivity of resource inputs is a short-run average cost function that rises to the right of its minimum point. This is depicted in Figure 23.

Unfortunately, there are no specific data for the farms used in this study showing the response of crop yields to increases in the application of fertilizer. There are however, experiments done by The University of Manitoba in

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[2]The following studies are cited as evidence of this phenomena.

(i) H.E. Tolton, Response of Cereals to Anhydrous Ammonia as Correlated with Tests from Available Soil Nitrogen, Unpublished Master's Thesis, Faculty of Graduate Studies and Research, University of Manitoba, 1957.

(ii) H.E. Tolton, J.C. Gilson, R.A. Hedlin, "Physical and Economic Relationships Involved in Fertilizer Use", Canadian Journal of Agricultural Economics, Vol. V. No. 2,1957.

(iii) J.C. Gilson, V.W. Bjarnasson, "Effects of Fertilizer Use on Barley in Northern Manitoba", Journal of Farm Economics, Vol. XL, No. 4, 1958.

(iv) Soil Science Department, University of Manitoba, Annual Conferences, 1959, 1960 and 1961.

In a study by J.C. Gilson and M.H. Yeh, Productivity of Farm Resources in the Carman Area of Manitoba, Faculty of Agriculture and Home Economics, University of Manitoba, Technical Bulletin No. 1, September, 1959. These research workers showed diminishing returns to labour, land investment, operating expenses, machinery and equipment; and negative returns to building investment.

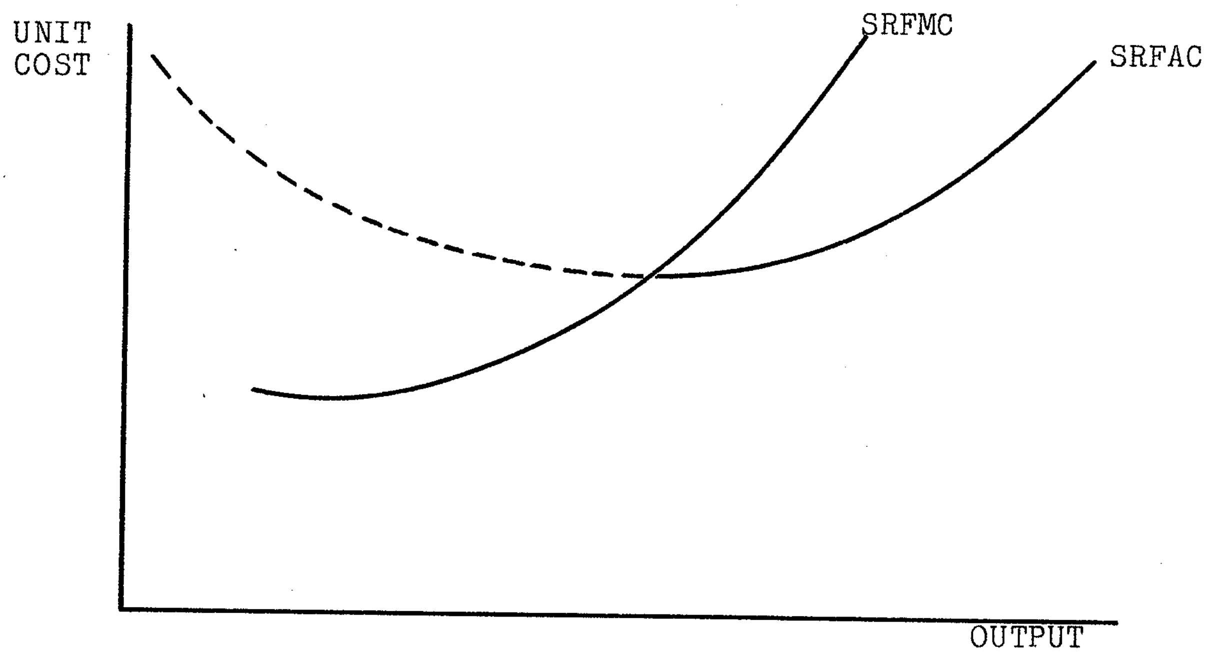

Figure 23 : Rising Portion of Farm's Short-run Average Cost Function Associated with the Phenomenon of Diminishing Marginal Productivity.

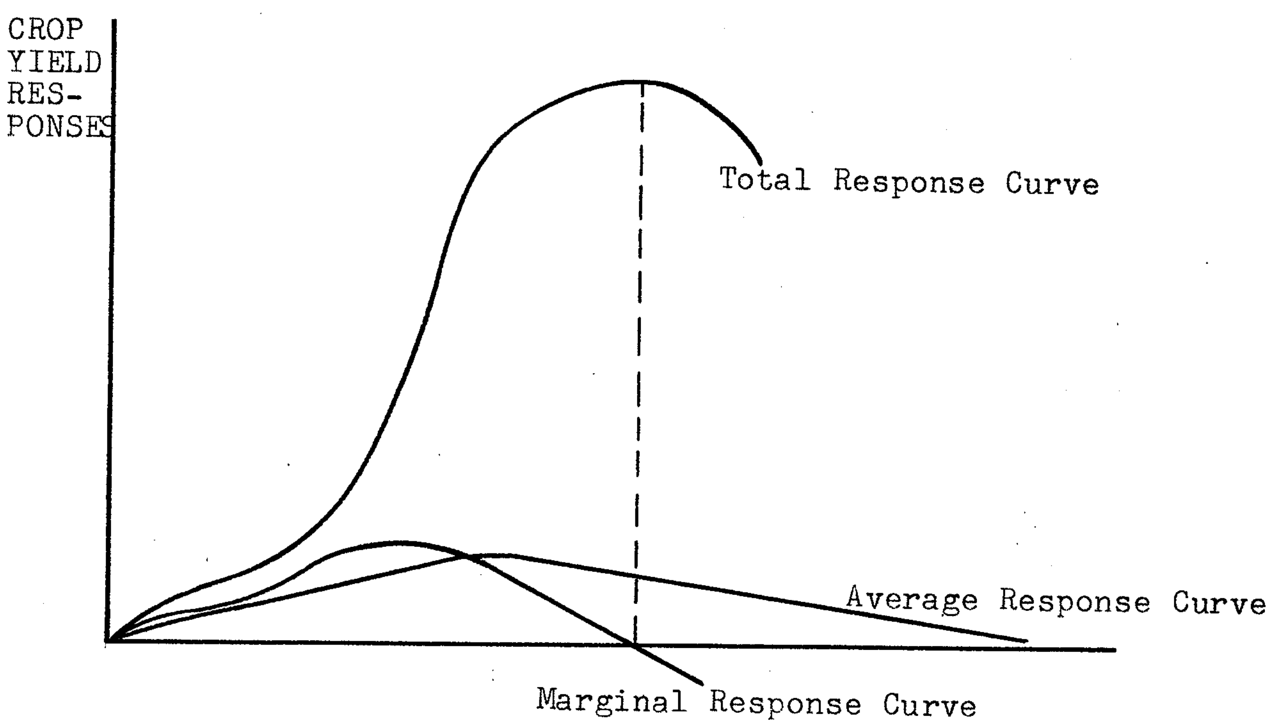

Figure 22 : Response of Crop Yields to Fertilizer Application.

this area that shows diminishing marginal productivity to increased fertilizer application. There is no reason to suggest that phenomenon other than diminishing marginal crop response to increased levels of fertilizer application will be obtained on these farms.

The falling portion of the farm's short-run average cost function is estimated by spreading the fixed costs over greater volumes of output. Expansion of production beyond the level in the actual farm record in 1962 is obtained by assuming that wheat is grown on the acreage normally devoted to summer-fallow. This increase in production causes the average unit cost to decrease still further.

Beyond this, production is stepped up through increases in the levels of fertilizer application. The different levels of fertilizer application and their associated yield responses were obtained from fertilizer experiments conducted by the Soils Department, University of Manitoba[3]. The experimental data show diminishing marginal

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[3]The experimental data used in this study were obtained from the following sources:

(i) Department of Soil Science, University of Manitoba, "Reports of Fertilizer Experiments in 1959, 1960, 1961 and 1962". (Mimeographed).

(ii) R.A. Hedlin and J.M. Parker, "Co-operative Fertilizer Trials in Manitoba," (Winnipeg: Department of Soil Science, University of Manitoba, 1952, 1953, 1954).

(iii) Department of Soil Science, University of Manitoba and Soils and Crops Branch, Manitoba Department of Agriculture, "Co-operative Fertilizer Trials in Cereals and Flax," 1956. (Mimeographed).

crop yields to increased application of fertilizer beyond the optimum point. The farm's short-run average cost function begins to rise beyond this point.

The limitation in the experimental data is that the experiments are not carried out at sufficiently high levels of fertilizer application to permit the estimation of the entire rising portion of the cost curve. In view of this, the remainder of the rising portion of the curve is represented by a broken line, which suggests the shape and position of the curve if sufficient data were available to estimate it. While the experimental data used in this study did not go far enough in terms of the levels of fertilizer application, studies done in the Province invariably show

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(iv) Department of Soil Science, University of Manitoba and Soils and Crops Branch, Manitoba Department of Agriculture, "Co-operative Fertilizer Experiments in Manitoba", 1957. (Mimeographed).

(v) Soils Department, University of Manitoba, "Report on Field Strip Tests on Cereal Grains", 1958 (Mimeographed).

(vi) Soils Department, University of Manitoba, Effect of Anhydrous Ammonia and Phosphoric Acid upon the Yields of Oats and Barley", 1954. (Mimeographed).

(vii) R.A. Hedlin and J.M. Parker, "Report of Fertilizer Trials Carried out by the Manitoba Fertilizer Board during 1951", (Winnipeg: Department of Soil Science, University of Manitoba). (Mimeographed).

(viii) Manitoba Fertilizer Board, "Fertilizer Experiments with Wheat, Oats and Barley", 1950. (Mimeographed).

(ix) Soils Department, University of Manitoba, "Progress Report of Fertilizer Trials with Hay Crops at La Broquerie, Manitoba 1949-50". (Mimeographed).

(x) R.A. Hedlin and K. Schreiber, "Sugarbeets Yields on Fallowed and Non-fallowed Land on Two Soil Types", Agronomy Journal. Vol. 55, 1963, pp. 10-12.

diminishing marginal productivity throughout the entire range of fertilizer application[4]. The planning curve is then derived as the envelope of the short-run cost curves.

Method of Regression Analysis

This method involves the use of forty-one crop farms, all of which received upwards of seventy-five of their gross current receipts from crop production. Adjustments to total farm expenditures were made for outlay on livestock production and custom work.

The adjustments were based on the percentage of current receipts that was obtained from sources other than crop production. For example, if two per cent of receipts came from custom work, then only ninety-eight per cent of the particular item of machinery cost and the operator's wages were debited to crop production.

In standardizing the crop combinations, actual production costs and value of crop output were converted to wheat production. The model for normalizing actual production costs involves an estimation, for the Carman area, of the cost of producing an acre of each crop. These areal estimates were then used to determine the opportunity cost,

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[4]For examples see:

(1) J.C. Gilson and V.W. Bjarnarson, "Effects of Fertilizer Use on Barley in Northern Manitoba", Journal of Farm Economics, Vol. XL, No. 4, November, 1958, pp. 932-941.

(2) H.E. Tolton, "Response of Cereals to Anhydrous Ammonia as Correlated with Tests for Available Soil Nitrogen", Unpublished Master's Thesis, University of Manitoba, Winnipeg, 1957.

for each farm, of devoting their entire crop acreage to wheat production. The opportunity costs were then used as the basis of adjusting the actual production costs.

An illustration of a specimen farm will now be made so as to present the model mathematically. This farm has ninety-nine crop acres of which twenty-four were in wheat; fifteen were in oats; and sixty were in hay. The actual cost of production is $4,994.29.

With the present acreage allotment, the costs of producing oats and hay are as follows:

15 acres of oats at $17.15/acre	=	$257.25
60 acres of hay at $14.71/acre	=	882.60
Total cost for oats and hay	=	$1,139.85

If the seventy-five crop acres are devoted to wheat production the total cost of production would be

75 acres of wheat at $21.36/acre = $1,602.00

The opportunity cost of growing all wheat is the residual i.e. $1,602 - $1,139.85 = $462.15. Had the operator of this farm grown all wheat his total cost of production would have been $462.15 higher than the actual cost of production with the present combination of wheat, oats and hay. Hence the actual cost of production must be adjusted by the amount of the opportunity cost. The normalized cost of production is therefore $4,994.29 + $462.15 which amounts to $5,456.44. If the cost of production under the wheat-oats-hay combination was higher than the alternative of all wheat, then the opportunity cost would have to be taken from the actual total production cost.

The model for normalizing value of production involves an adjustment to the value of each crop product by an index of price per pound with the price of wheat. The price per pound of each crop was calculated; and an index series was constructed with wheat as the base commodity. The actual value of production in respect of each crop was then adjusted by an index.

The process of constructing the index series and of normalizing the value of crop production are presented in Table VI. The actual value of crop production was \$2,390 in the specimen farm whereas the adjusted value is \$1,298.

The regression analysis model involves the presentation of the average cost per improved acre, and per unit of output in the form of a scatter diagram with the conventional least squares curve fitted to it. Where improved acreage is the criterion of size, the mathematical specifications of the model are as follows:

$$Y = \alpha - \beta_1 X_1 + C_1 X_1^2 + \epsilon \quad . \quad . \quad . \quad . \qquad (1)$$

where Y, the dependent variable, is average cost per improved acre; X_1 the independent variable, is improved acres; α is the regression constant; and β_1 and C_1 are the regression coefficients.

TABLE VI

INDEX SERIES AND NORMALIZATION OF CROP PRODUCTION

Crop	Normal Units	Price Per Unit	Price* Per lb	Index	Actual Value Of Crop	Adjusted Values
Wheat	bu.	$ 1.50	2.5¢	100	$ 740.00	$ 740.00
Oats	bu.	.50	1.5	60	450.00	270.00
Hay	ton	12.00	0.6	24	1,200.00	288.00
Flax	bu.	3.00	5.4	216	1,290.00	2,786.00
Sun-flower	lbs	.04	4.0	160	523.00	836.00
Peas	bu.	1.40	2.3	92	203.00	186.76
Buckwheat	bu.	1.40	2.9	116	578.55	671.12
Sugar beets	ton	12.00	0.6	24	2,484.00	596.16
Hay seed	lb.	.20	20.0	800	1,808.00	14,464.00

* Conversion from original units was made on the basis of 2,000 lbs per ton.

The specifications of the model, where volume of crop product is the criterion of size, are presented below:

$$Y = \alpha - \beta_2 X_2 + C_2 X_2^2 + \epsilon \quad . \quad . \quad . \quad . \quad (2)$$

where Y is average cost per $40.00 crop product; X_2 is the volume of crop production; α is the regression constant and β_2 and C_2 are the regression coefficients.

By definition the regression curve depicts the average cost size relationships for the whole group of farms. Each point on the scatter diagram represents a farm with its particular cost-size relationship and with its specific level of capacity and management. Farms of the same size, but with disparities in their unit costs, operate at different levels of capacity and managerial skill. The high unit cost farms operate with greater excess capacity and lower management than those with low unit costs. Farms at the bottom of the scatter operate at near to full capacity and efficient management.

The regression curve therefore represents a combination of the variations in unit cost, that are associated with more efficient resource use on a given size of farm, with cost changes that arise from changes in the size of the farm firm. Moreover, it depicts unit costs that are greater than the minimum levels which define the cost economies associable with units that operated with optimum levels of efficiency. In addition thereto, the slope of curve has a tendency to over-state the cost economies that are associated with an expansion in the size of the farm which had been operated at full capacity. This seems to justify the conservatism of the operator of the five hundred and sixty acre farm that has been discussed earlier. The slope of curve also tends to understate the cost economies that are available to farms that contemplate fuller utilization of capacity and further expansion eventually.

In effect, the regression curve represents a combination of the effects of the level of management, excess capacity and variations in farm size. It is obviously necessary to hold management and excess capacity constant, if it is desired to determine the net effects of farm size on unit cost. As the operator's co-ordinating responsibilities increase with expansion in farm size, it is not practical to keep the management variable constant. The conceptual and empirical problems relating to capacity make it difficult to measure this variable.

However, it is still possible to approximate the real cost-economies curve. This involves estimating it by fitting an envelope curve to the points at the bottom of the scatter diagram. The curve depicts the locus of the points of least unit cost that are obtainable from the different sizes of farms. As such, it is a more realistic approximation to the planning curve in so far as the actual group of farms includes some farms that were efficiently managed and operated to full capacity.

The greatest limitation to this method of estimating the planning curve is that there are not enough of such farms especially in the large size range where there are very few observations. However, this curve is more defensible as an approximation to the planning curve rather than the average regression function, in that at least it may approach the real curve in so far as every farm in the sample is efficiently organized and operated at capacity. At least, it represents the lowest upper bound of the actual position of the real planning curve.

The method of regression analysis made it possible to estimate the proportion of the variation in unit cost that is associated with the combined relationship between the relevant independent variables and the dependent variable. The specifications of the models used in making these estimates will now be examined.

$$Y = \alpha - \beta X_1 + CX_1^2 + DX_2 + \epsilon X_2^2 + e \quad . \quad . \quad (3)$$

where Y, the dependent variable, represents unit cost; X_1 an independent variable, is volume of output; X_2, the other independent variable, is improved acreage; α is the regression constant; and β , C, D, and ϵ are regression coefficients. This model was used to determine the proportion of the variations in unit costs that are associated with the combined relationship of volume of output, improved acreage and unit cost.

The following model was used to estimate the proportion of the variation in unit cost that is associated with the relationship between the crop yield index and the unit cost:

$$Y = \alpha - \beta X_1 + CX_1^2 + DX_2 + \epsilon X_2^2 + FX_3 + GX_3^2 + e \quad (4)$$

where X_3, an independent variable, is the crop yield index, and the other symbols have the same meaning as those in equation (3). The value of the co-efficient of determination in this model was subtracted from that in model (3), so as to determine the proportion of the variation in unit cost, that is associated with the relationship between unit cost and the crop yield index.

In estimating the effects of machinery use on cost economies the following model was used:

$$Y = \alpha - \beta X_1 + CX_1^2 + DX_2 + \epsilon X_2^2 + FX_3 + GX_3^2 + HX_4 + IX_4^2 + e \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where X_4, an independent variable, is machinery investment per improved acre. In determining the proportion of the variations in unit cost that is associated with the relationship between machinery investment per improved acre and unit; the co-efficient of determination in this model was subtracted from that obtained in model (4).

The model specified here-under was used to estimate the proportion of the variation in unit cost that is associated with the relationship between the number of crop work units and unit cost.

$$Y = \alpha - \beta X_1 + CX_1^2 + DX_2 + \epsilon X_2^2 + FX_3 + GX_3^2 + HX_4 + IX_4^2 + JX_5 + KX_5^2 + e \quad . \quad . \quad . \quad (6)$$

where X_5 is the number of crop work units. The difference between the co-efficients of determination in models (6) and (5) is an estimation of the proportion of the variation in unit cost that is associated with the relationship between the number of crop work units and unit cost.

CHAPTER VIII

EMPIRICAL ANALYSES

Details of the empirical analyses are presented in the appendices of this study. In this chapter the results of the analyses are summarized and presented in the form of tables and graphs for the budgetary analyses. The results of the regression analyses are presented graphically in Charts 3 to 5 of this chapter.

Budgetary Analysis

The results of the budgetary analysis are summarized in Tables VII to XII. In Table VI, the results of the analysis for the farming situations in the first stratum are presented. Situation (4), which is the base point situation, is an actual farm whose input-output coefficients of variable inputs per $100.00 crop product were used to synthesize the other seven situations in the first stratum.

The results of the budgetary analyses for the situations in the second, third, fourth, fifth and sixth strata respectively are presented in Tables VIII, IX, X, XI and XII. Situation (3) in the second stratum, and situation (4) in the third, fourth, fifth and six strata, which are the base point situations, are actual farms whose input-output coefficients of variable inputs per $100.00 crop

TABLE VII

SUMMARY OF BUDGETARY ANALYSIS OF SITUATIONS IN THE FIRST STRATUM

Characteristics	Situation (1)	Situation (2)	Situation (3)	Base Point Situation (4)	Situation (5)	Situation (6)	Situation (7)	Situation (8)
Improved Acreage	155	155	155	155	155	155	155	155
Total Acreage	160	160	160	160	160	160	160	160
Gross Output	$ 500.00	$1,000.00	$1,500.00	$2,391.00	$4,121.40	$4,811.50	$5,419.50	$5,729.00
Cost Analysis								
Fixed Cost	4,161.88	4,161.88	4,161.88	4,161.88	4,161.88	4,161.88	4,161.88	4,161.88
Variable Cost								
Machinery Cost	113.85	227.70	341.55	544.53	1,064.50	1,095.58	1,234.02	1,304.49
Crop Cost								
Fertilizer	--	--	--	--	--	262.90	471.30	845.70
Other	56.10	112.20	168.30	268.34	524.54	539.85	608.07	642.79
Total Crop Cost	56.10	112.20	168.30	268.34	524.54	802.45	1,079.37	1,488.49
Miscellaneous	3.45	6.90	10.35	16.54	32.26	33.20	37.39	39.53
Total Variable Cost	173.40	346.80	520.20	829.41	1,621.30	1,931.53	2,350.78	2,832.51
Total Production Cost	4,335.28	4,508.68	4,682.08	4,991.29	5,783.18	6,093.41	6,512.66	6,994.39
Cost per $40. Crop Product	346.82	180.34	124.85	83.50	56.13	50.64	48.00	48.84

TABLE VIII

SUMMARY OF BUDGETARY ANALYSIS OF SITUATIONS IN THE SECOND STRATUM

Characteristics	Situation (1)	Situation (2)	Base Point Situation (3)	Situation (4)	Situation (5)	Situation (6)
Improved Acreage	308	308	308	308	308	308
Total Acreage	320	320	320	320	320	320
Gross Output	$5,000.00	$6,000.00	$7,670.00	$9,518.00	$9,944.55	$10,183.65
<u>Cost Analysis</u>						
Fixed Cost	5,787.06	5,787.06	5,787.06	5,787.06	5,787.06	5,787.06
<u>Variable Cost</u>						
Hired Labour	464.50	557.40	712.46	884.22	923.85	946.06
Machinery Cost	589.50	707.40	904.42	1,122.17	1,172.46	1,200.00
Maintenance & Repair	53.00	63.60	81.33	100.89	105.41	107.95
Crop Cost						
Other	201.50	241.80	309.45	383.58	400.76	410.40
Fertilizer	365.00	438.00	559.68	694.81	826.96	1,123.84
Total Crop Cost	566.50	679.80	869.13	1,078.39	1,227.72	1,534.24
Miscellaneous	14.50	17.40	22.41	27.60	28.84	29.53
Total Variable Cost	1,688.00	2,025.60	2,589.75	3,213.27	3,458.28	3,817.78
Total Production Cost	7,475.06	7,812.66	8,376.81	9,000.33	9,245.34	9,604.84
Cost per $40. Crop Product	60.00	52.00	43.69	37.82	37.10	37.73

TABLE IX

SUMMARY OF BUDGETARY ANALYSIS OF SITUATIONS IN THE THIRD STRATUM

Characteristics	Situation (1)	Situation (2)	Situation (3)	Base Point Situation (4)	Situation (5)	Situation (6)	Situation (7)
Improved Acreage	502	502	502	502	502	502	502
Total Acreage	560	560	560	560	560	560	560
Gross Output	$9,000.00	$10,000.00	$11,000.00	$13,130.00	$17,252.75	$18,207.35	$18,389.05
Cost Analysis							
Fixed Cost	8,778.29	8,778.29	8,778.29	8,778.29	8,778.29	8,778.29	8,778.29
Variable Cost							
Hired Labour	106.20	118.00	129.80	155.57	204.22	214.85	216.99
Machinery Cost	807.30	897.00	986.70	1,177.85	1,552.41	1,633.20	1,649.50
Maintenance & Repairs	90.00	100.00	110.00	130.99	173.07	182.07	183.89
Crop Cost							
Fertilizer	342.00	380.00	418.00	499.40	616.70	1,107.24	1,574.65
Others	414.00	460.00	506.00	604.52	796.11	837.54	845.90
Total Crop Cost	756.00	840.00	924.00	1,103.92	1,412.81	1,944.78	2,420.55
Miscellaneous	107.00	119.00	130.00	156.50	205.95	216.67	218.83
Total Variable Cost	1,866.50	2,074.00	2,280.50	2,724.83	3,548.46	4,191.57	4,689.76
Total Cost of Production	10,644.79	10,852.29	11,058.79	11,503.12	12,326.75	12,969.86	13,468.05
Cost per $40. Crop Product	47.31	43.41	40.21	35.04	28.58	28.49	29.30

TABLE X

SUMMARY OF BUDGETARY ANALYSIS OF SITUATIONS IN THE FOURTH STRATUM

Characteristics	Situation (1)	Situation (2)	Situation (3)	Base Point Situation (4)	Situation (5)	Situation (6)	Situation (7)
Improved Acreage	658	658	658	658	658	658	658
Total Acreage	708	708	708	708	708	708	708
Gross Output	$14,000.00	$16,000.00	$18,000.00	$20,122.00	$24,494.35	$25,203.85	$25,196.00
Cost Analysis							
Fixed Cost	10,053.56	10,053.56	10,053.56	10,053.56	10,053.56	10,053.56	10,053.56
Variable Cost							
Machinery Cost	3,227.00	3,688.00	4,149.00	4,638.62	5,645.95	5,809.49	5,807.68
Crop Cost							
Fertilizer	443.80	507.20	570.60	638.30	743.36	1,297.22	1,851.08
Other	379.40	433.60	487.80	545.00	663.80	683.02	682.81
Total Crop Cost	823.20	940.80	1,058.40	1,183.30	1,407.16	1,980.24	2,533.89
Maintenance & Repair	128.80	147.20	165.60	184.30	225.35	231.88	231.80
Miscellaneous	21.00	24.00	27.00	29.90	36.74	37.81	37.79
Total Variable Cost	4,200.00	4,800.00	5,400.00	6,036.12	7,315.20	8,059.42	8,611.16
Total Cost of Production	14,253.56	14,858.56	15,453.56	16,089.68	17,368.76	18,112.98	18,664.72
Cost per $40. Crop Product	40.72	37.13	34.34	31.98	28.36	28.75	29.63

TABLE XI

SUMMARY OF BUDGETARY ANALYSIS OF SITUATIONS IN THE FIFTH STRATUM

	Situation (1)	Situation (2)	Situation (3)	Base Point Situation (4)	Situation (5)	Situation (6)	Situation (7)	Situation (8)
	883	883	883	883	883	883	883	883
	893	893	893	893	893	893	893	893
	$15,000.00	$17,000.00	$18,000.00	$19,946.00	$29,617.40	$34,394.85	$36,498.30	$36,364.00
	11,932.53	11,932.53	11,932.53	11,932.53	11,932.53	11,932.53	11,932.53	11,932.53
	960.00	1,088.00	1,152.00	1,276.00	1,895.51	2,201.27	2,335.86	2,327.30
	2,226.00	2,522.80	2,671.20	2,960.64	4,395.22	5,104.20	5,416.27	5,396.42
Repairs	67.50	76.50	81.00	89.07	133.28	154.78	164.24	163.64
	259.50	294.10	311.40	344.76	512.38	595.00	631.41	629.10
	99.00	112.20	118.80	130.87	130.87	1,055.19	1,979.51	2,821.01
s	358.50	406.30	430.20	475.63	643.25	1,650.19	2,610.92	3,450.11
	52.50	59.50	63.00	70.00	103.66	120.38	127.74	127.27
ost	3,664.50	4,153.10	4,397.40	4,871.34	7,170.92	9,230.82	10,655.03	11,464.74
a Cost	15,597.03	16,085.63	16,329.93	16,803.87	19,103.45	21,163.35	22,587.56	23,397.27
	41.49	37.85	36.29	33.70	25.80	24.61	24.75	25.74

TABLE XII

SUMMARY OF BUDGETARY ANALYSIS OF SITUATIONS IN THE SIXTH STRATUM

Characteristics	Situation (1)	Situation (2)	Situation (3)	Base Point Situation (4)	Situation (5)	Situation (6)	Situation (7)
Improved Acreage	1,160	1,160	1,160	1,160	1,160	1,160	1,160
Total Acreage	1,190	1,190	1,190	1,190	1,190	1,190	1,190
Gross Output	$12,000.00	$14,000.00	$16,000.00	$18,870.00	$20,142.00	$22,500.00	$23,196.46
Cost Analysis							
Fixed Cost	14,444.29	14,444.29	14,444.29	14,444.29	14,444.29	14,444.29	14,444.29
Variable Cost							
Hired Labour	3,012.00	3,514.00	4,016.00	4,745.01	5,055.64	5,647.50	5,799.12
Machinery Cost	3,852.00	4,494.00	5,136.00	6,058.48	6,465.58	7,222.50	7,446.06
Maintenance and Repair	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Crop Cost							
Fertilizer	648.00	756.00	864.00	1,019.64	1,059.80	2,399.10	3,737.40
Other	1,944.00	2,268.00	2,592.00	3,066.66	3,263.00	3,645.00	3,757.83
Total Crop Costs	2,592.00	3,024.00	3,456.00	4,086.30	4,322.80	6,044.10	7,495.23
Total Variable Cost	9,458.00	11,034.00	12,610.00	14,891.79	15,845.22	18,916.10	20,742.41
Total Production Cost	23,902.29	25,478.29	27,054.29	29,336.08	30,289.51	33,360.39	35,186.60
Cost per $40. Crop Product	79.67	72.79	68.64	62.19	60.15	59.31	60.78

product were used in synthesizing the other situations in the respective strata. The budgetary coefficients are presented in Appendix II of this study.

The results of the budgetary analysis are presented graphically in Charts 1 and 2. The criterion of size in these charts is the volume of output in dollars, and unit cost is given as cost per $40.00 crop product. The farm short-run average cost curves are represented by FAC_1 - FAC_6. The planning curve is the envelope of the average cost curves.

Regression Analysis

The results of the regression analysis are presented in Charts 3, 4 and 5.

In Chart 3 the criterion for farm size is improved acres, and unit cost is production cost per improved acre. The specifications of the regression equation are:

$$\hat{Y} = 35.08 - .025 X_1 + .0000127 X_1^2$$

where Y is unit cost, and X_1 is improved acreage. The variance is 28.8, and the coefficient of determination is .1449, which indicates that 14.49 per cent of the variation in unit cost is associated with the relationship existing between the improved acreage and the unit cost of production. The long-run average cost curve is the broken line, and the planning or cost economies curve is the heavy line.

The criterion for farm size in Chart 4 is volume

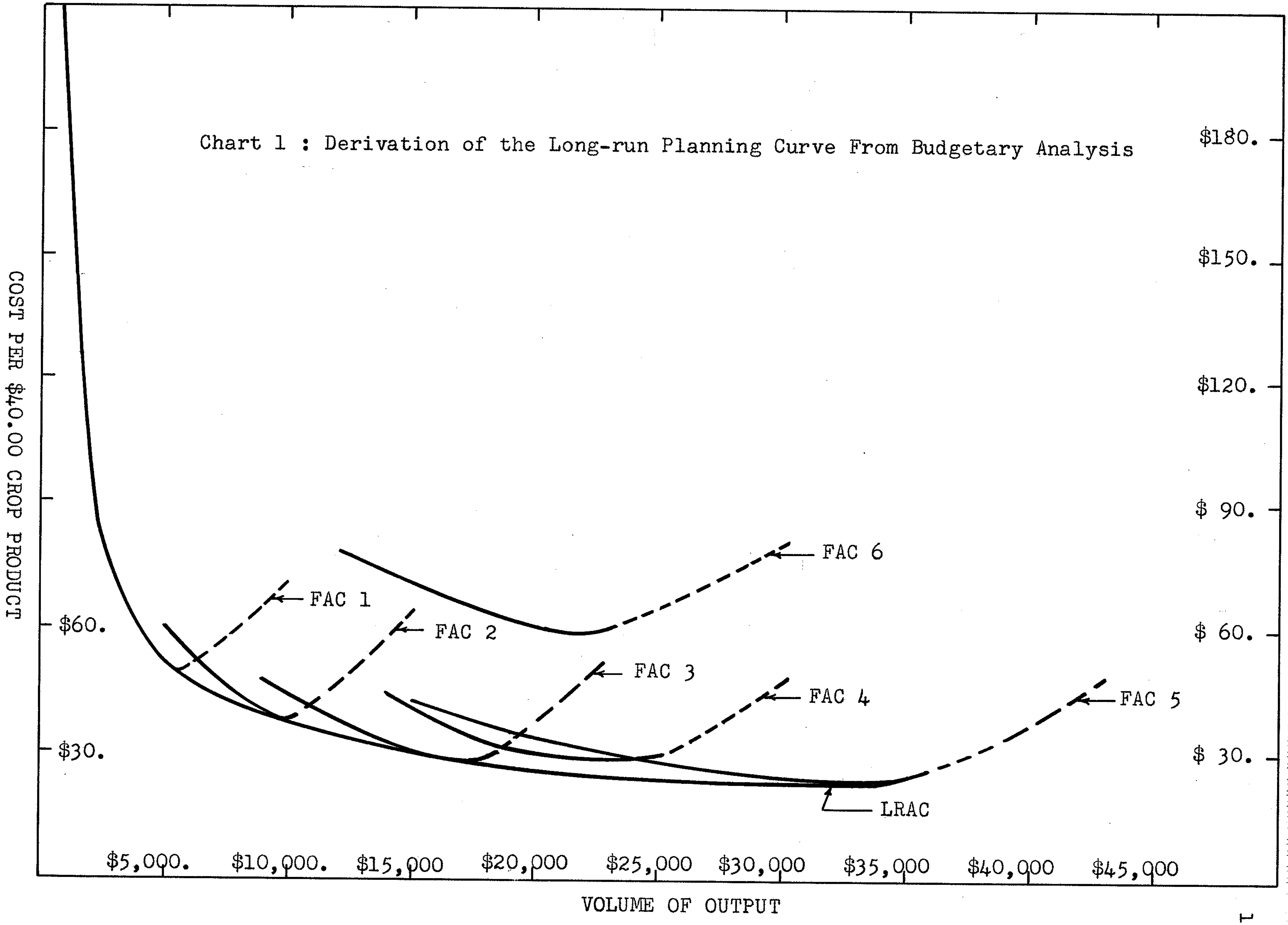


Chart 1 : Derivation of the Long-run Planning Curve From Budgetary Analysis
COST PER $40.00 CROP PRODUCT
$60.
$30.
$180.
$150.
$120.
$ 90.
$ 60.
$ 30.
FAC 1
FAC 2
FAC 3
FAC 4
FAC 5
FAC 6
LRAC
$5,000.
$10,000.
$15,000
$20,000
$25,000
$30,000
$35,000
$40,000
$45,000
VOLUME OF OUTPUT

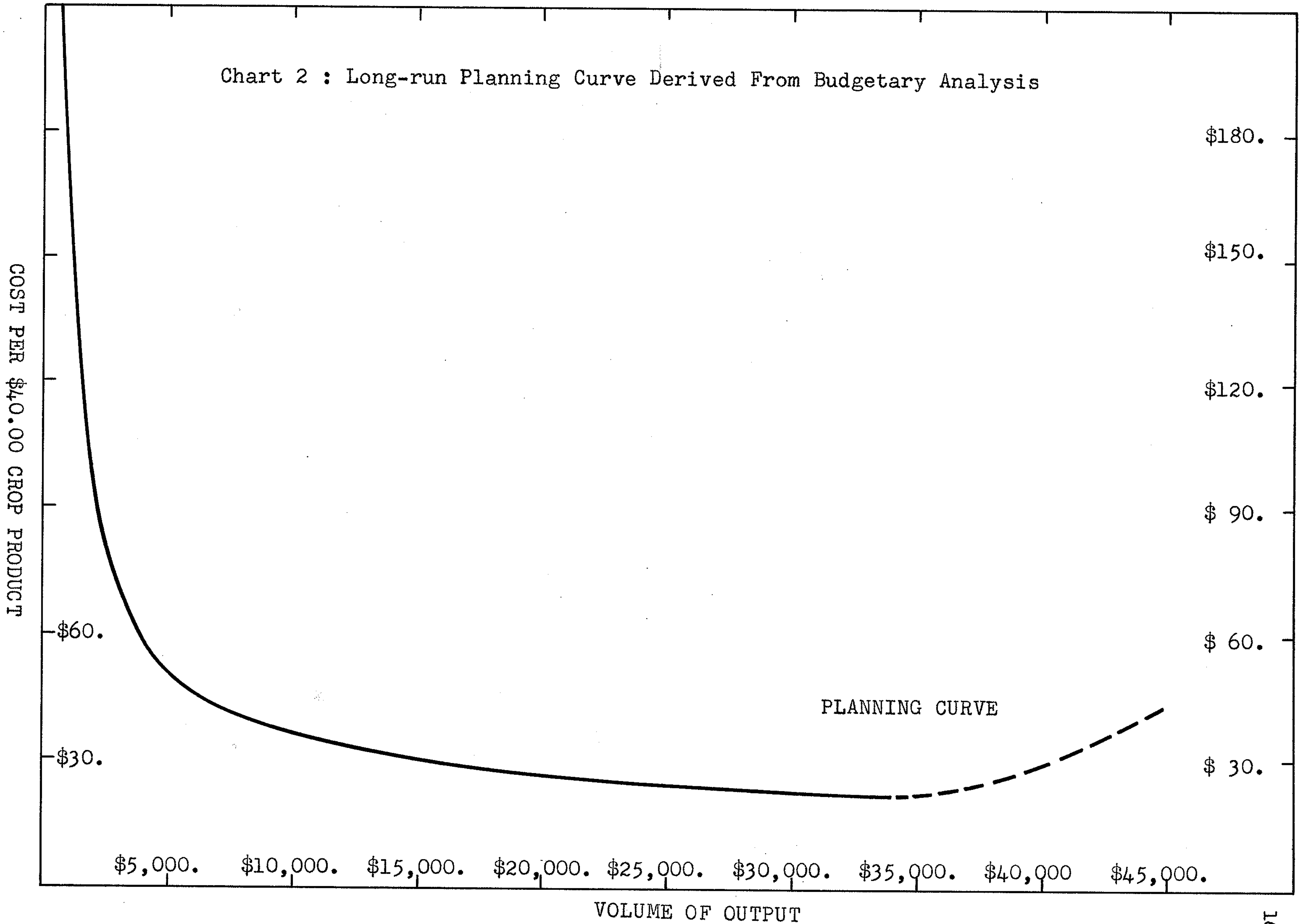
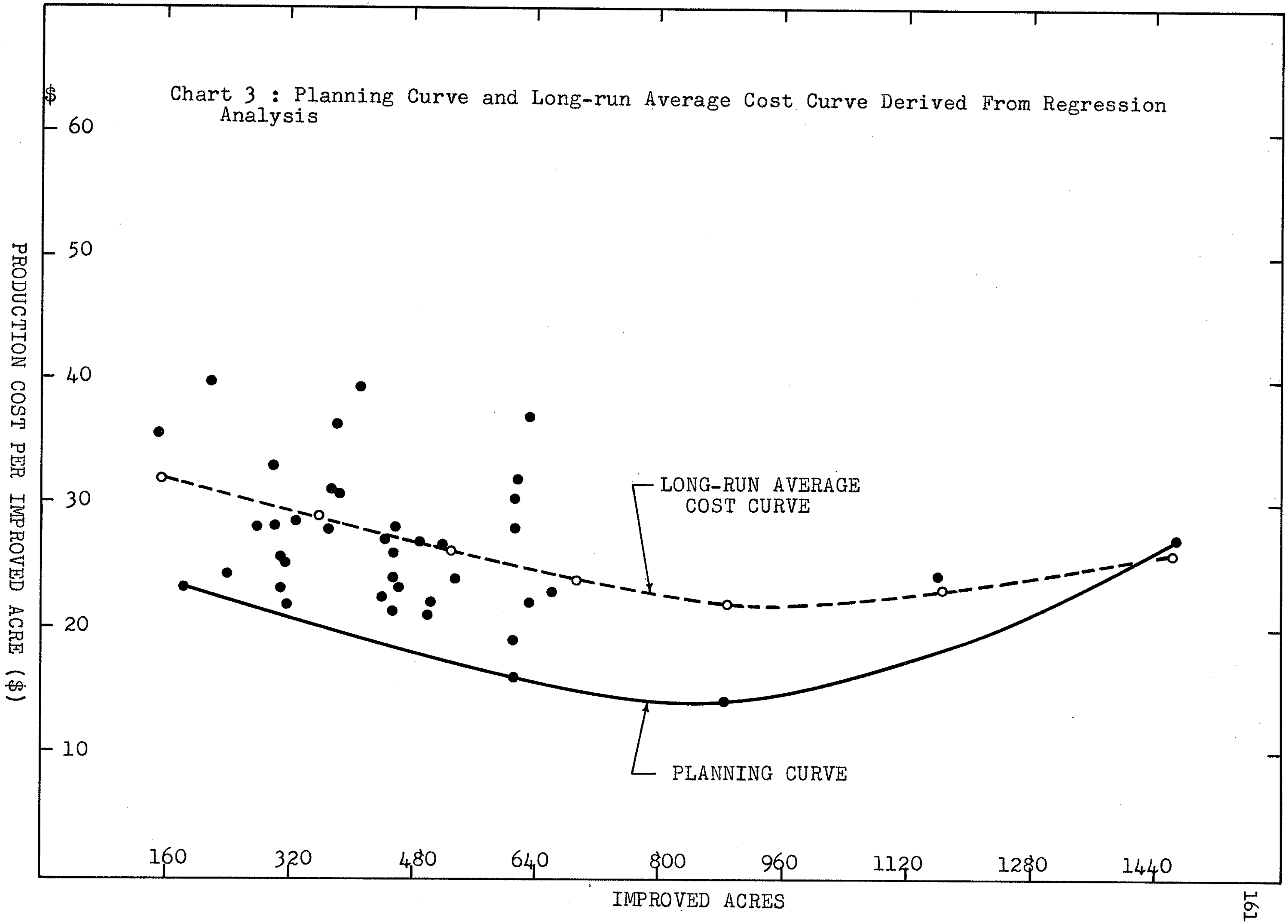


Chart 2 : Long-run Planning Curve Derived From Budgetary Analysis

Chart 3 : Planning Curve and Long-run Average Cost Curve Derived From Regression Analysis



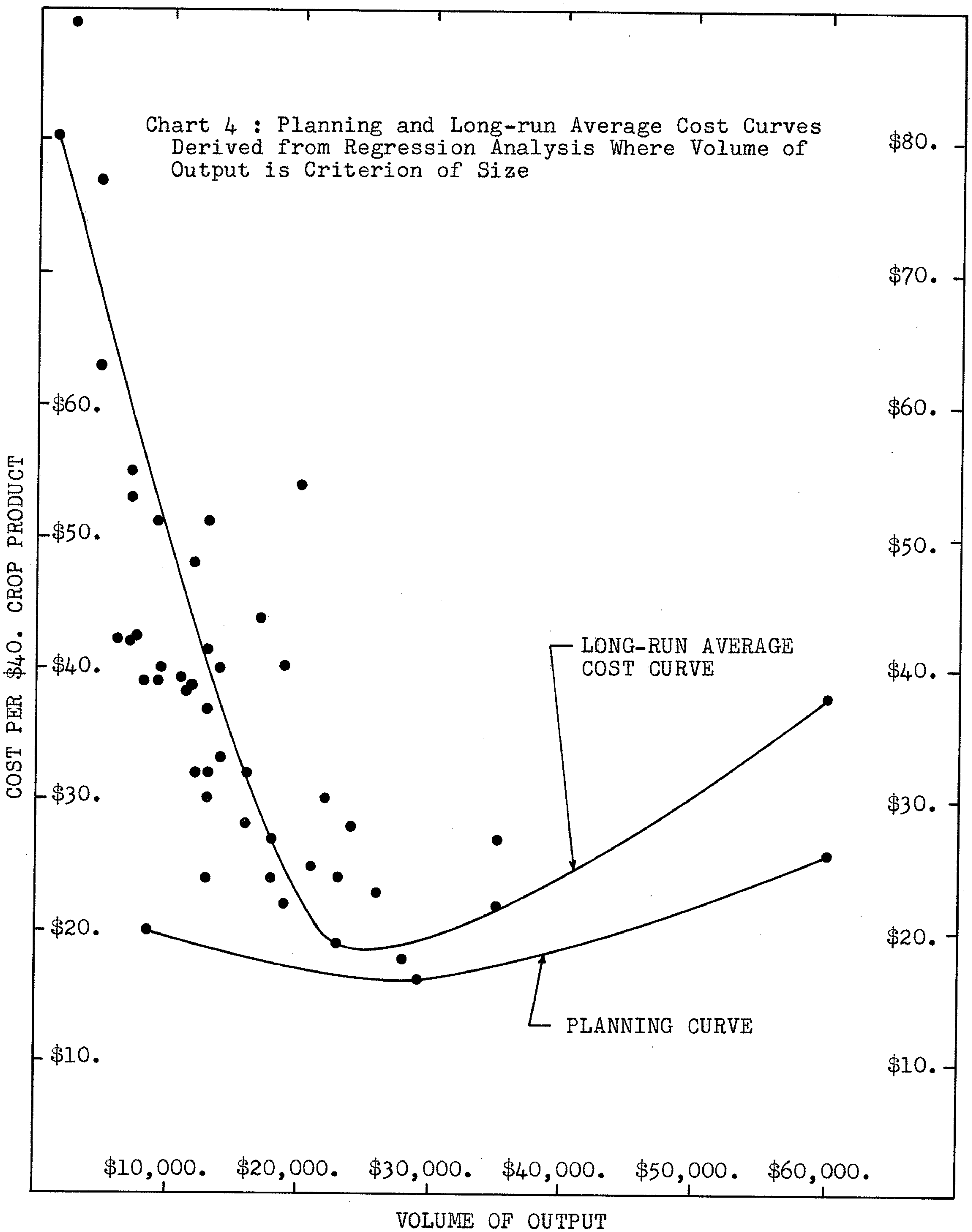


Chart 4 : Planning and Long-run Average Cost Curves Derived from Regression Analysis Where Volume of Output is Criterion of Size
COST PER $40. CROP PRODUCT
$10.
$20.
$30.
$40.
$50.
$60.
$70.
$80.
LONG-RUN AVERAGE COST CURVE
PLANNING CURVE
$10,000.
$20,000.
$30,000.
$40,000.
$50,000.
$60,000.
VOLUME OF OUTPUT

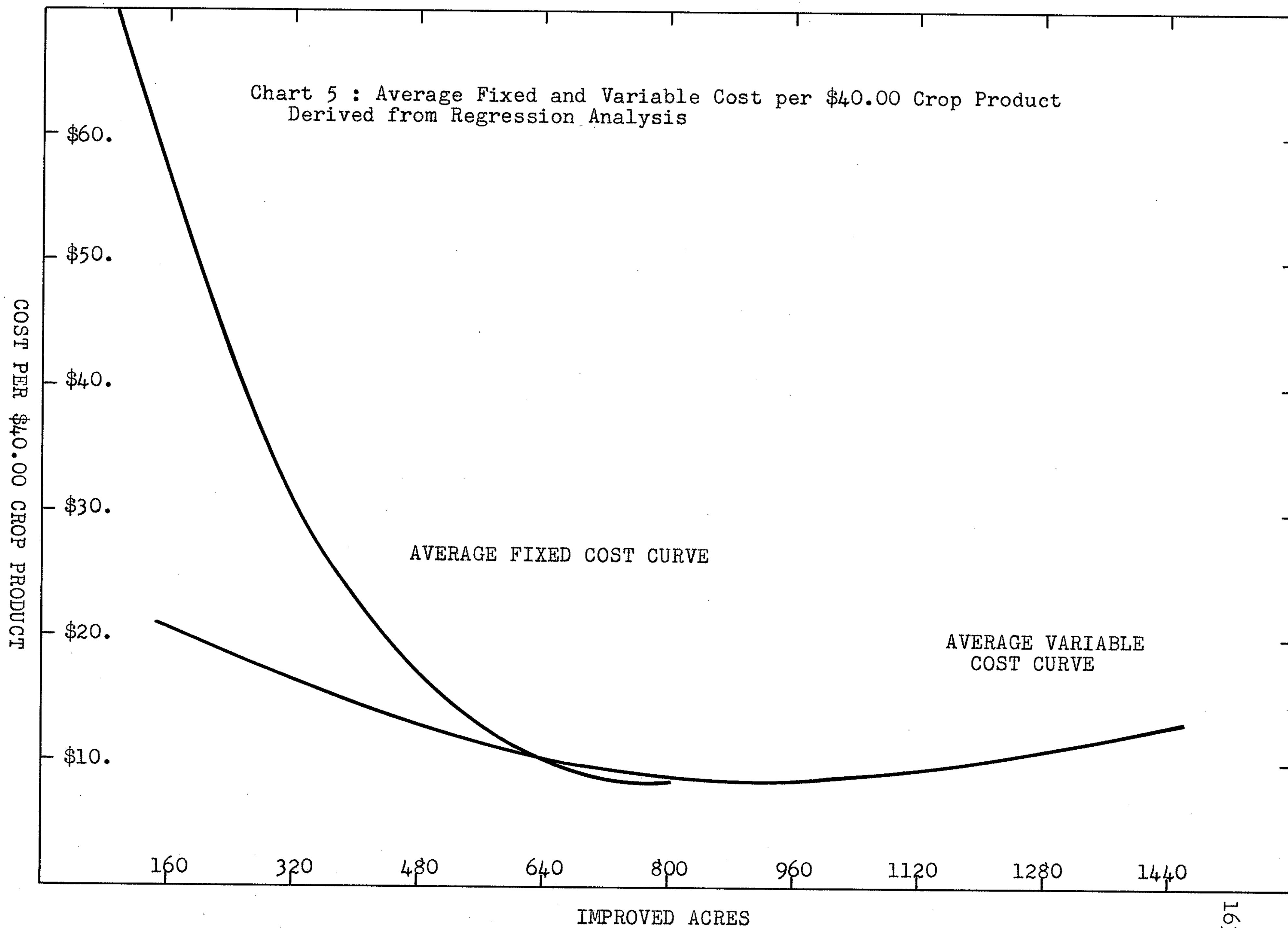


Chart 5 : Average Fixed and Variable Cost per $40.00 Crop Product
Derived from Regression Analysis
$60.
$50.
$40.
$30.
$20.
$10.
COST PER $40.00 CROP PRODUCT
AVERAGE FIXED COST CURVE
AVERAGE VARIABLE COST CURVE
160
320
480
640
800
960
1120
1280
1440
IMPROVED ACRES

of output in dollars, and unit cost is given as cost per \$40.00 crop product. In this chart the specifications of the model are as follows:

$$\hat{Y} = 85.57 - .0041\ X_1 + .00000006\ X_1^{2}$$

where Y is unit cost, and X_1 is the volume of output. The variance is 35.30, and the coefficient of determination is .4801 which indicates that 48.01 per cent of the variations in the unit cost are associated with the relationship between the unit cost and the volume of output. The long-run average cost curve is given by LRAC and the planning curve is depicted as PC.

In Chart 5 the criterion for farm size is improved acres, and unit cost is cost per \$40.00 crop product. The average fixed cost is given by AFC, and the average variable cost is given by AVC.

The equation specified below was derived for estimating the proportion of the variation in unit cost that was associated with the relationship between improved acreage, volume of output and unit cost:

$$\hat{Y} = 83.61 - .0042\ X_1 + .000000048\ X_1^{2} + .0055\ X_2 + .00001289\ X_2^{2}$$

The coefficient of determination is .496, which indicates that 49.61 per cent of the variation in unit cost is associated with the relationship between these variables.

The equation for estimating the proportion of the variation in unit cost that is associated with the relationship between unit cost and crop yield index is

$$\hat{Y} = 71.0095 - .00446 X_1 + .00000051 X_1^2 + .01842 X_2 + .00000622 X_2^2 + .21978 X_3 - .00109 X_3^2$$

where X_3 is the crop yield index. The coefficient of determination is .5001, which indicates that 50.01 per cent of the variation in unit cost is associated with the relationship between the variables.

The model used for estimating the proportion of the variation in unit cost that is associated with the relationship between unit cost and machinery investment per improved acre is as follows:

$$\hat{Y} = 42.39 - .00481 X_1 + .00000005198 X_1^2 + .00826 X_2 + .0000195 X_2^2 - .003515 X_3^2 + .68974 X_4 - .00126 X_4^2$$

where X_4 is machinery investment per improved acre. The coefficient of determination is .5589, which states that 55.89 per cent of the variation in unit cost is associated with the relationship between the variables.

The model specified here-under was used to determine the proportion of the variation in unit cost that was associated with the relationship between unit cost and number of crop work unit.

$$\hat{Y} = 63.24 - .009171 X_1 + .000000169 X_1^2 - .022935 X_2$$

$$+ .000085 X_2^2 - .08203 X_3 + .001327 X_3^2 + 1.63497 X_4$$

$$- .01749 X_4^2 + .18926 X_5 - .009412 X_5^2$$

where X_5 is the number of crop work units. The coefficient of determination is .6504, which explains that 65.04 per cent of the variation in unit cost is associated with relationship between these variables.

In the regression analysis the distribution of sizes of farms on the bases of volume of outputs, and improved acreage is presented in Table XIII

TABLE XIII

DISTRIBUTION OF SIZES OF FARMS ON THE BASES OF VOLUME OF OUTPUT AND IMPROVED ACREAGE

Volume of Production	No. of Farms	Improved Acreage	No. of Farms
(Dollars)			
$<$ 5,999	2	$<$ 299	6
6,000 - 9,999	11	300 - 499	19
10,000 - 15,999	17	500 - 699	12
16,000 - 19,999	6	700 - 799	1
20,000 - 25,999	2	800 -1,000	1
26,000 - 57,533	3	$>$1,000	2
Total	41	Total	41

CHAPTER IX

INTERPRETATION OF RESULTS AND CONCLUSION

The results of this study indicate that there is a functional relationship between the size of the farm firm and its unit cost. The relationship, that has been established on the basis of the budgetary analysis, shows that cost economies extend over a wide acreage of crop farms in the Carman District of Manitoba.

Where volume of output is the criterion of farm size, Chart 1 indicates that cost economies accrue to farms with a wide range in the volume of production. The cost economies is greatest over a relatively narrow range of small farms.

Cost economies are very substantial on farms that produce a volume of output up to $10,000 per annum. The reason for this is the very high fixed costs on crop farms. The reduction in unit cost are less substantial on farms that market between $10,000 and $25,000 worth of crop product. This can be explained, in part, by the fact that variable costs make up the larger proportion of average total cost as average fixed costs assume a less important role in the farm's cost structure.

Savings in unit costs are almost constant on farms that produce between $25,000 to about $30,000 worth of output. Unit cost increases beyond a volume of output of $34,000. The optimum size of farm in terms of volume of output is therefore the farm firm that can produce about $34,000 worth of crop product. This optimum size farm consists of 883 improved acres.

The results of the regression analysis which are presented in Chart 3 indicate that considerable cost economies accrue to farms that are between 160 and 640 acres in size. However, the savings in cost decline appreciably on farms that are between 640 and 883 acres in size. Unit cost increases on farms in excess of 883 improved acres. The results in the regression analysis support the conclusions arrived at in the budgetary analysis, which indicated that the optimum size of farm firm is the unit of 883 improved acres.

The analysis, which is presented in Chart 4 also indicates that considerable cost-economies exist over a wide range in the volume of output on crop farms in Carman. Cost economies are greatest in crop farms with a volume of business between $10,000 and $25,000. They are less significant in the range $25,000 and $29,000. Unit cost rises on farms with a volume of business in excess of approximately $30,000.

The results of this analysis are also supported by the conclusions in the budgetary analysis which indicated that the optimum size of farm firm was the unit which produces about $34,000 worth of crop product. In this analysis the 883 acres farm was also the optimum size in terms of both acreage and volume of crop product marketed.

A very substantial proportion of farms are incurring unit costs well in excess of those indicated by the planning curve for a similar size of unit both in terms of volume of output and improved acreage. In effect, there is a substantial gap between the existing use of resources and the empirical optimum. This indicates that a large proportion of farms have been left behind in the process of adjustment. It is an objective of this study to determine the reasons for this. A great deal of excess capacity exists in farms, which can improve the productivity of resources as they exist at the present time on the farms. The implication here is that greater scope exist for obtaining cost-economies on the existing size of farm business through more intensive use of resources rather than by expansion in the size of unit.

Those farms that are on the rapidly declining unit cost section of the planning curve would find great advantages in expanding the size of their farm so as to capture all existing cost-economies. Many farmers are conscious of the economies that are associated with larger size farms. However some of them do not contemplate any expansion of the farms because of subjective discounting for risk and uncertainty. These operators hold that in many cases the advantages in cost do not compensate for the risk associated with a larger size farm.

Some other farmers maintain that the size of their units provides them with an adequate standard of living. Hence they are unwilling to risk the possibility of foregoing this in the attempt to obtain the cost-economies that are associated with a larger size unit.

The case that has just been discussed is that of the operator of the 560 acre farm which is the base point situation in the third stratum of the budgetary analysis. This operator is very progressive and imaginative in the use of his resources. However, he wants to be his own manager, to provide his own capital, and to provide all labour requirement from the farm family. He is quite satisfied with their standard of living, and claims that the size of business is consistent with his management potential.

Although scope exists for greater savings in cost through expansion, the operator has no incentive to expand. In addition to this he does not want to have hired help on the farm which he feels is necessary with expansion. He regards the farm as the home, and feels that having hired hands on the farm will be compromising the privacy of the home and family.

Some operators, particularly those on the 320 - 480 acre farms, do not intend to expand the size of the units because of their aversion to debt. They regard debt as debt, and not credit. They feel very strongly that by mortgaging their farms, they are also mortgaging their homes. Hence, they try to secure equity in the business by ploughing back their earnings into the farm firm. Some in this group do not have the confidence that they can handle a larger size unit.

Several farmers are very happy with the traditional ways of doing things, and so are very reluctant to make changes. Many in this group employ practices that are not best for the farm. In some instances the operator of his son lacks the initiative and imagination to use available credit. The necessary adjustments do not seem to be apparent to them. In effect, this group of operators do not seem to have the incentive and/or lack the managerial capacity to handle a large size unit. On this group of farms, there is urgent need for adjustment, but the operators lack the knowledge to envisage the direction it should take. These farmers need to be educated in the forms that adjustments should take.

In some cases operators do not have profit maximization as their goal. They engage themselves in other off-farm activities to the detriment of the efficient management of the operations. This represents their value judgments, which may be disturbing to the extension specialist, who is very conscious of, and would prefer to see a better use of society's scarce resources.

Unimaginative planning results in a small volume of output in some farm units. The problem involved on such farms is not expansion but getting the chores done on the existing size of business. In some instances the enterprise combination is far too diversified to yield a substantial volume of production. In other instances the operators do not use the enterprise combination that is most profitable.

Many farmers would like to expand but capital rationing prevents them from doing so. Some do not have the collateral for obtaining expansion. Others do not have a good credit rating, and their families either will not provide the collateral, or do not have the funds to enable expansion.

Dis-economies accrue to the farms to the right of the planning curve because of the particular crop combination that is adopted. These farms have substantial acreages of sugar beets and sunflowers. These crops are labour intensive, and so the operators have large wage bills, which in most cases include board, lodging plus the normal wages.

One of the objectives of this study was to determine what is the optimum size of farm firm in agriculture; and to examine the resource combination on this farm. On the basis of both the budgetary and the regression analysis, the optimum size of farm firm was the unit of 883 improved acres, which can produce an optimum volume of crop product of approximately $30,000.00. This is an actual farm which is the base point situation of the fifth stratum of the budgetary analysis.

The total number of acres, both improved and unimproved of this optimum size was 893. The average farm capital in 1962 was $122,597. The operator's equity was $99,297, and the average net worth was $103,715. The investment in machinery and equipment was $27,976. The wage bill which includes board amounted to $1,689.26. The figures indicate the large capital requirements on a crop farm that would enable an operator to capture all existing cost economies.(Appendix V).

In view of the cost economies that are indicated on larger farms, the co-existence of small and large farms might not ordinarily be expected in a competitive industry. However, the persistence of the small farm may be attributed to the sacrifice that these operators are prepared to make in order to stay in the industry. It is also due, in part, to the government's desire to preserve the family farms through price support programmes, and other similar legislation.

CHAPTER X

IMPLICATIONS FOR THE FAMILY FARM AND PROBLEMS FOR FUTURE RESEARCH

Indications in this study are that the family farm is consistent with the optimum size of firm in agriculture. However, substantial adjustments need to be made if these farms are to achieve the cost economies that are possible on the optimum size farm.

The most obvious implication of this study is that the farms should first effect the required internal adjustment on the existing size of unit, so as to utilize their unused capacity. Expansion of size without full utilization of excess capacity is irrational in terms of the productivity potential of existing resources.

Progressive operators, who possess the imagination and managerial capacity to handle efficiently a larger size unit, face problems of capital accumulation, and obtaining the required quantity of credit. The resource combination on the optimum size farm indicates that the capital requirements are substantial. Governments and other credit-granting agencies must take the initiative of ensuring that operators with adequate managerial dexterity are provided with the amount of capital required for making the necessary adjustments in agriculture.

This study shows that of the forty-one farms investigated, one farm is of optimum size, two are larger than optimum size, and thirty-eight are smaller than the optimum i.e. 92 per cent of the group of farms. There is however, a wide spectrum of sizes among the third group of thirty-eight farms (Table XIII). The implication here is that two kinds of adjustments are now needed in this group of farms viz: (i) intensification in the use of existing resources, and (ii) expansion in the number of acres operated.

On the larger proportion of the farms that are smaller than the optimum, greater possibilities exist for achieving more cost economies through intensive use of existing resources rather than through expansion in size. There are distinct possibilities for the smaller proportion of these farms to achieve greater cost economies through expansion in the existing size of farm unit.

Indications are that a greater measure of adjustments will be required in the future as changes in technology are made. The implication of this is that there will continue to be the exodus of redundant farm labour into the other sectors of the economy. Since 1957 there has been an un-employment problem in Canada. Some economists have interpreted this as seasonal un-employment, and therefore feel that it will be corrected through the adjusting mechanism of the economy. Other economists have pointed out that since 1957 the problem has become progressively worse. In this connection Professor Barber has shown that in Canada

> Before 1954 un-employment averaged about 2.5 per cent of the labor force and was never a significant problem. During the next four years a moderate increase occurred and in this period un-employment averaged about 4.2 per cent. Then, in late 1957, un-employment passed the 5 per cent point; the next three years 1958 to 1960 it averaged 6.7 per cent of the labour force and in early 1961 it has been remaining close to 8 per cent on a seasonally adjusted basis[1].

While there was this increase in the level of unemployment in Canada, there has also been a decline in the farm population[2], and therefore an increase has occurred in the non-farm population. There has also been a great decline in the growth of the whole economy. The economic and social problems created by these phenomena are widespread. But a treatment thereof does not fall within the scope of this thesis. However, it may be noted that they have some serious implications for the family farms[3].

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[1]C.L. Barber, "The Canadian Economy in Trouble", C.J.E. & P.S. Volume XXVIII, No. 1, February 1962.

[2]The Canadian Census of Agriculture, 1961. Bulletin No. 5. 1-1 Volume V. pt:1, pp. 21-2-2 has shown that whereas the farm population in 1951 was 20.8 per cent of the population it declined to 11.7 per cent in 1961. That is, that farm population declined in this period by 9.1 percentage points.

[3]Table 56 on page 64 of the National Accounts Income and Expenditure 1962 published by the Dominion Bureau of Statistics has indicated that with 1949 = 100 the G.N.P. for the Canadian economy in constant dollars for the years 1955-1961 inclusive was as follows: 134.2, 145.7, 147.6, 149.3, 154.4,157.9 and 162.0. The G.N.P. had grown during the period 1955-56 by 11.5 percentage points whereas the growth in the period 1960-61 was 4.1 percentage points. The inference to be drawn from this analysis is that there was a relative decline in the growth of the Canadian economy during the period 1955-61 of some 7.4 percentage points.

The phenomena just discussed indicate that grave social and economic problems await the surplus farm population that seeks refuge in the non-farm sector. In the first case, these people will seriously aggravate the un-employment problem which has existed since 1957. Many of these people do not have the training and skills required for non-farm employment. They are, therefore, placed at a serious disadvantage in competing for jobs. In the short-run at least, the maintenance and welfare of these people will place an additional burden on an already sluggish economy.

Clearly, it appears that society has only recently recognized that investment in developing the human potential is as important as the development of the physical resources in agriculture. This study indicates that many farmers have very little knowledge of either the type and/or the magnitude of the adjustments that are necessary for their economic survival. It seems inevitable therefore that some farms will be left behind in the process of adjustment. Hence, as a consequence of continuous change in agriculture there will be a small farm problem. Society should therefore develop policies for dealing with this problem.

A valuable contribution, that a research worker makes by way of advice to people who utilize the results of his work, is to criticize and evaluate the work that he has completed. This will enhance an objective appraisal of his work.

It is due to the difficulties encountered in measuring management and excess capacity that the isolation of the cost-economies, that accrue to farms of different sizes, is a very difficult task. This study indicates that future research is necessary so as to set out precisely the processes of management in order that it becomes quantifiable. Research should also be directed to devise some methods for measuring capacity and excess capacity on farms.

It is only when research workers can resolve the problems that are encountered in measuring these variables that it may be possible to refine the estimates relating to cost-economies. However, these estimates can provide an objective basis for effective planning of the agricultural industry.

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APPENDIX I

CARMAN DISTRICT FARM BUSINESS ASSOCIATION 1962 FARM RECORDS VALUE OF CROP PRODUCTION

Stratum	Dollar Value of Crop Production	Crop Yield Index	Total Farm Acreage	Improved Acreage	Percentage crop Farm	Crop Value per crop Work unit	Machinery Investment Average	Intensity of Land Use
I	$ 2,391.00	107.1	165	155	95 %	40.87	$ 31.80	0.55
	3,250.00	81.7	240	240	77	50.00	20.05	0.79
II	6,191.00	98.3	240	210	80	51.09	38.13	1.37
	6,425.00	110.5	320	275	84	60.61	7.50	0.55
	7,240.00	60.1	640	616	75	40.00	17.86	0.42
	7,486.00	86.0	320	313	90	51.45	16.57	.73
	7,670.00	101.7	320	308	95	60.49	19.48	.84
	7,874.00	126.8	190	183	85	84.94	18.03	.60
	8,130.00	86.3	340	331	96	57.86	38.42	.82
	8,589.00	120.0	320	310	94	76.01	43.80	.58
	9,371.00	105.5	435	370	92	72.64	25.30	.60
	9,500.55	61.6	480	460	87	39.24	26.20	.76
	9,974.90	64.3	470	460	86	53.92	26.73	.88
III	10,024.00	98.8	320	303	86	53.98	38.30	.81
	10,176.50	107.8	310	291	96	53.39	34.23	1.01
	10,563.00	107.8	391	376	95	69.58	20.90	.54
	11,436.50	102.4	400	386	84	56.93	43.69	1.52
	11,642.00	97.7	473	438	97	68.24	33.25	.54
	11,715.00	105.7	480	387	95	63.67	30.40	.78
	12,061.00	119.5	476	457	90	72.01	26.00	.75
	12,963.27	86.7	550	524.5	90	46.46	32.50	.93
	12,977.70	126.3	333	319	91	53.87	9.00	1.20
	13,130.00	95.6	560	502	99	64.49	35.00	.41
	13,312.60	96.6	550	495	92	61.09	28.08	.57
	13,357.80	93.3	477	460	96	64.37	31.50	.61
	13,681.00	102.2	560	536	90	61.88	18.00	.74
	13,785.00	129.8	440	419	84	69.45	64.00	1.70
	13,794.00	112.0	463	448	94	54.46	41.08	.69
	14,640.00	75.6	628	610	81	51.05	19.20	.94
	14,983.00	121.5	480	465	88	81.61	36.50	.72
IV	16,416.00	89.0	640	505	91	44.11	15.70	1.07
	16,500.00	100.0	640	619	96	69.47	19.15	.68
	17,587.60	85.1	780	696	93	55.75	33.75	.83
	18,870.00	54.2	1190	1160	96	35.01	26.07	.62
	19,302.00	102.5	725	630	90	69.99	18.00	.68
	19,946.00	89.4	893	883	100	53.63	31.70	.42
V	20,122.45	109.3	708	658	100	71.74	35.14	.43
	23,268.00	123.2	619	609	75	63.92	36.36	1.22
VI	26,195.00	117.2	640	628	92	71.96	55.50	1.24
	30,780.00	140.2	640	612	94	67.71	25.40	.96
	57,533.00	115.2	1520	1460	92	55.70	29.17	1.00

SEGREGATION OF FIXED AND VARIABLE COSTS

iable a per- tage of al Cost	Total Cost Normalized	Fixed Cost Normalized	Variable Cost Normalized	Normalized Average Costs Per			Cost per Dollar Crop Product	Normalized Value of Crop Product	Normalized Average Cost Per $40. Crop Product		
				Total	Fixed	Variable			Total	Fixed	Variable
6.28 %	$ 5,456.44	$ 4,568.13	$ 888.31	$ 35.20	$ 29.47	$ 5.73	$ 4.20	$ 1,298.00	$ 168.00	$ 140.65	$ 27.35
4.67	4,277.07	3,221.92	1,055.15	23.37	17.60	5.77	.49	8,795.76	19.60	14.76	4.84
0.69	5,671.00	4,497.67	1,173.33	23.63	18.74	4.89	2.22	2,550.00	88.80	70.43	18.37
7.38	8,332.50	5,217.81	3,114.69	39.68	24.85	14.83	1.92	4,334.80	76.80	48.09	28.71
8.61	9,546.16	5,860.39	3,685.77	32.80	20.14	12.66	1.01	9,425.10	40.40	24.80	15.60
8.61	7,640.44	4,690.47	2,949.97	27.78	17.05	10.73	1.58	4,840.20	63.20	38.80	24.40
5.48	7,794.75	5,029.17	2,765.58	25.31	16.33	8.98	.97	8,066.80	38.80	25.03	13.77
2.30	7,880.30	6,122.99	1,757.31	25.42	19.75	5.67	.61	12,863.60	24.40	18.96	5.44
3.75	7,337.17	4,860.88	2,476.29	23.44	15.53	7.91	1.04	7,047.16	41.60	27.56	14.04
3.50	8,407.29	3,909.39	4,497.90	27.75	12.90	14.85	.97	8,632.56	38.80	18.04	20.76
2.92	7,173.59	4,094.68	3,078.91	22.49	12.84	9.65	1.00	7,208.60	40.00	22.83	17.17
4.03	9,438.02	6,226.26	3,211.76	28.51	18.81	9.70	1.33	7,089.20	53.20	35.10	18.10
7.40	11,574.14	6,088.00	5,486.14	30.78	16.19	14.59	.98	11,828.88	39.20	20.62	18.58
5.59	14,011.87	7,623.86	6,388.01	36.30	19.75	16.55	1.19	11,729.04	47.60	25.90	21.70
9.50	10,248.69	8,250.20	1,998.49	27.70	22.30	5.40	.96	10,666.32	38.40	30.91	7.47
5.68	16,474.39	10,596.33	5,878.06	39.32	25.29	14.03	1.27	12,986.40	50.80	32.67	18.13
5.92	12,117.87	7,765.13	4,352.74	27.05	17.33	9.72	1.28	9,558.76	51.20	32.81	18.39
6.45	11,967.48	7,605.33	4,362.15	26.02	16.54	9.48	.82	14,533.00	32.80	20.84	11.96
1.13	9,843.11	7,763.26	2,079.85	22.47	17.72	4.75	.75	13,131.84	30.00	23.66	6.34
0.19	10,917.48	8,634.63	2,282.85	23.89	18.89	5.00	.70	15,549.36	28.00	22.14	5.86
7.04	12,675.76	10,515.81	2,159.95	27.56	22.86	4.70	.45	28,292.78	18.00	14.93	3.07
9.11	12,093.99	8,573.43	3,520.56	31.25	22.15	10.10	.93	12,978.88	37.20	26.37	10.83
4.24	10,814.02	7,111.30	3,702.72	23.26	15.30	7.96	.56	19,394.70	22.40	14.73	7.67
7.39	9,883.07	7,176.10	2,706.97	21.48	15.60	5.88	.80	12,410.72	32.00	23.23	8.77
5.53	13,888.52	8,953.93	4,934.59	26.48	17.07	9.41	1.03	13,461.25	41.20	26.56	14.64
6.08	13,364.38	9,878.95	3,485.43	27.00	19.96	7.04	.81	16,403.89	32.40	23.95	8.45
5.12	11,056.10	8,168.25	2,887.85	22.02	16.27	5.75	.61	17,978.00	24.40	18.03	6.37
2.80	13,063.43	8,778.62	4,284.81	24.37	16.38	7.99	.62	20,943.36	24.80	16.67	8.13
0.71	18,430.22	9,084.26	9,345.96	30.26	14.92	15.34	.99	18,686.02	39.60	19.52	20.08
5.08	12,065.05	7,832.63	4,232.42	19.78	12.84	6.94	.68	17,826.38	27.20	17.66	9.54
1.02	9,574.61	7,562.03	2,012.58	15.54	12.27	3.27	1.38	6,939.60	55.20	43.60	11.60
5.00	16,890.03	9,289.52	7,600.51	27.60	15.18	12.42	.71	23,722.60	28.40	15.62	12.78
4.99	10,806.79	5,944.82	4,861.97	21.40	11.77	9.63	.97	11,122.20	38.80	21.34	17.46
8.87	19,034.19	11,635.60	7,398.59	30.75	18.80	11.95	1.10	17,376.00	44.00	26.90	17.10
1.30	23,533.63	13,814.24	9,719.39	37.47	21.99	15.48	.67	35,290.00	26.80	15.73	11.07
0.70	15,020.78	8,907.32	6,113.46	22.83	13.54	9.29	.57	26,394.88	22.80	13.52	9.28
8.92	13,854.41	9,847.71	4,006.70	21.99	15.63	6.36	.60	23,083.68	24.00	17.06	6.94
7.54	16,529.68	10,324.44	6,205.24	23.75	14.83	8.92	.74	22,209.22	29.60	18.49	11.11
6.58	12,271.81	7,782.78	4,489.03	13.90	8.82	5.08	.42	29,368.56	16.80	10.65	6.15
0.94	28,222.94	11,023.88	17,199.06	24.33	9.50	14.83	1.36	20,750.60	54.40	21.25	33.15
5.13	38,357.44	21,046.73	17,310.71	26.27	14.41	11.86	.64	60,286.94	25.60	14.05	11.55

Improved	Total Adjusted cost of Production	Total Variable Cost	Total Fixed Cost	Fixed as a Percentage of total Cost	Variable as a percentage of Total Cost	Total Cost Normalized	Fixed Cost Normalized	Variable Cost Normalized	Normalized Average Costs Per — Total	Fixed	Variable	Co (
155	$ 4,994.29	$ 812.87	$ 4,181.42	83.72 %	16.28 %	$ 5,456.44	$ 4,568.13	$ 888.31	$ 35.20	$ 29.47	$ 5.73	$
183	3,965.17	978.12	2,987.05	75.33	24.67	4,277.07	3,221.92	1,055.15	23.37	17.60	5.77	
240	5,324.70	1,101.61	4,223.09	79.31	20.69	5,671.00	4,497.67	1,173.33	23.63	18.74	4.89	
210	7,808.40	2,918.97	4,889.43	62.62	37.38	8,332.50	5,217.81	3,114.69	39.68	24.85	14.83	
291	10,880.61	4,200.54	6,680.07	61.39	38.61	9,546.16	5,860.39	3,685.77	32.80	20.14	12.66	
275	7,004.04	2,704.12	4,299.92	61.39	38.61	7,640.44	4,690.47	2,949.97	27.78	17.05	10.73	
308	7,275.67	2,581.59	4,694.08	64.52	35.48	7,794.75	5,029.17	2,765.58	25.31	16.33	8.98	
310	7,302.47	1,628.50	5,673.97	77.70	22.30	7,880.30	6,122.99	1,757.31	25.42	19.75	5.67	
313	6,654.79	2,245.70	4,409.09	66.25	33.75	7,337.17	4,860.88	2,476.29	23.44	15.53	7.91	
303	9,811.67	5,249.63	4,562.04	46.50	53.50	8,407.29	3,909.39	4,497.90	27.75	12.90	14.85	
319	8,723.13	3,743.64	4,979.49	57.08	42.92	7,173.59	4,094.68	3,078.91	22.49	12.84	9.65	
331	8,932.87	3,039.43	5,893.44	65.97	34.03	9,438.02	6,226.26	3,211.76	28.51	18.81	9.70	
376	10,964.96	5,197.11	5,767.85	52.60	47.40	11,574.14	6,088.00	5,486.14	30.78	16.19	14.59	
386	12,661.37	5,772.60	6,888.77	54.41	45.59	14,011.87	7,623.86	6,388.01	36.30	19.75	16.55	
370	9,887.73	1,928.32	7,959.41	80.50	19.50	10,248.69	8,250.20	1,998.49	27.70	22.30	5.40	
419	15,513.90	5,534.56	9,979.34	64.32	35.68	16,474.39	10,596.33	5,878.06	39.32	25.29	14.03	
448	14,302.19	5,137.41	9,164.78	64.08	35.92	12,117.87	7,765.13	4,352.74	27.05	17.33	9.72	
460	11,335.63	4,132.28	7,203.35	63.55	36.45	11,967.48	7,605.33	4,362.15	26.02	16.54	9.48	
438	9,403.31	1,987.06	7,416.25	78.87	21.13	9,843.11	7,763.26	2,079.85	22.47	17.72	4.75	
457	10,077.73	2,107.13	7,970.60	79.09	20.19	10,917.48	8,634.63	2,282.85	23.89	18.89	5.00	
460	11,814.79	2,012.86	9,801.93	82.96	17.04	12,675.76	10,515.81	2,159.95	27.56	22.86	4.70	
387	11,842.19	3,447.18	8,395.01	70.89	29.11	12,093.99	8,573.43	3,520.56	31.25	22.15	10.10	
465	10,494.55	3,593.26	6,901.29	65.76	34.24	10,814.02	7,111.30	3,702.72	23.26	15.30	7.96	
460	8,993.23	2,462.96	6,530.27	72.61	27.39	9,883.07	7,176.10	2,706.97	21.48	15.60	5.88	
524.5	13,204.15	4,691.23	8,512.92	64.47	35.53	13,888.52	8,953.93	4,934.59	26.48	17.07	9.41	
495	12,527.23	3,267.61	9.259.62	73.92	26.08	13,364.38	9,878.95	3,485.43	27.00	19.96	7.04	
502	10,637.64	2,778.88	7,858.76	73.88	26.12	11,056.10	8,168.25	2,887.85	22.02	16.27	5.75	
536	12,118.98	3,975.14	8,143.84	67.20	32.80	13,063.43	8,778.62	4,284.81	24.37	16.38	7.99	
609	16,826.41	8,532.99	8,293.42	49.29	50.71	18,430.22	9,084.26	9,345.96	30.26	14.92	15.34	
610	10,556.75	3,702.70	6,854.05	64.92	35.08	12,065.05	7,832.63	4,232.42	19.78	12.84	6.94	
616	8,950.55	1,881.38	7,069.17	78.98	21.02	9,574.61	7,562.03	2,012.58	15.54	12.27	3.27	
612	22,355.03	10,059.42	12,295.61	55.00	45.00	16,890.03	9,289.52	7,600.51	27.60	15.18	12.42	
505	16,249.52	7,309.75	8,939.77	55.01	44.99	10,806.79	5,944.82	4,861.97	21.40	11.77	9.63	
619	18,437.34	7,166.96	11,270.38	61.13	38.87	19,034.19	11,635.60	7,398.59	30.75	18.80	11.95	
628	22,549.09	9,311.73	13,237.36	58.70	41.30	23,533.63	13,814.24	9,719.39	37.47	21.99	15.48	
658	14,120.38	5,747.14	8,373.24	59.30	40.70	15,020.78	8,907.32	6,113.46	22.83	13.54	9.29	
630	12,796.51	3,700.84	9,095.67	71.08	28.92	13,854.41	9,847.71	4,006.70	21.99	15.63	6.36	
696	16,015.33	6,012.02	10,003.31	62.46	37.54	16,529.68	10,324.44	6,205.24	23.75	14.83	8.92	
883	14,254.23	5,214.63	9,039.63	63.42	36.58	12,271.81	7,782.78	4,489.03	13.90	8.82	5.08	
1,160	25,699.39	15,662.49	10,036.90	39.06	60.94	28,222.94	11,023.88	17,199.06	24.33	9.50	14.83	
1,460	44,411.44	20,044.50	24,366.94	54.87	45.13	38,357.44	21,046.73	17,310.71	26.27	14.41	11.86	

APPENDIX II

BUDGETARY CO-EFFICIENTS FOR VARIABLE INPUTS BASED ON ONE HUNDRED DOLLARS CROP PRODUCTION

Variable Inputs	Budgetary Co-efficients					
	Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5	Stratum 6
Cost of Operating Farm Machinery	$ 22.77	$ 11.79	$ 8.97	$ 23.05	$ 14.84	$ 3.21
Hired Labour	--	9.29	1.18	--	6.40	2.51
Maintenance and Repair	--	1.06	1.00	.92	.45	--
<u>Crop Costs</u>						
(a) Fertilizer	--	7.30	3.80	3.17	.66	.54
(b) Other	11.22	4.03	4.60	2.71	1.73	1.62
Miscellaneous Items	.69	.29	1.19	.15	.35	--

APPENDIX III

NORMALIZATION OF PRICES AND GROSS RECEIPTS FROM CROP PRODUCTION FOR REGRESSION ANALYSIS

Crops	Units	Standard-pounds per Bushel	Price per Original units	Price per pound	Index of prices Normalized in terms of Wheat price
Wheat	bu	60	$ 1.50	2.5¢	100
Oats	"	34	.50	1.5	60
Barley	"	48	.80	1.7	68
Mixed Grain	"	41	.70	1.7	68
Rye	"	56	1.00	1.8	72
Corn	"	56	1.25	2.2	88
Peas	"	60	1.40	2.3	92
Buckwheat	"	48	1.40	2.9	116
Millet	"	50	2.00	4.0	160
Hayseed	lbs	60	.20	20.0	800
Flax	bu	56	3.00	5.4	216
Sun-flowers	lbs	24	.04	4.0	160
Rapeseed	"	50	.04	4.0	160
Hay	ton	60	12.00	0.6	24
Silage	"	60	5.00	0.25	10
Sugar Beets	"	50	12.00	0.6	24

ESTIMATED WHEAT PRODUCTION COST PER ACRE

Cost Items	Per acre cost 1956	Index No. 1956=100	Per acre cost 1962
Land Preparation			
A. Summer fallow			
(i) Plow	1.53	1 104	1.59
(ii) Cultivate	$ 1.67	104	$ 1.74
(iii) Harrow	.37	104	.38
B. Crop year			
(i) Cultivate	1.11	104	1.15
(ii) Harrow	.36	104	.37
Seed	2.00	110	2.20
Seed treatment and cleaning	.09	118	.11
Seeding	.54	104	.56
Weed Spraying			
(i) Machine	.19	104	.20
(ii) Spray	.22	118	.26
Harvesting			
(i) Swather	.42	104	.44
(ii) Combine	2.46	104	2.56
Interest on Investment on land 5% of $100/acre	5.00		5.00
Labour Cost			
(i) Time/acre (Machinery) (2.03 hrs @ $1.00/hr)	2.03	124	2.51
(ii) Time/acre (Pre-harvesting) (1.24 hrs @ $1.00/hr)	1.24	124	1.54
(iii) Time/acre (Harvesting) (.6 hrs @ $1.00/hr)	.60	124	.74
Total Cost	$ 19.83		$ 21.36

ESTIMATED BARLEY PRODUCTION COST PER ACRE

Cost Items	Per acre Cost 1956	Index No. 1956=100	Per acre Cost 1962
<u>Land Preparation</u>			
Plow	$ 1.53	104	$ 1.59
Cultivate	1.11	104	1.15
Harrow	.36	104	.37
<u>Seed</u>	1.76	110	1.94
Seed treatment and cleaning	0.09	118	.11
Seeding	0.54	104	.56
<u>Weed Spraying</u>			
1. Machine	.19	104	.20
2. Spray	.22	118	.26
<u>Harvesting</u>			
Swather	9.42	104	.44
Combine	2.46	104	2.56
Interest on Investment on land	5.00		5.00
<u>Labour</u>			
1. Time for pre-harvest = 2.07 hrs @ $1.00/hr.	2.07	124	2.57
2. Time for harvesting = .60 hrs @ $1.00/hr.	.60	124	.74
Total Cost	$ 16.35		$ 17.49

ESTIMATED OATS PRODUCTION COST PER ACRE

Cost Items	Per acre Cost 1956	Index No. 1956=100	Per acre Cost 1962
<u>Land Preparation</u>			
Plow	$ 1.53	104	$ 1.59
Cultivate	1.11	104	1.15
Harrow	.36	104	.37
Seed	1.45	110	1.60
Seed treatment and cleaning	.09	118	.11
Seeding	.54	104	.56
<u>Weed Spraying</u>			
Machine	.19	104	.20
Spray	.22	118	.26
<u>Harvesting</u>			
Swather	.42	104	.44
Combine	2.46	104	2.56
Interest on Investment (land)	5.00		5.00
<u>Labour</u>			
1. Time for pre-harvest = 2.07 hrs @ $1.00/hr.	2.07	124	2.57
2. Time for harvesting = .60 hrs @ $1.00/hr.	.60	124	.74
Total Cost	$ 16.04		$ 17.15

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ESTIMATED FLAX PRODUCTION COST PER ACRE

Cost Items	Per acre Cost 1956	Index No. 1956=100	Per acre Cost 1962
<u>Land Preparation</u>			
Plow	$ 1.53	104	$ 1.59
Cultivate	1.67	104	1.72
Harrow	.37	104	.38
Seed	2.14	110	2.35
Seed treatment and cleaning	.09	118	.11
Seeding	.54	104	.56
<u>Weed Spraying</u>			
Machine	.19	104	.20
Spray	.22	118	.26
<u>Harvesting</u>			
Swather	.42	104	.44
Combine	2.46	104	2.56
Interest on Investment	5.00		5.00
Labour	2.91	124	3.61
Total Cost	$ 17.54		$ 18.78

ESTIMATED RYE PRODUCTION COST PER ACRE

Cost Items	Per acre Cost 1956	Index No. 1956=100	Per acre Cost 1962
Land Preparation			
Plow	$ 1.53	104	$ 1.59
Cultivate	1.67	104	1.72
Harrow	.37	104	.38
Seed	1.23	110	1.35
Seeding	.54	104	.56
Seed treatment and cleaning	.09	118	.11
Harvesting			
Swather	.42	104	.44
Combine	2.46	104	2.56
Interest on Investment	5.00		5.00
Labour	2.67	124	3.31
Total Cost	$ 16.00		$ 17.02

ESTIMATED PER ACRE PRODUCTION COST FOR THE FOLLOWING CROPS

Cost Item	Buckwheat Per acre cost 1962	Millet Per Acre Cost 1962	Mixed Grain Per acre cost 1962	Corn Grain Per acre cost 1962	Peas Per Acre Cost 1962	Rapeseed Per acre cost 1962	Hayseed Per acre cost 1962
Land Preparation							
Plow	$ 1.59	$1.59	$1.59	$ 1.59	$ 1.59	$ 1.59	$ 1.59
Cultivate	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Harrow	.37	.37	.37	.37	.37	.37	.37
Seed	1.25	3.35	1.77	2.40	9.25	1.00	.97
Seed treatment	.11	.11	.11	.11	.11	.11	.11
Seeding	.56	.56	.56	.56	.56	.56	.56
Weed Spraying							
Machine	.20	.20	.20	.20	.20	.20	.20
Spray	.26	.26	.26	.26	.26	.64	.76
Harvesting							
Swather	.44	.44	.44	.44	.44	.44	.44
Combine	2.56	2.56	2.56	2.56	2.56	2.56	2.56
Interest on Investment	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Labour Cost	3.31	3.31	3.31	3.31	3.31	3.31	3.31
Total Cost	$ 16.80	$18.90	$17.32	$17.95	$24.80	$16.93	$ 16.52

ESTIMATED PRODUCTION COST PER ACRE FOR HAY AND SILAGE

Cost Items		Hay Per acre	Ensilage Per acre
Land Preparation			
Plow ..... $1.59 Cultivate... 1.15 Harrow ..... .37	$3.11 spread over 3 years	$ 1.04	$ 1.04
Seed			
Alfalfa ... 3 lbs Brome ... 9 lbs	$2.90 " " " "	.97	2.50
Machinery Cost		5.10	5.10
Interest on Investment on Land		5.00	5.00
Labour		2.60	6.86
Total Cost		$ 14.71	$ 20.50

APPENDIX IV

PRODUCTION COSTS PER SUGAR BEET ACRE

Item	Cost in 1956	Index Number 1956 = 100	Cost in 1962
Summer fallow	$ 2.26	114	$ 2.57
Fall work	1.16	114	1.32
Preseeding	2.63	114	3.00
Seeding	1.42	114	1.62
Post-seeding			
Cultivation	4.33	114	4.94
Thinning (manual)	22.63	124	28.06
(mechanical)	1.50	114	1.71
Other post-seeding	.46	114	.52
Harvesting	14.57	114	16.61
Transportation			
Trucking	10.15	114	11.57
Rail	15.00	114	17.10
Other	2.14	114	2.44
Miscellaneous			
Fertilizer	3.19	101	3.22
Seed	2.51	110	2.76
Spray material	.46	118	.54
Association dues	.57	--	.57
Interest on debt	.11	--	.11
Land Rent	20.85	117	24.39
Total cost per acre	$ 105.94		$ 123.05

SUNFLOWER PRODUCTION COSTS PER ACRE

Cost Item	Small Enterprise (Heavy soils) $ per acre 1959	Large Enterprise (Heavy soils) $ per acre 1959	Average Enterprise $ per acre 1959	Index No. 1959=100	Average Enterprise $ per acre 1962
Land Charges					
Owned	3.84	3.96	3.90	107	4.17
Rented	2.82	2.68	2.75	107	2.94
Building Costs	.83	1.13	.98	101	.99
Own Machinery					
Tractor	4.50	3.64	4.07	102	4.15
Truck	.86	.59	.73	102	.74
Car	.71	.57	.64	102	.65
Combine	.78	1.16	.97	102	.99
Pre-seeding	.43	.41	.42	102	.43
Seeding and Post-seeding	.79	.60	.70	102	.71
Custom work Machinery rental	2.82	2.97	2.90	105	3.05
Own Labour	2.76	2.83	3.30	107	3.53
Hired Labour	.28	.14	.21	107	.22
Seed, fertilizer and insecticides etc.	1.51	1.30	1.41	110	1.55
Supplies	.23	.22	.23	106	.24
General overhead	.80	.72	.76	98	.74
Miscellaneous	.17	.15	.16	106	.17
Total	$ 25.13	$ 23.07	$ 24.13		$ 25.27

APPENDIX V

SOME CHARACTERISTICS OF THE SIX ACTUAL FARMS USED IN THE BUDGETARY ANALYSIS

Characteristics	Farm (1)	Farm (2)	Farm (3)	Farm (4)	Farm (5)	Farm (6)
<u>Capital Structure</u>						
Total acreage	160	320	560	708	893	1,190
Improved acreage	155	308	502	658	883	1,160
*Real Estate (av.)	$16,000.00	$32,000.00	$ 56,000.00	$ 70,800.00	$ 89,300.00	$119,000.00
Livestock (av.)	--	2,990.00	110.00	--	--	6,994.00
Machinery and Equipment	5,252,00	5,999.96	17,587.50	23,120.50	27,976.00	30,246.00
Farm Capital	22,489.00	45,070.34	86,752.43	104,125.50	122,597.00	166,605.50
Operator's Equity	14,034.43	42,820.34	82,252.43	79,763.54	99,297.00	164,037.50
Total Farm Assets	22,489.00	45,070.34	86,752.43	104,125.50	122,597.00	168,596.50
Total Assets	20,337.93	46,971.56	104,924.97	83,688.54	103,715.01	165,157.66
Net Worth	20,037.53	46,971.56	104,924.97	83,688.54	103,715.01	165,157.66
<u>Farm Receipts</u>						
Crop Sales	1,443.35	4,383.89	12,567.61	12,141.53	15,545.71	15,411.59
Livestock	1,909.83	1,814.83	201.87	--	--	6,132.24
Custom Work	--	894.50	40.00	2,401.00	1,525.55	1,992.95
Miscellaneous	263.41	967.23	1,570.47	1,049.95	2,336.85	5,675.75
Total Product Sales	3,616.59	8,060.45	14,379.95	15,592.48	19,408.11	29,212.53
Total Receipts	10,584.88	8,580.23	23,454.91	23,315.48	25,664.21	41,413.15
<u>Farm Expenses</u>						
Total Farm Expenses	2,115.31	3,755.90	4,684.27	8,571.21	9,197.06	32,898.30
Total Capital Expenses	1,366.54	5,538.41	9,586.44	8,712.88	7,159.40	629.60
Total Expenses	3,481.85	9,294.31	14,270.71	17,284.09	16,356.46	33,527.90
Total Cash Spent	10,922.11	11,517.10	23,430.08	22,312.59	21,196.56	39,620.98
Receipts per $ Expenditure	1.71	2.15	3.07	1.82	2.11	.89
Accounts Paid	3,255.17	500.00	1,000.00	3,663.07	4,767.03	480.00

* Land is valued at a uniform price of $100.00 per acre.