AN EVALUATION OF COST OF PRODUCTION STUDIES IN AGRICULTURE

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ABSTRACT OF THESIS

I PROBLEM

II METHODS

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I PROBLEM

The supply of cost-of-production data is not adequate in Canadian agriculture. The volume of current data is insufficient to deal with growing complexity of the industry. Existing data have limited usefulness. These data have brought varying degrees of success when applied in farm management and farm policy. The main need of cost data in farm policy is for price setting. In farm management, cost data are vital for increased efficiency.

This project contributes to a solution of the above problem as follows: Firstly, it comprises a sunflower cost study to provide the basis for decisions on production and policy in Canadian agriculture. Secondly it comprises a critical evaluation of traditional cost studies to determine how they can be improved to supply more useful data.

II METHODS

Three analyses were used in the sunflower study. The first was cross-tabular analysis. Basic data were derived from a sample survey of eighty sunflower growers in southern Manitoba. These farms comprised a random sample of approximately 10% of the total sunflower growers in the province. Group averages were used to determine the effect of size of enterprise and type of soil on cost of production per pound of sunflower seed. This analysis also served to indicate the average cost of production for all farms in the study. A second analysis was used to determine the mathematical relationship between cost per pound, yield per acre, and size of enterprise. This regression analysis gave continuous curves to show the relationships between the variables. A third analysis was undertaken to determine the opportunity cost of producing sunflowers on a selected farm. All the resources used for sunflowers were valued at their alternative return in wheat production. Major characteristics of this farm corresponded most closely to the average characteristics of the 80 farms in the sample.

The evaluation of cost studies followed several steps. A review of the literature on cost studies was first completed to determine the properties of current cost data. This review was followed by an investigation of the nature of costs in agriculture. Purpose of the investigation was to determine the required characteristics of cost data in farm management and farm policy. These preliminary steps were useful to point out procedures responsible for discrepancy between existing and required cost data. Implications of these procedures were examined for usefulness of cost data in both farm management and farm policy. This made it possible to indicate where revisions in procedures were necessary for more reliable cost data.

III FINDINGS

The principal conclusions from evaluation of traditional cost studies are as follows: Valuation at imputed market prices tends to misrepresent cost on particular farms. Arbitrary allocations of joint costs are also sources of inaccuracy. Unreliable results also occur from treating data from a post-stratified sample as representative of the universe. There is also a danger from making incomplete analyses of factors affecting cost. The apparent effects of the factors are not their true effects.

An important factor causing limited usefulness of cost studies is the attempt usually made to provide data for use in both farm management and farm policy. Different accounting and sampling procedures are often required for each purpose.

Limited usefulness of cost data in agriculture can be largely overcome by improvement in procedures. Better recognition of known economic models will help to prevent adoption of inadequate procedures. As a result, it will become apparent that a single study cannot be carried out for numerous purposes. Data from particular studies can then be reliable for their specific purposes.

Major direct findings from the sunflower study were as follows: Average cost of sunflower production was 3.5 cents per pound. Production costs ranged from below 2 cents to above 8 cents per pound. Yield per acre was found to be the most influential factor affecting cost per pound. Cost per pound of sunflower seed decreased with higher yields per acre. Size of enterprise also affected cost. Farms with small enterprises had highest costs. Soil also had an effect on cost. Farms with lighter soils had slightly lower cost of production per acre.

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PART ONE

CHAPTER I

INTRODUCTION

<u>Problem</u>. There is a serious lack of adequate data on production costs in Canadian agriculture. While various types of cost studies are being carried out in many of the provinces at the present time, much of the resulting data is not being effectively used for farm management and price policy purposes. There are several reasons for this. The present study is devoted to a critical evaluation of traditional cost studies to determine these reasons for limited usefulness of cost data.

A second part of this study comprises an investigation of sunflower production costs in Manitoba. The sample survey method was used to gather basic data from 80 farms. This sunflower cost study is typical of many current studies designed to determine the cost of producing a specific product. These enterprise cost studies receive major emphasis in the evaluation part of this project. Therefore the sunflower cost study is a useful illustration of procedures and data in cost of production studies.

The need for this project is evident in many respects. There is a definite gap between quantity of useful existing cost data and the requirements for farm management and farm policy.

It is apparent from the increasing demands made for cost studies. Legislators are repeatedly asking for cost data upon which to base government action in a farm policy.[1] Farmers' organizations request cost-of-production studies to aid policymakers and to help in management decisions.[2] Extension services are becoming more active in helping farmers with their resource management problems. Linear programming has enlarged the application of cost data in farm management work. Extensive commercialization of agriculture and its associated adjustment problem of low farm income are adding to these demands.

The need for a sunflower cost study in southern Manitoba typifies the need for many other enterprise cost studies in today's agriculture. Factors affecting demand and supply for agricultural products are changing the competitive position of sunflowers relative to other products. Technology is one of these important factors. The new position of sunflowers must be determined for sound decisions in farm management and farm policy. All products in agriculture undergo similar changes. Cost studies are required to analyze the new situations for these products.

The gap between the cost data that are now available and required data is also evidenced by limited success with which cost data have been usefully applied. Farmers have found and continue to find that results of cost studies frequently contradict known phenomena. For example, many studies imply increasing returns when it is well known that decreasing returns exist in agriculture. Reported cost curves slope downward throughout. There appears to be no economic limit to expanded use of a resource or its substitution for another. The effect of particular factors on cost is often exaggerated.

The application of cost data in farm policy has also met with limited success. The results of prices based on cost data have not achieved the desired integration with an overall farm policy. The prices have the effect of drawing too many or too few resources into the specific enterprise. The result is overproduction or underproduction of the commodity. A similar situation is illustrated when farmers do not curtail output of a commodity after a study reports that cost of production exceeds its price.

Objectives. Two major objectives of the sunflower study were:

(1) To determine the composition and level of costs incurred in the production of sunflower seed.

(2) To establish the influence of various characteristics on cost of sunflower production.

Objectives in evaluation of cost of production studies were:

(1) To determine characteristics of existing cost data.

(2) To determine characteristics of cost data required for managerial decision-making in farm management.

(3) To determine characteristics of cost data required for price setting in farm policy.

(4) To determine the characteristics of existing cost data which limit their usefulness in farm management.

(5) To determine the characteristics of existing cost data which limit their usefulness in farm policy.

(6) To determine cost study procedures responsible for limited usefulness of cost data in farm management.

(7) To determine cost study procedures responsible for limited usefulness of cost data in farm policy.

(8) To point out the difficulties that must be solved in cost study procedures for more useful data.

(9) To point out revisions that are necessary in cost study procedures to obtain more reliable data in the future.

(10) To use the sunflower cost study to illustrate procedures and characteristics of cost data in general.

Hypotheses. This project is carried out on the thesis that continuation of traditional cost studies will not bring greater application of cost data in agriculture. Progress can come only from critical evaluation of traditional cost data and procedures.

The hypotheses used to guide the investigation are as follows:

(1) The major characteristic of cost data that limits their usefulness in agriculture is an untrue picture of increas-

ing returns. Many studies overestimate the effect of size on cost. This error becomes larger for larger farms. This gives a false impression of increasing returns and constantly declining unit costs of production. Similar inaccuracies arise in analyses of factors other than size.

(2) Cost data also reflect underestimation of cost and the effect of factors affecting it.

(3) Many cost studies have been drawn up without regard to known economic models. This has resulted in unreliable data. There has been a failure to distinguish between the type of cost data needed for farm management purposes and that required for the effective development of price policies for agriculture.

(4) Important cost characteristics which must be recognized in useful studies are:

(a) The distinction between fixed and variable costs.

(b) The cost-yield relationship.

(c) Inter-farm variation.

(d) Inter-year variation.

(e) Opportunity costs.

(f) Enterprise relationships.

(g) Joint costs.

(h) The distinction between marginal and average costs. If $AC>MC$, expansion can be profitable when a study indicates it is not. If $AC<MC$, expansion

can be unprofitable when a study indicates that it is profitable.

(5) The procedures largely responsible for unreliable data are:

(a) Valuation at imputed market prices.

(b) Arbitrary allocations of joint variable and overhead costs.

(c) Treating results from a post-stratified sample as representative of the universe from which the sample was drawn.

(d) Incomplete analysis of factors affecting cost.

(e) Allocation of overhead costs tends to mask the true cost of various alternatives in farm management.

(6) Cost of sunflower production per acre varies with size of enterprise and type of soil.

(7) Cost of sunflower production per pound varies with yield per acre and size of enterprise.

(8) The opportunity cost of sunflower production exceeds the reported cost of production on an average farm.

Methods and Scope. Three analyses were used in the sunflower cost study. They were: cross tabular, cost function, and opportunity cost analyses. The first comprised a measurement by group averages to determine the effect of factors on cost. The second was similar but used regression analysis to give continuous mathematical relationships which supplement the single point observations in the first analysis. In the third, all resources to produce sunflowers were valued at the best alternative return that the limiting resource could earn in wheat production.

A random sample of 80 sunflower growers in southern Manitoba was the source of basic data. This sample constituted approximately 10 per cent of the population of sunflower growers in Manitoba. Enumerators recorded relevant production aspects during a three-call survey in 1959.

Results were first reported in March, 1960.[3] Background information and related data on production practices were included in the report. The empirical data are restated below in Chapter VI, along with an expansion of the original analysis.

Several steps were followed in the general evaluation of cost studies. The first was a review of the literature on cost studies. Its purpose was to clarify the characteristics of existing cost data. The next step was an examination of the nature of costs in agriculture. It served to clarify the characteristics of required cost data in farm management and farm price policy. This made it possible to point out the discrepancy, or gap between existing and required data. It also served as a useful background to (a) isolate cost characteristics responsible for difficulties in enterprise cost studies, and (b) determine the implications of ignoring known economic models in designing cost study procedures.

In the evaluation of cost studies in general, and in the sunflower study in particular, the requirements of cost data were interpreted as follows: Cost data must provide farmers with information for profit-maximizing decisions. The goal of farmers in resource management is assumed to be maximization of profit. It is further assumed that farmers utilize the marginal cost model in attempting to maximize profit. Farmers in actual practice do not compute their marginal cost curves. They do, however, base their decisions on a crude form of marginal analysis. It may range from crude calculations in budgetary form to flexible budgetary control. Formal budgets are becoming more necessary to plan new operations and revise existing ones on the farm. By these methods, farmers attempt to select the most profitable combinations of enterprises and resources. Decisions are involved concerning production cost at different levels and with different resource combinations.

Requirements of cost data for price setting in farm policy were interpreted as follows. Cost data must provide bases for prices that achieve the farm policy objective of fair returns to resources in agriculture. Fair returns are interpreted to mean the possible earnings of resources in their best alternative uses. Hence fair return is synonymous with opportunity cost.

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CHAPTER II

A REVIEW OF THE LITERATURE ON COST STUDIES

An examination of previous cost studies in agriculture is necessary to clarify the extent to which they were useful in managerial and pricing decisions. This chapter presents major findings from such an examination.

Cost studies in agriculture usually fall into one of three types: cost-route studies, farm management surveys, and enterprise cost studies. The latter are most common. They developed as modifications of the other two. All three are described below. The advantages and limitations of data receive emphasis. While enterprise cost data are most important, the advantages and limitations of other cost data are useful to assess enterprise cost data.

(1) Cost-Route Studies.

(a) Nature. The cost-route study originated in Minnesota during the first decade of the present century. It was the forerunner of many cost studies being carried on in North America today. Cost-route studies have used a complete cost accounting approach involving detailed observation of every enterprise on each farm. These studies have usually included relatively few farms compared to other studies. Eight farms were the basis for a cost-route study in Minnesota in 1904.[1] The number of farms has gradually risen to approximately 100 per study in recent studies in Illinois, Minnesota, and New York. This number remains a small per cent of the universe being studied.

The primary objective of cost-route studies has been to analyze cost of production on each farm as accurately as possible. Necessary detail in the accounting procedures required frequent visits by enumerators.[2] Inputs such as feed, seed, supplies, and labor were recorded in detail for quantity and methods of application. Some studies have used greater participation by farmers to replace some visits by enumerators.

(b) Advantages. Cost-route studies have been found valuable in managerial decision-making on the farms studied. These data enabled farmers to assess possible outcomes of various adjustments in their operations. Data for each farm comprised a complete analysis of the cost and returns situation. They showed the relative profitability of various alternatives from which the farmer could choose the most profitable. For example, with these data the farmer could decide whether to increase or decrease output of a particular commodity, or whether to change the method of producing it.

Many cost-route studies were conducted over a period of years. This practice has made data from these studies an important source of historical information. Cost-route data have helped to depict trends in utilization of major farm inputs such as labor. They have shown the changes in hours of work per man and therefore have been useful to maintain up-to-date standards in man work units. These other events show that cost-route studies have been helpful supplements to data from less complete studies.[3]

(c) Limitations. Data from cost-route studies have had questionable reliability for farms other than those studied. There were two major reasons. One was the small number of farms in these studies. The number was generally not adequate to be regarded as representative of all farms in the universe being studied. Another reason was uniqueness of the farms being studied. They were usually not selected on a random basis, but according to other criteria, such as accessibility. It was imperative that the enumerators be able to travel their routes during the proper time. Farms were concentrated in small, easily accessible areas for most studies. A second criterion often governing selection of a farm was co-operation of the farmer. Farmers unwilling to impart and record the necessary information could not be included in the study. In some studies, a third criterion was important in selecting the farms. It was exemplary value of a farm; model farms, or those above average prosperity, were selected to provide an objective to farmers. Data from cost-route studies, therefore, were generally not representative of enough farms to have wide usefulness.

The poor representativeness of cost-route data also precluded their use for setting prices. Cost-route studies, however, were not designed to provide data for price setting decisions. The main purpose of data from these studies was to help individual farmers increase profits.[4]

Other limitations of data from cost-route studies were inherent in the method of analysis. It was a slow method, because data from a single year could not be regarded as reliable. The cost-route method was relatively expensive compared to other methods. In addition, data were difficult to interpret.[5]

(2) Farm Management Surveys.

(a) Nature. These studies were developed soon after the cost-route type.[6] They originated at Cornell and are still being carried on today, but modifications have generally been made in the procedures.

Farm management surveys included more farms than the cost-route studies. Accounting procedures were less detailed. Cost accounting for individual enterprises was replaced by financial accounting for the complete farm. One or two yearly surveys replaced frequent cost-route visits. Enumerators secured estimates from the farmers concerning the relevant aspects of production. For example, they recorded estimates, not exact quantities, of bushels fed or used as seed. Labor use was not observed each day, but estimated for the year. Yields were estimated, not measured. These accounting concessions were necessary to permit larger sample size with a minimum cost.

One of the primary objectives of farm management surveys, was to supply data for use in managerial decisions on many farms. These data consisted of profits on different types of farms. For this, the average cost of each type of farm was computed. High profits were assumed to by synonymous with low cost. The purpose of this information was to furnish bases for conclusions regarding factors that affected profitability.

The method of analysis was by group averages. If the effect of one factor on profitability, or cost, was being studied, the farms were stratified into groups on the basis of that factor. Each group become known as a farm type. The average cost and profitability of each type was determined. For example, two farm types, large and small, were selected to stratify farms in studying the effect of size of farm on cost. The average cost of the group of farms in the small type was compared with the average cost of those in the large type. Conclusions about the effect of size were based on the difference between the two cost figures.

This method of analysis by group averages has come to be known as cross-tabular analysis. When several variables were being studied for their effects on cost, the farms were tabulated into several groups. These groups were derived by first sorting the farms into groups on the basis of one factor and then subsorting the initial groups on the basis of other factors.

For example, to study the effects of size of farm and type of soil, a cross-tabulation of the farms into a minimum of four groups was necessary. These groups could have been described as follows: small farms on light soils; small farms on heavy soils; large farms on light soils; large farms on heavy soils. If the farms were classified into three groups on the basis of each factor, the total number of farm types was nine.

(b) Advantages. Data from farm management sample surveys were more representative of farms outside the study than were data from cost-route studies. The infrequent visits to each farm did not require selection of easily accessible farms. Accounting based on estimates placed a lighter burden on the farmer, making co-operation less decisive in farm selection. Above average farms were not exclusively selected; there were definite attempts to study representative farms. These characteristics increased the reliability of the data obtained.

(c) Limitations. However, the data derived from the sample survey have shown certain limitations. The data obtained by estimates in the sample survey have tended to be less accurate than cost data obtained through the more detailed cost-route study. It has been estimated that income and expense figures from a sample survey were incomplete by at least 12 per cent.[7] Financial accounting, not cost accounting was the procedure used in the surveys. The resulting data indicated costs and profits for the complete farm but not for each product. These data were not adequate for conclusions concerning factors affecting efficiency in each enterprise. A farmer, for instance, could not decide whether to expand his hog enterprise or not. The data only indicated, for example, that farms with hog enterprises made high profits. The profitability, however, may have resulted from factors not analyzed by the study. This limited the usefulness of farm management surveys to areas of specialized production.

Although large samples were used for farm management surveys, data from these studies frequently were in error for the universe of farms. Cost of production in a sample has exceeded cost on other farms of the same type. The converse has also occurred. Stratification of the sample rather than the universe has been largely responsible for these overestimations or underestimations of cost. After the post-stratification, some farm types were represented by too few farms for data to be representative of each type. No device was used to assure adequate numbers of farms for each type to be studied. Furthermore, precautions to obtain a random sample for each type could not be observed in post-stratified samples.

(3) <u>Enterprise Cost Studies</u>.

(a) <u>Nature</u>. Most present-day cost of production studies in agriculture are enterprise cost studies. They evolved from farm management surveys but differ from them in that each farm is analyzed only for one commodity out of the several it may produce. The desire for more specific information for each product was partly responsible for rising importance of enterprise cost studies. Also, survey studies were found most useful in areas of specialized production.

The analytical model in enterprise cost studies usually takes the form $C = f(X_1X_2X_3 \ldots X_n)$ where C is cost of production per unit of the commodity and X_1-X_n are factors that affect cost.

Two methods of analysis can be used to determine the effect of the factors on cost. One is cross-tabular analysis similar to that used in farm management surveys. In this case it is the cost of producing a specific commodity, not the total cost of the farm, that is analyzed. The other is mathematical analysis to determine the exact functional relationship between cost and the factors affecting it. The latter will be termed cost function analysis.

Most studies also report the cost elements which comprise cost. Important resources, such as labor, are sometimes reported in physical terms as well as value terms. The distribution of labor use throughout the year is also commonly reported. Data from a large sample of farms are the basis for the final results.

Emphasis is given to the regional aspect in enterprise cost studies. Samples of farms are drawn from different regions.

Analysis on a regional basis reflects an attempt to achieve greater accuracy. It shows a realization that costs differ between regions. Regional analysis prevents information on a specific region from being affected by the characteristics of another region.

(b) Advantages. Data from enterprise cost studies have several advantages. They have wider applicability than cost-route data. More farmers can apply these data in their decisions. Enterprise cost data show a greater amount of detailed information for specific products than do farm management surveys. Farmers can use data from two or more enterprise cost studies to make product-product decisions. Enterprise cost studies are also designed to furnish information regarding the most profitable methods of production. For example, an enterprise cost study can show the cost of producing hay by two methods: baling and silage cutting.

Enterprise cost data have also been used for pricing purposes. One of the first uses of cost data apart from farm management was in the sugar beet industry in the United States.[8] Farmers relied on cost data to bargain with sugar processing firms for contracts. This took place as early as 1918. Wheat prices were also set on the basis of cost investigations in this period.[9] Subsequently, interest in the use of cost data for pricing declined.[10] This has now been followed by a renewed emphasis on the use of cost data for pricing. The role of government in price setting is increasing with the complexity of the agricultural economy. There is evidence of greater government attention to cost data in its pricing decisions for agricultural commodities.[11] Farm groups are demanding cost data for use by legislators in setting prices.[12] The use of cost data in the field of price policy has become much more important than at the time when enterprise cost studies first appeared.

(c) Limitations. Results of enterprise cost studies frequently contradict currently accepted theory. Cost curves appear to slope downward throughout. Often there appears to be no economic limit to the use of a particular resource or its substitution for another. This indicates that maximum output is synonymous with maximum profit. These findings imply increasing returns, when in fact, many writers contend that diminishing returns exist in agriculture.

Also, the reported cost of production has exceeded the price received by farmers. Yet they continue to produce the commodity.

It is not uncommon for data from enterprise cost studies to overstate the effect of a factor on cost. Farmers find that these results do not describe the nature of costs on their farms.

Several inferences can be drawn from an examination of data from previous cost studies in agriculture. Some studies failed because they were based on small samples, non-random samples, or both. The data were representative of few farms and therefore were not widely applicable in farm management. Also, these data were inadequate for development of sound agricultural policy. Other cost data had limited usefulness because they were derived by inadequate accounting procedures. The method of analysis has also affected reliability of data obtained from cost studies. Post-stratification has resulted in data that are not representative for the universe. These data also have shown phenomena for the sample that appear to be unrealistic. An example is a series of data that imply increasing returns for the sample of farms studied. The effects of factors other than size on cost have also appeared to deviate from those expected.

These findings indicate that cost data can be in error due to the procedures used to obtain them. It is necessary to evaluate the accounting, analytical and sampling procedures of enterprise cost studies. The objective in this evaluation is to assess the revisions that are necessary to make cost data more reliable to meet the expanding need for them in farm management and farm policy.

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CHAPTER III

THE NATURE OF COSTS IN AGRICULTURE

The findings in many cost studies contradict economic theory. Part of the reason is the failure to recognize important properties of cost in agriculture. This can lead to inadequate design of the study or dangerous misinterpretations of the data.

The main purpose of this chapter is to clarify cost properties that must be recognized in useful enterprise cost studies. It also sets the conceptual framework for design and interpretation of the sunflower cost study.

Fixed and Variable Costs. A farmer incurs fixed and variable costs to produce a commodity. Fixed costs are present only if costs are regarded in terms of the short run. They become variable in the long run, when all resources are variable.

Total fixed costs do not change if output changes. Average fixed costs, or fixed costs per unit of output, decrease if output expands and increase if output contracts. Fixed costs are always present. Many resources, such as machinery, are durable and give service for more than one production period. These polyperiod resources rarely require replacement at the same time.

The Cost Function-Production Function Relationship. Variable costs change if output changes. They are a function of output and can be expressed as VC = f(Y). The total cost function also includes fixed costs and therefore is TC = f(Y)+FC. In the short run, the relationship between total cost and the production function depends on the proportion variable costs are of total costs. In the long run, the relationship between total cost and the production function is the same as for variable cost in the short run.

The relationship between cost and production functions is expressed by:

$$VC = f(Y)$$

$$Y = f(X_1 X_2 X_3 X_4 \ldots X_n)$$

therefore $VC = f[f(X_1 X_2 X_3 \ldots X_n)]$

and $TC = f[f(X_1 X_2 X_3 \ldots X_n) + FC]$

Where Y is the production function for the enterprise with the variable cost function VC. X_1 to X_n represent quantities of the various resources required to produce Y. Figure 1 describes this relationship when only one resource is variable. The same relationship holds when n resources are variable.

There is an inverse relationship between the total cost and production functions. The total cost function rises at a decreasing rate when there are increasing returns in the production function. It rises at an increasing rate when there are decreasing returns in the production function. The marginal

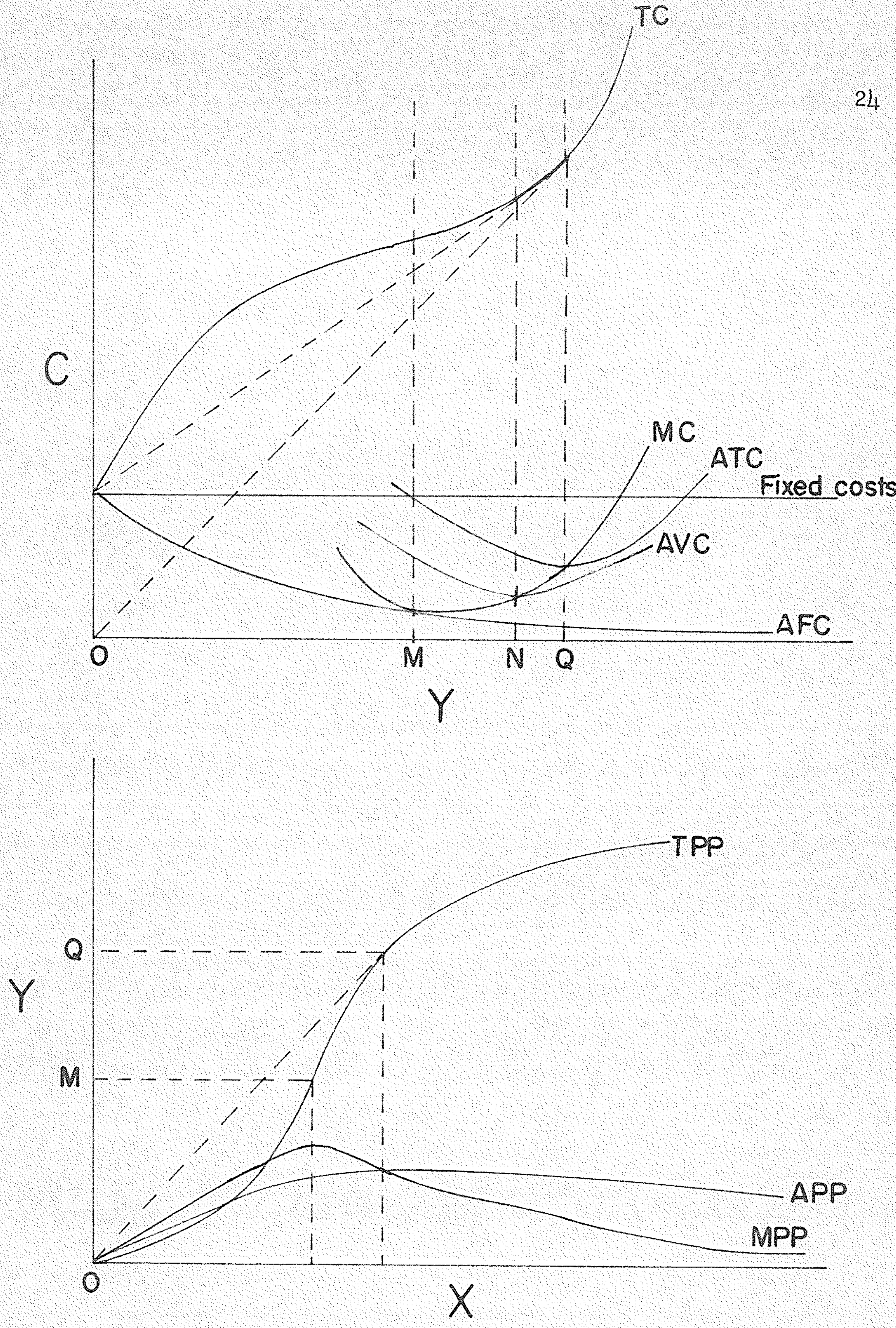

Figure I. The nature of costs in agriculture.

curves also bear a relationship to each other. Their height corresponds to slope of the total curves. The marginal cost function (MC) drops until the marginal physical product function (MPP) stops rising. Then it rises while MPP drops.

The rising nature of this curve shows that cost of production per unit of output increases as output expands. This is due to decreasing returns in the production function. More units of the resource are needed for each successive additional unit of output because MPP is declining.

Height of the total cost function is related to height of the production function. The average cost function (ATC) is lowest when the average physical product function (APP) is highest. Each unit of output has least cost when the smallest number of variable resources are required for it. This is when one variable resource yields the greatest output. The rising AVC offsets the dropping AFC to make ATC rise. Rising cost of additional units of output acts to increase the average cost of all units produced.

Inter-Farm and Inter-Year Variation. These relationships between the cost and production functions hold when n resources are variable in an enterprise. Many factors affect the production function in agriculture. They vary from farm to farm and from year to year on each farm. Any two farms are unlikely to have the same production function in one year. Their cost functions also differ. When the production function of a farm changes with time, so does its cost function.

Causes of Cost Variation. The causes of variation in cost are actually due to the factors that change the production function. These factors can be classified into five major groups:

(1) Soil

(2) Technology

(3) Weather conditions

(4) Biological forces

(5) Enterprise combinations

With other inputs equal, inter-farm differences in (1)-(5) lead to inter-farm variations in the production function of an enterprise. Similarly, the production function of a farm varies from year to year with changes in (1)-(5). If these factors are favourable, they raise the production function. They lower the production function when they are unfavourable.

The above can be stated thus $Y = f[X_1 X_2 \ldots X_n, (1), (2), (3), (4), (5)]$. Yield of a product depends on physical inputs used, as well as factors in groups (1)-(5). If equal X_1-X_n inputs are used, yields will differ if (1)-(5) differ. Since cost depends on yield, these factors affect cost. An examination of each group of factors will show the nature of inter-farm and inter-year cost variation.

(1) Soil. Topography, chemical composition, acidity, texture, and other soil characteristics are not uniform. They vary

from farm to farm and within some farms. Some are affected by production practices used.

(2) Technology. Each farmer adopts a different degree of technology. Personal preferences, traditions, and customs have an influence as well as the supply of capital. These factors also change for each farmer.

(3) Weather conditions. Resources are more productive in favourable weather. Fertilizer, for example, has a greater effect on yield with some levels of precipitation than others. Precipitation varies from farm to farm and year to year. Other factors, such as temperature and wind velocity act similarly.

(4) Biological forces. Disease and insects act to lower the production functions more excessively on some farms than others and in some years than others.

(5) Enterprise combinations. The combination of enterprises selected by a farmer affects the production function of any one enterprise. Most large enterprises have higher and steeper production functions than small enterprises of the same type.

The farmer also determines the environment of other enterprises in which a specific one will operate. An enterprise may have a favourable or an unfavourable environment. It is favourable when the other enterprises are complementary. They interact with the given enterprise to raise its production function. An example is a hay-grain rotation. The hay crop provides nitrogen which increases productivity of resources for grain. An environment is unfavourable when the other enterprises are competitive. They lessen productivity of factors in the given enterprise. An example is a hay-wheat-barley rotation. Wheat competes with barley for nitrogen from hay. The production function for barley would be higher if wheat were not present. Some enterprise relationships are supplementary. One enterprise has no effect on the production function of others.

The effect of other enterprises on the environment of a specific one is variable. It depends on the effect that soil, weather, technology, and biological forces have on their production function.

There are two reasons why combinations of enterprises are important in their effect on production functions. First, there is much mixed farming. Many farmers must decide the combination of enterprises they will have in each year. Second, each farmer has unique preferences and experiences. They change with time. There is much subjectivity in decisions about enterprise combination.

For these reasons, two farmers will not likely have an enterprise of the same size or in the same environment in any given year. Size of an enterprise on one farm will not likely be the same in two different years. Environment of the enterprise will rarely remain constant over the years.

All these factors - soil, weather, technology, biological forces, and enterprise combinations - cause many variations in the production function. Two farms are unlikely to have the same production function. One farm is unlikely to have the same production function from year to year.

Because they depend on production functions, cost functions on two farms will be different for an enterprise. Also, the cost function on one farm is unlikely to be the same each year. This explains why cost of production may not be the same on each farm. It also explains why cost may be different each year on one farm.

The Nature of Cost Variation. The cost of producing a commodity can be different between two farms or between two years under two particular circumstances. One is that all farmers produce where their marginal cost equals price. Their marginal costs are equal at that point. However, because each has a different set of cost curves, their average cost of production is not the same.

The other circumstance is when all farmers do not produce where marginal cost equals price. This is possible even if all attempt to equate marginal cost and price. Some effects on cost are uncontrollable. Farmers do not have complete control of the effect of soil, technology, weather, biological forces and enterprise combination on the production function. Marginal cost may deviate from that expected. In this case inter-farm variation in average cost will be greater than with equal marginal costs.

Opportunity cost. The real cost of producing a commodity is the alternative given up for it. This is opportunity cost and is the value sacrificed by using resources to produce that commodity. The value sacrificed for cash cost resources is their market price. Examples are hired labor, fuel, and repairs. No amount above market price must be paid for services of these resources.

Other resources do not have an easily identifiable opportunity cost. They enter the specific enterprise from inside the farm business. They are products of other enterprises or resources that could be used to produce these products. Examples of the latter are land, operator labor, and fixed machinery investment. Examples of the former are grain and hay grown on the farm and used in dairy production.

Opportunity cost varies from farm to farm and from year to year because the alternative returns differ. This is apparent by regarding average and marginal opportunity cost of a particular commodity Y. Average opportunity cost is total value productivity in the best competing use of resources used to produce Y divided by the number of units of Y. Marginal opportunity cost is total value productivity in the best competing use of resources used to produce the last unit of Y. These cost functions have inter-farm and inter-year variations similar to those discussed above.

Reasons for inter-farm and inter-year variations in opportunity cost of producing a commodity are threefold: production function variations, price-determination of opportunity costs, and limited capital.

Production function variations in alternative enterprises affect opportunity cost of a specific product. The production function in the best alternative use of resources for the product is not uniform. The best competing use may not be the same kind on each farm or during every year. If it is the same kind, it may not be as productive on each farm or in each year.

Opportunity costs are price-determined. They depend on price of alternative production from resources being used for the product. These prices may not be the same each year. Also, competing products may not be similar on all farms.

Thirdly, opportunity costs depend on the supply of capital. It is more limited on some farms than others and in some years than others. It affects resource use in the alternatives to a particular enterprise. Most profitable resource use with unlimited capital occurs when price (P) equals marginal productivity (MP) of each resource. MP will exceed P in a situation of limited capital because resource use is restricted. Smaller farms are usually characterized by greater restriction on resource use due to limited capital. Given greater restriction on small farms, MP exceeds that on large farms. Marginal opportunity cost on small farms exceeds that on large farms. Average opportunity cost, however, can be higher on large farms if they have higher production functions.

<u>Joint Costs</u>. Joint production is very common in today's diversified agriculture. Resources are frequently used for two or

more products. The products may be closely related such as milk and veal, wheat and straw, or wool and mutton. Resources used for one also result in production of the second commodity in the process. The joint products can be less closely related. An example is production of wheat, oats, and hay with one tractor. It is a resource for each enterprise, but only part of its service goes into each. The production function of each enterprise contains not the complete tractor, but part of its service. Tractor cost is a joint cost borne by all enterprises.

Many resources in agriculture are used jointly by two or more enterprises. Some machinery items are specialized, but most are designed for several commodities. They have joint costs that form part of the cost function for each enterprise in which they are used. Other joint costs are telephone and hydro expense and taxes. Each are necessary for operation of the farm. They comprise part of the cost function for each enterprise on it.

Joint costs can be either fixed or variable. Telephone expense and other overhead costs are examples of fixed joint costs. Machinery repairs fall into the variable joint cost category.

Implications of Cost Characteristics. It becomes apparent that costs in agriculture have properties with implications for cost studies. Failure to recognize these properties in design of a study will limit the usefulness of data from it. The data will not reflect some of these properties. Procedures used will not provide reliable data by dealing successfully with some of these properties. As a result, the data will not have characteristics for wide usefulness in agriculture. Some of these properties show differences in cost concepts for different purposes, such as for farm management and farm policy. If these differences are not recognized, the resulting data will have characteristics not desirable for usefulness in either field. A summary follows for each cost property and its implications.

(1) The cost-yield relationship. There is a functional relationship between the cost and production functions. This implies the need for data over a flexible output range. Single point analysis does not describe shape of the cost curve. The cost-yield relationship also implies need for data to reflect rising unit cost curves to correspond with decreasing returns in the production function. These requirements of data are (a) to select the most profitable size of enterprise from the long run cost curve, and (b) to select the most profitable output from an enterprise of given size in the short run. Associated with (a) and (b) are decisions concerning most profitable use of particular resources in each situation.

(2) The distinction between average and marginal costs. Maximum profit is not synonymous with maximum productivity. Studies must guard against implying that it is. Variable resources have maximum productivity at the point of lowest average cost. Fixed resources have maximum productivity with marginal productivity of variable resources equal to zero. Maximum profit occurs between

these two points. Data must show this to be useful bases for decisions on resource use. If the data show increasing returns, they imply that maximum profitability occurs at maximum output. Data of this type exaggerate the advantage of increased resource use.

(3) The distinction between fixed and variable costs. Fixed costs do not change with alternative outputs or methods of production. They are not required in analyses to determine the relative costs of different alternatives in the short run. If they are included in data for short-run use, the differences in costs between alternatives become obscured. Data for long-run use in managerial decisions and for price setting must include fixed cost.

(4) Multiplicity in factors affecting cost. Cost is affected by many factors because of their effect on the production function. This implies the need for data to show the effect of each factor on cost. Single factor analysis is not adequate. Data from multi-variable analysis are needed to control cost in an enterprise or estimate it for a new one.

(5) Inter-farm variation. Agriculture is characterized by wide inter-farm variation in cost of production for each commodity. This indicates the need for cost data to show range of variation in cost. Failure to do this may bring misinterpretations of cost uniformity at the average.

(6) Inter-year variation. Cost varies widely from year to year due to yearly changes in factors affecting the production function. This indicates the need for cost data over a period of

years for best reliability.

(7) Opportunity cost. Cost data must include opportunity cost of non-cash resources to be meaningful. These resources have a cost for a particular commodity in terms of the highest alternative return they could earn. If they are not valued at opportunity cost, the resulting data will not be accurate. This is especially relevant for price setting to equate returns of resources for a particular commodity with highest alternative earnings.

(8) Joint costs. Data on a particular commodity must include only that part of the joint costs attributable to that commodity. To include excessive parts of joint costs will make the particular commodity appear to have a false high cost. The opposite situation will arise if too few joint costs are included in data for the particular commodity. Fixed joint costs can be omitted for short run use in farm management. They must be retained in data for pricing and long run managerial use.

CHAPTER IV

METHODOLOGICAL AND EMPIRICAL DIFFICULTIES IN ENTERPRISE COST STUDIES

The purpose of this chapter is to point out procedures responsible for discrepancy between existing and required characteristics of cost data. The previous chapter presented requirements of cost data. These requirements differ from properties of current cost data outlined in Chapter II.

The effect of difficulties in cost study procedures on usefulness of the data has received little investigation. Three criticisms have been made for limited usefulness of cost data in agriculture:

(1) Most influences on cost are uncontrollable. Therefore cost studies give information that cannot be used by the farmer in controlling his cost of production.[1]

(2) Many studies are conducted without the benefit of clearly defined objectives. The resulting data are only by accident consistent with the objectives implied in the study.[2]

(3) Marginal cost is not equal to average cost. Most studies report factors affecting average cost. Marginal cost, however, is needed for decision-making.

These criticisms do not directly refer to procedures in cost studies as reasons for limited usefulness of the resulting data. The following evaluation of procedures is carried out on the hypothesis that there are many difficulties that cause disregard of known theory in design of procedures. As a result, cost data from traditional studies are generally unreliable.

There are three main sources of difficulty in obtaining reliable cost data:

(1) Accounting procedures that result in poor cost estimates for individual farms.

(2) Analytical procedures that prevent accurate data for the sample.

(3) Sampling procedures that prevent data for a sample from being representative of a specific larger population.

The objective of the following is to show what is involved in each major step in enterprise cost study procedures. This will permit a clearer understanding of difficulties encountered and will indicate the procedures at fault for unreliable data.

(1) Accounting Procedures. The main difficulties in accounting procedures are:

(a) To impute a realistic opportunity cost to non-cash resources such as:

- (i) wages for labor
- (ii) interest on land
- (iii) depreciation and interest on capital resources
- (iv) value of farm products used as inputs for the specific enterprise.

(b) To allocate joint costs

(c) To guard against empirical errors in observation.

(a) Opportunity Costs. The opportunity cost of a resource is the return it could earn in its best alternative use. It is difficult to determine actual opportunity cost for every resource used in the specific enterprise on each farm. A multitude of factors affect it and the effort to consider them independently for each farm is almost prohibitive. For this reason, opportunity cost is usually imputed at market value in enterprise cost studies. Values to be imputed are wage rates, interest rates, farm products used as inputs, and value of depreciated capital resources.

Factors to be considered in determining opportunity cost or value productivity are: production functions and prices of alternative products, supplies of capital, and effects of resource shifts on production functions. The latter are especially difficult to estimate before they happen. Opportunity cost valuation presumes a resource shift into another use to find what value productivity would be. A resource shift out of one enterprise will change the enterprise relationships on a farm. Production functions for all enterprises can be affected. In the new situation, resources can be more or less productive in each enterprise. The production function of the best competing use for resources being valued can be affected. Net income from all enterprises can be decreased in the proposed situation. There are three possible effects, depending on the existence of competitive, complementary, or supplementary enterprise relationships.

Only infrequently do imputed market valuations equal opportunity cost. Part of the reason is inability to account for differences in opportunity cost throughout the year. For example, labor of the farm operator can earn a higher alternative return in some seasons than others. The opportunity cost of each day's labor differs from that of other days. Similar variations are possible for capital resources. One imputed value for the year will rarely give the combined opportunity costs for each period in the year.

Studies of Manitoba agriculture have shown discrepancies between the imputed market price and value productivity of resources. These discrepancies illustrate the implications of using imputed market valuations in cost studies. A 1957 study on resource productivity showed these discrepancies:[4]

(Resource Group)	Marginal (Value) Productivity (MVP)	Market Price (P)
Land	$ .25	$ .08
Labor	.27	.75
Capital	.91	1.05

These comparisons are for groups of farms. Larger discrepancies can be expected for individual farmers. A study of resource productivity in a different area for 1958 gave discrepancies as follows:[5]

(Resource Group)	Marginal Value Productivity (MVP)	(Market) Price (P)
Labor	$ .08	$ .60
Buildings	.13	.10
Machinery & Equipment	.16	.15
Cash Operating Expenses	1.54	1.05
Land	.11	.05
Livestock	.21	.05

Differences in absolute amounts between the two studies can be partly attributed to different units of measurement. The significant observations are relationships between marginal value productivity and market prices. For some resources, MVP exceeds price. The reverse is true for other resources. Greater inequalities can be expected for individual farms and for individual resources in each group.

If MVP>P, valuation at P will underestimate opportunity cost. The error will become larger as greater quantities of resources are used. If MVP<P, valuation at P will overestimate opportunity cost. Costs are inflated depending on the quantities of resources used. Large farms will have the greatest error in overestimation.

The error from using imputed market valuations is larger for short run costs. Resources have a lower opportunity cost in the short run depending on the extent they are committed to a specific use and cannot be put to another use. This extent differs from farm to farm. Opportunity cost deviates more widely from market price in the short run than in the long run.

Valuation at market price can be inaccurate for farm products used as inputs for a specific enterprise. The opportunity cost of these resources can exceed their market value. Value productivity of seed and feed, for example, can exceed their market price. In this case, market value of these resources is less than their value if used on the farm in an alternative enterprise to the one studied.

The use of imputed market values for polyperiod resources such as machinery affects the accuracy of the depreciation charge. Actual depreciation costs depend on loss in market value due to use and other external factors. Depreciation of two identical items will differ on two farms due to variations in resources. The machinery owned by two farmers, for example, will differ in type, size of specific items, and age. Uniform market valuations combined with uniform depreciation rates will tend to overstate the actual depreciation for some farms and understate it for others.

Market value imputation of opportunity cost results in errors for particular farms because the imputed values are the same for each farm.

Uniform valuations can inflate costs on small farms and deflate it for large ones. For example, the opportunity cost of an hour of labor may be lower on a small farm. A possible reason is that the farmer is a less capable manager, which reflects his lower earning power in other occupations as well. Uniform valuation for labor would inflate the cost of labor for the studied product on this farm. Farms larger than the average, however, may be managed by more capable operators. Their alternative return for labor is higher than the uniform valuation. As a result, uniform valuation deflates the labor cost. The opposite situation can also occur. Uniform valuations deflate cost on small farms and inflate it for large ones.

In summary, it is difficult to use realistic imputed values for non-cash costs on each farm in a study. Uniform valuations, usually market prices, are commonly used, irrespective of factors such as farm size which affect the opportunity cost of resources. Resulting values for labor, farm products used as inputs, interest and depreciation on capital can be too general for accuracy on each farm.

(b) <u>To Allocate Joint Costs</u>. The only realistic basis for allocating the joint cost of a resource is proportion of its use in each enterprise. It is almost a prohibitive task to obtain that basis for every jointly-used resource in the enterprise under study. The necessary detailed observation of the production process on each farm is impractical. For this reason, most enterprise cost studies use arbitrary methods for allocating joint costs.

Methods for joint cost accounting include:

(i) Treat one product as main one and others as by-products when the latter comprise less than 10 per cent of total income. Veal is a by-product from a dairy enterprise if milk sales exceed 90 per cent of total income in it. All joint costs are allocated to the main product and sales of by-product are deducted from cost of main product.

(ii) Use quantity as a basis. Joint costs of resources to produce wheat and oats are allocated according to bushels of each.

(iii) Use a weighted average of price times quantity. Wheat would receive a larger share of joint costs than from a quantity basis because its price exceeds that of oats.

(iv) Use a theoretical or formula basis. This is valid if the joint products are produced in fixed proportions.

(v) Determine actual record of use for each product. Tractor use for production of wheat can be used as a basis for allocating total tractor costs to wheat.

(vi) Estimate actual record of use for each product. Machinery costs can be allocated to wheat on the basis of its acreage as a proportion of total acreage. Accuracy depends on relation between acres and actual use.

Arbitrary methods can misrepresent actual cost of important resources. Machinery is particularly significant due to its high proportion in total cost of production. Labor is also a large part of total cost; if it must be allocated it is a source of possible error. Joint overhead costs, such as taxes and building depreciation are usually relatively small. Arbitrary allocation therefore does not make them a major source of error in cost.

Diversified application of machinery in today's agriculture adds to the problem of allocating machinery costs among the various farm enterprises. While some machinery expenses are confined to particular enterprises many are used in several different enterprises. The proportion of use in each enterprise will vary between farms due to different sizes of enterprise and preferences of farmers. Machinery investment itself varies in nature from farm to farm. Two farmers will rarely have identical machinery. If they do, their use of particular items will not be identical. Such heterogeneity in agriculture leads to inaccuracy in cost data from arbitrary cost allocations.

In conclusion, there is great chance for an arbitrary allocation that is uniform for all farms to be inaccurate for many farms. For example, an arbitrary allocation may inflate cost for small farms and deflate it for large ones. The allocation procedure can misrepresent cost on particular farms for which the arbitrary allocation is not suitable.

(c) To Guard Against Empirical Errors in Observation. It is difficult with the survey method to obtain accurate cost figures for each farm.[6] Accuracy depends on the farmer's memory concerning cost items and relevant production aspects. Errors in cost from this source may, or may not be random. Consequently, cost is usually biased upward for small farms and downward for the large farms.

Yield is a relevant production aspect which can also have errors in observation. Errors in yield have implications for accuracy of the average cost figure. It is possible for high yield estimates to offset high total cost estimates and diminish the error in average cost. Low yield estimates can also offset low estimates of total cost on a farm. However, it is more likely that errors in yield estimates add to those in total cost to enlarge the error in average cost.

Observation errors during a survey often are correlated with factors such as farm size and managerial ability. For example, errors in cost can be larger for farmers with lesser managerial ability. These farms will likely have the lowest total cost of production because their farms are smallest. Cost errors will be larger in this situation for farms with lower cost of production.

(2) Analytical Procedures. The analysis of relation-

ships between cost and factors affecting it can give inaccurate results for the sample studied. Basically, the objective in analysis is to illustrate the average cost curve for each important factor affecting cost with all other factors held constant. This illustration can be discrete or continuous. Cross-tabular analysis provides single point observations for several different levels of the variable factor. Cost function analysis provides observations for all levels of the variable factor.

Both methods have inherent statistical difficulties. The following is an examination of these difficulties as they apply to enterprise cost studies in agriculture.

Accurate analysis of factors affecting cost is difficult in cross-tabular studies. Size of any given sample limits the number of factors that can be analyzed for their independent effects on cost. There is a maximum number of groups into which the sample can be stratified. A sample of 80 farms, for example, can be stratified into 16 groups of 5 farms. These groups are adequate to analyze only two factors if the farms are stratified into 4 groups on the basis of each factor. The effects of other factors on cost cannot be analyzed to keep them constant and isolate the effect of each studied factor. If the two factors that are studied are correlated with other factors, the effects of the latter will appear as effects of the former.

Figure 2 shows the outcome of single variable analysis

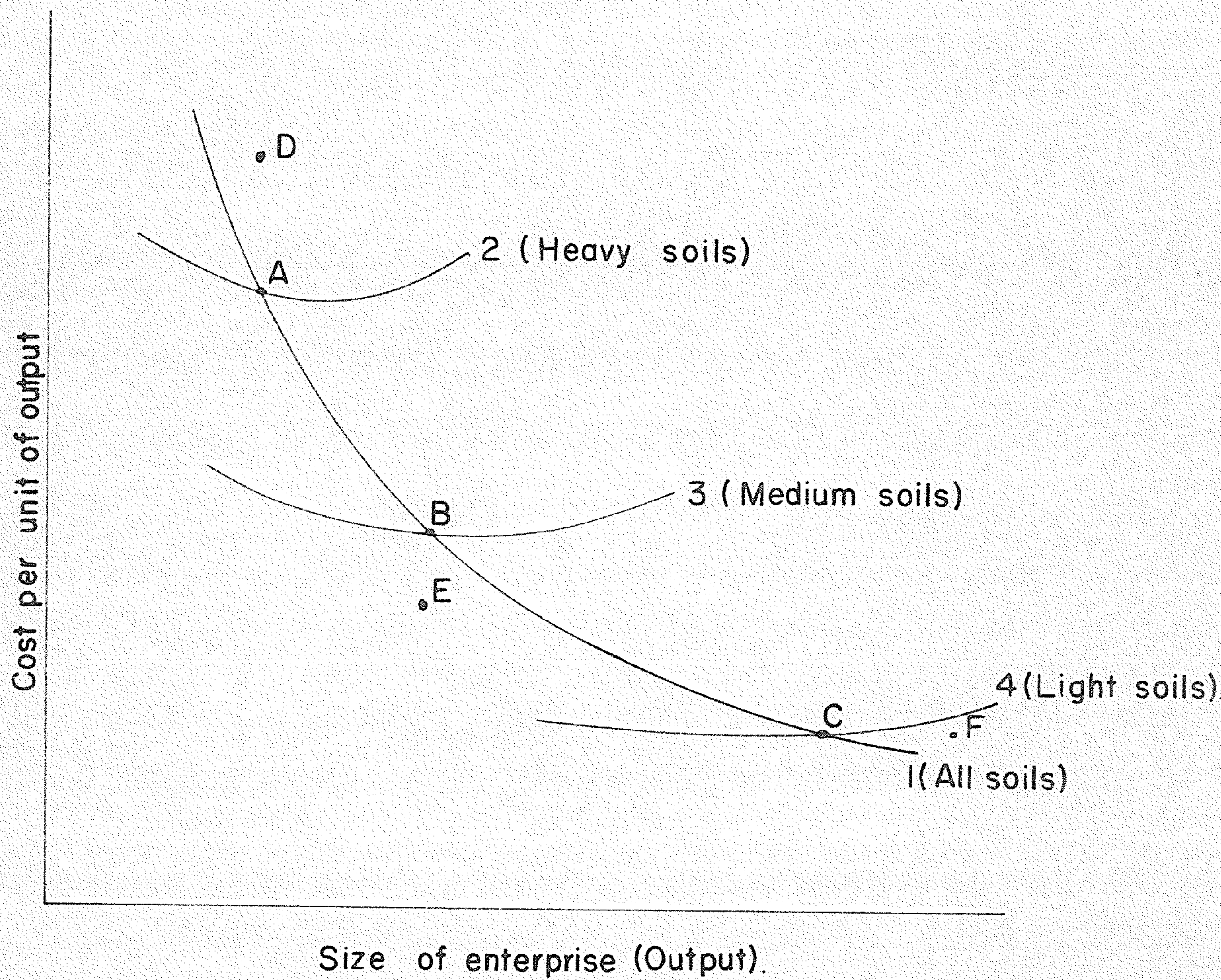

Figure 2. Effect of size on cost
a. with soil not held constant.
b. with soil held constant.

in such a situation. Size and soil are two inter-correlated factors affecting cost. Curve 1 shows an exaggerated effect of size on cost because soil is not kept constant. If soil were analyzed by a three-way stratification, it could be kept constant at each of the three levels. The illustration of size would be closer to its actual effect in curves 2, 3, and 4. Similar confounding of results can occur in analyses that are incomplete for all factors affecting cost.

In the illustration above, cost function analysis would have the same shortcoming as cross-tabular analysis. If size were the only variable studied, the analysis would provide a continuous curve approximately through points A, B, and C in Figure 2. It would be approximately through these points because they depend on boundaries selected for dividing the sample into groups. It is quite possible that a stratification with fewer farms in the middle group would result in points D, E, and F. The results of cost function analysis are not affected by the method of stratification. All observations are analyzed in their true position without having it converted into averages and hidden.

Sample size also places some limitation on the number of factors that can be analyzed in cost function analysis. A given sample is adequate to give satisfactory tests of significance for results from analysis of a limited number of factors. Incorporation of more variables in the mathematical analysis will not permit satisfactory test of significance for the results. These data cannot be regarded as reliable. Increasing complexity of mathematical computation also restricts the number of factors that can be considered. This restriction brings inaccurate results for the sample in the manner described in Figure 2.

Analytical procedures will also show inaccurate results for the sample if accounting or observation errors in cost are not random. Errors in cost at the extreme ranges of the independent variables are most influential in causing inaccurate data for the sample. For this reason, regression coefficients in cost function analysis are less reliable outside the medium ranges where most observations occur for each factor.

(3) Sampling Procedures. The sampling procedures that are adopted in a study affect reliability of data from a sample for a specific larger population. There is a necessary size and nature of the sample to obtain reliable results from analysis of particular factors. Limited facilities for research usually prevent proper sample design for each factor to be studied. Often the sample does not have the size or representativeness needed for reliability.

Stratification of the sample into groups of farms affects reliability of results from the sample, even if these results are accurate for the sample. This post-stratification procedure may provide subgroups that are not representative of the actual farm types they are designed to represent. Too few farms of the particular type may occur in each subgroup. Those that do occur may not be random within a population of farms of that type.

There is greater chance for a sample to be random and large enough if it is pre-stratified. Separate samples are drawn from populations of each farm type. This makes it possible to select as many farms as necessary to get a sample of adequate size. Also it is possible to number the farms in the population and use random sampling tables to select the farms for the sample.

In many studies, however, some factors affecting cost become apparent only after the farms are observed. Post-stratification is the only choice. The same sample is used for analysis of several factors although it may not be random for each factor. Also, one sample is the maximum because it is prohibitive to select different samples to analyze each factor.

The sample selected in many enterprise cost studies has doubtful reliability for indicating cost of production for the population. To be reliable for this purpose, the sample must be drawn to give the same cost distribution as exists in the population. Frequently, however, samples are drawn for other farm management purposes. Examples of the latter are to show the effect of size of enterprise, soil, and enterprise combinations. Samples selected to analyze these factors will often not show the same cost distribution as exists in the population. The proper sample to analyze one factor will often be different from that required for another factor.

Random samples rarely are the best for cost function analysis. The tendency in random samples is for most observations to occur in the medium range for each factor. As a result, the regression coefficients have questionable reliability for the population in the range where few observations occur for the factors. What is needed is a sample with fewer observations at the midpoints and more at the extremes.

Summary. Many difficulties occur in procedures for enterprise cost studies. As a result, unreliable data can be reported. Accounting procedures, combined with accounting errors, can give inaccurate data for the sample. Sampling procedures can prevent data for a sample from representing the population. The net effect of these possibilities is a large chance for data from a study to be unreliable indications of cost of production and factors affecting it for farms in general.

FOOTNOTES AND REFERENCES

[1] M. K. Bennett, Farm Cost Studies in the United States (California: Food Research Institute, 1928) p. 101.

[2] Ibid., pp. 29-36

[3] Data can be unreliable for particular farms although they are reliable for the population. The reason is wide inter-farm variation in cost and factors affecting it. This type of unreliability is not examined here but its implications are noted in Chapter VII and VIII.

[4] L. Auer, Resource Productivity, Newdale-Hamiota, Unpublished M.Sc. thesis, University of Manitoba, 1957, p. 84.

[5] J. C. Gilson and M. H. Yeh, Productivity of Farm Resources in the Carman Area of Manitoba, Technical Bulletin No. 1, Department of Agricultural Economics and Farm Management, University of Manitoba, Sept. 1959, p. 30.

[6] See above, p. 15.

PART TWO

CHAPTER V

NATURE AND SCOPE OF SUNFLOWER STUDY

An economic study of the sunflower industry was carried out in 1959.[1] Enterprise cost data for sunflowers were lacking because this crop is relatively new in Manitoba. Sunflower cost data were needed for production and price policy considerations. The objectives of the study were:

(1) To determine the composition and level of costs incurred in the production of sunflower seed, and

(2) To establish the influence of various characteristics upon costs.

This study illustrates typical data, objectives, and problems in enterprise cost studies.

Cross-tabular, functional, and opportunity cost analyses were used. This was done to find what the difficulties and limitations of each were. Three analyses also make the study more comprehensive. Basic data came from a sample survey of eighty farms. They were picked at random from a population that satisfied the following criteria:

(1) A minimum sunflower acreage of 20

(2) A maximum sunflower acreage of 80

(3) Row cropping

(4) Mechanical tillage only.

Some growers did not have these criteria. They were excluded from the population to keep it relatively free from unique characteristics. This did not give a population uniform in all respects. To make it more uniform, its size would have to be sacrificed. If more farms had been excluded, the study would have represented fewer growers. Appendix A contains detail of the sunflower-producing region in Manitoba.

The eighty farms constituted approximately 10 per cent of the population. Enumerators made three calls to each farm during 1959 to compile production records. Appendix B gives a description of the farms studied.

The investigation was done to test the hypothesis that cost of producing sunflowers varies with size of enterprise and type of soil. This required the population to be stratified into farm types based on each criterion. To simplify the empirical work, the farms were classified into two farm types based on each. This gave the following stratification:

(1) Small enterprises (20-35 acres) on light soils

(2) Small enterprises (20-35 acres) on heavy soils

(3) Large enterprises (36-80 acres) on light soils

(4) Large enterprises (36-80 acres) on heavy soils.

From the empirical results of the cross tabular analysis it appeared that cost per pound of sunflower seed decreased with increased size of enterprise. Also it appeared that lighter soil was conducive to lower costs. But it is recognized that soil has an influence on yield. It was therefore hypothesized that lower costs per pound were incurred on lighter soils due to higher yields per acre. A Cobb Douglas function was derived to obtain the exact influence of yield per acre and size of enterprise on cost per pound.

An opportunity cost analysis was done for one farm to compare this cost with that from the cross tabular study. This farm was selected from the original sample of eighty. Its production situation corresponded most closely with the average one for the 80 farms.

REFERENCE

[1] L. R. Rigaux, *Economic Aspects of Sunflower Production in Manitoba*, Research Report No. 6, Department of Agricultural Economics and Farm Management, University of Manitoba, March, 1960.

CHAPTER VI

EMPIRICAL RESULTS OF SUNFLOWER STUDY

Cost of Production. The average cost of producing sunflowers was found to be 3.5 cents per pound. The total cost for all farms was computed and divided by total yield on the eighty farms. Methods used to calculate cost on each farm are described in Appendix C.

A large degree of inter-farm variation was observed in cost per pound of sunflower seed. Only 28 farms had production costs between 3 and 4 cents. Costs on the remaining 52 were outside this area. They ranged from 1.8 cents to over 8 cents per pound.

Farms with high costs generally had lower yields. Those with low cost generally had higher yields. Figure 3 shows the cost-yield relationship for each farm. The broken line indicates the average cost of 3.5 cents per pound. Dots above it are to the left of the graph, those below it are at the right. Their pattern follows a curve with diminishing negative slope. Cost per pound decreased with higher yields.

Components and Levels of Costs for Selected Groups of Farms. The large enterprise, light soil group had lowest costs per acre. As Table I shows, the average cost for this group was $20.76 per acre. It was $23.07 for the large enterprise, heavy soil group. Next in line were the small enterprise groups on heavy and light soils. They had $25.13 and $25.67 respectively.

Cost of production was reported per acre for two reasons.

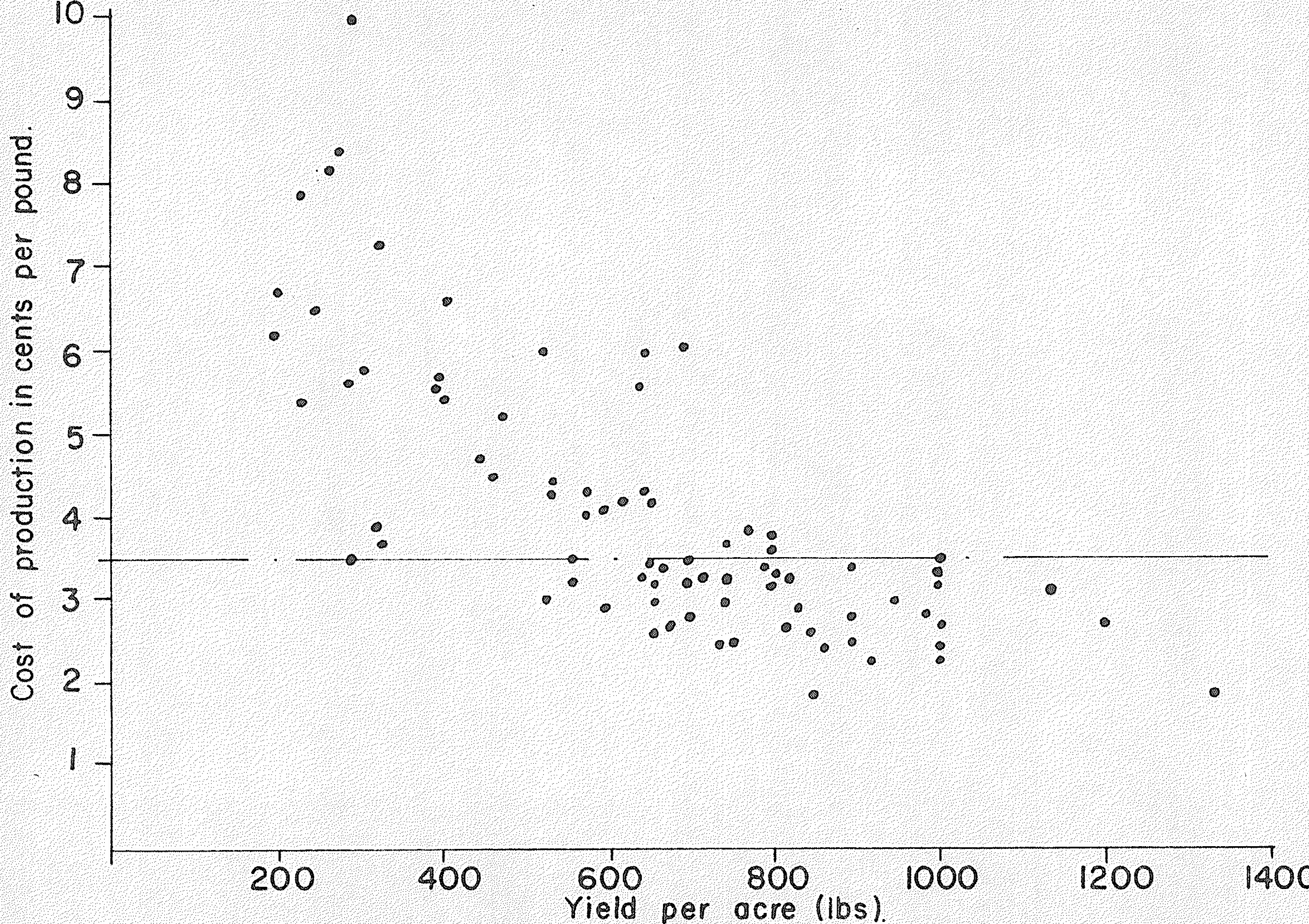

Figure 3.

The relationship of cost per pound of sunflower seed and yield per acre.

TABLE I

SUNFLOWER PRODUCTION COSTS PER ACRE BY GROUPS, 80 FARMS, 1959

COST ITEM	Small Enterprises		Large Enterprises	
	Light soils	Heavy soils	Light soils	Heavy soils
		$ per acre		
Land Charges:				
Own	4.67	3.84	2.88	3.96
Rented	2.05	2.82	3.48	2.68
Building Costs	1.32	.83	.79	1.13
Own Machinery				
Tractor	3.54	4.50	2.39	3.64
Truck	.91	.86	.46	.59
Car	.77	.71	.65	.57
Combine	.33	.78	.86	1.16
Preseeding	.36	.43	.39	.41
Seeding & Postseeding	.59	.79	.68	.60
Custom Work, Mach. Rent	3.92	2.82	2.86	2.97
Own Labor	4.33	3.76	2.83	2.83
Hired Labor	.04	.28	.25	.14
Seed, Fertilizer, Insecticides, etc.	1.78	1.51	1.13	1.30
Supplies	.25	.23	.21	.22
General Overhead	.72	.80	.81	.72
Miscellaneous	.09	.17	.09	.15
TOTAL	25.67	25.13	20.76	23.07

First, this knowledge is advantageous for farm management purposes. Second, it does not depend on yield as does cost per pound. Cost per unit of the land input is not affected by uncontrollable factors that influence yield.

There is an apparent tendency for costs to be lower on the larger enterprises. In total costs per acre, the difference between large and small enterprises is almost \$5. With knowledge available concerning the composition of costs for the two groups, it is possible to decipher some major differences in their cost structures.[1] The bulk of the additional \$5. for the small enterprise group is caused by higher machinery and labor costs. Tractor costs, the largest cost item in the own machinery category, are \$3.54 for the small enterprise group, and \$2.39 for the large enterprise group. This accounts for a difference of \$1.15. Further differences of \$1.50 and \$1.06 are accounted for by costs in the labor and custom work, machinery rent categories. Greater efficiency of larger units is also borne out by similar observations for the two size groups on heavy soils.

The comparison of production costs depending on soil is as follows: total costs per acre are appreciably higher in the large enterprises (\$23.07 for heavy soils, \$20.76 for light soils), but not in the small enterprises. Tractor costs are significantly larger for enterprises in both size groups on heavy soils. For small enterprises, tractor costs per acre are \$4.50, which is \$0.96 higher than on light soils. The difference is even greater for large enterprises, $1.25. Most of the extra costs on heavy soils can be attributed to higher costs of machinery use.

Machinery Use In Sunflower Production. The amount of time that machinery was used, on the average, for each acre of sunflowers, by kind of operation, is listed in Table II. On light soils, 2.74 hours of machinery use per acre were utilized, but one-quarter hour more was required on heavy soils. Mainly responsible for this was the longer time necessary for post-seeding operations, 1.37 hours as compared to 1.09 hours for light soils. This is to be expected, as proper inter-row tillage is more difficult on heavy soils. Any tillage operation on heavy soils can be more time consuming. More time was necessary for seedbed preparation also. (1.01 hrs. for heavy soils, 0.96 hrs. for light soils). Slightly less machinery hours were used for seeding and harvesting on heavy soils. These operations, however, are subordinate to postseeding and seeding preparation in machinery use requirements.

The percentages refer to the proportion of each kind of work that was performed by owned machinery (Table II). It is evident that owned machinery was predominant in the major operations of seedbed preparation, seeding and postseeding. With the exception of harvesting, at least 66 per cent of the work was done by owned machinery, 92 per cent being the maximum in any one kind of operation. Owned machinery carried out less than half

TABLE II

HOURS OF MACHINERY USE PER ACRE*

	Light Soils		Heavy Soils	
	hrs.	own mach. as % of total	hrs.	own mach. as % of total
Seedbed preparation	0.96	(86%)	1.01	(92%)
Seeding	0.28	(66%)	0.26	(72%)
Postseeding	0.09	(86%)	1.37	(80%)
Harvesting	0.40	(31%)	0.35	(45%)
Other	0.01	(0%)	....	
TOTAL	2.74	(76%)	2.99	(79%)

* Variation in machinery use depending on size of enterprise is not given in Table II. A calculation of total machinery hours per acre for the two size groups which has been made can serve as an indicator for this comparison. The farms were classified into two groups on the basis of size alone, irrespective of soil type. Machinery hours per acre averaged 3.3 for small enterprises and 2.7 for large enterprises.

of the harvesting work. Most of the custom machinery was used for harvesting. If machinery was rented, it was mainly for seeding and postseeding.

Labor Use in Sunflower Production. The distribution of labor hours per sunflower acre by type of operation follows roughly the same pattern as machinery use. This is because most of the labor time spent in sunflower production is in the form of machinery-man hours. Labor hours would therefore be composed of machinery hours plus any additional time required for preparations, servicing, supervision and the like. Total labor time per acre for heavy soils amounted to 3.66, which was 0.14 hours more work than that required to produce an acre of sunflowers on light soils. Variation in postseeding time requirements again largely accounts for the difference.

The work of the operator[2] was sufficient to meet the main labor requirements for sunflower production. The part of total time for each operation that was spent by the operator is indicated by the percentages in brackets in Table III. Operators in the light soil group supplied 86 per cent of the total labor requirements for sunflower production on their farms; those on heavy soils supplied 85 per cent of their total labor requirements. Therefore a slightly larger part of the work was performed by the operators in the light soil group. They did, on the average, 89 per cent of the work on preparing the seedbed, and 99 per cent of seeding, 88 per cent of postseeding, and 72

TABLE III

HOURS OF LABOR USE PER ACRE*

	Light Soils		Heavy Soils	
	hrs.	own labor as % of total	hrs.	own labor as % of total
Seedbed preparation	1.08	(89%)	1.10	(89%)
Seeding	0.30	(99%)	0.31	(95%)
Postseeding	1.31	(88%)	1.50	(87%)
Harvesting	0.72	(72%)	0.63	(67%)
Other	0.11	(100%)	0.12	(100%)
TOTAL	3.52	(86%)	3.66	(85%)

* Considerably more labor time per acre of sunflowers produced was needed on small enterprises than on large ones. 4.5 hours of labor per acre were used on small enterprises, with large enterprises requiring only 3.3 hours per acre.

per cent of harvesting operations. The difference between 100 and the percentages in brackets can be attributed to the percentage of work done by hired and custom labor. Custom labor performed part of the harvesting operations, and a small amount of labor was hired for all operations, but predominantly for seedbed preparation and postseeding.

<u>The Influence of Size of Enterprise and Yield Per Acre on Cost Per Pound</u>. Results of the cross tabular analysis indicated a tendency for cost per pound to decrease with increased size of enterprise and also with increased yields per acre. A Cobb Douglas function has been derived to measure the influences of these two factors on cost per pound. It has the form $C = .23126 \; Y_A^{-.754873} \; S^{-.124252}$ where

C = cost per pound in cents

Y = yield per acre in hundredweight

S = size of enterprise in acres

Both b values for the independent variables test significantly at or below the 2 per cent level.[3] The R^2 value is 0.72128.

Results of the functional analysis are depicted graphically in Figures 4 and 5. In Figure 4, the influence of yield per acre on cost per pound is represented by five curves for five different enterprise sizes. The dotted lines indicate average cost per pound and average yield per acre for the eighty farms in the study. Each curve corresponds to the average cost curve for an acre of sunflowers. Although the nature of a

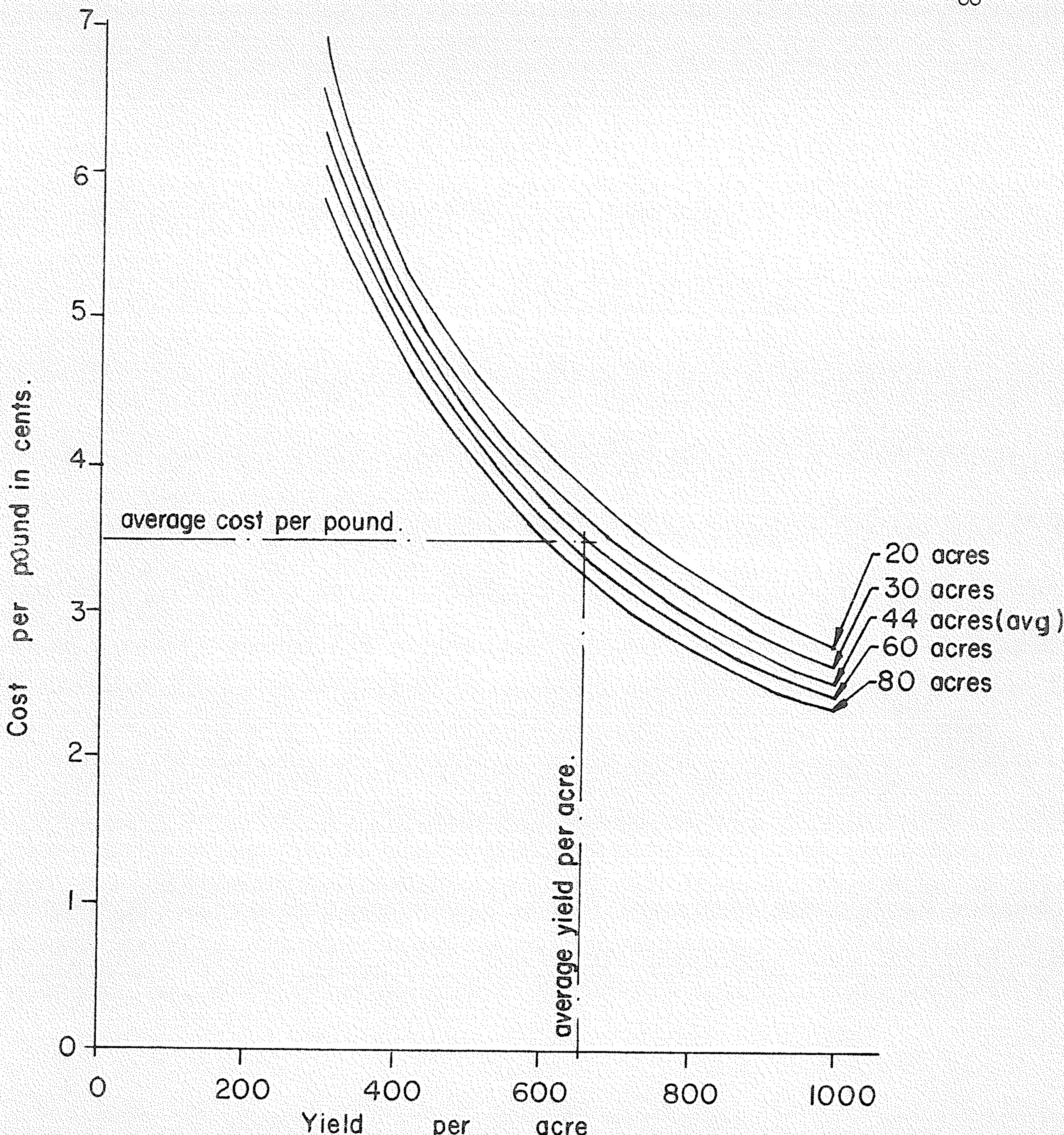

Figure 4

Cost per pound at various yields per acre on five sizes of sunflower enterprise.

Cobb Douglas function prevents a minimum from being reached on any of the curves, nevertheless their steep slopes at the average yield of 652 pounds per acre show that sizeable production is occurring in the decreasing costs range. Following the average cost curve for the eighty acre size of enterprise, it can be seen that, at an output of 300 pounds per acre, a yield increase of 100 pounds per acre would lower costs by approximately 1 cent per pound, from 5.85 to 4.8 cents. An equal increase in yield at the 500 pound level of output would decrease cost per pound by approximately $0.005. The corresponding value for 800 pounds per acre is an approximate cost decrease of one-quarter cent per pound.

The difference in height between any 2 curves in Figure 4 is indicative of the cost advantage of larger sized enterprises. At the average yield of 652 pounds, for instance, the 80 acre size can produce at an approximate cost of 3.25 cents per pound, or about 0.15 of one cent lower than the 60 acre size. The distance between the curves is fairly narrow, however. For the average output of 652 pounds per acre, the cost advantage for the 80 acre size over the 20 acre size is only about .6 cents per pound. When wide variation in costs per pound is observed therefore, it is not because the cost curves of the individual farms are very unlike one another. More likely the reason is that each farm is operating at a different point on the cost curve, which closely resembles that of his neighbour. Output is pushed further on one farm than another.[4]

The influence of output on cost per pound can be appreciated more clearly with the aid of Figure 5. Size of enterprise is plotted against cost per pound for four yields per acre. The curvilinear relationship with no minimum point is again apparent due to the nature of the Cobb Douglas type of function. The curves have very little slope; this reiterates what was said previously concerning the small influence exerted by size of enterprise on cost per pound. The large distances between the curves, however, signify that yield per acre is very influential upon costs. This was borne out in Figure 4 also, by the steep slopes of the curves. For any particular size of enterprise, the cost advantage of high yield is indicated by the differences in height of two curves representing costs for high and low yields per acre. At the average enterprise size of 44 acres, indicated by the dotted line, cost per pound can vary from 6.3 cents to 2.5 cents, depending on whether the yield per acre is 300 pounds, 1000 pounds, or some intermediate figure.

The Opportunity Cost of Growing Sunflowers. Two criteria governed the basis for selecting the farm. These were sunflower acreage and size of farm. Both characteristics for the farm closely approximated the average for the 80 farms in the study. There were 45 acres of sunflowers on this particular farm; its total size was 346 acres. The average for the eighty farmers is 44 acres of sunflowers on a farm of 364 acres.

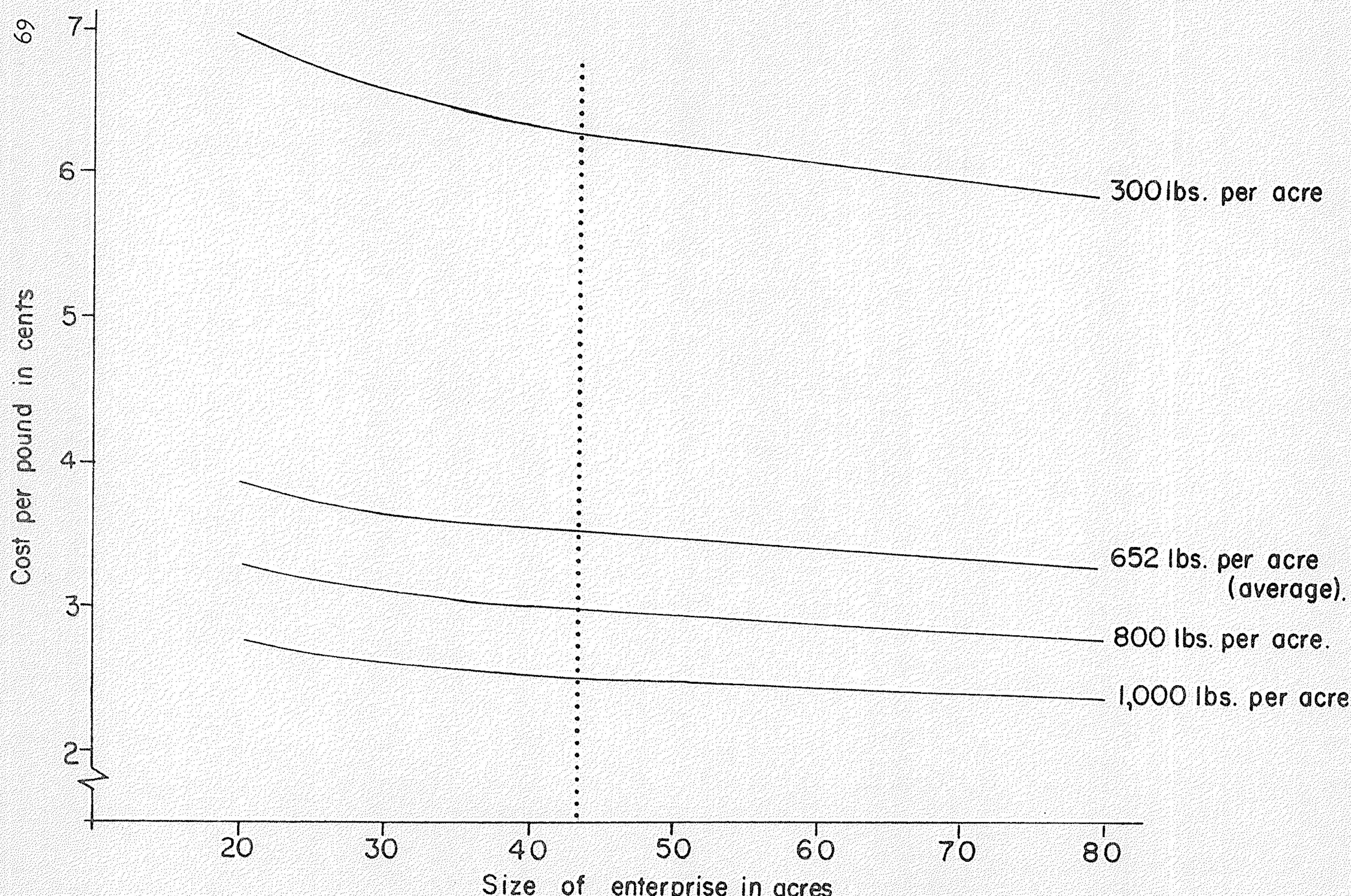

Figure 5.

Cost per pound at four different yields on various sizes of sunflower enterprise

Table VIII in Appendix B gives the land use pattern of the particular farm to compare with the average land use pattern.

There were 52 acres of wheat on the farm. It was the one enterprise of approximately the same size as the sunflower enterprise. Because of this fact, and also for the sake of simplicity, wheat was assumed to be the best alternative to sunflower production.[5] Costs of sunflower production were then valued in terms of the return foregone by not producing wheat. This required the assessment of how much wheat could be obtained from moving resources out of sunflower production into the wheat enterprise. Naturally, any attempt at including overhead charges is omitted from this type of cost analysis, because those charges are borne irrespective of which enterprise exists.

Valuation of sunflower inputs, the use of which can be adjusted to wheat production, is the subject of Table IV. The presentation is in terms of the complete sunflower enterprise, so that the opportunity costs calculated will be average cost, not marginal cost. To obtain marginal costs, movement of marginal input units receives sole attention in valuation. Marginal units normally would incur a higher cost than the average cost, due to the likelihood of alternatives becoming more expensive as the given enterprise is expanded. The acres of wheat which could be produced with the total amounts of each sunflower input have been calculated on a standard coefficient basis for the area in which the farm is situated.[6] Wheat yielded 35

TABLE IV

THE OPPORTUNITY COST OF GROWING SUNFLOWERS ON A SELECTED FARM

Kind of Input*	Amount Presently in Sunflowers	Wheat Acreage Potential
Land (acres)	45	45
Machinery (hours)	196	72
Labor (hours)	218	54

Opportunity cost of sunflower production:

a) For complete enterprise $\equiv 45 \times 35 \times 1.25 = \$1,968.75$

b) Per pound of sunflower seed $= \frac{1,968.75}{26,000} = 7.6¢$

c) Per acre of sunflowers $= \frac{1,968.75}{45} = \$43.75$

* The cost of inputs such as seed, fertilizer, and chemicals are assumed to be equal for both enterprises.

bushels per acre on this farm in 1959; consequently this figure was used for budgeting. The value placed on a bushel of wheat was $1.25.

Machinery was used for 196 hours in sunflower production on this farm. The use of machinery to this extent would be adequate for production of 72 acres of wheat, according to the standard for the area. Likewise, the 218 hours of labor in sunflower production are adequate for 54 acres of wheat production. Only 45 acres of wheat, however, are possible from a similar transfer of the land input. A complete shift of the land input therefore requires the corresponding machinery and labor inputs to be used on 45 acres of wheat, not 72 or 54. Consequently, the land input limits the alternative wheat output from the total inputs presently in sunflowers. This is the output from 45 acres of wheat, the value of which is $1,968.75. The total yield of sunflowers on the 45 acres was 26,000 pounds. Per pound, the opportunity cost is then 7.6¢ and per acre it is $43.75. These costs considerably exceed those arrived at by cross tabular procedures. Costs calculated as such for this farm are 4.2¢ per pound and $24.11 per acre.

FOOTNOTES AND REFERENCES

[1] Additional inter-group farm differences, such as farm size and production organization, may also affect costs. Some indication of these characteristics for the four groups is given in Appendix B.

[2] For simplicity, extra family labor was classed as own labor, so that when reference is made to the operator's labor, family labor is included.

[3] The tests of significance for the b values will ensure that the b values do indicate how cost per pound will vary with changes in the independent variables.

If the variables Y_A and S are correlated, and it was not definitely established that they are not, then the tests of significance do not necessarily ensure that C will vary with changes in Y_A and S as indicated by the b values. The influence of one variable may partly appear in greater influence of the other variable. Such a condition of intercorrelation would detract from the predictive value of the function in addition to the normal danger of predicting beyond the range studied with a Cobb-Douglas function.

[4] The b values in the function of course describe the above situation very well.

[5] It is recognized that wheat is normally grown earlier in the rotation than sunflowers. For the present purpose, this is not a serious limitation.

[6] MacKenzie, J. G. and J. C. Brown, "How Labor is Used on Red River Valley Farms," Economics Division, Canada Department of Agriculture, Publication 923, December 1954. p. 25.

[7] This figure may be in excess of what would actually occur, because the wheatland is usually better land.

CHAPTER VII

COST OF PRODUCTION DATA FOR FARM POLICY PURPOSES

This chapter comprises two main sections. The first is a summary of cost data and procedures as they pertain to farm policy. Several points in it are well illustrated by the sunflower study. The summary includes the following topics:

(1) Characteristics of cost data required for price setting in farm policy.

(2) Characteristics of existing cost data which limit their utility in price-setting.

(3) Procedures responsible for limited usefulness of cost data in farm policy.

(4) Difficulties to be solved in procedures for more useful cost data in farm policy.

This summary is designed to serve as a basis for conclusions in the second section. These conclusions concern necessary revisions in procedures for more useful cost data in farm policy.

<u>Required Data</u>. To be usefully applied in price-setting, cost data must have one specific property. They must be a reliable indication of the opportunity cost of production for the farms to be affected by the price. For this, the data must contain the opportunity cost of non-cash resources on each farm studied. Also it is necessary the data be derived from a sample of farms that represent all the farms producing the specific

commodity. The costs observed in the sample must leave no doubt concerning the level of cost for remaining farms producing the commodity.

Existing Data. Data from current enterprise cost studies have doubtful validity for all farms producing the specific commodity. The reported cost of production frequently exceeds price received. Yet production remains constant, or expands, contrary to the expected decrease in output. This type of situation implies that reported cost of production for the sample exceeds opportunity cost of production for the population.

The opposite type of situation has arisen in which price set on the basis of reported cost is less than opportunity cost. Farmers find that production of the commodity at that price does not give an adequate return to resources. Price does not meet opportunity cost of production. There was a significant difference between opportunity cost and reported cost for one farm in the sunflower study. Opportunity cost was 181 per cent of reported cost. Other farms can be expected to have discrepancies that vary from this example. This particular farm approximated most closely the average land use pattern for all farms in the study.[1]

One major characteristic of cost data that limits their usefulness in price setting decisions is their dispersion in the sample. The range of costs observed in many studies is very wide. Inter-farm variation observed in the sunflower study is typical of that for other products. Some farms had a production cost below 2¢ per pound; others higher than 8¢. With inter-farm variation of this nature, it becomes difficult to determine the cost for all farms producing the commodity. This makes a decision arbitrary concerning at what level within the range to fix the price.

The reliability of cost data over a period of years is questionable. Cost data over a period of years have shown wide inter-year variation. It is to be expected since the same causes for inter-farm variation will act to change cost over time as well. This characteristic of cost data makes the results from a one-year study less reliable for setting price in later years.

Cost data in agriculture have been inadequate in agriculture not only because they have been incorrect. Wide inter-farm variation in cost has caused doubts concerning the actual cost of production for the population. Furthermore, several considerations have affected decisions on whether or not to use cost data for price fixing. For example, there is the undesirability of fixing prices in itself because consequences cannot be predicted, or are predicted undesirable. The setting of price at a fixed level is usually to keep the price higher than would otherwise prevail. This practice invariably results in surplus production. Long run cost of production has been reported in most cost studies. Yet this cost is not related to price in the short run. The need for fixed prices usually occurs in short periods during which farmers face difficulty in adjusting to new market conditions. Data on long run cost of production are not adequate for these purposes. There has been no calculation of short run costs to determine necessary price in the short run.

The limitations cited above do not preclude the usefulness of cost data for price setting. The setting of price at the average cost within a wide range in cost of production will bring greater efficiency in production. Farms having above average cost of production will be forced to become either more efficient producers or non-producers. Over an extended period of time, greater numbers of producers will have production costs at or below the initial average.

Procedures That Limit Usefulness of Data. The procedures described below are relevant for limited usefulness of cost data in both farm management and farm policy. They involve (a) calculation of cost of production on each farm studied and (b) selection of sample to assure representativeness for the population. Additional procedures, concerned with analytical methods, can affect usefulness of cost data in farm management. The implications of these procedures are examined in Chapter VIII, along with the implications for farm management of procedures discussed below.

(a) Calculation of cost. Procedures in calculating cost of production on each farm have a three-fold classification on the basis of how they cause limited usefulness of cost data for price setting in farm policy. They are:

(i) Market value imputation of opportunity cost.

(ii) Arbitrary allocation of joint costs.

(iii) The survey method.

The sunflower study is typical of most enterprise cost studies in the use of uniform valuations. Generally these valuations were market prices.

Methods for allocation in the sunflower study are shown in the Appendix. These methods are similar to many used in other enterprise cost studies.

(b) Selection of sample. In one respect, the sample selected in the sunflower cost study was typical of that used for traditional enterprise cost studies in agriculture. It was a stratified random sample. However, it was pre-stratified on the basis of size of enterprise and type of soil. In this respect it was different from studies which use post-stratified samples to analyze cost. The sample used in this particular study provided typical observations for a random sample. Most of the observations were clustered around the midpoints in the values for each variable. This type of sample did not provide most reliable analysis of cost by the regression method.

Difficulties to be Solved. Four major areas of difficulty require attention to obtain improved procedures for useful cost data in pricing. These difficulties are: imputation of opportunity cost, allocation of joint costs, securing accurate cost figures by the survey method, and selecting samples that give representative data for the population. The latter is a special problem in studies where different samples are required to analyze cost rather than show the level of cost itself. This conflict between samples for farm management and farm policy is a serious cause of unrepresentative data for cost of production.

Necessary Revisions. More reliable data for farm policy purposes requires better recognition of known economic models in designing procedures for enterprise cost studies. Recognition of important properties of cost will show the fallacy of assuming uniform valuations for imputed costs. For example, many factors affect opportunity cost of the farm operator's labor. Realizing this will make for greater effort to obtain accurate estimates of opportunity cost. Recognition of other cost properties will prevent the indiscriminate use of arbitrary allocations for joint costs. Each farm generally has its unique distribution of joint costs in the specific enterprise under study. The danger of inaccuracy from using the survey method also implies the need for great caution in formulating the questionnaire and in devising methods to make empirical estimates of cost on each farm.

The greater use of opportunity cost valuation will help to remove much of the dispersion in cost data. Much of the dispersion is caused by yield over which farmers have limited control. One of the findings in the sunflower study was a relationship between yield and cost. Farms with high costs per pound generally had lower yields per acre. Those with low costs per pound had higher yields. The relationship was very close in a Cobb-Douglas function derived from the cost-yield data. This shows that inasmuch as yield is controllable, so is cost. However, yield is largely affected by soil, weather, technology, biological factors, and enterprise combinations. Farmers do not have complete control over all of these factors.

The dispersion in cost data will be much narrowed with opportunity cost valuations. Higher valuations will usually be applied to larger farms which generally have the highest yields. Lower valuations will be applied to low yielding small farms. Alternatives for resource use are generally fewer and less productive on small farms than on large farms. As a result of recognizing these differences, data will be more uniform from a study.

FOOTNOTE

[1]Although standard input-output coefficients and prices were used to calculate opportunity cost, these were quite representative for the farm. Its size was in the intermediate range, neither extremely large nor extremely small. The coefficients and prices can be expected to apply within this range.

CHAPTER VIII

COST OF PRODUCTION DATA IN FARM MANAGEMENT WORK

This chapter has parallel construction to the previous one but refers to cost data and procedures as they pertain to farm management. Some content of Chapter VII applies to farm management as well as farm policy but is not repeated here.

Required Data. Several characteristics of cost data are required for managerial decision-making by the individual farmer. For better understanding of these characteristics, the decisions confronting the farmer must be clarified.

The objective of decisions regarding resource management on each farm is optimum resource use.[1] It can be expressed as:

$$\frac{MVPx_1}{Px_1} = \frac{MVPx_2}{Px_2} = \cdots\cdots\cdots = \frac{MVPx_n}{Px_n} \quad ^{2}$$

At this point, resources are being used as efficiently as possible. Profit is maximum. Resources are being used equally as efficiently in the following situation:

$$\frac{Px_1}{MCy_1} = \frac{Py_2}{MCy_2} = \cdots\cdots\cdots = \frac{Py_n}{MCy_n} \quad ^{3}$$

Both expressions for optimum resource use are equal to 1 under conditions of unlimited capital. They are larger than 1 when capital is limited on a farm. Resource use is not pushed to the point where MVP = Px and where Py = MC. As a result, MVP exceeds Px and Py exceeds MC. Both the long and short run are commonly characterized by limited capital in agriculture.

Farmers are continually finding that adjustment is necessary. The $\frac{P}{MC}$ fraction is not uniform for all products. They want to narrow the gap between existing and optimum resource use. For this, they must know size of the gap at present and under various alternatives. Farmers want to know where to shift resources to obtain greater uniformity in the $\frac{P}{MC}$ fractions.

The apparent requirement of a specific enterprise cost study is to provide the existing $\frac{P}{MC}$ for one product. Also required are the expected $\frac{P}{MC}$ fractions with alternative adjustments. This information then becomes useful to integrate with similar information for other products.

Existing Data. Apart from their paucity, the major limitation of existing cost data is unreliability. Many farmers find enterprise cost data provide incorrect information for their purposes. Results clearly do not show how wide the gap is between existing and optimum resource use. The reported existing resource use often deviates from that of a particular farmer. Furthermore, the means recommended to decrease the gap are obviously not possible to achieve in practice. Some of the findings upon which the recommendations are based are distorted from the true situation for the population of farms. Data sometimes imply a different MC than will actually occur with a given set of conditions or resource shifts.

The sunflower study contains data that are typical. It shows a constantly declining average cost curve with larger enterprises. It also implies that cost per pound continues to decrease as yield per acre is increased. There appears to be no economic limit to the quantity of resources that can profitably be used on an acre.[4] To report a declining average cost curve implies that marginal cost is less than average cost, and that it will remain less with expansion. Frequently, however, the actual average cost curve will not continue to drop, but rise. In that case the MC curve exceeds the average cost. A farmer who acts on the belief that expansion is profitable may find it is not so. The new MC may exceed P in the $\frac{P}{MC}$ fraction. This is definitely unprofitable since $\frac{P}{MC}$ exceeds 1.

<u>Procedures That Limit Usefulness of Data</u>. Procedures that result in cost data of limited usefulness in farm management can be classified into three groups. One is concerned with determining the relationship between independent variables and cost of production. The second one involves those procedures in measuring cost itself. This group was presented in Chapter VII above. The third group involves sampling procedures. They were discussed in Chapter VII but in relation to their effect on cost data for pricing. They are discussed further here in relation to their effect on cost data for farm management purposes.

Sampling procedures tend to make results from a sample unreliable for a larger population of farms. Post-stratification in cross-tabular analysis has implications for reliability. For example, to be certain the observed effect of enterprise size on cost in a sample is reliable for the population, the sample must be drawn to obtain the same size distribution as exists in the population. That sample will rarely give distributions for other factors, such as soil, and size of farm, that have similar distributions in the population. Yet these other factors must be considered to obtain the true effect of enterprise size on cost for farms in the sample. They are analyzed by post-stratification. Results of analyzing these factors will not be reliable for the population. They are correct for the sample, however, and must be only interpreted as such.

A specific sample is needed to analyze each factor. The use of one sample to analyze several factors and generalize these results for the population is misleading. The only analytical results that can be justifiably generalized for the population are from analysis of size in the example above. If the sample is drawn to obtain a random distribution of cost of production, analytical results are not valid for the population. The dual role of cost studies in farm management and policy therefore acts to limit usefulness of cost data in either field.

The sample used for cross-tabular analysis was pre-stratified for size and soil in the sunflower study. Any further analysis of additional factors would have had to be based on post-stratification.

Random sampling gives too few observations at extreme ranges for each factor. It causes results of cost function analysis to have questionable reliability for the population. The sample for cost function analysis in the sunflower study was comprised of the farms selected for cross-tabular analysis. Figure 3 shows that the bulk of observations occurred in the intermediate cost range and in the intermediate range of yield per acre. Due to this, the curves derived to show the relationship between cost per pound and yield per acre have questionable reliability at each end. They definitely are unreliable for extrapolation beyond the ranges observed in yield per acre.

Analysis of factors that affect cost can be obviously invalid for a particular farmer. The results may be unreliable simply due to sampling variability. In such situations a large range occurs in the data obtained. Implications for unreliability from this cause cannot be ignored. Much unreliability, however, comes from the sampling methods used.

A major reason for invalid results is analysis of too few factors. It exaggerates the effect of factors that are analyzed. Exaggeration is especially serious for agriculture where many factors are inter-correlated. Use of pesticides, for instance, usually takes place on larger, more prosperous farms where capital is less limited than on smaller farms. Pesticides usually increase yield and bring a lower cost of production per unit. Pesticide effect on yield will appear as effect of size on cost. A farmer who increases size of his enterprise will not get the cost decrease indicated by the study. Limited resources for research often prevent complete analysis of the cost of producing a commodity. Effects of factors not analyzed appear as effects of those that are considered in the study.

Two factors, size and soil, were analyzed by cross-tabular analysis in the sunflower study. Factors omitted undoubtedly had effects on costs, with these effects acting to misrepresent those of size and soil to some extent.

In the cost function analysis, factors affecting yield are included in effect of yield per acre. This cost-yield relationship observed in the sunflower study is empirical evidence of the theoretical cost function-production function relationship.

Allocation of overhead costs will obscure the real difference in cost between alternative situations. This procedure is consistent with farm policy needs. All costs must be included for pricing. Only cost elements that will differ between alternatives need be analyzed for farm management purposes. Fixed costs in the short run have zero opportunity cost in short-run cost analysis for farm management. This difference in costing for farm management and farm policy is another cause for limited usefulness of cost data in either field.

Methods of allocation in the sunflower study are shown in the Appendix. These methods are similar to many used in other enterprise cost studies. Fixed costs were included, by allocation if necessary, in the cost figure for each farm. The primary reason was the need for cost data in farm policy. This procedure has delimited usefulness of the data in farm management.

Errors in calculating the dependent variable cost can also act to make analytical results unreliable for farm management purposes. These errors can be random or non-random. Their implications are especially serious for farm management when these errors are correlated with a factor that is being analyzed. For example, if imputation, allocation, or empirical observation of cost exaggerate total cost of production more on large farms than on small farms, or deflate it on small farms, the observed effect of size on cost will be false.

Difficulties to be Solved. The major areas of difficulty that require attention in procedures to obtain more useful data for farm management are in attempts to obtain the following: accurate calculation of cost of production, adequate samples to obtain reliable results for the population, and complete analysis of factors affecting cost.

Necessary Revisions. The necessary revisions in procedures to calculate total cost of production were presented in Chapter VII. If cost of production is being calculated for short run purposes in farm management, however, similar methods cannot be employed as for farm policy. For example, fixed costs should be omitted for farm management. This shows the need for fewer objectives in enterprise cost studies. A study should be done specifically for farm management purposes or farm policy purposes. Another solution is to present cost in both forms in results of a study. Total costs are to be given for price setting, but overhead costs are omitted to show the real difference in cost between alternatives in managerial decision-making.

Concerning analysis, there is need for more effort to make complete analysis of factors affecting cost. The outcome will be more reliable data on the effect of each factor on cost in the sample.

Greater care is necessary in interpreting analytical results. All the effects of factors observed in the sample should not be accepted as valied for the population. Only those factors with the same distribution in the sample as the population can be regarded to have equal effects in the population. If a sample is biased toward the high extremes for a factor, such as size, it cannot give the cost-size relationship for small sizes. As a result, the observed effect of size is not accurate.

In addition to lack of bias, a sample must have adequate size for reliability for the population. With adequate sample size, means in cross-tabular analysis will be less doubtful indications of the true means in the population. Adequate sample size in cost function analysis will also narrow the expected range where true regression coefficients lie around those observed.

The simple random sampling procedure should not be used for regression analysis. Stratified samples should be used. These would provide the same number of observations for each level of the independent factor. Fewer intermediate observations occur with more occuring at the extreme ranges of the factor. The resulting regression coefficients will have better reliability throughout the values of the independent factor. The results from analyzing its effect on cost will be more useful.

This chapter has indicated the extent that traditional procedures have provided useful data for better resource administration. Several desirable adjustments for improved procedures are cited. Generally, these adjustments involve more recognition of the nature of costs in agriculture. The major advantage from this will be to prevent design of procedures that give data indicating increasing returns. Use of known economic models in designing the procedures will contribute toward better analysis of cost and more reliable data for management decisions.

FOOTNOTES

[1]See Chapter I for the assumption of profit maximization.

[2]MVP = Marginal value productivity, x_1-x_n = resources 1 to n, p = price of the resources.

[3]y_1-y_n = products 1 to n, P = price of the products, MC = marginal cost of the products.

[4]Figures 5 and 6 illustrate these findings. The Cobb Douglas equation used in the sunflower study can take only one curvature into account. Results, however, are valid because the Cobb Douglas equation best fitted the data.

CHAPTER IX

SUMMARY AND CONCLUSIONS

The empirical part of this study is based on a stratified random sample of 80 sunflower growers in Manitoba. Its principal findings are enumerated below. These findings, and the procedures used well illustrate problems and shortcomings of current enterprise cost studies. Problems and shortcomings lie in the three areas of accounting, analysis, and sampling. Their examination has helped to determine their implications for future enterprise cost studies in agriculture.

Major Direct Findings. Main results of the sunflower study are as follows for 1959:

(1) Average cost of sunflower production was 3.5¢ per pound.

(2) There is wide inter-farm variation in cost of production. The approximate extremes were 2¢ and 8¢ per pound.

(3) Cost of production depends to a large extent on yield per acre. Most of the variation in cost is explained by yield variations. Cost per pound decreases with higher yields per acre.

(4) Cost of production depends on soil. Farms with lighter soils had a slightly lower cost of production per acre.

(5) Cost of production depends on size. Farms with small enterprises had higher costs than farms with larger enterprises.

Major Limitations of Enterprise Cost Studies. The usefulness of enterprise cost studies has not been as extensive as it might be. Part of the reason is heterogeneity in agriculture. This causes limited usefulness in farm management when many farmers find cost data do not apply to their conditions because they are derived from farms unlike their own. In farm policy, this heterogeneity is partly responsible for the wide range in reported cost of production. The range makes it difficult to decide with certainty the true average for the population.

However a large part of limited usefulness of cost data in agriculture can be overcome by improvement in procedures. Several revisions in enterprise cost study procedures are possible and desirable. These revisions can be best described as those resulting from a better recognition of known theory in designing the procedures. This will prevent design of studies that imply increasing returns or otherwise false measurement of factors affecting cost. It will also show the need for devising different procedures for data for use in farm management and farm policy. Different samples and methods of costing are needed for farm management than for farm policy purposes. Better recognition of known economic models will also result in greater efforts to determine opportunity cost. This will make cost data more reliable for both farm management and farm policy. It can also be expected to remove some of the heterogeneity in cost data. The ranges observed in cost of production partly result from use of uniform valuations for resources on all farms. These valuations have a tendency to inflate cost for small farms and deflate it for large ones. This magnifies the actual range in cost of production, because small farms would normally have the lower costs. Large farms usually would have the higher costs.

Implications for Future Studies. The recent demand for enterprise cost studies has generated a need to evaluate their usefulness. In view of the evaluation carried out, it appears that the usefulness of any single study is limited. If this is recognized, future studies can be expected to be done for more narrow purposes than previously. Studies for both farm management and farm policy purposes will be the exception.

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APPENDIX A.

GENERAL FEATURES OF THE SUNFLOWER - PRODUCING REGION

Sunflowers are grown predominantly in the southern Manitoba rural municipalities of Dufferin, Thompson, Roland, Morris, Stanley, Rhineland, and Montcalm. These municipalities comprise an area the size and position of which are indicated by the shaded portion of the map in Figure 6. The blackearth soils of this region vary within fairly broad limits. Most soils are developed on sandy to silty lacustrine and deltaic deposits. Differences exist between relative maturity, drainage, and texture of the soils. Clay soils and sandy soils are both represented. Topography is level to very gently sloping or rolling in the western portion.

Climatic conditions are favourable to special crop production. The frost-free period ranges from 130 to 140 days. Average mean temperature for the growing season approximates 57° F. Precipitation averages from 19 to 20 inches per year.

Calculated from 1956 census figures, average farm size in these seven municipalities is 288 acres. There were 4,213 farms in this area, according to the 1956 Census of Agriculture. Average farm size ranges from 210 acres in Rhineland to 373 acres in Thompson.

TABLE V

NUMBER AND AVERAGE SIZE OF FARMS

IN SEVEN MANITOBA MUNICIPALITIES, 1956.

Municipality	No. of farms	Ave. size of farms (acres)
Dufferin	615	343
Montcalm	319	351
Morris	684	338
Rhineland	1,079	210
Roland	298	366
Stanley	902	229
Thompson	316	373
TOTAL -	4,213	288

1956 Census of Agriculture.

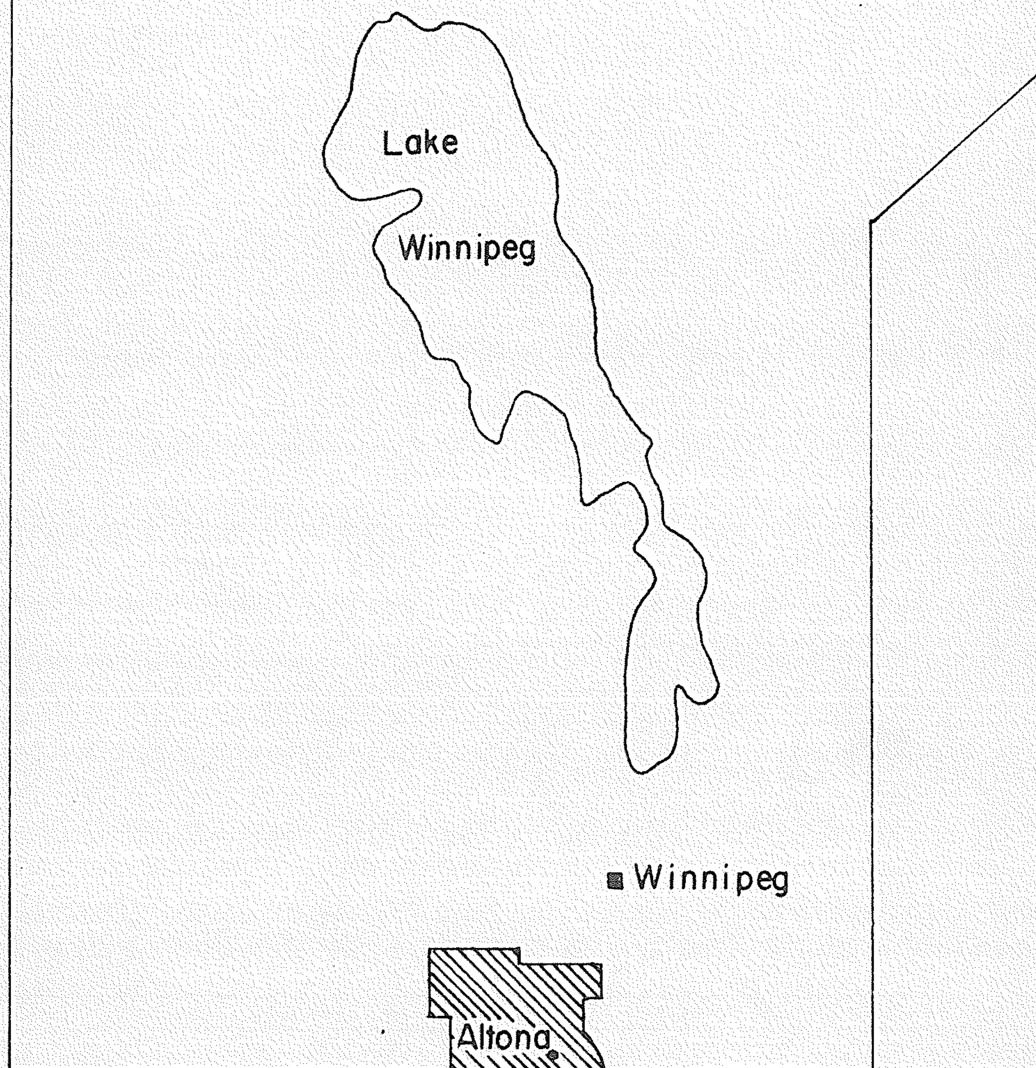

Figure 6.

Map of Manitoba showing location of sunflower production.

APPENDIX B.

GENERAL DESCRIPTION OF THE FARMS STUDIED

Average Capital Investment. Land constitutes the largest proportion of the capital investment on the 80 co-operating farms. Table VI shows forty-seven per cent of total farm capital is invested in land, twenty per cent in machinery, and eighteen per cent in buildings, with livestock, grain, feed, and supplies comprising the remaining fifteen per cent. The average capital investment for all eighty farms is $42,030. Of this total, the figure of $2,172 for livestock investment indicates that on the average these farms are diversified in the sense that farm output includes both crop and livestock products.

Size of Farm and Land Use, 1959. Table VII shows average acreage per farm in the various uses for the four groups. Total acreage per farm ranges from an average of 308.1 for farms on light soils with small sunflower enterprises to 419.9 acres for farms on heavy soils with large sunflower acreage. For all groups, the high figure for total cropland as a percentage of total acres is consistent with the high degree of intensification on these farms. Very little land area is taken up by waste and farmstead.

Wheat was the predominant crop grown on the eighty farms participating in the study. The wheat acreage figure is

TABLE VI

AVERAGE CAPITAL INVESTMENT, 80 FARMS, 1959.

Type of Investment	Value	% (rounded)
Land	19,747	47
Buildings	7,703	18
Machinery:		
Tractor(s)	2,173	)
Truck	755	)
Car	1,256	) 20
Combine	1,329	)
General	2,910	)
Livestock	2,172	5
Grain & feed	3,704	9
Supplies	281	1
TOTAL	42,030	100

TABLE VII

LAND USE PATTERN, 80 FARMS, 1959.

Type of Use	Small Enterprises				Large Enterprises			
	Light soils		Heavy soils		Light soils		Heavy soils	
	acres	%	acres	%	acres	%	acres	%
Wheat	53.8	17.3	70.3	22.9	63.3	16.5	99.8	23.9
Oats	51.1	16.6	32.8	10.6	53.1	13.9	35.8	8.5
Barley	24.5	8.0	24.2	7.8	10.5	2.7	27.5	6.5
Flax	26.2	8.5	52.4	17.0	54.6	14.3	57.5	13.7
Sunflowers	23.9	7.8	26.5	8.6	58.6	15.3	53.5	12.7
Sugarbeets	5.9	1.9	13.2	4.3	3.4	.9	6.0	1.4
Corn	10.5	3.4	2.8	.9	4.9	1.3	3.4	.8
Other crops	17.4	5.7	5.7	1.8	20.8	5.4	11.8	2.8
Hay, pasture	16.0	5.2	2.7	.9	6.2	1.6	20.8	5.0
Summerfallow	42.1	13.7	49.7	16.0	52.4	13.7	66.5	15.8
Total Cropland	271.4	88.1	280.3	90.8	327.8	85.6	328.6	91.1
Non-cropland	36.7	11.9	28.4	9.2	54.9	14.4	37.3	8.9
Total acres	308.1	100.0	308.7	100.0	382.7	100.0	419.9	100.0

proportionately greater on heavy soils, where 23 to 24 per cent of the land was used for wheat. On the lighter soils wheat occupied approximately 17 per cent of the land, although it is still the dominant crop.

The next most important division of land use, measured by percentage of total acreage in that type of use, is sunflower production for the large enterprise group on light soils. Relative importance of sunflowers was not as great for other groups. Farms with small enterprises on light soils incorporated sunflowers into the cropping system sixth in importance after wheat, oats, summerfallow, flax, and barley according to the proportion of total productive[1] land in each use.

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[1]This excludes non-cropland, composed of waste and farmstead.

TABLE VIII

LAND USE PATTERN OF FARM SELECTED FOR OPPORTUNITY COST ANALYSIS

Type of Use	Acres	% of total acres
Wheat	52	15.0
Oats	34	9.8
Barley	30	8.7
Flax	80	23.1
Sunflowers	45	13.0
Sugarbeets	10	2.9
Corn	0	0
Other Crops	20	5.8
Hay, Pasture	0	0
Summerfallow	45	13.0
Total Cropland	316	91.3
Non-Cropland	30	8.7
Total Acres	346	100.0

APPENDIX C

TABLE IX

CALCULATION OF COSTS IN SUNFLOWER PRODUCTION

	Farm Cost		
Cost Item	Description	Calculation	Proportion to Sunflowers
Land Charges:			
Own	Taxes	Tot. real estate tax, 1959	Own sunflower acreage / Total acres owned
	Interest	Acre value X 5%X own acres sunflowers	All
Rented	Cash rent	Total cash rent 1959	Rented sunflower acres / Total acres rented
	Share rent	Landlord's share of production at 1959 price	All
Building Costs	Fixed cost on granaries, machinery buildings, and $\frac{1}{4}$ value of house	Interest at 5% and depreciation at 8% of owner-operator's evaluation	Sunflower acreage / Total Acreage
Own machinery	Total fixed & variable costs of machinery & equipment for all items except car.	Interest at 5% depreciation at owner's estimate License & Insurance (if any) Fuel used (value)	Tractor: Hrs. in sunflowers / Tot. hrs. 1959 Truck: Mi. in sunflowers / Tot. miles 1959

Cost Item	Farm Cost: Description	Farm Cost: Calculation	Farm Cost: Proportion to Sunflowers
	where 1/3 is charged to farm expense	Repairs bought (parts & Labor) Hours of own labor on repairs @ $1 per hour	Car: $\frac{\text{Sunflower acreage}}{\text{Total acreage}}$ Combine: $\frac{\text{Hrs. in sunflowers}}{\text{Total hrs. 1959}}$
	Preseeding-costs of machinery used for tillage, 1958 & spring 1959.	Interest at 5% Depreciation @ 12%. Repairs bought, 1959	$\frac{\text{Sunflower acreage}}{\text{Total acreage}}$
	Seeding-grain drill or planter	Interest @ 5% Depreciation @ 12%. Repairs bought, 1959	$\frac{\text{Sunflower Acreage}}{\text{Tot. acres. done, 1959.}}$
	Postseeding- Harrows Cultivator Sprayer Packer	Interest @ 5% Depreciation @ 12%. Repairs bought, 1959.	$\frac{\text{Sunflower acreage}}{\text{Total acreage}}$
Custom work, machinery rent	Cash outlay, for renting machinery or hiring machinery plus operator, for sunflower operations	None	All
Own labor	Value of total time spent by operator & family on sunflower production	$1 per hour	All

Cost Item	Farm Cost: Description	Calculation	Proportion to Sunflowers
Hired labor	Directly hired for sunflower production	Cash cost	All
	Hired for sunflower & additional production.	Hourly rate X hrs. worked in sunflower production.	All
Seed, fertilizer spray material	Bought seed Own seed	Cash cost Farmer's evaluation	All
	Fertilizer	Cost of fertilizer applied	
	Spray material (insecticide)	Cash cost	
	Bird scaring & other materials	Cash cost	
Supplies	Grease, oil, antifreeze	Cash cost, bought in 1959	Sunflower acreage / Total acreage
General Overhead	Hydro Telephone Fire Insurance Hail Insurance	Cost per year	Sunflower acreage / Total acreage
Miscellaneous	Repairs on buildings listed under (2)	Cash	
	Cost of auger use	Interest @ 5% Depreciation @ 12%. Repairs	Sunflower acreage / Total acreage
	Tools	5% interest	