COSTS OF PRODUCTION AND FRESH MARKET PREPARATION OF MANITOBA POTATOES - 1968

A Thesis

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Garth Elvin Stone

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ABSTRACT

The potato industry in Manitoba has expanded during the past decade. Development of mechanized harvesting and handling methods, along with contract production for processing firms, have combined to encourage the establishment of large production units on soils of a texture suited to modern methods of harvesting. As changes such as these take place, the importance of cost of production and market preparation information increases, particularly as the ranges in size of enterprizes and methods of production become large.

The objectives of the study were to determine the cost of inputs required to produce potatoes for various sizes of production units, to determine the costs of storage, preparation and delivery of table stock and seed potatoes to market, and to review the resource requirements and cultural practices employed by producers in Manitoba.

Information was collected from sixty producers, selected on the basis of a stratified random sample. This sample included growers ranging in size from four to 1,540 acres. Five strata were used in the analysis of production costs; three in the analysis of market preparation costs. Implicit as well as explicit costs were included in the analysis.

Land costs were included in the analysis as a rental

fee. Equipment depreciation was calculated on a modified reducing balance method, and interest on investment was based on estimated current market values. Repairs were estimated according to the annual hours of operation of the equipment.

Storage depreciation charges were calculated by the straight line method, repairs were estimated as a percentage of original construction cost, and interest charges were based on the average value of the structure over the twenty year life of the building.

The cost comparisons were carried out on a per seventy-five pound bag of yield and per acre basis. Results showed that costs dropped on a per acre basis from $164.17 for Group I, the smallest size of enterprize, to $120.86 for Group V, the largest size of enterprize. Comparison of individual groups on a per acre basis revealed that costs decreased from Group I through Group IV, but increased from Group IV to Group V. However, a similar comparison on a per seventy-five pound bag basis showed costs continued to fall continuously from Group I through Group V.

The analysis of market preparation costs indicated costs decreased as size of enterprize increased from Group A through Group C. The range in the weighted average costs of market preparation was from $0.674 to $0.402 per seventy-five pound bag.

The significance of the differences in the quantity and

cost of specific inputs was examined by the use of the analysis of variance technique. The results showed a significant decrease in labour requirements and cost per unit as size increased. This was because of the increased mechanization by the larger production units. Costs of fertilizer, chemicals, and machinery repairs were among those inputs which showed an increase as size of enterprize increased. However, the large reduction in labour costs resulted in a net decrease in the average cost of production for the larger enterprizes.

Similar trends were present in the analysis for costs of market preparation with reduced labour costs showing up as a major influence in the general trend.

For Groups I and II, family labour made up a significant portion of the total labour requirement. For the other groups, family labour made up a much smaller portion of the labour input and monetary returns to the family for this input were not an important source of income. Because of the difference in labour source, growers in Group I and II incurred a lower percentage of their total production cost as cash costs, as compared to Groups IV and V.

The range of costs of production and market preparation within each group was large. This indicated many individual producers should examine their enterprize closely and determine which cost items are higher than the average and seek out ways

to reduce these costs.

Capital requirements for potato production are substantial. The majority of the demand for funds is of a short-term nature. This necessitates careful planning to ensure adequate funds to carry out production practices which minimize risk of crop loss.

The results of regression analysis indicated total production costs and harvesting costs could be estimated by relatively few inputs. The inputs which were significant in predicting cost of production were hours of labour, yield of potatoes, cost of seed, and cost of fertilizer. The major inputs which were significant in predicting harvesting costs were the cost of harvest labour and machinery repairs. The regression analysis was carried out on a per acre and a per seventy-five pound bag basis. In all instances, the "R^2" value was higher for the seventy-five pound bag relationships. Linear and quadratic functions were tested and the inclusion of squared terms improved the "R^2" value only slightly.

There was no attempt to quantify the effect, or cost, of management in the study. Likewise, no evaluation was made of risk and the effects of risk in the production of potatoes for various outlets. No information was collected or analysis done on shrinkage in storage, the merits of washing versus dry grading potatoes, the advantage or disadvantage of bulk handling, or the costs of storing various types of

processing potatoes.

There was a lack of specific engineering information on costs of operating many of the types of equipment used by the growers, and of using particular types of equipment under various working conditions.

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The author wishes to acknowledge the assistance of Professor Om P. Tangri, under whose supervision the study was carried out. The valuable guidance and helpful criticisms provided by Dr. A. W. Wood, Dr. J. S. Townsend, and Professor J. A. Menzies throughout the study are sincerely appreciated.

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This thesis is dedicated to my wife, Mae, and family whose endurance and encouragement made the completion of this study possible.

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CHAPTER I

INTRODUCTION

Manitoba's importance as a potato production area is increasing. During the past decade, commercial acreage planted to potatoes has increased approximately 70 percent to 26,500 acres.[1] By comparison, other areas of Canada have increased much less rapidly with the exception of Alberta where the increase over the same time period has been approximately 62 percent to 22,000 acres.[2] The estimated value of potatoes produced in Manitoba in 1967 was 4.4 million dollars.[3] This was 30 percent of the total value of horticultural production in Manitoba.

The rapid increase in acreage planted to potatoes has taken place to meet the requirements of potato processing firms located in the province. In 1968, 66 percent of Manitoba's planted acreage was produced under contract for processing firms. This is by far the largest percentage of the total potato acreage going to processing of any area in

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[1]Manitoba Department of Agriculture and Conservation, Yearbook of Manitoba Agriculture (Winnipeg: R. S. Evans, Queen's Printer for Province of Manitoba, 1968), p. 14.

[2]Information obtained in correspondence with Mr. L. G. Jorgenson, Alberta Potato Marketing Commission.

[3]Manitoba Department of Agriculture and Conservation, loc. cit.

Canada. In 1967 it was estimated that 16 percent of total production in Canada was utilized by processors.[4]

A large area of Manitoba has soil and climatic conditions which are suited for the production of potatoes. It has been estimated that 2.4 million acres of land in Manitoba are suited to fully mechanized production of potatoes. This land is located within practical climatic limits for this crop.[5] Traditionally, potatoes were produced on the fine textured soils along the Red and Assiniboine Rivers near Winnipeg.[6] As techniques of transportation and mechanization of harvest were improved, increased acreages were planted to potatoes in coarser textured soils surrounding areas such as Portage la Prairie, Steinbach and Winkler. These newer production areas began to play an increasingly important role in the potato industry. In the late 1950's and early 1960's, building of processing plants in Winnipeg, Portage la Prairie, Carberry and Teulon, and the acreage under contract for these

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[4]Manitoba Department of Agriculture, Manitoba Farm Outlook (Winnipeg: R. S. Evans, Queen's Printer for Province of Manitoba, 1969), p. 33.

[5]Garth E. Stone, "Promising Area for Vegetable Crop Production in Manitoba," Technical and Scientific Papers Presented at the V.G.A.M. Annual Meeting (January, 1968), pp. 31-42.

[6]R. S. Elliot, B. A. Campbell, and P. J. Thair, The Marketing of Fresh Fruits and Vegetables in Greater Winnipeg (Winnipeg: James L. Cowie, King's Printer for Manitoba, 1946), p. 30.

plants substantially increased the proportion of total acreage on the more favourable soil types within the province. In addition, much of this acreage was produced by farmers who had not produced potatoes as a commercial enterprize previously.

The rapid development of processing techniques, and the acceptance of dehydrated potatoes, has extended the potential market area of Manitoba's production far beyond what was possible a relatively short time ago. Potato products produced in Manitoba are sold throughout Canada, and in several off-shore countries.[7] Expanding markets for processed potato products and an increasing population will require an expansion of potato production. This crop will assume increasing importance in the economy of Manitoba.

I. THE PROBLEM

This study was initiated to provide detailed information on costs of inputs required to produce potatoes. As mentioned above, the production techniques have changed rapidly during the past decade and major shifts have occurred in size of operation, capital investment and operating costs.

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[7]J. Anderson, "The Significance of Processing to the Vegetable Industry and the Economy of Manitoba," Proceedings of the Thirteenth Annual Convention of the V.G.A.M., (January, 1966), p. 49.

As these changes take place, the gap between the small and the large producer grows wider and the difficulty faced by an individual grower to make adjustments is increased, unless an accurate picture of costs is available. At present, adequate information which reflects the cost of potato production for Manitoba growers is not available. Also, farmers who are contemplating whether or not to begin the production of the crop do not have adequate information to compare this enterprize with other alternatives. Because of the large capital outlays required for specialized equipment and structures, a decision, once taken and acted upon to enter this enterprize, is not easily reversed without the possibility of financial loss. Frequently, a substantial line of credit is required to establish the enterprize, and without information on costs, it is extremely difficult to develop the required budget projection as a basis to obtain the necessary credit.

Processing firms require a supply of raw product which can be obtained from growers producing potatoes or firms who are willing to begin potato production. To ensure a continuous and reliable supply of raw product, the processor must pay a return to the growers which will at least equal the return available from alternative employment of the resources. Where processors and growers determine contractual agreements through the process of negotiation, accurate and up-to-date cost information is one essential ingredient to obtaining

satisfactory and understandable arrangements for both parties.

Marketing firms or organizations must also be aware of production and market preparation costs if they are to have a realistic market development program for table stock and seed potatoes. If costs of production, market preparation, and transportation to a market area add up to a delivered price in that market area which is above what can be achieved on a continuing basis, it is unrealistic to encourage production to obtain that market. Without a knowledge of the production costs, marketing firms have an impossible task in developing reasonable long-term market policies.

Information on production costs is also needed by those charged with the responsibility of developing realistic policies for the industry and society as a whole. It is important to realize the significance of various groups as they contribute to the total picture and the relative efficiency of these categories. If these factors are not taken into account, programs and policies may hinder rather than enhance the development of a growing and rapidly changing industry.

Availability of Cost Information

In the potato enterprize, there are many possible combinations of various resources to achieve production of a satisfactory yield of potatoes. Production can take place on a wide range of soil types, but risk appears to be a function,

in part at least, of soil characteristics. To a significant degree, capital, in the form of machinery, can be substituted for labour. However, the amount of capital required to purchase the specialized equipment necessary to mechanize a potato enterprize runs into thousands of dollars. Because of the large overhead and the relatively rapid obsolescence of the major portion of the equipment, it is also important that the size of enterprize be such that use of the equipment be at, or near, optimum capacity levels in the interests of efficiency of resource use.

There have been a number of studies done on potatoes, but few of these apply directly to the particular size range of producers found in Manitoba. A recent study done in Alberta[8] sets out the cost of production for various sizes of mechanized potato enterprizes under irrigation, and dry land conditions. However, this study does not make any allowance for the operator's labour as a cost, nor does it attempt to separate costs incurred in the production and marketing segments of the potato enterprize. A study done in North Dakota[9]

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[8]E. E. R. King, Capital Investments, Production Costs and Yields of Commercial Potato Production in Alberta, Economics Branch, Canada Department of Agriculture (Edmonton: C.D.A. [1965]).

[9]M. G. Maier and Laurel D. Loftsgard, Potato Production Costs and Practices in the Red River Valley, Bulletin Number 451 (Fargo: North Dakota State University, Agricultural Experiment Station, Department of Agricultural Economics, September, 1964).

presents a detailed cost of production picture for growers within the range of ninety-five to 1,005 acres. No attempt was made in the North Dakota study to examine the costs of production for producers below ninety-five acres or to include costs of storage and preparation of potatoes for market.

Studies in other sections of the United States provide information on their specific areas but frequently quantities of inputs such as fertilizer and other factors are markedly different.

Three studies done in Manitoba[10] dealt to some extent with production costs but were primarily concerned with various aspects of marketing. In addition, changes in techniques of production, handling, and outlets have been very significant in the past ten years.

The potato industry, like every other segment of agriculture, must face the challenge of continual change. One of the necessary requirements for meeting such a challenge is an adequate knowledge of costs incurred in the production of

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[10]Arthur G. Wilson, Primary Aspects of Potato Marketing in Manitoba, Research Report Number 8 (Winnipeg: University of Manitoba, Faculty of Agriculture and Home Economics, Department of Agricultural Economics and Farm Management, March, 1961); Emmanual Newton Afful, "A Study of Primary Marketing Costs for Manitoba Potatoes" (unpublished Master's thesis, The University of Manitoba, Winnipeg, 1960); and Susheel Chandra Chowdhury, "Determination of the Optimum Location of Grading and Packaging of Manitoba Potatoes" (unpublished Master's thesis, The University of Manitoba, Winnipeg, 1963).

potatoes.

II. OBJECTIVES OF THE STUDY

The specific objectives of the study are:

1. To determine the cost of inputs required to produce potatoes for various acreages or sizes of production;
2. To determine the cost of inputs required to store, prepare and deliver potatoes to the table market;
3. To determine the resource requirements and cultural practices employed by producers in Manitoba.

III. HYPOTHESIS AND METHODOLOGY

With the objectives stated above, the following hypothesis are tested:

1. Growers who produce large acreages of potatoes incur a lower cost of production than do growers who produce small acreages of potatoes;
2. Substitution of capital for labour reduces cost of production of potatoes;
3. Producers with large volumes of table stock potatoes incur a lower cost of market preparation than do growers who produce a small volume of table stock potatoes.

In testing these hypothesis, it is assumed that the following conditions exist:

1. Any price advantage achieved in the purchase of equipment

and supplied by large scale producers as compared to small scale producers is insignificant;

2. Prices paid for specified goods and services within the area surveyed are uniform.

In some instances, buyers achieve price concessions, and prices differ between areas. However, after contacting suppliers and dealers of chemicals, fertilizer, equipment, and equipment repairs, it was concluded that any advantages achieved by growers for a particular commodity or service, because of size and a location within the survey area, would rarely be as great as 10 percent, and would likely average out at considerably less than 5 percent for all products and services purchased. Accordingly, the above assumptions do not appear unrealistic.

In testing the above hypothesis, the mean cost figures are compared. This comparison is made by applying the technique of analysis of variance. Regression analysis is used to develop equations which reflect the significance of several variables that contribute to the cost of production for this crop.

IV. SCOPE OF THE STUDY

The Population

The population from which the sample was taken was defined to exist within the following restrictions:

1. Growers who produced at least four acres of potatoes;
2. Growers who produced potatoes for the table market or a processing firm located in Manitoba;
3. Growers that are located east of a north-south line drawn through the town of Douglas and south of an east-west line drawn through the town of Teulon (See Figure I);
4. Growers who sell potatoes for the table market out of storage for that portion of the study dealing with market preparation and transportation costs.

The first restriction was used to eliminate the very small producers who do not contribute in a major way to the total production picture. In addition, names, addresses, and acreages of growers with less than four acres are not readily available. The second and third restrictions include almost all of the major commercial production areas and serve to limit the travel distances involved in the survey. The fourth restriction facilitates the evaluation of the third hypothesis.

With the above restrictions adopted, a master list of potato producers was developed. This was done by combining the names, addresses, and acreages as provided in the following lists:

1. The voters' list used by the Manitoba Marketing Board on the vote held in the fall of 1967;
2. The list of registered growers at the Manitoba Vegetable Marketing Commission;

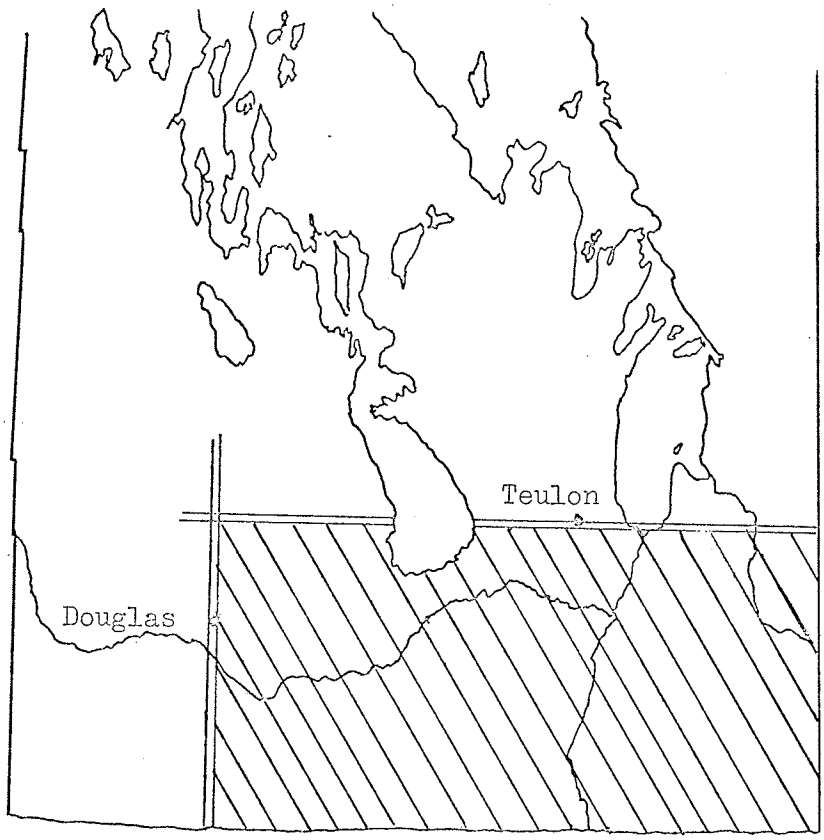

FIGURE I

MAP OF MANITOBA INDICATING AREA SURVEYED

3. The list of growers obtained from the processing companies who contract for potatoes.

This master list was then divided into five acreage groups as follows:

Group I: 4 - 19.9 acres;

Group II: 20 - 59.9 acres;

Group III: 60 - 149.9 acres;

Group IV: 150 - 299.9 acres;

Group V: 300 acres and over.

Although the divisions chosen are arbitrary, they were selected to represent several of the possible groups that exist within the industry. The first group represents the smallest type of potato production unit studied. This group includes a large number of growers who produce potatoes, but whose production represents only a minor portion of the volume produced by the industry. The enterprize itself cannot be expected to contribute a high total dollar return to the operator for his management and labour unless the production is for a very specialized outlet.

Those producers in the second group are fewer in total number as compared to the first group, but plant a greater acreage to potatoes.[11] However, the enterprize must still be considered small in scale. It is likely that if there are

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[11] Appendix B, Table XIV.

advantages to mechanization of operations such as harvesting, seed cutting, and handling, these producers will not be in a position to justify the capital outlays required to purchase the most efficient machines. If these factors are in fact true and the individual producers in this group wish to take advantage of mechanization, they will either have to expand their acreage as individuals or work together to spread the overhead costs over a larger acreage.

The third group represents producers for which potatoes are definitely a major enterprize. However, growers in this group may still find it difficult to justify the capital outlays for equipment used in many up to date potato enterprizes.

The fourth group appears to be a minimum acreage for a full line of potato equipment on the basis of information supplied by equipment manufacturers and observations by processing companies. Opinions expressed by people in the industry indicate that one potato harvester, without the use of the four or six row harvesting system, approaches capacity to harvest 250 acres of potatoes for storage under Manitoba conditions.

The fifth group represents producers with the largest individual and total acres of production. In several cases these production units are operated by more than one family. At this level of production, use of several units of a particular machine is common. For example, several growers

in this group have two or more harvesters for their potato enterprize.

The variation among growers within each group was unknown, but it was expected that the smallest group would have the smallest variation within the group. In view of this, it was decided to select a smaller percentage of the population falling within the small size group than the percentage selected in the large size group. It was estimated that, in view of time available, it would be impractical to interview more than seventy-five producers. It was also expected that some producers would be unable or unwilling to co-operate in the study. Accordingly, it was decided to select, using random number tables, one hundred growers with the numbers of producers in each size class as presented in Table I.

Of the selected growers, twenty-three indicated that they could not take part in the survey. The grouping of these twenty-three according to size is presented in Table II. In addition, records were not obtained for sixteen of the selected growers. This was due to joint operations of two or more growers which were considered as one enterprize, or inability to locate the individual concerned. This is also presented in Table II.

The above stratification was used in analyzing various

TABLE I

TOTAL NUMBER OF GROWERS AND NUMBER OF GROWERS SELECTED BY SIZE GROUP

Group No.	Size in Acres	Total Number of Growers	Number of Growers Selected
I	4 - 19.9	138	37
II	20 - 59.9	61	22
III	60 - 149.9	28	15
IV	150 - 299.9	29	15
V	300 and over	17	11
All		273	100

TABLE II

NUMBER OF GROWERS FOR WHOM RECORDS WERE NOT OBTAINED BY GROUP

Group No.	Refusals	Joint Operation and Uncontracted	No. of Records
I	8	14	15
II	8	2	12
III	3	2	9
IV	1	1	14
V	1	0	10
All	21	19	60

aspects of production concerning objectives one and two.[12] Analysis to determine costs of storage, preparation, and delivery of table stock and seed potatoes to market, objective three, requires a different stratification. First, two growers of Group III, ten growers from Group IV, and five from Group V were dropped because they produced no table stock or seed potatoes. In addition, the processing acreage of two growers from Group III, three growers from Group IV, and five growers from Group V was eliminated from the analysis. Second, the remaining production was reclassified into three groups of growers. Growers in Group A had 500 to 1,499, Group B had 1,500 to 5,999, and Group C had over 6,000 seventy-five pound bags of production for table and seed outlets.

Collection of Data

Information used to calculate and compare costs of production was collected by personal interviews. A general questionnaire was developed and used for all five groups.[13] The questionnaire was completed in a single sitting. The time required ranged from two to four hours. Sixty records were obtained with a range in size from four to 1,540 acres.

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[12]Chapter I, p. 5.

[13]Appendix A.

This introductory chapter presented the problem, objectives, and scope of the study. Chapter II reviews a series of recent studies on potato production and marketing costs.

CHAPTER II

REVIEW OF RECENT STUDIES

Many studies have been done on various cost aspects of production and marketing of potatoes. Of those done recently, none apply to the size range of growers currently under study for an area which compares with Manitoba.

I. RECENT STUDIES CONDUCTED IN MANITOBA

The three studies completed in Manitoba on potatoes in the 1960's had various aspects of marketing as their prime concern. Several aspects of these studies are of interest to the present study.

Wilson[1] outlined numerous factors which indicated wide disparity among potato growers within the province. In 1957, only seventy-seven out of 307 growers studied used fertilizer on their potatoes. However, these seventy-seven accounted for 45 percent of the total planted acreage.[2] This is an indication of the willingness of the larger than average producer to adopt newer technology first. Wilson

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[1] Arthur G. Wilson, Primary Aspects of Potato Marketing in Manitoba, Research Report Number 8 (Winnipeg: University of Manitoba, Faculty of Agriculture and Home Economics, Department of Agricultural Economics and Farm Management, March, 1961).

[2] Ibid., p. 22.

also pointed out that although the scale of potato enterprize was increasing, it was still quite small. It was also observed by Wilson that producers in North Dakota had, on the average, a much larger scale of enterprize and that this would appear to be nearer the optimum.[3] The question of mechanization was also discussed, and it was suggested that mechanical harvesting systems were being adopted at a slower rate than other aspects of mechanization in potato production. Wilson indicated that this was a result of the fine textured soil on which much of the production in Manitoba was located, and the small scale of the average potato enterprize.[4]

A limited analysis of cost of production and marketing was carried out by Wilson, and this indicated that total costs incurred were $205.84 per acre. This included $172.25 of variable costs and $33.59 fixed costs. Wilson also concluded that of the total cost figure, 53.9 percent was incurred in producing the crop, and 46.1 percent in marketing the crop.[5]

Afful[6] studied primary marketing costs of Manitoba potatoes for the 1958-59 crop season. This study indicated

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[3] Ibid., p. 25. [4] Ibid., p. 36. [5] Ibid., p. 42.

[6] Emmanual Newton Afful, "A Study of Primary Marketing Costs for Manitoba Potatoes" (unpublished Master's thesis, The University of Manitoba, Winnipeg, 1960).

that marketing costs accounted for 41.1 percent of the average gross farm price of the season. Of the total cost of marketing, transportation accounted for 37.9 percent, sacks for 27.8 percent, grading for 21.1 percent and storage for 13.2 percent.[7] The variation between individual producers was wide, and costs associated with small volumes were higher on the average than those associated with large volumes. There were, however, exceptions to this. Two farmers in the largest sized group had very high costs.

As would be expected, transportation costs increase as distance from the market increases. In addition, the larger production units were located at greater distances from the market. The added transportation cost incurred by the larger producers tended to mask the savings achieved by this group in storing and grading larger volumes of potatoes. As a result, the large group of producers tended to have slightly higher cost of marketing than did the medium sized group of producers.[8]

Chowdhury's study[9] also considered the marketing of potatoes. Major aspects studied were optimum location of the

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[7] Ibid., p. 58. [8] Ibid., p. 60.

[9] Susheel Chandra Chowdhury, "Determination of the Optimum Location of Grading and Packaging of Manitoba Potatoes" (unpublished Master's thesis, The University of Manitoba, Winnipeg, 1963).

grading function and the relative economics of machine and hand grading of potatoes.

In that study, eleven out of thirty-eight growers graded their potatoes by hand. The availability of family labour and the volume produced per grower were major considerations in selecting the method of grading. Cost of hand grading in the study ranged from 44.5¢ to 13.9¢ per hundredweight, with a weighted average of 23.0¢ per hundredweight.[10] The corresponding costs for machine grading were 22.7¢ to 6.2¢ with a weighted average of 11.9¢ per hundredweight.[11] These differences in costs proved to be significant, and it was estimated that approximately 2,000 hundredweight of potatoes were needed to justify the purchase of equipment to grade potatoes by machine.[12]

After analyzing costs of grading at the farm and wholesale, Chowdhury concluded that grading on the farm was significantly less expensive than grading at the wholesale level.[13] However, it must be realized that this conclusion was based on data arising out of the survey and it was not possible to evaluate any possible savings which may accrue as a result of different methods of handling or sizes of plant. It was also impractical to evaluate any effect which might

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[10] Ibid., pp. 133-134. [11] Ibid., pp. 135-138.

[12] Ibid., p. 73. [13] Ibid., p. 86.

develop from standardized grading procedures or special packs, particularly as consumer preferences change.

II. RECENT STUDIES IN OTHER AREAS

A study on investment costs and yields of potato production in Alberta was carried out by the Economics Branch, Canada Department of Agriculture.[14] This study included growers who produced potatoes under irrigation as well as dry land. Four size groups were studied ranging up to 350 acres. The study did not evaluate the contribution that the operators' labour or management made to the enterprize and this input, although discussed, is not included as a cost in the study. It is the opinion of the author of the present study that a cost comparison of the various sizes of enterprize, without making allowance for the contribution of the labour of the operator and his family, could lead to the selection of the incorrect size of operation by growers assessing the merits of the size groups listed. By excluding the cost of family labour, the total cost of the small enterprize could well be underestimated to the point of accepting the small size as being the most economic scale on which to operate. This is particularly so where more than one

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[14] E. E. R. King, Capital Investments, Production Costs and Yields of Commercial Potato Production in Alberta, Economics Branch, Canada Department of Agriculture (Edmonton: C.D.A. [1965]).

operator is involved in the same enterprize, or where the operator and his family contribute a significant portion of the total labour in the production and marketing of the crop.

The Alberta study indicated that total costs per acre (excluding return to the operator and his family for labour and management), in the Edmonton area was $130.04 for growers up to one hundred acres, $120.39 for growers from 101 to 150 acres, and $147.07 for growers 151 to 350 acres. Costs per hundredweight are $1.22, $1.00 and $1.10 respectively. The costs for production under irrigation were approximately $25 to $40 per acre higher but the costs per hundredweight were ten cents to twenty cents lower.[15] The analysis of data collected did not outline the costs of market preparation separately from production and storage. In addition, it is not indicated whether the cost of transportation to market and selling make up part of the cost figures presented.

Maier and Loftsgard conducted a study in 1960 in the Red River Valley of the United States.[16] It developed costs of production for potatoes from spring until the harvest was completed. No information was presented on the costs of

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[15] Ibid., pp. 13-14.

[16] M. G. Maier and Laurel D. Loftsgard, Potato Production Costs and Practices in the Red River Valley, Bulletin Number 451 (Fargo: North Dakota State University, Agricultural Experiment Station, Department of Agricultural Economics, September, 1964).

storage or any aspect of marketing. Information was collected from eighty-two producers ranging in size from ninety-five to 1,003 acres, with an average acreage of 287. The study revealed a considerable range in cultural practices used, and the larger producers, on the average, tended to use more mechanized methods along with higher levels of fertilizer and chemicals. The average yield produced by small, medium and large sized groups was 130, 140 and 150 hundredweight per acre, respectively. Cost of production per acre was $107.35 for the smallest size group, $105.35 for the middle size group, and $104.45 for the large size group.[17] The largest size group incurred a lower fixed cost per acre but additional inputs in the variable cost category compensated somewhat for the saving on fixed costs per acre. However, the higher yields obtained by the larger group resulted in a cost per hundredweight into storage of seventy cents compared to seventy-five cents for the medium, and eighty-three cents for the small size group.[18]

Several cost of production studies have been carried out in Aroostook County, Maine. One of these was published in May, 1965,[19] and outlines costs and general practices of

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[17] Ibid., p. 24. [18] Ibid., p. 25.

[19] Winston E. Pullen and Dean F. Tuthill, Cost of Producing Potatoes Central Aroostook County, Maine, Bulletin 635 (Orno: University of Maine, Agricultural Experiment Station, May, 1965).

production from land preparation through storage. The study involved 180 producers in three size groups. The size groups were: 20 to 49; 50 to 149; and 150 to 330 acres. Costs of planting, growing and harvesting averaged out to $383.00 per acre, and were $387,00, $396.00, and $361.00 for the small, medium, and large sized groups respectively. Costs per hundredweight were $1.41, $1.35, and $1.28, respectively. Labour was the largest single cost item. This accounted for 35 percent of all costs on the average. There was considerable variation in labour costs from farm to farm. The management of this input appeared critical if reduced costs were to be achieved by the growers of this area. Of the 180 producers studied, only five made use of potato harvesters in 1959. This in part accounts for the high proportion of the total cost which labour comprises.[20]

This chapter outlined several aspects of costs incurred in the production and marketing of potatoes in neighbouring areas. The next chapter reviews the recent developments in the processing and table stock industry.

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[20] Ibid., pp. 5-6.

CHAPTER III

RECENT DEVELOPMENTS IN THE POTATO INDUSTRY

The potato industry has undergone a period of rapid change and development. Some of the significant changes are improved techniques in processing potatoes, rapid decrease in total number of producers accompanied by increased size of enterprize, higher yields, and a gradual increase in the per capita consumption of potato products in very recent years.

I. GROWTH AND INFLUENCE OF THE PROCESSING INDUSTRY

The processing of potatoes was developed in recent years as compared to processing of other vegetable products. Furthermore, the early techniques of processing resulted in a product which was distinctly different from freshly prepared potatoes.

During the last two decades, there have been major developments in processing. About 1945, the first frozen french fries were marketed in the United States. Five years later, the product was being processed in Canada.[1] By 1967,

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[1]W. H. Heeney, "Trends in Processing Quality French Fried Potatoes", Proceedings of the Eighth Canadian Potato Industry Conference, sponsored by the Canadian Horticultural Council (Ottawa: C.H.C., 1966).

12.8 percent of the potatoes sold in the United States were processed into frozen french fries.[2]

Various types of dehydrated potato products have been on the market for some time. However, major technological developments in the late 1950's resulted in dehydrated products which were superior to their forerunners. In 1959, a large potato processing plant was built at Alliston, Ontario, using these newly developed techniques, and with its construction the influence of dehydrated potato products on the potato industry began to be felt in Canada.[3] By 1967, dehydrated products accounted for 7 percent of all potatoes sold in the United States.[4]

The third major processed product is the Saratoga style potato chip. The development of this product created a new outlet for potatoes in the form of a snack food. The Saratoga potato chip has a distinct flavour and texture, and has been widely accepted. At the present time the consumption per capita continues to increase. The volume of potatoes being processed as "potato chips" and "shoestrings"

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[2]The National Potato Council, The National Potato Council Fourth Annual Statistical Report (Washington: N.P.C., 1969), p. 27.

[3]S. E. Turner, "Trends in Processing and Marketing Instant Potato Products," Proceedings of the Eighth Canadian Potato Industry Conference, sponsored by the Canadian Horticultural Council (Ottawa: C.H.C., 1966).

[4]The National Potato Council, op. cit., p. 27.

represented 12.1 percent of all the potatoes sold in the United States during 1967.[5]

The increase in the significance of the processing industry as a part of the total potato industry in Canada and the United States is depicted in Figures 2 and 3.

Prior to 1956 in Manitoba, there was very little potato processing of any type. By 1960, approximately 1,000 acres of production,[6] or 5.9 percent, were grown for processing, with the largest portion being "chipped". In 1961, a major transaction occurred when The J. R. Simplot Company, with its head office in Idaho, purchased property at Carberry. This property consisted of land and buildings used during World War II for training Royal Canadian Air Force personnel. During the first season following the purchase, the company planted approximately 2,000 acres of potatoes in the Carberry district and proceeded to install equipment and modify buildings to begin processing several dehydrated and frozen potato products. In the years which have followed, the company has continued to produce a portion of their requirements but the portion of their total acreage produced under contract by growers has increased steadily. In addition to the dehydra-

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[5] Ibid.

[6] Manitoba Department of Agriculture and Conservation, Manitoba Farm Outlook (Winnipeg: R. S. Evans, Queen's Printer for Province of Manitoba, 1967), p. 8.

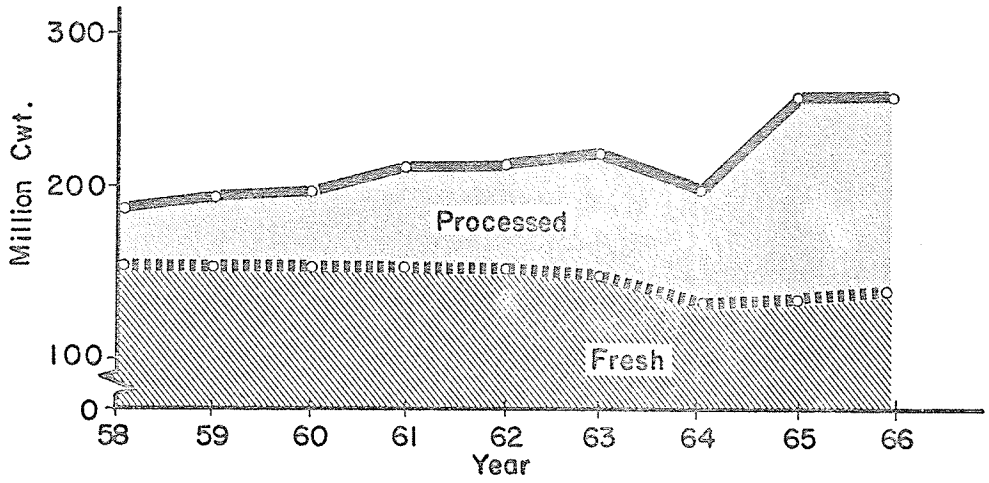

FIGURE 2

POTATOES USED FOR FOOD IN THE UNITED STATES,
FRESH AND PROCESSED

SOURCE: The National Potato Council, The National Potato Council Fourth Annual Statistical Report. Washington: N.P.C., 1969, p. 24.

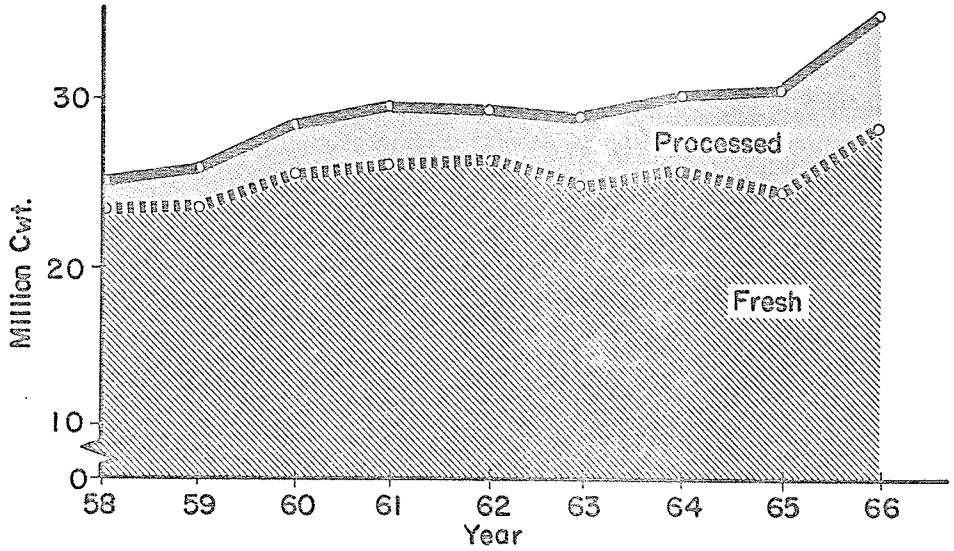

FIGURE 3

POTATOES USED FOR FOOD IN CANADA,
FRESH AND PROCESSED

SOURCE: Dominion Bureau of Statistics, Agricultural Division, Apparent Domestic Disappearance of Food in Canada, Catalogue Number 32-226. Ottawa: D.B.S., 1961-1968; Dominion Bureau of Statistics, Estimated Population of Canada by Provinces, Catalogue Number 91-201. Ottawa: D.B.S., 1967.

tion and frozen french fry firm, there are two chipping firms and one soup company using potatoes grown under contract in Manitoba. All of these firms have been successful in expanding their markets and have increased the acreage under contract to supply their needs for raw product. In 1968, these contracts amounted to 17,5000 acres, or 66 percent of the total commercial acreage of potatoes in the province.

The growth of the processing industry and the purchase of potatoes through the technique of the forward contract have had a major influence on the production pattern within Manitoba. Processing firms strive for uniformity of finished product, and this in turn requires a considerable degree of uniformity in the raw product that they purchase. In addition, processors are interested in efficient producers who grow a substantial volume of potatoes with the recognized modern techniques of production, and who do so with continuity of quality and quantity from year to year. These requirements have resulted in the majority of contract potato acreage being located on medium to medium coarse textured soils, and with growers who have a fully mechanized harvesting system (See Tables III and IV).

TABLE III

ACREAGES AND PERCENTAGES OF POTATOES CONTRACTED
BY GROUP AND SOIL TEXTURE

Group	Total Potato Acres	Contracted Potato Acres	Contracted Acreage on		% Contracted on	
			Medium to Coarse Texture	Fine Texture	Medium to Coarse Texture	Fine Texture
I	124	0	0	0	0	0
II	449	0	0	0	0	0
III	706	295	255	40	86.4	13.6
IV	3,249	2,859	2,709	150	94.8	5.2
V	6,188	4,652	4,652	0	100.0	0
All Groups	10,716	7,831	7,641	190	97.6	2.4

TABLE IV

HARVESTING METHODS USED BY CONTRACT GROWERS BY GROUP

Group	Harvesting Method		No. of Contract Growers
	Harvesters	Pickers	
I	0	0	0
II	0	0	0
III	2	2	4
IV	12	1	13
V	10	0	10
All Groups	24	3	27

The average size of acreage under contract by growers is also striking. There were twenty-seven producers in the survey growing 7,806 acres under contract in 1968, or an average of 289 acres per grower. It is also of interest to note that of these twenty-seven producers, eleven had additional seed or table stock production.[7]

The specifications of the processing industry have also had a significant effect on storage requirements and design. Traditionally, potatoes for table stock have been stored with the temperature of the tubers between thirty-eight and forty degrees Fahrenheit. At this temperature range, the tubers of all of the present commercial varieties develop unacceptable levels of reducing sugars and, as a result, do not process satisfactorily. Potatoes used for processing are stored at forty-five degrees Fahrenheit or warmer. This storage temperature is also conducive to the rapid development of many micro-organisms which cause various types of rot to develop in the tubers. As a result of these two factors, as well as the volumes of potatoes frequently involved within the building, an increase in the amount of ventilation and humidity control is commonly recommended for processing potatoes in storage. This has necessitated more elaborate ventilation and humidity control systems than were

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[7]Appendix C, Table XVI.

required previously.

The volume of potatoes used by processing firms and the contracting of this volume with medium to large sized production units made the introduction of bulk handling systems for loading and transport of potatoes practical in Manitoba. Because of labour and time savings, the transportation of 40,000 pounds of potatoes which have been mechanically loaded loose into heated semitrailer trucks is common today. Five years ago this was not done in Manitoba.

The processing industry has developed rapidly, and has brought with it substantial changes. This is true where processing requires 20 to 30 percent of the potato production of an area, and it is especially true in Manitoba where processors use the potatoes produced from two-thirds of the total acreage planted to this crop.

II. CHANGES IN TABLE STOCK PRODUCTION AND MARKETING

The fresh potato industry has a much longer history than the potato processing industry. The consumption per capita of fresh potatoes has been declining for many years[8] and it appears this will continue. Prior to processing a

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[8]Roger W. Gray, Vernon L. Sorenson, and Willard W. Cochrane, An Economic Analysis of the Impact of Government Programs on the Potato Industry of the United States, North Central Regional Publication Number 42 (St. Paul: University of Minnesota, Agricultural Experiment Station, 1953), pp. 8-21.

very limited number of substitute foods for the fresh potato were available. However, as processing techniques developed and were improved, the substitutability between potato products was a factor which had to be considered by the fresh producer. This influence has been recognized by progressive people within the industry, and considerable effort has been put forth to present potatoes as an attactively packaged, clean, relatively well sized product. These trends have resulted in extensive use of attractive polyethelene packages. Provisions have been made for the use of consumer packs weighing 3, 5, 10, 20, and 50 pounds. The expanded use of cardboard box-type cartons frequently holding fifty pounds of washed potatoes which have been carefully graded within a restricted weight range of approximately two ounces, and the general tightening of the specifications for table stock grades, appear to be improvements which must be incorporated into the table stock industry. This will result in a higher percentage of potatoes which are unsatisfactory for marketing as a fresh product. In an effort to utilize this food product, some production areas have made it available to the processing plants at prices which permit the extra trimming losses incurred in processing without making the finished product excessively expensive to produce.

The increased concentration of the distribution system for food products carries with it the requirements of large

volumes of standardized product and continuity of supply. It is difficult for a large number of small unorganized producers to operate effectively within this type of merchandising system. In addition, the rapid development of specialized production units in areas where tracts of land were available and suited to the production of potatoes resulted in the concentration of the major portion of potato production in the hands of relatively few producers.

Changes in Manitoba

These general trends and developments have been felt in Manitoba as they have been in other areas. However, the response to these changes in Manitoba has been somewhat different as compared to Canada as a whole. For the last few years, the acreage planted to table stock in Manitoba has declined. Several of the larger producers who have grown table stock have switched to the production of processing potatoes. Other table stock growers have not increased their production to maintain the acreage planted for this market. In addition, while there has been a substantial number of new producers for the production of processing stocks, very few farmers who have not had previous experience with potatoes have begun to grow them for the table stock market in the past few years.

The average size of the table stock enterprize in 1967

was 32.5 acres per grower,[9] as compared to 30.3 in 1959.[10] This is a sharp contrast to the average contract size for growers producing for processing of 289 acres. Although the average table stock acreage per grower was higher several years ago, this has been reduced because several large producers of table stock have begun producing potatoes under contract and reduced or stopped the production of table potatoes.

For many years, table potatoes grown in Manitoba have been sold in Saskatchewan and Ontario, as well as locally. Carlot unloads of potatoes in Regina and Saskatoon[11] reveal that over 10 percent of the total unloads recorded for Manitoba are shipped to these centres. This figure, however, does not indicate the total shipment outside of provincial boundaries because lots moving direct to several other centres are not reported. Potatoes produced in Manitoba are shipped regularly to Fort William, Port Arthur, Fort Frances, Sault Ste. Marie and other points in western Ontario. The quantities

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[9]Appendix C, Table XVI.

[10]Arthur G. Wilson, Primary Aspects of Potato Marketing in Manitoba, Research Report Number 8 (Winnipeg: University of Manitoba, Faculty of Agriculture and Home Economics, Department of Agricultural Economics and Farm Management, March, 1961), p. 28.

[11]Canada Department of Agriculture, Production and Marketing Branch, Markets Information Section, Annual Unload Report, Fresh Fruit and Vegetables on Twelve Canadian Markets (Ottawa: 1958-1967).

involved are significant but figures are not published on this movement. It has been estimated that at times 40 percent of Manitoba's table potatoes move beyond the borders of the province.[12]

Changes in Neighbourhood Production Areas

Saskatchewan. One of the traditional markets for Manitoba potatoes has been in Saskatchewan. Although the movement of potatoes into this area does not constitute a major percentage of the fresh market production in Manitoba, it is a significant factor considering the inelastic nature of the demand curve for fresh potatoes.[13] It would appear that the continued movement of potatoes from Manitoba into Saskatchewan cannot be taken for granted. The recent development of the Gardiner Dam and irrigation farming from that structure is encouraging additional production of potatoes in Saskatchewan. It would seem logical to expect a significant increase of potato production in the area.

Alberta. During the past decade the volume of potatoes produced in Alberta has increased sharply and the largest

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[12]Information provided to the author by Mr. John Plantje, Manitoba Vegetable Marketing Commission.

[13]Mascell Leonard Beckford, "Demand Analysis for Selected Commodities, Canada, 1926-1962" (unpublished Master's thesis, The University of Manitoba, Winnipeg, 1964), pp. 94 - 95.

part of this is produced for the fresh market.[14] In addition, the Alberta potato industry has an active promotion program through their grower organization, the Alberta Potato Commission. As a result, Manitoba production is facing increased competition from Alberta in Saskatchewan and Manitoba. It appears extremely unlikely that this competition will decrease in the future.

United States. For the past several years, the fall production areas of the United States have been producing a higher percentage of the total quantity grown in that country. Production in winter, spring, and summer areas has remained stable or dropped to some extent while fall states have increased their production of potatoes.[15]

Table V indicates that potato production in the United States has been higher than the 1951-1960 average each year for the period 1958-1967. The greatest increase in the period was 31 percent with an average of 17 percent. The production of the fall states was above the 1951-1960 average for the same period in all years. The greatest increase for the period was 47 percent with an average of 25 percent. North

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[14]Information obtained in correspondence with Mr. L. G. Jorgenson, Alberta Potato Marketing Commission.

[15]The National Potato Council, The National Potato Council Fourth Annual Statistical Report (Washington: N.P.C., 1969), p. 15.

TABLE V

INDEX OF POTATO PRODUCTION IN THE UNITED STATES[a,b] AND SELECTED STATES

Year	United States	Fall States	North Dakota	Minnesota	Idaho	California	Maine
1958	113	117	132	116	127	109	109
1959	104	105	116	119	118	102	100
1960	110	111	129	137	125	106	98
1961	125	131	126	144	168	128	108
1962	114	122	131	128	135	104	114
1963	116	126	120	145	155	109	110
1964	102	110	92	101	115	100	117
1965	124	138	135	133	177	118	102
1966	131	145	126	123	203	129	111
1967	131	147	117	133	186	122	111
Average	117	125	122	128	151	113	108

[a]United States Department of Commerce, The National Data Book and Guide to Sources, Statistical Abstracts of the United States (Washington: Government Printing Office, 1962-1966); United States Department of Agriculture, Agricultural Statistics (Washington: Government Printing Office, 1959-1961).

[b]Base 1951-1960 = 100.

Dakota and Minnesota have been above the 1951-1960 average for the same period nine years out of ten, and ten years out of ten, respectively, the highest increase being 31 and 45 percent and with an average increase of 22 and 28 percent, respectively. Increases in Idaho are larger in most years than the increases in the Red River Valley, while production in Maine tends to be below the national picture. An index of price for the same period and production areas is presented in Table VI. This table indicates that the index of price in areas of the United States competing in Manitoba markets were lower than the average for all states with similar marketing seasons. This tends to establish a price ceiling for Manitoba potatoes, even though the crop produced in Manitoba may be reduced in a particular year or series of years.

The recent trends discussed in this chapter provide background information for the development of theoretical cost considerations. These follow in Chapter IV.

TABLE VI

INDEX OF FARM PRICE IN THE UNITED STATES[a,b] AND SELECTED STATES

Year	United States	Fall States	North Dakota	Minnesota	Idaho	California	Maine
1958	64	60	47	48	60	69	62
1959	110	113	96	93	129	110	129
1960	97	93	77	74	110	116	76
1961	66	63	58	61	63	68	63
1962	81	77	57	70	89	84	68
1963	86	81	63	77	93	77	105
1964	152	176	206	207	209	171	212
1965	123	99	81	96	116	164	131
1966	99	97	93	104	100	88	94
1967	92	89	70	84	95	94	83
Average	97	95	85	91	106	104	102

[a]United States Department of Commerce, The National Data Book and Guide to Sources, Statistical Abstracts of the United States (Washington: Government Printing Office, 1962-1966); United States Department of Agriculture, Agricultural Statistics (Washington: Government Printing Office, 1959-1961).

[b]Base 1951-1960 = 100.

CHAPTER IV

CONSIDERATIONS IN COST AND SAMPLING THEORY

That portion of static-micro economic theory which explains the relationships of costs to various levels of output is of interest to this study. The application of accepted theoretical models to actual situations assists in the logical evaluation and explanation of trends and developments which are revealed by the analysis of data.

The application of the theory of sampling assists in the efficient use of resources in obtaining data. In addition, samples properly drawn serve as an accurate base for analysis which is representative of the population from which the sample is drawn.

I. COSTS AS THEY APPLY TO PRODUCTION

The concept of cost differs to a significant degree, depending on the area of interest that is under consideration. In the current study the concept of cost is used in an economic sense. This can be briefly defined as "the value of the alternative that has been foregone to produce a certain output".[1] In actual fact, this may be the market price

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[1] J. P. McKenna, Intermediate Economic Theory (Toronto: Holt, Reinhart, and Winston, Inc., 1960), p. 15.

of the input utilized in the production of the output, or it may be the opportunity which was given up when the decision to produce the output was made. Inputs which are purchased by an outlay of money, directly or through contractual arrangement, are referred to as expenditure or explicit costs. Non-expenditure costs are sometimes referred to as implicit costs and represent the cost of self-owned resources which are employed as inputs. In this study, such items as operator's labour and management, return on owned investment, and risk, are implicit costs. It is true that these costs were not of the out-of-pocket nature, and the return from these inputs was a source of income which the operator receives. However, estimates of these factors must be included in a cost analysis if the analysis is to represent, in an economic sense, the total amount of expenditure required for the firm to continue to operate. The inclusion of implicit costs is important where firms of various sizes or types of organization are compared, and the proportion of explicit costs to implicit costs is different among the various firms under study.

The problem of allocating the cost of an input among several outputs arises in an analysis where the input is used in the production of more than one output. The analysis of the cost of such an input can be accomplished in a number of ways. Among them are:

1. The actual cost incurred in using the input for a specific output;
2. The percent of total hours the input is used by the specific output;
3. The percent of total output that is attributable to the production process in which the input in question is being used.

The first of these is the most accurate of the three, but frequently it is not practical to use. The difficulty lies in lack of knowledge about the relative cost of using the input for the production of several outputs under consideration. The second system is the next best alternative, and can be used if the total hours of use can be apportioned to the outputs in which the input is being used. The third alternative listed is the least desirable of the three because it has the least probability of accuracy. In the current analysis, information was obtained which allowed the use of alternative number two.

Consideration must be given to the time period under study. If the time period is sufficiently long for the firm to change its organization in all respects, all costs are considered as variable. On the other hand, if a very short time period is under consideration, and the organization of the firm cannot be changed, all costs are of a fixed nature. This is considered to be the very short run situation. In the

analysis of costs, many studies select a time period between these two extremes. In doing this, the costs of inputs are frequently divided into two general classifications. These are fixed costs and variable costs. Fixed costs are defined as those which are the same in total, regardless of the output produced. Fixed costs exist whether or not the plant is in the process of producing an output. Examples of fixed costs are: interest on investment, property taxes, and depreciation. The second category, variable costs, includes those costs which are incurred only when production takes place and vary with the amount of output produced. Examples of variable costs include such items as fuel for tractors, fertilizer, seed, and chemicals. Frequently, the above two-way classification of costs is not fully adequate. Consequently, a third category is sometimes used in cost analysis and is referred to as semi-variable costs. Semi-variable costs represent expenditures on those items which are needed when production is undertaken, but they are not as directly related to the level of output as are the variable costs. The occurrence of semi-variable costs results from indivisibility of some of the inputs required for production.[2] The effect of semi-variable costs are illustrated by the following

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[2]J. F. Due and R. W. Clower, Intermediate Economic Analysis (4th ed.; Homewood, Illinois: Richard D. Irwin Inc., 1961), pp. 149-151.

example. Assume that a potato grower rents trucks for hauling potatoes from the field to storage, and that these trucks are leased on a per diem basis, plus the cost of operating expenses. Because of the special boxes required to haul potatoes, it is impractical to return the trucks for a short period of time when they are not needed. Assume further that the number of trucks required for hauling potatoes varies from field to field according to the turn-around time per load. In this situation, the grower must make a decision whether to rent sufficient trucks to take care of peak hauling requirements, or rent fewer trucks and have harvesting equipment and workers wait for trucks to return to the field. If the first alternative is chosen, the per diem rental fee is a semi-variable cost. Once the truck is rented, the per diem fee is charged whether or not the truck is required for harvesting at a given time.

Cost relationships or schedules are used to indicate the changes which occur in cost as output is altered. However, in any given situation there are three major factors which will determine the cost schedule for producing various levels of output. These can be listed as production technique, efficiency with which the inputs are used, and the prices paid for the inputs. A change in one or more of these factors will cause a shift in the position of the cost schedule. A second source of change is an alteration of the amounts of the inputs

used, for example, additional fertilizer or acres of land in the production of crop. Such a change will result in a different level of output. The cost of this new output will be indicated by a shift along the cost schedule, rather than an actual shift of the schedule.

Theoretical cost schedules have been developed in an attempt to explain cost and output relationships. In the process of development of cost theory, criticisms and modifications have been suggested which reflect more accurately what occurs in terms of real world conditions.[3] However, several points in connection with short run costs have been accepted. Among these are:

1. Total fixed costs remain constant regardless of output;
2. Total variable costs change as the level of output is changed;
3. Total cost has the same relationship to output as does total variable cost.

These relationships are frequently expressed by a chart, such as the one presented in Figure 4. For purposes of comparative analysis, these relationships are of limited practical importance. This is because the firms which are being studied

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[3]Don Zasada and Om P. Tangri, An Analysis of Factors Affecting the Cost of Handling and Storing Grain in Manitoba Country Elevators, Research Report Number 13 (Winnipeg: University of Manitoba, Faculty of Agriculture and Home Economics, Department of Agricultural Economics and Farm Management, 1967), pp. 36-54.

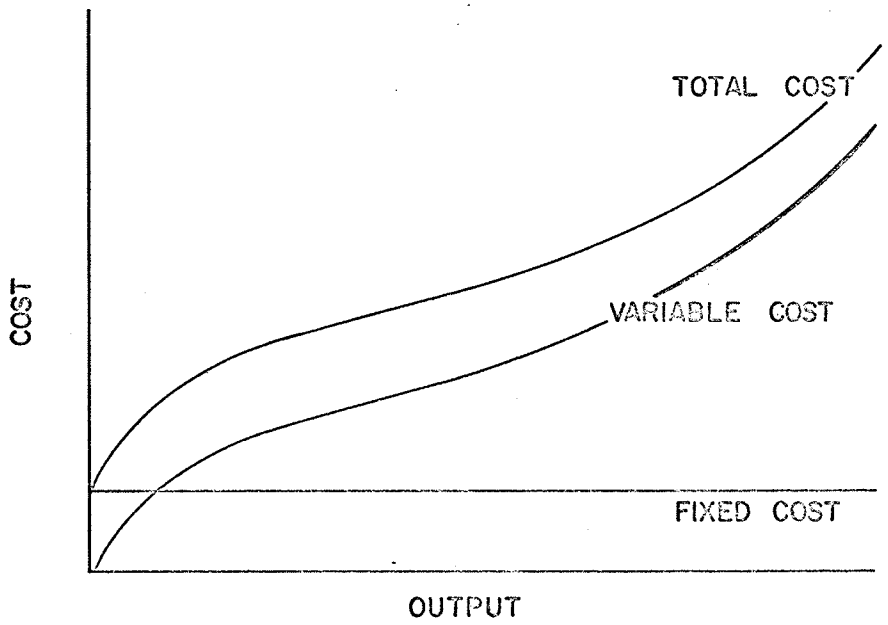

FIGURE 4

RELATIONSHIP OF TOTAL FIXED, TOTAL VARIABLE, AND TOTAL COST TO OUTPUT

SOURCE: Richard H. Leftwich, The Price System and Resource Allocation (3rd ed.; Toronto: Holt, Rinehart and Winston, 1966), p. 132.

frequently do not have the same levels of input or output. As a result, per unit relationships are of much more interest. Figure 5 is one illustration of per unit or average relationships. These relationships are based on several important assumptions. These are:

1. Certain factors used by the firm are fixed in quantity and, therefore, contain cost items which are fixed in total.
2. The fixed factor units require a certain minimum quantity of variable factor units for efficient operation, but have at least some degree of adaptability for utilization with varying quantities of other factors.
3. Some types of variable factors cannot be acquired in infinitesimally small amounts. For example, workers often cannot be hired for periods of less than one day.
4. Technological conditions and factor prices are given.
5. Successive variable factor units are of equal efficiency.[4]

The development of the above theoretical framework follows a pattern which is logical, considering the assumptions that are made. However, on numerous occasions the cost functions which result from empirical studies appear to be quite different from those illustrated in Figures 4 and 5. These differences have been brought about by changes in techniques of production. Several economists, including Brems,[5]

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[4]Due and Clower, op. cit., pp. 154-155.

[5]Hans Brems, "A Discontinuous Cost Function," American Economic Review, Vol. XLII (1952), pp. 577-586.

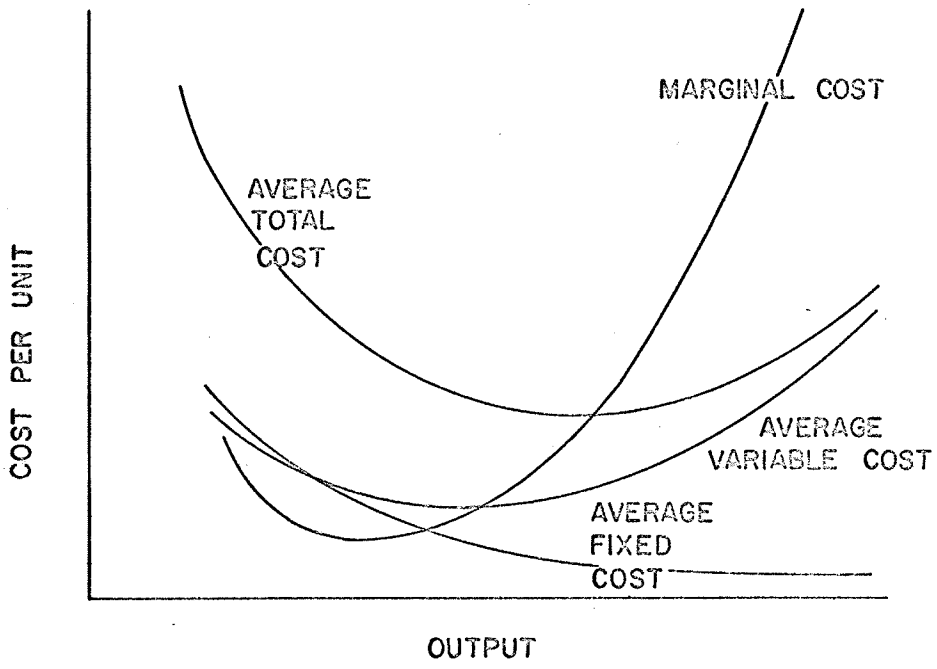

FIGURE 5

RELATIONSHIP OF AVERAGE FIXED, AVERAGE VARIABLE, AVERAGE TOTAL, AND MARGINAL COST OT OUTPUT

SOURCE: Richard H. Leftwich, The Price System and Resource Allocation (3rd ed.; Toronto: Holt, Rinehart and Winston, 1966), p. 135.

developed cost functions to depict these changes. The indivisibility of resources, for example, results in a discontinuous or step function rather than a continuous or smooth function. As technology has progressed, man has developed machines to do many tasks. In most instances, these machines are not available in a large number of sizes. In addition, they usually have definite levels of output per unit of time, and costs associated with using the machine are a significant portion of the total cost incurred in the production of an output.

For example, assume one machine is used in the production of an output, and that unit cost drops as output is increased. This is a result of spreading the overhead costs of the machine over additional units of output. When the physical capacity of the machine is reached, one way of achieving additional output is by bringing another machine into operation. However, this results in additional costs and thus, for levels of production slightly above the capacity of one machine, per unit cost is comparatively high. As output is increased and the second machine becomes more fully utilized, unit costs decrease and continue to do so until physical capacity of the two machines is reached. With the introduction of a third machine, the same cycle is repeated. An example of this type of discontinuous cost function is presented in Figure 6.

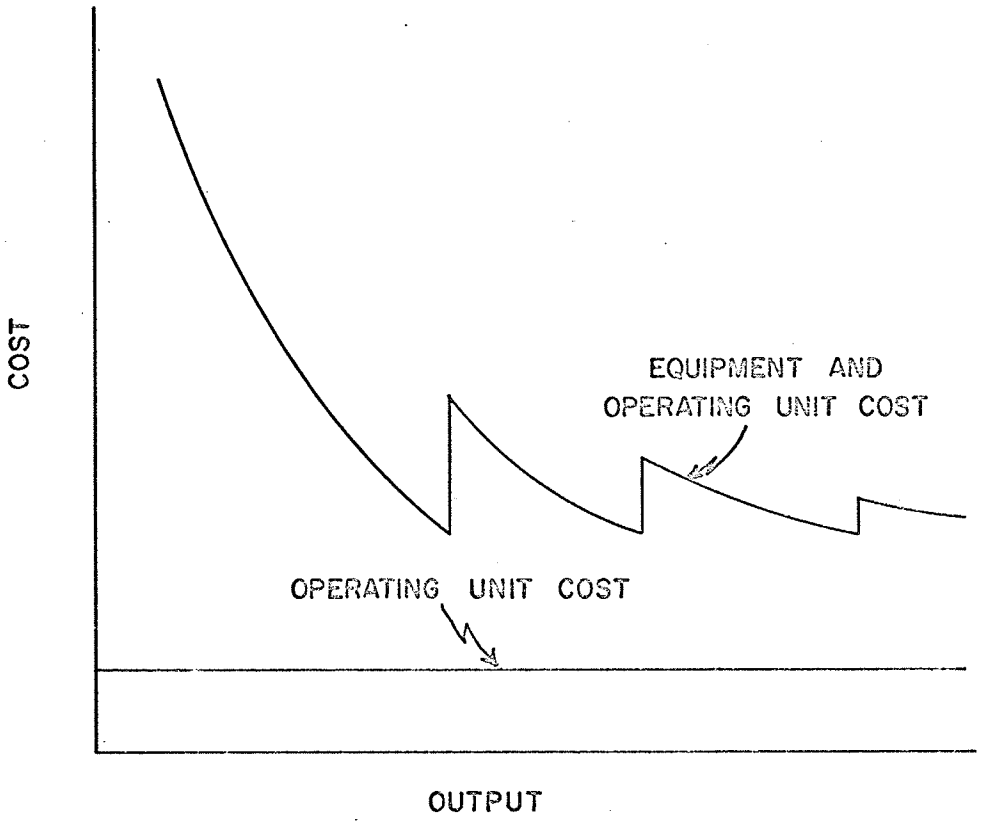

FIGURE 6

A DISCONTINUOUS COST FUNCTION

SOURCE: Hans Brems, "A Discontinuous Cost Function," American Economic Review, Vol. XLII (1952), p. 579.

This situation is encountered by potato growers because many of the machines they purchase, particularly the specialized potato equipment, are available only in a few discreet sizes and these machines constitute a significant portion of the total investment.

French, Sammet, and Bressler[6] examinedfactors which are usually not included explicitly in conventional marginal analysis. These factors are particularly important when analyzing production plants where the products produced pass through a sequence of transformations or stages. The first of these factors is the effect of varying the rate of operation of a production sequence. Normally, equipment is manufactured to produce an output at a fairly specific rate. If the rate of output is increased significantly beyond the capacity at which the machine is designed to produce, an increase in cost in excess of the relative increase in output can be expected. This may result from an increased percentage of substandard product, or excessive wear of the equipment. Where there are numerous stages in the production of an output, it may be practical to attain a reasonable degree of co-ordination between the stages only when the rate of

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[6]B. C. French, L. L. Sammet, and R. G. Bressler, "Economic Efficiency in Plant Operations with Special Reference to Marketing of California Pears," Hilgardia, Vol. XXIV, No. 19 (July, 1956), pp. 543-721.

operation remains relatively fixed. The second factor is the changing of operating hours of the plant. If output must be increased at a particular season of the year, this may be achieved by operating the plant an additional shift. By doing this, assuming additional supplies can be purchased at the same price as the initial inputs, cost schedules are linear rather than curvilinear as output increases from such a change in operations. The third factor which influences the picture is the storability of output. Where it is possible to store output for a period of time, the level of output does not have to match the level of consumption. However, where storage is not realistic, production and consumption levels must be very closely co-ordinated in an efficient operation. The fourth factor which must be considered is the relatively limited degree of substitutability of inputs that is experienced in many production processes, particularly in the short run. For example, it is unrealistic to assume substitutability between gasoline, diesel fuel, and L.P. gas, as an energy source unless the time period being studied allows for the exchange of equipment. However, in the past it used to be realistic to consider the relative costs incurred when buying hay or oats as an energy source for horses.

The distinction between the influence of rate versus time dimensions on cost relationships is very significant.

Changes in the rate of operation can be expected to result in cost functions which are curvilinear. However, changes in the time dimensions frequently result in linear cost relationships, and Figure 7 presents these differences.

The inclusion of the above factors in the theoretical model significantly expands the base for analysis of a modern plant. The effects these factors have on costs are applicable to the production of potatoes. It is obvious that machinery used in the production of this crop is not completely divisible; thus the discontinuous type of cost function is a distinct possibility. Both rate and time dimensions can be changed to affect the cost picture of equipment used in the production of potatoes. While it is not within the limits of the present study to examine and quantify the significance of all these factors, this does illustrate the type of information that producers need in order to evaluate the alternatives that are currently present in the production and marketing of potatoes. Furthermore, it also points up the complex framework within which decisions must be made.

II. SAMPLING TECHNIQUES

There are numerous methods of selecting information to study a specific subject. These range from the case study method to the study of the total population. In the study

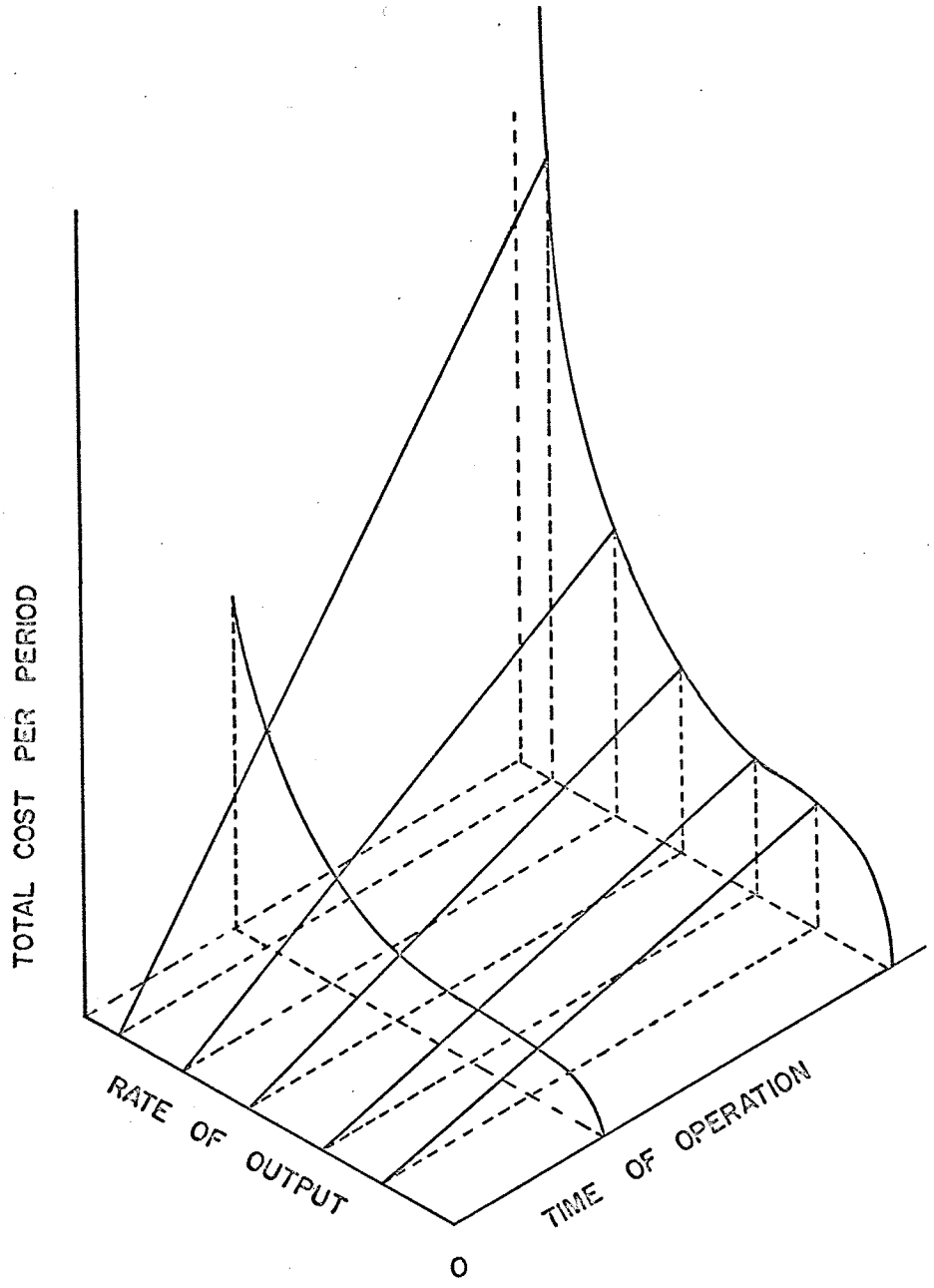

FIGURE 7

TOTAL COST AS AFFECTED BY TIME
AND RATE DIMENSIONS

SOURCE: B. C. French, L. L. Sammet, and R. G. Bressler, "Economic Efficiency in Plant Operations With Special Reference to Marketing Pears," Hilgardia, Vol. XXIV, No.19 (July, 1956), p. 568.

under consideration, information was collected from a portion of the total population. The application of sampling theory in selecting the portion, or sample of the population to be studied, assists in selecting a sample which is representative of the population, and of the size necessary to provide the desired degree of confidence in the information collected. The application of sampling theory to select the desired size of sample, in view of the degree of confidence required, depends upon a knowledge of the variability existing in the population. Where the variability is unknown and cannot be estimated, some other method must be used to determine the size of sample selected. However, once the sample is selected and the information is analyzed, the degree of confidence which exists in the data can be estimated.

In selecting the sample, it may be sufficient to obtain a listing of the total population and select the individuals to be studied on a random basis. However, there are numerous variations to the straight random sampling technique which may improve the selection of the sample for the purpose of a specific study. One of these is the stratified random sample.[7] This is accomplished by dividing the total population into two or more groups according to some

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[7]George W. Snedecor and William G. Cochrane, Statistical Methods (6th ed., Ames, Iowa: Iowa State University Press), p. 524.

particular characteristic, and then selecting a sample at random from each of the stratifications. This technique will assure that representatives of the characteristic which forms the basis of the stratification will be available for study, even though some strata may have very limited population. In this study, the stratified random sampling technique was employed in the selection of the sample. This was done because of the importance of the relatively few growers in the largest size range, and the relative lack of importance of the large population of growers in the smallest size range, considering the contribution of these groups of growers to the industry.

CHAPTER V

RESOURCE REQUIREMENTS AND PRACTICES FOR POTATO PRODUCTION AND MARKETING

The production of potatoes in Manitoba has taken place for many years. The resource combination used in the production of this crop varied considerably. This resulted in a wide variation of production practices.

I. RESOURCE REQUIREMENTS FOR POTATO PRODUCTION AND MARKETING

In the survey, potatoes were produced on a wide variety of soils. The plant prefers a well-drained, friable soil with adequate fertility. Potatoes are tolerant to low levels of salts in the soil[1] and can be produced on soil slightly alkaline to acid in reaction. In recent years, with the increase in the size of enterprize and mechanization of production practices, greater importance has been placed on soils which are free of stones and have suitable textures. With increased knowledge of the yield response to chemical fertilizers and the technique of soil testing, there has been concern over the quantities of the three major nutrients

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[1]University of Manitoba, Faculty of Agriculture and Home Economics, Principles and Practices of Commercial Farming (Winnipeg: University of Manitoba, 1968), p. 48.

available directly from the soil.

The texture of soils used in the production of potatoes ranged from sands, such as the Stockton and Almasippi associations, to clays, such as the Red River and Fort Garry associations. Potatoes were being produced on stone-free soils, such as the Wellwood association, and stoney soils, such as the Semple association. It must be realized that although the crop was grown on a wide range of soil textures, the greatest portion of production took place on soils of a texture favourable for the mechanical harvest of the crop. This was substantiated by the fact that only 10.3 percent of the 10,716 acres surveyed was planted on fine textured soils. This 10.3 percent of the total acreage was produced by 49.2 percent of the growers in the survey.[2] There has been a genuine concern on the part of growers that a moderately coarse textured soil would not have sufficient supplies of moisture to produce a satisfactory yield of potatoes unless precipitation was very favourable, both in terms of quantity and frequency. Observations and experiences related by growers indicated that the ability of these soils to sustain growth was sufficient to produce as high a yield as the soils of slightly finer texture, in the majority of recent years, as long as fertility levels were adequate.

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[2]Appendix C, Table XVII.

This tends to be substantiated by the fact that the amount of available water to a depth of four feet for moderately coarse textured soils, is not greatly different from that of moderately fine textured soils.[3]

Labour was another major resource required for the production and market preparation of potatoes. Recent developments in equipment for handling, seed cutting, cultivation, harvesting, grading, and hauling have reduced the man hours of labour considerably, but it is still a significant input. In addition, there were periods in the production season when labour requirements were greater than others. For example, cutting and planting requirements varied from 7.44 man hours per acre to 1.10 man hours per acre for Groups I and V, respectively. These operations were generally completed in less than fifteen days. Labour requirements for harvest operations varied from 32.04 man hours per acre, to 7.46 man hours per acre for Groups I and V, respectively. Harvesting for the storage portion of the crop was usually completed within thirty days. Summer operations, which included cultivation, hilling, hoeing, and spraying, required 9.85 man hours per acre to .84 man hours per acre.[4] These operations were carried out over the time period from the

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[3]University of Manitoba, op. cit., p. 50.

[4]Appendix C, Table XXXVI.

last part of May to the middle of September. Figure 8 illustrates these aspects of labour use in detail.

The range of labour required for production from Group I to Group V was 51.2 to 10.4 per acre, respectively. Of these requirements, family labour made up 53 percent in Group I and 0.7 percent in Group V. The proportion of family labour hours to hired labour hours changed significantly as size changed. With an increase in size and the associated increase in mechanization, average family labour hours dropped from 27.0 to 0.7 hours per acre for Group I to Group V, respectively. Hired labour hours followed a similar trend, but the decrease in hours per acre was not as great. Group I hired 24.2 hours per acre while Group V hired 9.6 hours per acre.[5]

A considerable amount of labour was required for grading, loading and hauling of table stock potatoes to market. Grading and loading required from .163 to .103 man hours per seventy-five pound bag for Groups A and C, respectively. Transportation to market required from .202 to .116 man hours per seventy-five pound bag for the same groups.[6]

In addition to using different quantities of labour, various levels of skill and responsibility were required within any given grower's enterprize. For example, the skill

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[5] Ibid. [6] Appendix C, Table XXVII.

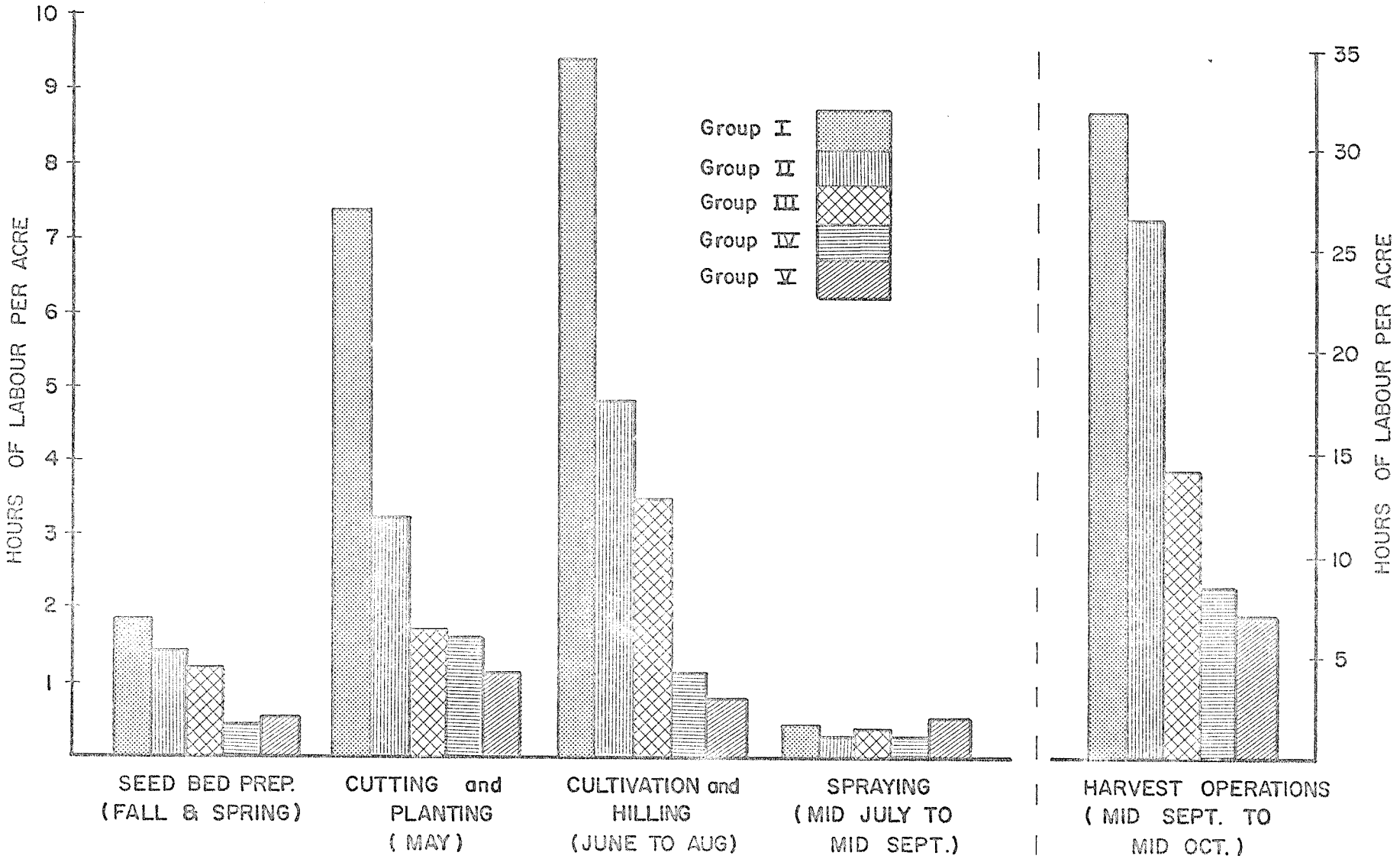

FIGURE 8

QUANTITY AND DISTRIBUTION OF LABOUR DURING THE PRODUCTION SEASON

SOURCE: Appendix C, Table XXXVI.

and responsibility required to drive a truck loaded with potatoes on the highway and in city traffic is greater than that required to pick potatoes from the field or trash from the harvester.

Potato production required outlays of capital which contributed significantly to the total cost of production. For the purposes of this study, these requirements have been divided into three categories. They are: long-term, intermediate-term, and cash operating or short-term capital. Rates of interest charged in this study for the three types of capital are 6, 8 and 8 percent, respectively.

Capital outlays in the long term category normally include such items as storage structures and land. Original investment in storage structures ranged from $1.08 to $0.52 per seventy-five pound bag for Groups A and C, respectively.[7] These facilities were of various types depending on the accepted techniques of storage construction at the time the structure was built. Structures which were nine or more years old were frequently of the underground or semi-underground design. Materials used in the construction of these types of storage were frequently concrete for the below ground portion of the building, and lumber for the above ground section. Storages built in more recent years were usually of the above

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[7]Appendix C, Table XL.

ground design with a wood frame covered with sheet metal or wood placed on a concrete foundation and floor. Frequently, the storage had equipment installed for circulation of air around the potatoes or through the potatoes. Some structures utilized the combination of these two systems to control temperature and humidity within the pile.

Actual investment in land was not obtained from growers in the survey. Factors considered in deciding not to collect this information were: first, the prior knowledge that a significant portion of land planted to potatoes was rented on a cash rental arrangement and, second, that the value of some land used to produce potatoes did not reflect the agricultural potential of the land, but rather its real estate value. It is argued that costs directly associated with land values that reflect real estate prices rather than agricultural productivity should not be charged to the potato enterprize. The study revealed that of the total potato acreage in the survey, 68 percent was planted on rented land and this ranged from 8 percent in Group I, to 79 percent in Group II.[8] As a result of using actual and estimated rental charges for land utilized by the potato enterprize, and because most of the rental arrangements were for one year, the cost of land was analysed on a short-term

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[8]Appendix C, Table XVIII.

capital requirement rather than a long-term capital requirement.

Intermediate-term capital was used to purchase equipment needed in the production, storage, and marketing of potatoes. It has been indicated in Chapter IV, page 44, that some of the equipment used in the potato enterprize was also used for other enterprizes. The allocation of capital requirements and costs for equipment which was not specific to the potato enterprize was made on the basis of the grower's estimate of the percentage of actual use of the equipment which potatoes required.

Investment in equipment for which a potato enterprize must compensate varied between groups of growers studied, and between individual growers in each group. This variation stemed partly from the decision of producers to purchase a high proportion of new or nearly new equipment, while others tended to purchase used machinery. Growers who chose the first alternative tended to incur a higher depreciation and interest charge, and a lower repair cost than growers who purchased used equipment. Another factor contributing to the variability of investment was the type of equipment purchased. The most striking example of this was illustrated by considering the purchase of a new potato harvester for approximately $10,000.00, versus the purchase of a new two-row potato digger for $1,600.00. Actual variation among individual

growers in per acre investment in production equipment was $11.32 to $193.64. Although the individual variation was high, the variation in the weighted average investment per acre for groups was only $71.62 to $81.12.[9] Investment in market preparation equipment ranged from $0.20 to $0.40 per seventy-five pound bag.[10]

Short-term operating capital is required each year to purchase the supplies and services necessary to carry out activities of production and marketing. Such items as fuel, fertilizer, seed, chemicals, hired labour, repairs, and containers were typical expenditures which require short-term capital. The time period for which funds were actually tied up in the enterprize extended from a month or less up to one year. Examples of these extremes were some types of labour expenditures on one hand, and land rental on the other. The range of short-term capital required for production in the study was from $137.11 to $96.93 per acre for Group I and Group IV, respectively.[11] It was assumed that these funds were tied up within the business for six months on the average. The range of short-term capital required for storage and marketing of the crop was from $0.504 to $0.341 per seventy-five pound bag for Group A and B, respectively,

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[9]Appendix C, Table XXXVIII. [10]Appendix C, Table XL.

[11]Appendix C, Table XXXIX.

and it was assumed that operating capital for storage and marketing was tied up for an average of three months.[12]

II. GENERAL PRACTICES IN THE PRODUCTION AND MARKETING OF POTATOES

Methods used by growers in the production and marketing of potatoes tended to be quite variable. Some producers sought out the recommended procedures and practices and followed them quite closely, while others used methods and materials no longer recommended. In some instances, the larger producers followed the recommended practices more closely than did smaller producers, while in other cases acceptance of a particular practice or method was quite uniform for all size groups.

Production Practices

Most growers chose a rotation of three or more years when planting potatoes on their own land.[13] Some producers definitely considered that potatoes should not follow sugar beets, flax, or sunflowers. Of the total potato acreage surveyed, 97.8 percent was planted on cereal stubble, 0.3 percent on vegetable crop land, 0.4 percent on summerfallow, 1.2 percent on potato land, and 0.3 percent on sugar

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[12]Appendix C, Table XLI. [13]Appendix C, Table XX.

beets, flax, or sunflower land from the previous year.[14]

Fall tillage practices used in preparation for spring planting varied considerably. Of the growers surveyed, 65 percent cultivated, 18.3 percent plowed, and 10.0 percent used other methods in the fall. The remaining 6.7 percent did no fall tillage. In the spring, 86.7 percent of the growers in the survey cultivated, 3.3 percent plowed and 5 percent used other methods prior to planting. The remaining 5 percent did not till the soil prior to planting.[15] Of the sixty growers surveyed, fifty-four or 90 percent applied chemical fertilizers to their potatoes. Of these fifty-four growers, thirty were located on light soil and twenty-nine on heavy soil. One grower had potatoes on both categories of soil. Nitrogen and phosphorus were applied by all of the fifty-four growers while twenty-seven included potassium in the fertilizer application. Of the growers applying potassium, twenty-three were on light soils.[16]

Practices followed by producers in the cutting and treating of seed showed considerable variation. Some producers planted whole seed but the majority cut the tubers; some cut by hand, but the majority used machines; some did not treat their seed while others used a dry treating system

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[14]Appendix C, Table XIX. [15]Appendix C, Table XXI.

[16]Appendix C, Table XXII.

or a wet dip system; some growers were handling seed in bulk, other growers in bags.[17]

Tubers used to plant the crop came from two general sources. These were potatoes which had passed the standards of a certification program and potatoes which were one or more years removed from a seed certification scheme. The survey revealed that both types of potatoes were used to plant the potato crop, although one group of producers planted only potatoes from a registered source. Of the twenty-six growers not using 100 percent registered seed, nineteen purchased some registered stocks in the spring for planting. The production from this seed plot was utilized, in some cases, as a seed source for the majority of the following year's crop. The remaining seven growers used seed which was at least one year removed from a seed certification program.[18] Of all the seed planted, 85,495 hundredweight (93.3 percent),[19] was from registered seed sources. The remaining 6,187 hundredweight (6.7 percent), was at least one year removed from registered seed.[20]

Actual placement of the potato sets in the soil was

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[17]Appendix C, Table XXV. [18]Appendix C, Table XXIV.

[19]Figures in parenthesis refer to percentage of the sample population.

[20]Appendix C, Table XXIII.

accomplished in all cases by a picker type potato planter. Although the general principle of operation of the planting mechanism was the same for all planters in the study, improvements in design have been made in recent years. Growers in this survey used one, two and four-row planters. There were four one-row, thirty-two two-row, and twenty-eight four-row planters in the study. Group I averaged 4.8 acres of potatoes per row of planting unit, and Group V averaged 119 acres per row of planting unit.[21]

Potatoes are an inter-tilled crop and several methods or combinations of methods were used to control weed growth. In addition to controlling weed growth, ridging or hilling of soil along both sides of each row was practiced by the growers. Although there were differences in equipment used by individual growers, basically there were three methods of tillage practiced. Most growers combined more than one of these techniques in a weed control and hilling program. The techniques were harrowing or mulching, cultivating, and hoeing. The number of cultivations per season per grower remained quite constant for all groups with an average of 4.1 operations. Harrowing and hoeing followed trends. The smallest sized group harrowed only 0.07 times per grower and hoed 0.73 times per grower. The largest sized group harrow-

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[21]Appendix C, Table XXVI.

ed on an average of 3.0 times per grower and hoed .01 times per grower.[22]

Potatoes are subject to several insect and disease problems during the growing season which are normally controlled by applications of insecticides and fungicides as a spray or dust. Insecticides were used to a greater extent than fungicides and, in most cases, the larger sized groups employed these materials more frequently. Group V applied fungicides on an average of 3.1 times, and Group I made applications 0.4 times per season per grower. Group V and Group I applied insecticides on an average of 2.9 and 1.7 times, respectively.[23]

Techniques used in harvesting and handling potatoes for storage differed markedly. During the past decade, numerous developments took place in harvesting and handling equipment which increased the capital investment and reduced the labour required to harvest the crop. These developments took place in stages with a result that even within a given size range of growers, there was frequently more than one technique or method being utilized to harvest the crop.

In the survey there were three techniques used to prepare potatoes for harvest. They were: chemical vine

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[22]Appendix C, Table XXVII. [23]Appendix C, Table XXVIII.

killing, rotobeating, and no preparation. Only one grower combined vine killing with rotobeating in preparation for harvest. Of all the growers surveyed, five used vine killers on part of their acreage in combination with no preparation on the remainder. Forty-five growers rotobeat the vines and nine did not treat any of the vines mechanically or chemically.[24]

There are five basic methods of harvesting potatoes. These can be described as follows:

1. Digger, hand picking and sacks. With this method the potatoes are lifted with a potato digger and placed on the top of the ground. Labourers follow and pick up the tubers, putting them into picking containers and then dumping the potatoes from these containers into sacks. The sacks are later loaded onto trailers or trucks and hauled to the storage where the sacks are unloaded and emptied.
2. Digger, hand picking and bulk boxes. This method is similar to number one except that potatoes are dumped from the picking containers into bulk boxes mounted on trucks or trailers. The tubers are then taken directly to storage to be mechanically unloaded.
3. Indirect harvesting. The potatoes are lifted by a wind-

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[24]Appendix C, Table XXIX.

rower, or modified digger and placed on the surface of the ground. A second machine, usually a one-row potato harvester, follows. It picks up the tubers and conveys them into a potato bulk box for delivery to storage.

4. Direct harvesting. Potatoes are lifted, one or two rows at a time, and conveyed directly into a potato bulk box by the harvesting machine. They are then delivered to storage.

5. Direct-indirect harvesting. Two or four rows of potatoes are lifted by a windrower and placed between two undug rows. The harvester follows, lifting the two undug rows along with the two or four dug rows, and conveys the tubers into a bulk potato box for delivery to storage.

Growers surveyed used methods one, two, four and five. The most popular was four and was used by twenty-five growers (41.7 percent). This was followed closely by method one which was used by twenty-one growers (35 percent). Method two was used by eleven (18.3 percent), and method five by three growers (5 percent).[25]

Comparison of number of machines and acreage harvested per row of digging equipment for harvesters, harvester-windrower combinations, and diggers, is also of interest. The growers in the survey used ten one-row diggers, twenty-

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[25]Appendix C, Table XXX.

one two-row diggers, thirty-five two-row harvesters, one one-row harvester, and three two-row harvester-windrower combinations. Where harvesters or harvester-windrower combinations were used, 114.7 acres per row of digging equipment were lifted. Where diggers were used, 18.6 acres per row of digging equipment were lifted.[26]

Potatoes were placed into storage by two methods. The first simply consisted of emptying sacks into a bulk pile within the storage. The second consisted of emptying sacks onto a conveyor or bin piler, or unloading a potato bulk box into the bin piler which then conveyed the tubers onto the pile. Of the growers surveyed, thirty (69.8 percent), used mechanized piling methods, while thirteen (30.2 percent), unloaded the potatoes manually.[27]

Storage and Marketing Practices

The series of operations from land preparation through placement of the potatoes into storage consisted of production practices. Until this point in the study, all growers surveyed carried out a series of operations on a per acre basis. However, when potatoes were placed into storage, operations no longer centered around acres as a base, but rather a unit of volume such as the seventy-five pound bag.

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[26]Appendix C, Table XXXI. [27]Appendix C, Table XXXII.

In addition, the purpose for which the potato crop was produced now becomes very important in determining the practices carried out in the storage, grading, and delivery of the potatoes. As a result of these differences, and because of the limitations of the study, the discussion of practices followed in this second phase will be limited to those growers who produced potatoes for the seed and table stock markets as outlined in Chapter I, page 15.

Most potatoes were stored in semi-underground or underground type, and the above ground type of storage structure. In addition to these structures, potatoes grown by some producers in Group I were stored in house basements. In terms of the number of growers in this survey who produced table stock and seed potatoes, seven (16.2 percent), used house basements, eighteen (41.9 percent), used underground or semi-underground storages, and eighteen (41.9 percent), used above ground structures for storage of potatoes.[28]

Growers surveyed employed several techniques for grading and hauling of potatoes to market. Of the growers surveyed, fourteen (32.6 percent), graded their product by hand. These growers were in the two smallest sized groups. The largest quantity of potatoes graded for market by hand was 5,632 seventy-five pound bags. There were twenty-five

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[28]Appendix C, Table XXXIII.

growers (58.1 percent), grading on a dry basis with the aid of a machine. The smallest quantity graded in this manner was 700 bags. The remaining four growers (9.3 percent), washed their potatoes in the grading process. Of the total volume in the survey, 25,476 bags (4.9 percent), were dry graded by hand, 297,011 bags (57.0 percent), were dry graded by machine, and 198,400 bags (38.1 percent) were washed.[29]

Equipment which the grower had available for transport of his produce for market is also of importance. Some growers utilized an insulated van while others used only an open box with blankets and tarpaulins to provide insulation for the potatoes during cold weather. This second procedure does increase the risk of damage by frost while in transit, and in severely cold weather prevents producers from delivering potatoes. In the survey, twenty-nine (70.7 percent), of the growers were delivering potatoes in open trucks. This represented 47,773 bags (10.1 percent), of the total amount of potatoes delivered.[30]

The above discussion of resource requirements and cultural practices provides information for the analysis of costs. Chapter VI presents the methods and analysis of production and market preparation costs.

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[29]Appendix C, Table XXXIV. [30]Appendix C, Table XXXV.

CHAPTER VI

ANALYSIS OF COSTS

Two of the objectives of this study are to determine the costs associated with the production of potatoes and costs associated with preparation and transport of potatoes to market. This chapter outlines the methods of analysis used and determines these costs.

I. METHODS OF COST CALCULATION

Numerous methods have been used to analyse costs associated with production. Costs of a multi-period nature present special problems in the selection of specific methods for analyzing these outlays.

Fixed Costs

Fixed costs have been considered in a theoretical sense above.[1] Included in these costs are such items as depreciation allowances, interest charges, insurance, and tax costs.

Depreciation allowances. The most commonly used techniques of calculating depreciation allowances are the straight line and the reducing balance methods. The first of

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[1]Chapter IV, p. 46.

these carries implicit assumptions which are important to the analysis of equipment in the present study. The most significant of these assumptions is that the equipment, for which depreciation is calculated, is kept by the owner until it is completely worn out, or that the trade-in value of the equipment is directly proportional to age. Data collected indicated that potato growers did not, in many instances, keep equipment they purchased until fully worn out or obsolete. In addition, the market value of equipment for several significant items was reduced by a higher percentage of the total value in the first year than in later years. A second assumption which must be accepted in using the straight line method is that, at a specific age, a particular piece of equipment has only salvage value remaining. This assumption appears to be reasonably valid when wear-out life is reached prior to obsolescence, and when the point of obsolescence can be determined and is reasonably consistent for similar types of equipment. However, where obsolescence is not easily determined or consistent, the selection of a particular point in time to discontinue charging depreciation may be unrealistic. As a result of the above considerations, it was decided not to use the straight line method of determining the depreciation for equipment.

One alternate system is the reducing balance method. The calculation of depreciation charges by this method con-

sists of taking, on an annual basis, a percentage of the remaining value of the equipment. This system facilitates a decreasing allowance for depreciation as the age of the equipment increases and also allows for a small depreciation allowance when the equipment is quite old. This approximates more closely the decline in market value of equipment relative to age, as compared to the straight line method which depreciates from purchase price to estimated salvage value by a fixed depreciation charge each year, and makes no allowance for depreciation for years which follow should the equipment remain in use. However, the reducing balance method, using a fixed percentage charge each year, does not allow for a high rate of depreciation for the first year or two, to be followed by a more gradual annual decline in value as is reflected in market value. In the current study, a modification of the reducing balance method was employed whereby the percentage figure used in the calculation of depreciation is changed, depending on the years which have passed since the equipment was new. This method was used by Young[2] in calculating depreciation allowances for trucks. In the study, truck dealers were contacted to assist in

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[2]K. B. Young, An Analysis of the Costs of Assembling Grain by Farm Trucks in Manitoba, Research Report Number 11 (Winnipeg: University of Manitoba, Faculty of Agriculture and Home Economics, Department of Agricultural Economics and Farm Management, 1966), p. 113.

estimating current market values for trucks which were of various sizes and ages. In addition, there were several trucks in the survey conducted by Young that had been purchased just prior to the survey which figures on actual transactions. This information served as a base to calculate depreciation charges for trucks and was the equivalent of 30 percent for the first year on new trucks, 20 percent on trucks which were one or two years old, and 15 percent in subsequent years. The depreciation fund established in this manner approximates the amount of money needed to purchase a new replacement at any given time. This modification was used for several types of equipment for which the rate of depreciation on the first year or so was greater than the rate of depreciation in subsequent years.[3] The simple depreciating balance method was used for the remainder of equipment in the study.

The term "age", as used above, has two distinct connotations. Useful life of equipment is affected by several factors. Two of these factors are wear associated with use, and obsolescence associated with time. Use is normally expressed in terms of hours worked; obsolescence in years. Where annual use of a machine is such that wear-out life is

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[3]The establishment of depreciation rates for equipment was done in consultation with growers, equipment supply firms, and agricultural engineers.

reached prior to obsolescence, obsolescence need not be considered in determining depreciation rate. However, should obsolescence occur prior to the end of wear-out life, then obsolescence must be the base of determining depreciation charges.

In this study, data collected revealed that very few machines were used sufficiently to reach estimated total wear-out life hours prior to estimated obsolescence. As a result, it was not necessary to consider wear-out life as a base in calculating depreciation charges. Obsolescence was the major factor which was considered in the determination of depreciation schedules in this study. Some machines which were used in the production of potatoes, at the time of the survey, would normally be considered obsolete. This was particularly true of the smaller enterprizes and this would tend to indicate that, although the market value of a machine declines as the years go by, obsolescence, when thought of as being synonomous with no longer useful, is not easily determined in a precise manner.

In addition to selecting a suitable percentage of market value for a given piece of equipment with which to calculate depreciation, there were numerous instances where a machine was used in other enterprizes in addition to the production of potatoes. Some machines were used by more than one production unit. Data collected on equipment included

the percentage of total useage which the potato enterprize required and the share which the firm had in the machine. As a result, the following formula was used to calculate depreciation charges for equipment employed in the potato enterprize:

$$D_e = P_m(C_d)(U)(S)$$

where D_e = depreciation charge allocated to the potato enterprize in 1968,

P_m = market price at the beginning of 1968,

C_d = depreciation rate applicable to the type and years of age of the equipment,

U = portion of annual use that is charged against potatoes, and

S = portion of the machine which is owned by the firm.

As mentioned above, "U" and "S" were determined by the survey. The depreciation rate, "C_d" changes depending on the type of equipment analyzed. Table VII lists types of equipment, wear-out life, and depreciation rate as a percent of market price for different time periods for machinery found in the survey.

TABLE VII

TYPES OF EQUIPMENT, WEAR-OUT LIFE IN HOURS, AND DEPRECIATION RATE AS A PERCENTAGE OF MARKET VALUE

Equipment Type	Estimated Wear-out Life In Hours	Depreciation Rate as a Precentage of Market Price in Year			
		One	Two	Three	Four and Over
Tractors	12,000	20	15	15	15
Harvesters, Windrowers, Diggers	2,500	25	20	20	20
Toppers	2,000	20	20	20	20
Planter	1,000	20	20	20	20
Seed Cutter, Conveyors	1,000	20	20	20	20
Tillage Equipment	2,500	15	15	15	15
Fertilizer Box	1,200	20	20	20	20
Piler, Sack Loader, Bulk Loader	3,000	15	15	15	15
Grader, Washer, Brusher	7,000	15	15	15	15
Pallet Mover, Box Dumper, Scale, Van Heaters	7,000	15	15	15	15
Trucks	2,000	30	20	20	15
Sprayer	2,000	20	20	20	20
Bulk Boxes	6,000	10	10	10	10
Vans	6,000	10	10	10	10

SOURCE: The American Society of Agricultural Engineers, Agricultural Engineers Yearbook (St. Joseph, Michigan: American Society of Agricultural Engineers, 1966), p. 256; correspondence with equipment suppliers and others in the industry.

With the information provided in Table VII, relationships which depicted current per dollar value of original investment in new equipment could be calculated.[4] This current dollar value, or market price, was used to determine depreciation costs.

Depreciation charges on potato storage structures are somewhat different from those on machinery and equipment. Storage structures are not normally moveable to another location and thus are fixed to the spot on which they are built. Although they could be used for other purposes, such as machinery or grain storage, the type of structure required to store potatoes makes the building relatively expensive for uses of this nature. Potato storages are normally used in connection with the potato enterprize and other uses are incidental. Storage structures have a fairly long life and the results of the survey indicated an average estimated life of just over twenty-one years. Other studies have used, at least in part, a twenty year life in the calculation of depreciation charges.[5] In view of the above factors,

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[4]Appendix E, Table XLIII.

[5]Emmanual Newton Afful, "A Study of Primary Marketing Costs for Manitoba Potatoes" (unpublished Master's Thesis, The University of Manitoba, Winnipeg, 1960), p. 47; Susheel Chandra Chowdhury, "Determination of the Optimum Location of Grading and Packaging of Manitoba Potatoes" (unpublished Master's Thesis, The University of Manitoba, Winnipeg, 1963), p. 15.

depreciation on storage structures is calculated by the following formula:

$$D_s = \frac{V}{20}$$

where D_s = annual depreciation charge on storage structures,

V = original cost of the storage.

Interest Charges. As with depreciation, there is more than one method of determining the charge to be included as interest on investment in equipment. Where it is acceptable to utilize the straight line method of depreciation, an interest charge based on average value of equipment over its lifetime is also acceptable. However, where equipment is not kept for its total useful life and where market value drops at a decreasing rate, some other method should be used. In view of this, interest charges in this study were based on estimated market values calculated from Table XLII.[6] The interest rate charged on equipment was 8 percent.[7] Therefore, the following formula was used to calculate interest charges for equipment used in the potato enterprize:

$$I_e = (P_m)(I_i)(U)(S)$$

where I_e = annual interest charge on equipment allocated to potatoes,

P_m = market price of equipment in 1968,

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[6]Appendix E, Table XLIII. [7]Chapter V, p. 62.

I_i = interest rate for intermediate-term investment,

U = portion of annual use charged against potatoes, and

S = portion of the machine which is owned by the firm.

A charge for interest on investment in storage structures must also be calculated and the method used was based on the average investment in the structure over the life span of the building. Thus, the interest charge was a fixed amount per year as is the depreciation charge. Interest on storage structures was calculated by the following formula:

$$I_s = \frac{V}{2} (I_{rl})$$

where I_s = interest charge on storage structure,

V = original cost of storage, and

I_{rl} = interest rate for long-term investment.

Insurance and Taxes. With the exception of trucks, growers surveyed normally did not insure the machinery used in the potato enterprize. Most producers carried insurance on storage structures and some growers insured the contents of the storage. Separation of insurance into production and marketing cost was impractical and, as a result, this cost was treated as general overhead.

In Manitoba, there are no taxes on equipment or buildings, and because land costs were analysed in the form of rent, it was not necessary to include taxes on land as an expense.

Variable and Semi-Variable Costs

The concept of semi-variable costs was outlined in Chapter IV, page 46. In addition, an example was presented of this concept as it applied to potato production. For purposes of the study, variable and semi-variable costs are combined in the analysis and presented as variable costs. This is done because quantification of semi-variable costs, as distinct from variable costs which are incurred in potato production, is beyond the scope of the study.

For the most part, variable costs, as outlined above, were easily quantified in the analysis of the potato enterprize. Such items as chemicals, fertilizer, labour, and fuel were not considered to be of a multi-period nature. Perhaps it could be argued that in the production of potatoes, the fertilizer applied has an effect on the following crop. Although this may be true and significant, there was no practical method of quantifying any effects of this nature. These effects were not analysed in the study. As a result, costs associated with production inputs were treated as being directly related to the production of potatoes and were charged against the potato crop.

Although the cost of fuel and oil incurred in the production of potatoes was not of a multi-period nature, growers generally did not have separate accounts for these inputs and detailed accounts of fuel used for this enterprize were not

available. As a result, a method was needed for estimating the costs of these inputs.[8]

The following formula was used to determine the quantity of gasoline and diesel fuel used in tractors:

$$G_g = 0.0543 \text{ (max. P.T.O. H.P.) (HO) (U) (S)}$$

$$G_d = 0.0366 \text{ (max. P.T.O. H.P.) (HO) (U) (S)}$$

where G_g = gallons of gasoline per hour,

G_d = gallons of diesel fuel per hour,

Max. P.T.O. H.P. = maximum horsepower rating at the power-take-off based on the Nebraska tests,

HO = hours of operation,

U = portion of annual use charged against potatoes, and

S = portion of the machine which is owned by the firm.

Cost of fuel and oil for tractors is calculated by the following formula:

$$C = 1.15(G)(P)$$

where C = cost of fuel and lubrication per hour,

G = gallons of gasoline (diesel fuel), and

P = price of gasoline (diesel fuel).

These calculations were based on the assumptions that tractors in the study, on the average, worked at a rate equivalent to the varying power outlet test for the Nebraska

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[8]The American Society of Agricultural Engineers, Agricultural Engineers Yearbook (St. Joseph, Michigan: American Society of Agricultural Engineers, 1963), p. 228.

tests, lubrication costs were 15 percent of fuel costs,[9] and that the price of gasoline was .249 dollars per gallon and diesel fuel was .215 dollars per gallon.[10]

Costs of gasoline for trucks used in the potato enterprize involved the use of this equipment over many types of conditions. For example, a truck followed the potato harvester as the potatoes are being dug. In some instances, the same truck was used to haul potatoes to market on paved highways. Specific information on gasoline consumption for trucks used in the potato enterprize was not obtained. However, fuel costs for trucks hauling sugar beets were part of a cost of production study on that crop and, because there are many similarities between hauling sugar beets and potatoes, fuel costs associated with potato production were based on information from the sugar beet study.[11] It was estimated that trucks used in the potato enterprize averaged 6.3 miles per gallon while hauling materials on roads in connection with potato production. In addition, the number of gallons required for following a potato harvester were estimated by multiplying

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[9] Ibid.

[10] University of Manitoba, Faculty of Agriculture and Home Economics, Principles and Practices of Commercial Farming (Winnipeg: University of Manitoba, 1968), p. 407.

[11] A study of the costs of sugar beet production undertaken by Department of Agricultural Economics and Farm Management, University of Manitoba, unpublished.

2.74[12] by the total hours of harvest operation. The sum of these two figures is the estimated number of gallons of gasoline required by trucks for potato production. The cost is obtained by multiplying the gallons used by the cost of fuel per gallon.

Therefore, the formula for calculating fuel consumption of trucks is as follows:

$$G_{pd} = HOH(2.74) + \frac{M_d + M_s + M_f + M_w}{6.3}$$

and

$$G_m = M_m/6.3$$

where G_{pd} = gallons of gasoline used in production of potatoes,

G_m = gallons of gasoline used to haul potatoes to market,

HOH = total hours of harvester operation,

M_d = total number of truck miles required to deliver potatoes to storage,

M_s = total number of truck miles required to deliver seed,

M_f = total number of truck miles required to deliver fertilizer,

M_w = total number of truck miles required to deliver water for spraying, and

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[12]Estimated gasoline consumption per hour by trucks.

M_m = total number of truck miles required to deliver potatoes to market.

Repairs are normally considered as variable costs and, in the majority of cases, equipment repair costs are negligible when production ceases. However, it must be recognized that simply collecting information on all repair costs for a particular period may not provide a realistic estimate of average repair costs. This results from the multi-period nature of some types of repairs. For example, if a grower's truck or tractor requires a major overhaul on the engine, it is unrealistic to charge the full cost of this work to the current year's expenses, unless such a repair is of an annual nature.

In addition to the multi-period nature of some repairs, they are directly related to use of the machine. That is, a machine which is used only a few hours per year will have lower repair costs as compared to a similar machine which is used many hours per year. Repairs are a function of use rather than a function of time.

This was typical of repair costs in the production of potatoes. Information gathered on repair costs during the survey showed extreme variability, and in some instances it was evident that producers did not attempt to keep separate records of repairs required for the potato enterprize. As a result, a method to estimate repair costs was needed. Some

studies have been carried out, and bulletins published which estimated the average repair costs that were incurred during the life of a machine.[13] As would be anticipated, expenses associated with repairs on new equipment are relatively low. As the hours of use increased, the cost of repairs per time period also increased. The result was a schedule which originated at zero and increased at an increasing rate. It would be expected that the slope and the curvature of the schedule would change for different types of machines. This is because maintenance costs of some machines are fairly constant while for others, costs rise significantly during the latter portion of the equipment life. The 1966 Agricultural Engineers Yearbook outlines a series of schedules from which total accumulated repair costs for numerous machines can be estimated.[14] The following was the formula used to estimate what the total accumulated repair costs would be for a tractor:

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[13]The American Society of Agricultural Engineers, Agricultural Engineers Yearbook (St. Joseph, Michigan: American Society of Agricultural Engineers, 1966), pp.255, 257; Canada Department of Agriculture, Agricultural Machinery Costs, Publication 1291 (Ottawa: Information Division, Canada Department of Agriculture, 1966), pp. 5-6.

[14]The American Scoeity of Agricultural Engineers, Agricultural Engineers Yearbook (St. Joseph, Michigan: American Society of Agricultural Engineers, 1966), pp. 255, 257.

$$T.A.R. = 0.120\% \ (X)^{1.5}$$

where T.A.R. = total accumulated repairs as a percent of manufacturers suggested retail price, and

X = total accumulated hours as a percent of lifetime hours.

Figure 9 presents this relationship and indicates that where a tractor has been operated 100 percent of its lifetime hours, the total repair costs are estimated to be 120 percent of the suggested retail price. This was based on a wear-out life of 12,000 hours.

For some equipment, particularly the specialized equipment found in the potato enterprize, there was no specific schedule provided from which to calculate repair costs. However, it was observed that the power to which the factor "X" in the function was raised changed only from 1.3 to 1.5 on the wide variety of equipment listed in the Agricultural Engineers Yearbook. In addition, repair costs, although variable, were available on these machines from the survey data. Also, equipment suppliers were contacted in this connection, and they provided additional estimates of repair cost. With the above information as background, either one of the schedules outlined in the yearbook, or an estimated schedule, was used to calculate equipment repair costs for all machinery in the study.

Since this study was concerned with repairs that occur-

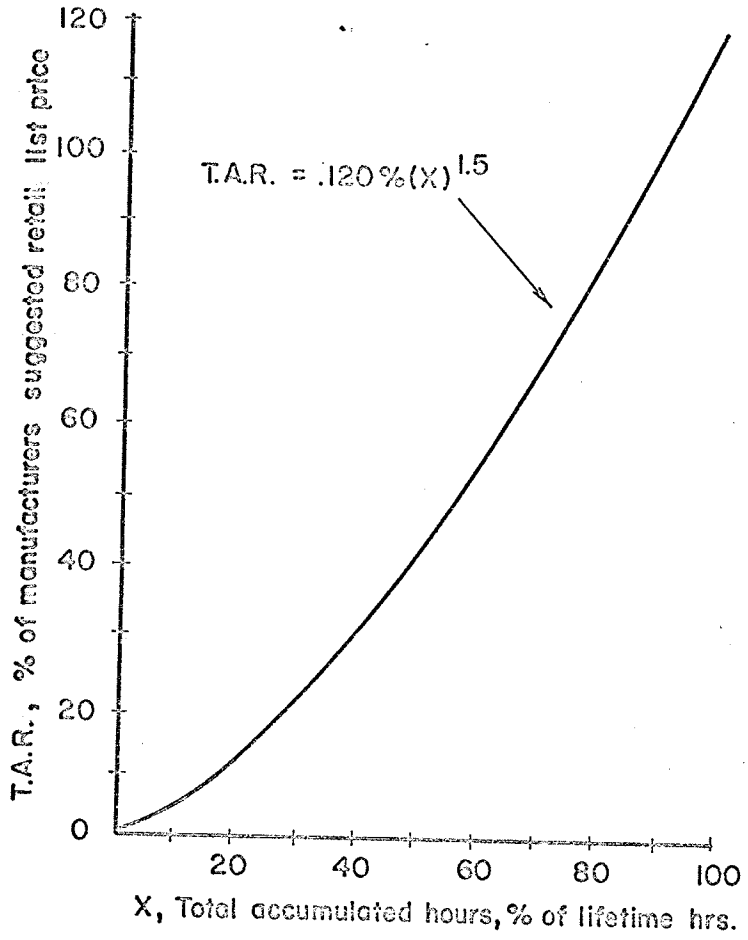

FIGURE 9

TOTAL ACCUMULATED REPAIR COSTS FOR TRACTORS

SOURCE: The American Society of Agricultural Engineers, Agricultural Engineers Yearbook (St. Joseph, Michigan: American Society of Agricultural Engineers, 1966), p. 257.

red at a specific time interval during the life of the equipment, a formula was needed which would determine the percentage of the suggested retail price of a new replacement machine that was required as a repair allowance during this time interval. This requirement led to the development of the following function;[15]

$$R = P_r\left(\frac{A}{100}\right)\left[\left(\frac{(HO)(Y)(100)}{HW}\right)^t - \left(\frac{(HO)(Y-1)(100)}{HW}\right)^t\right](U)(S)$$

where R = repair charges in dollars allocated to potatoes,

P_r = current replacement cost of the machine in dollars,

HO = hours of operation of the machine in 1968,

HW = total wear-out life of the machine in hours,

U = portion of annual use allocated to potatoes,

S = portion of the machine owned by the firm,

A and t = co-efficients which apply to the machine being analysed, and

Y = the total age of the machine in years at the end of the period for which repairs are to be determined.

In Figure 10, the line "AB" represents the percentage of suggested retail sale price of a new replacement that was required to be added to the repair fund for wear and tear which occurs from 50 percent of wear-out life to 60 percent of wear-out life. The above function calculates the dollar value

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[15]Appendix G.

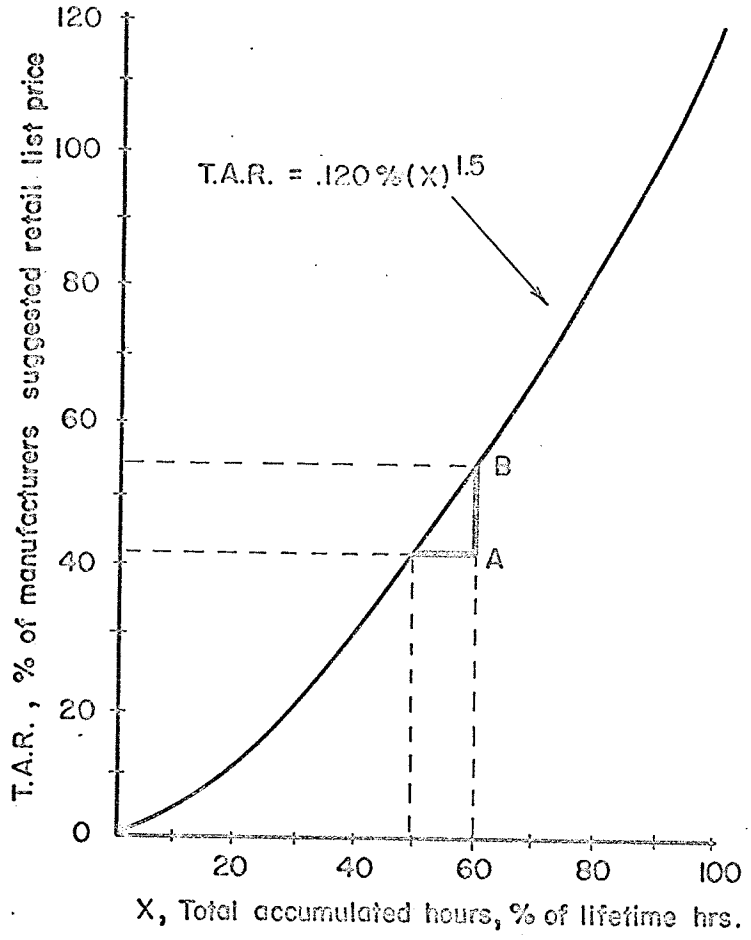

FIGURE 10

REPAIR COSTS FOR A SPECIFIC PERIOD DURING THE TOTAL LIFE-TIME OF A TRACTOR

of repairs (line "AB", Figure 10), for all equipment in the study.

The suggested retail sale price of new replacement machines was used for a specific reason. Although a machine may be several years old, and the list price of a replacement may be considerably higher than the list price of the original equipment, it is argued that repairs for the old machine are more closely related to current list prices of the same machine. Thus, repair costs would be under-estimated if the original list price was used in the calculation.

The formula which was used to calculate repairs was based on wear-out life of equipment. Since the slope of the function changes somewhat as the equipment is used, it would be helpful to know the total number of hours the equipment has been operated prior to the time period under study. This would be particularly true if use of the equipment in 1968 was different as compared to previous use. Unfortunately, producers could not provide information on which to calculate the proporation of total life that had been used at the time of the survey. As a result, it was necessary to assume that the use of the machine in the period under study was similar to previous time periods. Such an assumption could be very unrealistic if the curvature of the repair schedules was sharp. The power to which "X" is raised in the T.A.R. equation ranges from 1.3 to 1.5, and since equipment repairs

are being calculated for a single operating season, the error introduced by this assumption is not likely to be large, on the average.

As discussed earlier, the cost of short-term investment was also a factor in production of potatoes.[16] This cost was determined by the following formula:

$$I_c = (C)(I_{rs})(Y_p)$$

where I_c = interest charges allocated to the cost of variable inputs,

C = cost of variable inputs,

I_{rs} = interest rate for short-term investment, and

Y_p = portion of the year for which short-term investment is tied up, on the average.

Significance of Differences in Costs

As expected, there were differences in the cost of specific factors among the various groups of growers. In some instances, these differences were large, others were small, and still others were moderate. In view of this, a method was required to determine whether or not differences that existed were significant. The statistical technique of analysis of variance on a one-way classification with unequal number of observations in the groups was used to determine the signifi-

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[16]Chapter V, p. 65.

cance of differences that existed between factors in this study.[17] An outline of the procedure used to calculate the "F" values is given in Appendix D. The calculated value of "F" was then compared with the table value of "F" at the .05 and .01 levels of probability to determine whether or not the differences in the cost of a specific factor among the groups was due to chance or could be considered real.

Significance of Selected Inputs in Predicting Costs

It is possible that one or more of the inputs used in the production of potatoes had a functional relationship to cost which could provide a basis for estimating cost. In this study, the technique of regression analysis was used to estimate functional relationships which would be of significance in predicting total average cost of production and harvesting for "All" growers and for "non-mechanized" as well as "mechanized" growers.[18] These functional relationships will be useful to estimate costs incurred by growers not in-

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[17] Robert G. D. Steel and James H. Torrie, Principles and Procedures of Statistics With Special Reference to the Biological Sciences (Toronto: McGraw-Hill Book Company Inc., 1960), pp. 112-115.

[18] A "mechanized" grower was defined as one who harvests potatoes with a potato harvester, and a "non-mechanized" grower was defined as one who uses the hand picking method. "All" includes all growers in the survey.

cluded in the survey provided they are not used to predict costs for producers who are of a different type compared to the potato enterprizes in the survey.

II. PRODUCTION COSTS

Production costs are designated as those outlays, direct and indirect, which were associated with the production of the crop from the beginning of the production season until the potatoes were placed into the storage structure. For purposes of analysis and comparison, production costs were converted to a per acre base and to a per seventy-five pound bag base.

Fixed Costs

Fixed costs included depreciation allowances and interest on production equipment, and overhead charges. Table XIII outlines the average fixed costs and total costs for each size group analysed, and for all growers. Fixed costs, as categorized, made up 19 percent of the total average production costs.

The calculation of analysis of variance and the resulting "F" values on cost per acre and cost per seventy-five pound bag for equipment depreciation revealed that the differences between groups were not significant.[19] The same calculation

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[19]Calculated "F" values smaller than table "F" values at the .05 level are defined as not significant.

TABLE VIII

FIXED AND TOTAL COSTS OF PRODUCTION PER ACRE BY SIZE GROUP

Group No.	Equipment Depreciation	Equipment Interest	General Overhead	Interest on General Overhead	Total Fixed	Total Cost
I	$ 12.97	$ 6.49	$ 7.63	$ 0.31	$ 27.40	$ 164.20
II	11.38	5.78	4.72	0.19	22.07	136.07
III	12.50	6.11	3.87	0.15	22.63	122.18
IV	12.71	5.96	2.12	0.08	20.87	109.38
V	12.71	5.73	5.26	0.21	23.91	120.86
All	$ 12.64	$ 5.84	$ 4.22	$ 0.17	$ 22.87	$ 118.64

SOURCE: Appendix C, Table XXXVIII.

on general overhead provided a significant calculated "F" value at the .01 level. Figure 11 shows the per acre and per seventy-five pound bag means for these two factors for each group.

It was interesting to observe that production equipment depreciation charges do not change significantly among the five groups. The trend for interest on investment was very similar to that of depreciation. Growers in Groups IV and V were fully mechanized. Growers in Groups I and II, generally, did not use harvesters and some did not have seed cutting equipment. Growers in Group III utilized harvesters or diggers for lifting the crop but, in several instances, equipment used was of an older vintage resulting in a lower total investment as compared to growers in Groups IV and V. Thus, even though total investment per grower was relatively smaller for the growers with smaller acreages and equipment tended to be older, on the average, the depreciation charge on a per unit base was very similar to that of growers who were fully mechanized and who had large acreages.

However, if all groups of growers were to obtain new equipment to replace the machinery they used, the per unit investment comparison between groups would change. Investment per acre for the small group would then be significantly higher than for the larger groups.[20]

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[20]Appendix F, Table XLIII.

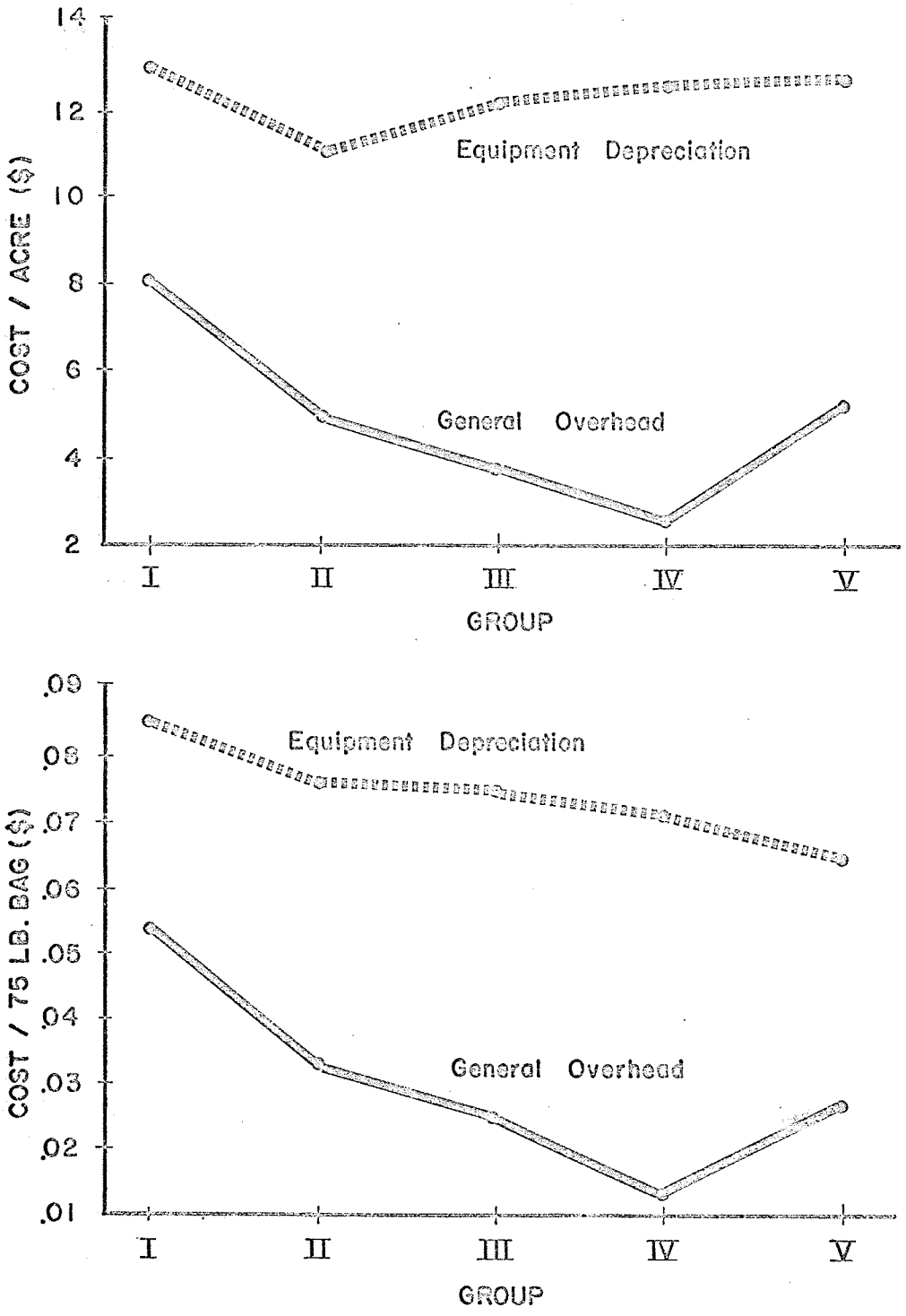


FIGURE 11

TRENDS FOR GROUP MEANS FOR GENERAL OVERHEAD, AND EQUIPMENT DEPRECIATION

SOURCE: Appendix F, Table XLIV and XLV.

General overhead presents a somewhat different picture. The per acre and per seventy-five pound bag charge tended to fall as acreage increased from Group I to Group IV. However, the charge for Group V took a sharp rise. First, the majority of growers in Group V had table stock production as well as processing production. As a result, storage facilities were required and, for example, cost of electricity for operating the storage could not, on the basis of information from the survey, be separated from other electricity costs. As a result, the electricity cost of operating storage structures is included in general overhead. In contrast, the majority of growers in Group IV did not have any table stock production and, therefore, costs of storage operation were not considered in the survey. Thus, their overhead charges were not directly comparable to Group V. Telephone costs presented the same problem as did electricity costs. A second factor involved in the apparently high overhead cost in Group V was the fact that a number of producers in this group had a higher degree of insurance coverage for the operation of their firm. This may be related, in part, to the higher proportion of labour which must be hired at all stages in the production of a large acreage of potatoes.

Variable Costs

Variable costs included such items as production equip-

ment repairs, seed fertilizer, land rental, chemicals, labour, etc. Table IX outlines these costs for each size group studied and for all growers. Average variable costs, as listed in the table, made up 81 percent of production costs.

Calculation of "F" values on cost per acre and per seventy-five pound bag for the various factors which made up average variable costs showed that the differences among the groups for fertilizer, chemicals, labour, fuel, and oil were significant at the .01 level. Differences in costs of land rental, and custom work and rental fees were not significant. Total seed cost differences were not significant on a per acre basis but were significant at the .01 level on a per bag basis. Figure 12 shows the trends of the means for fertilizer and chemical costs. These two factors increased in cost per acre as size of production unit increased. Fertilizer costs rose because a higher percentage of larger growers applied fertilizer and second, because the larger producers were located on relatively coarse textured soils. Generally speaking, the fertilizer rate required on coarse textured soils was higher than that for the moderately fine and fine textured soils.

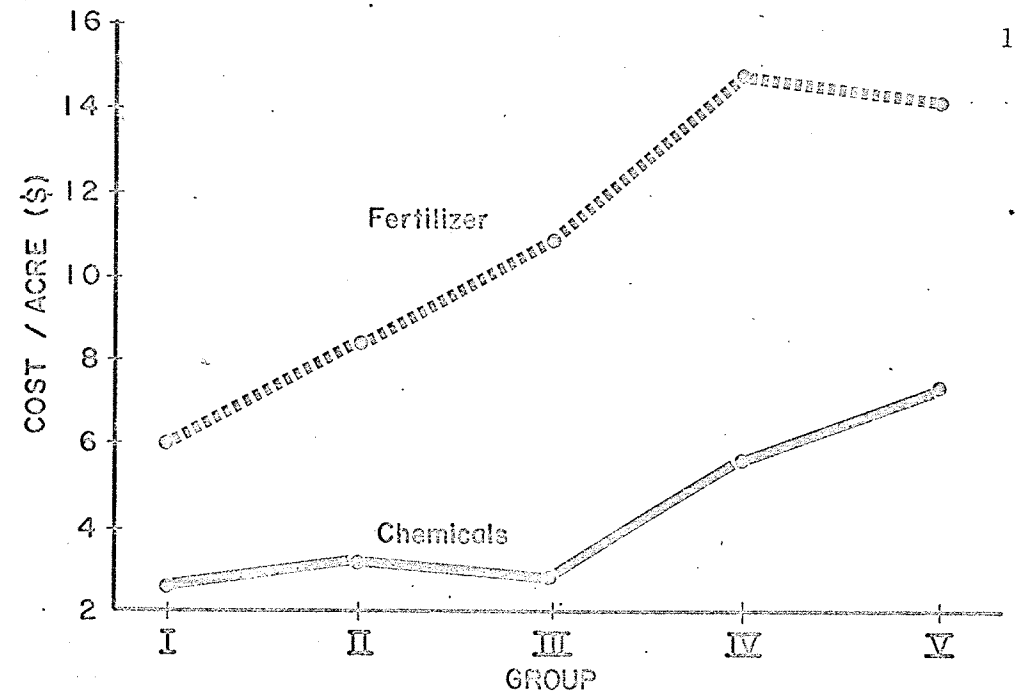
Expenditures on chemicals are a form of protection or insurance for the crop, and it was apparent that the larger production units utilized chemicals to a greater degree. This may have been because the growers with large acreages were

TABLE IX

VARIABLE COSTS OF PRODUCTION PER ACRE BY SIZE GROUP

Group No.	Equipment Repairs	Seed	Fertil-izer	Chemicals	Labour	Fuel & Oil	Land Rental	Custom & Rental	Interest	Total Variable
I	$ 4.74	$ 30.38	$ 6.20	$ 3.65	$ 68.56	$ 4.50	$ 12.56	$ .94	$ 5.27	$ 136.80
II	5.48	30.89	8.23	3.17	46.40	3.98	10.63	.84	4.38	114.00
III	6.52	28.67	10.94	2.84	29.38	3.52	10.32	3.52	3.84	99.55
IV	8.21	23.40	14.81	5.85	16.25	2.96	10.72	2.91	3.40	88.51
V	9.99	27.89	14.51	7.65	14.70	3.05	13.59	1.82	3.73	96.93
All	$ 8.97	$ 26.73	$ 14.01	$ 6.55	$ 18.09	$ 3.11	$ 12.37	$ 2.21	$ 3.68	$ 95.72

SOURCE: Appendix C, Table XXXIX.



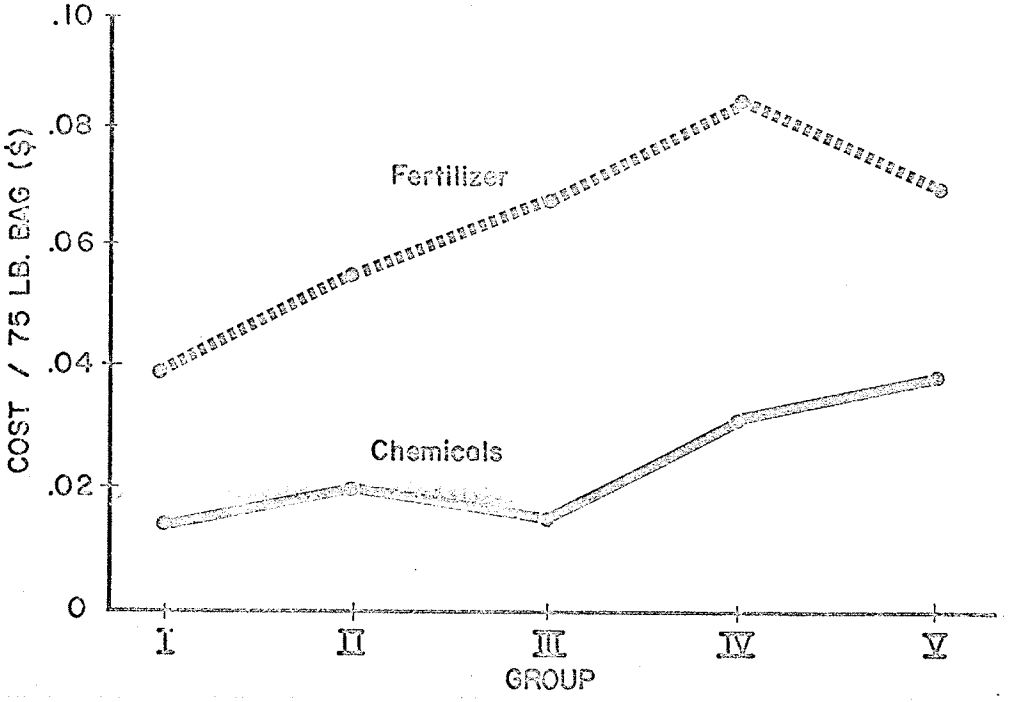


FIGURE 12

TRENDS FOR GROUP MEANS FOR FERTILIZER AND CHEMICAL COSTS

SOURCE: Appendix F, Tables XLIV and XLV.

more dependent on income from potatoes, and were not willing to take the risk of loss that application of chemicals would reduce.

Figure 13 shows the trend for the labour means. Increased acreage of production in the survey decreased the cost of labour per acre. This reduction in cost, as acreage increases, was directly associated with use of larger equipment as well as increased mechanization. For example, many of the growers producing small acreages utilized two-row equipment for planting and cultivating. Growers with large acreages used four-row equipment for the same aspects of production. Also, small acreages were frequently harvested by using the digger and hand picking methods, whereas large acreages were harvested mechanically.

Potatoes are a relatively intensive labour user, especially when compared to cereal crops and many other special crops. As a result, hired labour cost made up a significant portion of the labour cost used for all groups. However, as indicated in Figure 13, the proportion of hired to family labour changed as acreage increases. For Group I, this proportion was approximately two to three, for Groups II and III it was approximately one to one, for Group IV it was seven to one, and for Group V it was nine to one. In determining the cost of family labour, growers were requested to indicate what it would cost to replace the family labour used in the

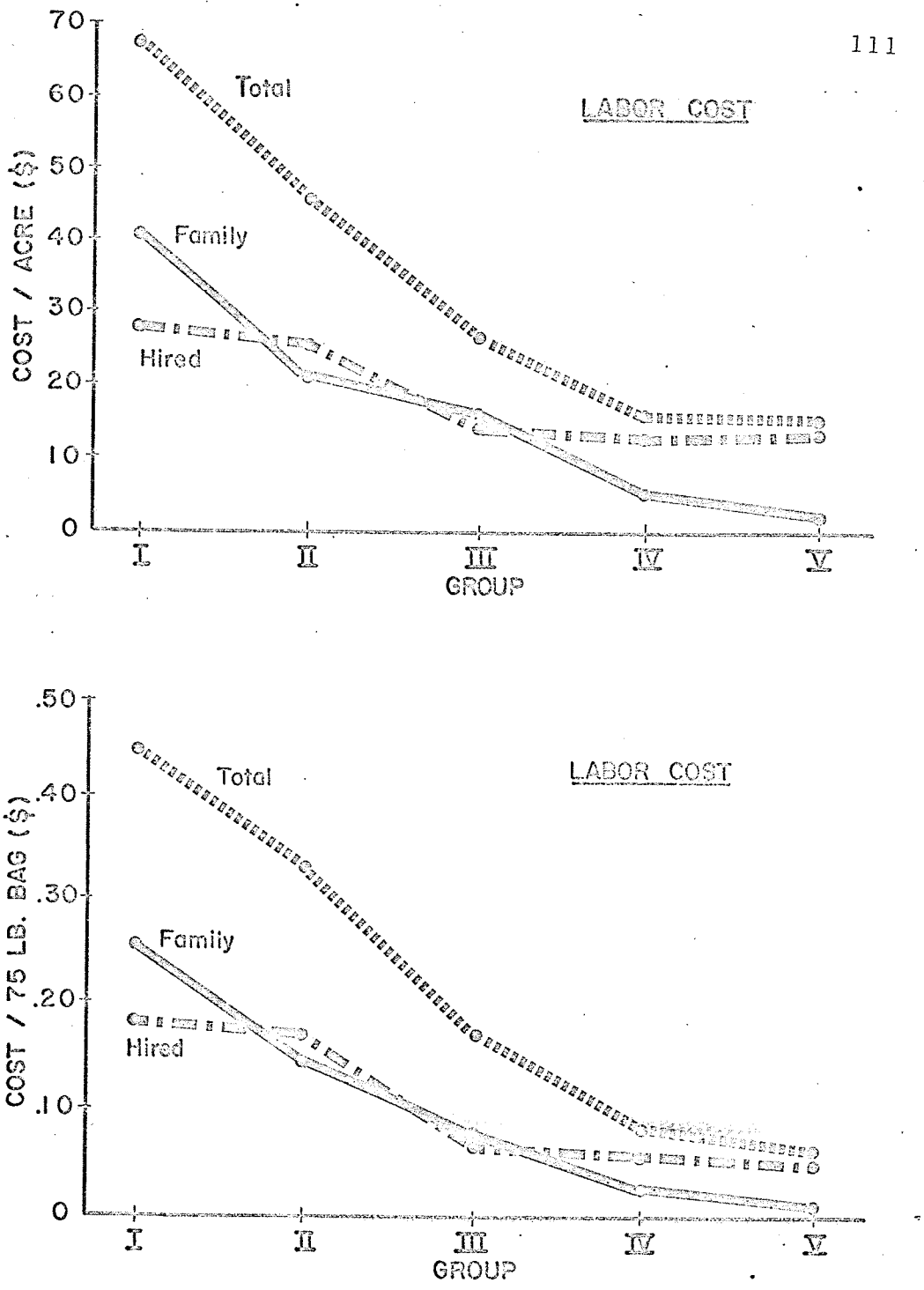


FIGURE 13

TRENDS FOR GROUP MEANS FOR LABOUR

SOURCE: Appendix F, Tables XLIV and XLV.

enterprize with hired labour.

It is important to realize that there has been no allowance made for management costs in the labour analysis. Some growers have suggested that $10.00 per acre was a reasonable figure, but the question of a management cost was not posed to all growers in the survey. Likewise, an allowance for risk beyond the interest charges made has not been included in the analysis.

The trend of means for fuel and oil was similar to the trend of means for labour, except that the size of the expenditure per acre was much less.

Figure 14 depicts the trend of the group means for average fixed cost and total average cost per acre and per seventy-five pound bag. As size of enterprize increased, the average cost dropped from Group I to Group IV. Per acre average cost of production was higher for Group V than for Group IV, while the reverse was true per seventy-five pound bag. The cost of labour was the input which resulted in the lower cost from Group I to Group IV. The average labour cost per acre for Group IV to Group V continued to drop from $16.42 to $14.82. This reduction of $1.60 was offset by the increase in cost of chemicals, repairs to machinery, and general overhead resulting in a net increase of $9.65 average cost per acre for Group V over Group IV.[21] However, when the

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[21]Appendix F, Table XLIV.

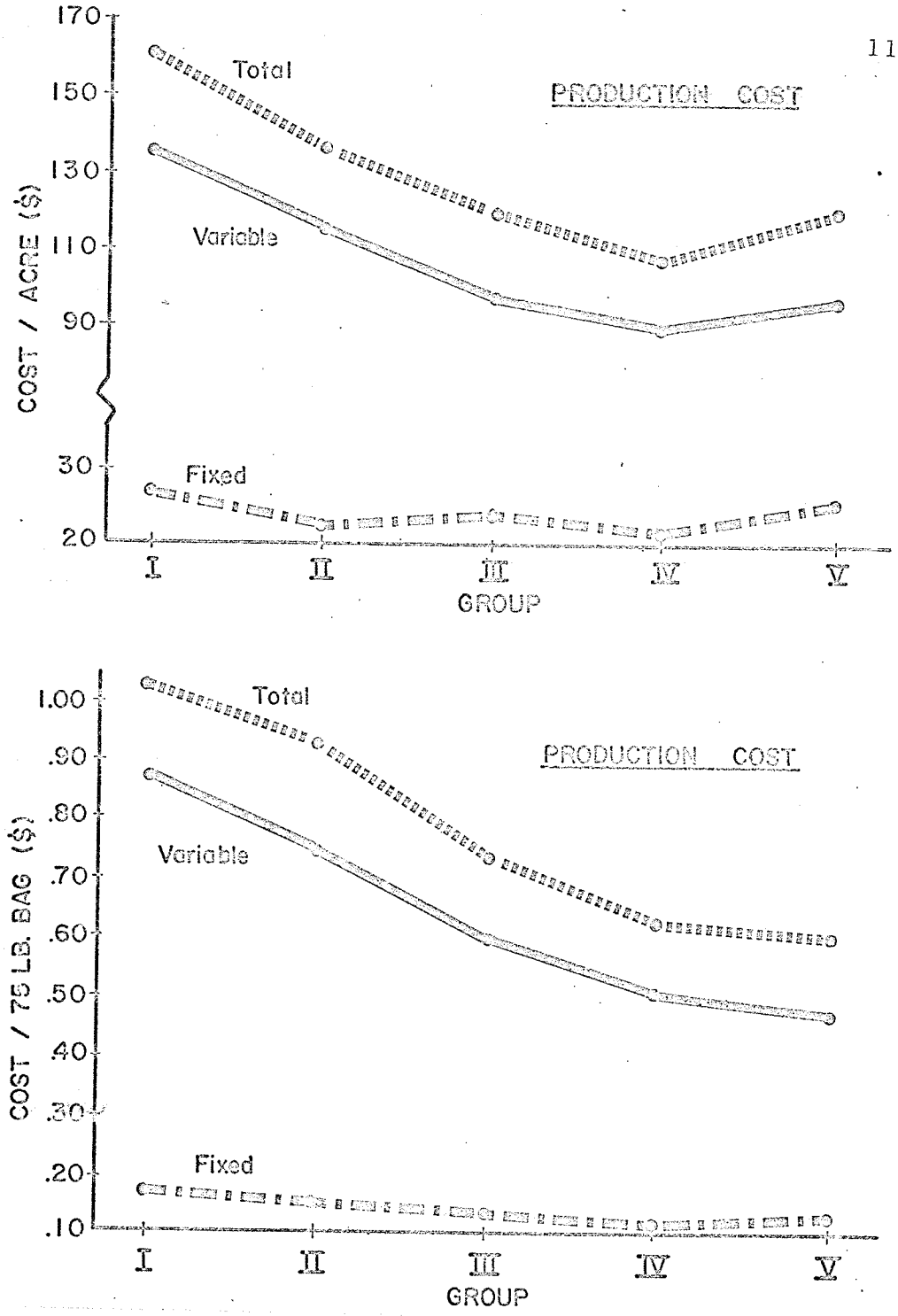

FIGURE 14

TRENDS OF GROUP MEANS FOR AVERAGE COSTS OF PRODUCTION

SOURCE: Appendix F, Tables XLIV and XLV.

costs of production for these two groups were compared on a per seventy-five pound bag basis, the cost of production continued to fall as size increased. This was because there was a significant increase in yield per acre as size increased.[22]

In addition to finding a significant variation in average cost per unit of production, there were wide differences in the costs incurred by individual growers. Table X reveals that the magnitude of the variation within the five groups ranged from $91.08 to $39.25 for Groups I and V, respectively. This indicates that individual growers within a given group could increase their net income by seeking out and using methods of production that other producers in their group used successfully. Such an improvement may well be more practical for many producers than the advantages that could be achieved by changing their scale of enterprize.

Regression Analysis Results

Inputs, or variables, used in the analysis to predict the total average production cost included cost of labour, fertilizer, chemicals, seed, land, equipment interest, equipment depreciation, and equipment repairs, as well as labour hours. In addition, yield per acre and size of operation expressed in acres were included in the analysis. Linear and

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[22] Ibid.

TABLE X

MAXIMUM, MINIMUM AND AVERAGE COST OF PRODUCTION PER ACRE BY GROUP

	Average Cost of Production/Acre		
Group	Minimum	Maximum	Average
I	$ 115.49	$ 206.57	$ 164.17
II	111.12	169.72	136.07
III	94.31	149.15	122.18
IV	97.13	142.85	109.38
V	106.10	145.35	120.86
All	$ 94.31	$ 206.57	$ 118.64

quadratic functions were used and the significance of "t" values and the "R^2" value were compared to determine the function which was the best estimator of cost. In this process, a number of the variables tested were discarded because the "t" value was not significant.

The following were the functional relationships selected for "All" growers. For these functions, as well as the ones that follow, the standard error of "b" is given in brackets below the "b" value. The levels of significance of the models are presented in Table XI:

$$Y_{1a} = 58.2725 + \underset{(.4722)}{0.9855}\ X_3 + \underset{(.1366)}{1.0218}\ X_7 + \underset{(.3016)}{1.2546}\ X_{15}$$

where Y_{1a} = average cost of production per acre for "All" growers,

X_3 = cost of fertilizer in dollars per acre,

X_7 = hours of production labour per acre, and

X_{15} = cost of seed in dollars per acre.

$$Y_{1b} = 0.2766 + \underset{(.4867)}{0.5641}\ X_3 + \underset{(.1307)}{1.2367}\ X_7 + \underset{(.2786)}{1.6196}\ X_{15}$$

where Y_{1b} = average cost of production per seventy-five pound bag for "All" growers,

X_3 = cost of fertilizer in dollars per seventy-five pound bag of yield,

X_7 = hours of production labour per seventy-five pound bag of yield, and,

TABLE XI

LEVELS OF SIGNIFICANCE FOR THE MODELS

Equation Number	Significance of the "t" value for						R^2 Value	"F" Ratio
	X_3	X_7	X_{13}	X_{14}	X_{15}	X_{19}		
Y_{1a}	.05	.001	-	-	.001	-	.682	.005
Y_{1b}	.20	.001	-	-	.001	-	.854	.005
Y_{2a}	-	-	.001	.01	-	-	.770	.005
Y_{2b}	-	-	.001	.001		-	.874	.005
Y_{3a}	-	.001	-	-	.001	-	.720	.005
Y_{3b}	-	.001	-	-	.001	-	.786	.005
Y_{4a}	-	-	.001	-	-	-	.926	.005
Y_{4b}	-	-	.001	-	-	-	.929	.005
Y_{5a}	.20	.05	-	-	.001	.001	.800	.005
Y_{5b}	.30	.02	-	-	.001	ns*	.906	.005
Y_{6a}	-	-	.001	-	-	.40	.399	.005
Y_{6b}	-	-	.001	-	-	.001	.765	.005

*Not significant at the .50 level.

X_{15} = cost of seed in dollars per seventy-five pound bag of yield.

The function "Y_{1a}" indicates that 68.2 percent of the average production cost per acre variation was explained by the inputs, fertilizer cost, hours of production labour, and cost of seed, while "Y_{1b}" explained 85.4 percent of the average production cost per seventy-five pound bag variation by the same inputs.

$$Y_{2a} = 16.2589 + \underset{(.0626)}{0.7424}\ X_{13} + \underset{(.3188)}{0.9182}\ X_{14}$$

where Y_{2a} = average cost of harvesting per acre for "All" growers,

X_{13} = harvest labour cost in dollars per acre, and

X_{14} = cost of harvest machinery repairs in dollars per acre.

$$Y_{2b} = 0.0647 + \underset{(.0517)}{0.9072}\ X_{13} + \underset{(.3460)}{1.4060}\ X_{14}$$

where Y_{2b} = average cost of harvesting per seventy-five pound bag for "All" growers,

X_{13} = harvest labour cost in dollars per seventy-five pound bag of yield, and

X_{14} = harvest machinery repairs in dollars per seventy-five pound bag of yield.

The function "Y_{2a}" revealed that 77.0 percent of the average harvesting cost per acre variation was explained by

the inputs, harvest labour cost, and harvest machinery repairs, and "Y_{2b}" explained 87.4 percent of the average harvesting cost per seventy-five pound bag variation by the same inputs.

The following were the functional relationships selected for the "non-mechanized" growers:

$$Y_{3a} = 41.3821 + \underset{(.2425)}{1.4478}\ X_7 + \underset{(.3352)}{1.3963}\ X_{15}$$

where Y_{3a} = average cost of production per acre for "non-mechanized" growers,

X_7 = hours of production labour per acre, and

X_{15} = cost of seed in dollars per acre.

$$Y_{3b} = 0.2045 + \underset{(.2456)}{1.5838}\ X_7 + \underset{(.3666)}{1.5591}\ X_{15}$$

where Y_{3b} = average cost of production per seventy-five pound bag for "non-mechanized" growers,

X_7 = hours of production labour per seventy-five pound bag of yield, and

X_{15} = cost of seed in dollars per seventy-five pound bag of yield.

The function "Y_{3a}" explained 72.0 percent of the average production cost variation per acre by the inputs, hours of production labour, and seed cost, and "Y_{3b}" explained 78.6 percent of the average production cost per seventy-five pound bag through the same inputs.

$$Y_{4a} = 11.1738 + \underset{(.0445)}{0.8765}\ X_{13}$$

where Y_{4a} = average cost of harvesting per acre for "non-mechanized" growers, and

X_{13} = harvest labour cost in dollars per acre.

$$Y_{4b} = 0.0513 + \underset{(.0485)}{0.9745}\ X_{13}$$

where Y_{4b} = average cost of harvesting per seventy-five pound bag for "non-mechanized" growers, and

X_{13} = cost of harvest labour in dollars per seventy-five pound bag of yield.

The function "Y_{4a}" explained 92.6 percent of harvesting cost per acre variation by the input harvest labour cost, and "Y_{4b}" explained 92.9 percent of the average harvesting cost variation per seventy-five pound bag by the same input.

The following were the functions selected for the "mechanized" growers:

$$Y_{5a} = -6.2686 + \underset{(.4122)}{0.5753}\ X_3 + \underset{(.5614)}{1.1750}\ X_7 + \underset{(.3320)}{2.097}\ X_{15} + \underset{(.0649)}{0.2663}\ X_{19}$$

where Y_{5a} = average cost of production per acre for "mechanized" growers,

X_3 = cost of fertilizer in dollars per acre,

X_7 = hours of production labour per acre,

X_{15} = seed cost in dollars per acre, and

X_{19} = yield of seventy-five pound bags per acre.

$$Y_{5b} = 0.1616 + \underset{(.4718)}{0.5875}\ X_3 + \underset{(.4600)}{1.1606}\ X_7 + \underset{(.3513)}{2.1672}\ X_{15} + \underset{(.0005)}{0.0003}\ X_{19}$$

where Y_{5b} = average cost of production per seventy-five pound bag for "mechanized" growers,

X_3 = cost of fertilizer in dollars per seventy-five pound bag of yield,

X_7 = hours of production labour per seventy-five pound bag of yield,

X_{15} = seed cost in dollars per seventy-five pound bag of yield, and

X_{19} = yield of seventy-five pound bags per acre.

The function "Y_{5a}" explained 80.0 percent of the average production cost per acre by the inputs fertilizer cost, hours of production labour, seed cost, and yield, and "Y_{5b}" explained 90.6 percent of the average production cost per seventy-five pound bag by the inputs fertilizer cost, hours of hired labour, and seed cost.

$$Y_{6a} = 26.2371 + \underset{(.2687)}{0.9675}\ X_{13} - \underset{(.0360)}{0.0316}\ X_{19}$$

where Y_{6a} = average cost of harvesting per acre for "mechanized" growers,

X_{13} = cost of harvest labour in dollars per acre, and

X_{19} = seventy-five pound bag yield per acre.

$$Y_{6b} = 0.2400 + \underset{(.2345)}{1.1789}\ X_{13} - \underset{(.0002)}{0.0008}\ X_{19}$$

where Y_{6b} = average cost of harvesting per seventy-five pound bag for "mechanized" growers.

X_{13} = cost of harvest labour in dollars per seventy-five pound bag yield, and

X_{19} = seventy-five pound bag yield per acre.

The function "Y_{6a}" explained 39.9 percent of the variation in average harvesting cost per acre by the inputs cost of harvest labour and yield per acre, and "Y_{6b}" explained 76.5 percent of the variation in average harvesting cost per seventy-five pound bag by the same imputs.

There was a significant relationship between several of the inputs and average production and harvesting costs per acre for "All" growers, as well as the "non-mechanized" and "mechanized" growers. The main variables which reveal this relationship are fertilizer cost, seed cost, hours of production labour, and yield for average production costs, and cost of harvest labour, harvest repair costs, and yield for average harvesting costs.

The cost relationships were more significant when made on a per seventy-five pound bag basis in all cases. This indicates that, although there is a relationship between average costs and several variables on a per acre basis, it was stronger on a per bag basis. A similar finding was reported by Maier and Loftsgard.[23]

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[23] M. G. Maier and Laurel D. Loftsgard, Potato Production Costs and Practices in the Red River Valley, Bulletin Number 451 (Fargo: North Dakota State University, Agricultural Experiment Station, Department of Agricultural Economics, September, 1964) p. 30.

There were different variables required to predict costs for the "non-mechanized" as compared to the "mechanized" group. This was the result of the reduced significance of labour as a cost for the "mechanized" group. In addition, the ability of the selected variables to estimate average was greater for the "non-mechanized" than for the "mechanized" group. It is quite possible that the inclusion of different variables in the function would improve the estimated relationship for the "mechanized" group. However, quantification of such factors is beyond the scope of the present study.

III. MARKET PREPARATION COSTS

Market preparation costs are outlays which are incurred in the storage, grading, and transport to market of table stock and seed potatoes. Costs in this phase are not related in any way to acres of production, therefore the basis of analysis is a unit of volume. The seventy-five pound bag has been used because it is the unit of commerce in this area for table stock and seed potatoes.

Fixed Costs

Fixed costs included depreciation and interest charges on equipment and storage structures. Equipment included grading machinery and trucks. Table XII outlines these costs for the three size groups and for all growers. Fixed costs

TABLE XII

FIXED AND TOTAL COSTS OF MARKET PREPARATION
PER SEVENTY-FIVE POUND BAG

Group No.	Storage Depreciation	Storage Interest	Equipment Depreciation	Equipment Interest	Total Fixed	Total Cost
A	.054	.032	.056	.028	.170	.674
B	.036	.021	.023	.012	.092	.502
C	.026	.016	.012	.007	.061	.402
All	.028	.017	.015	.008	.068	.422

SOURCE: Appendix C, Table XL.

made up 16 percent of the total market preparation costs.

Calculations of analysis of variance for interest and depreciation on equipment resulted in a non-significant "F" value. A similar calculation for cost of storage involving those growers who had potato storages indicated a significant "F" value at the .01 level.[24] The trend of the storage means is presented in Figure 15. This figure points out the significant savings achieved by the growers who store the larger volumes of product.

Variable Costs

Variable costs of market preparation included repairs to grading machines and trucks used to haul the potatoes to market, labour costs for grading, loading and transport, and the containers in which the potatoes were sold. Table XIII outlines these costs for the groups and for "All" growers. Variable costs made up 84 percent of the total market preparation costs.

Calculation of analysis of variance, and the resulting "F" values showed that the differences among the groups for machinery repairs and labour for grading were not significant.[25]

On the other hand, difference among the groups for cost of labour for trucking done by the growers was significant

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[24]Appendix F, Table XLVI. [25]Ibid.

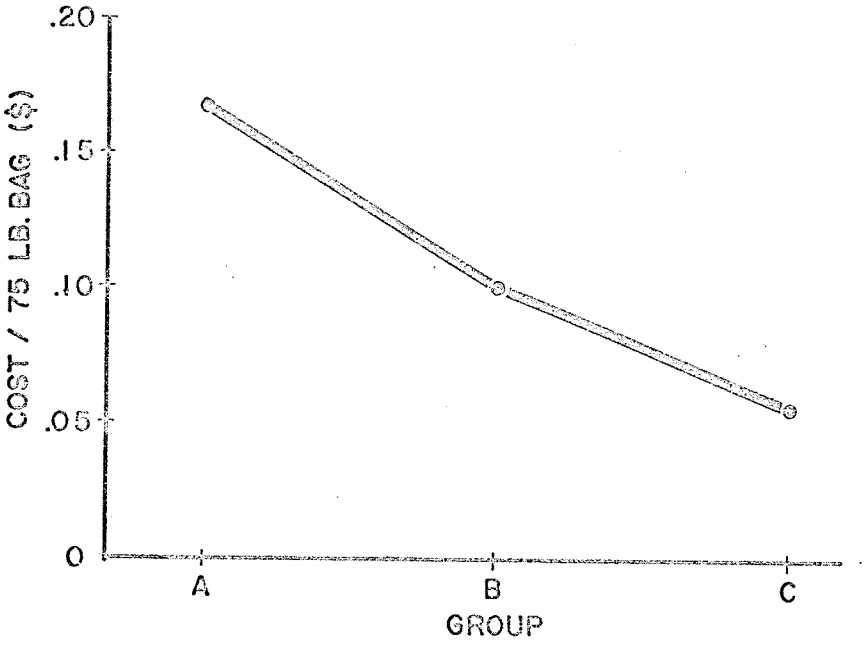

FIGURE 15

TRENDS OF GROUP MEANS FOR STORAGE COST PER SEVENTY-FIVE POUND BAG

SOURCE: Appendix F, Table XLVI.

TABLE XIII

VARIABLE COSTS OF MARKET PREPARATION
PER SEVENTY-FIVE POUND BAG
BY SIZE GROUP

Group No.	Storage Repairs	Equipment Repairs	Grading & Loading Labour	Transport Labour	Interest	Sub-Total	Containers	Total
A	.023	.021	.230	.057	.007	.338	.166	.504
B	.014	.019	.188	.022	.005	.248	.162	.410
C	.010	.011	.122	.014	.003	.160	.181	.341
All	.011	.012	.134	.016	.003	.176	.178	.354

SOURCE: Appendix C, Table XLI.

at the .05 level. Cost differences for grading and loading labour combined, and total labour costs for market preparation were significant at the .01 level. Differences in total average cost of market preparation were significant at the .01 level. Where there were significant differences in variable costs of market preparation, the large sized group incurred the lower cost in all cases.[26] Figure 16 points out these trends.

Total average market preparation costs were less for the growers in the largest sized group surveyed. This trend is consistent with the average production cost per seventy-five pound bag.[27]

Also, as was the case with unit production cost, there was a wide variation in market preparation costs among growers within a group. Growers would be well advised to examine their operations stage by stage and determine where their costs are higher than the average. This should be followed by a modification of techniques used to achieve cost-savings that are available.

Chapter VI presented the cost analysis results and their significance. Chapter VII summarizes and outlines the conclusions of the study.

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[26] Ibid. [27] Chapter VI, Table XIII.

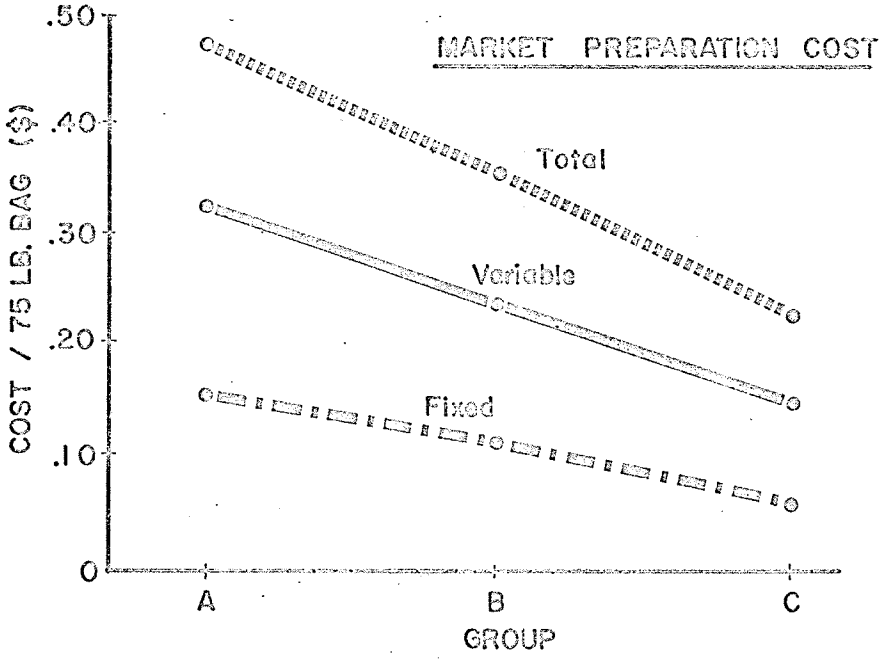

FIGURE 16

TRENDS OF GROUP MEANS FOR AVERAGE COSTS OF MARKET PREPARATION

SOURCE: Appendix F, Table XLVI.

CHAPTER VII

SUMMARY AND CONCLUSIONS

The general purpose of the study was to determine costs incurred, and to review the current cultural practices used by growers in the production of potatoes, and in the market preparation of table stock and seed potatoes.

I. COSTS OF PRODUCTION

It was found that, on the average, costs of production changed as size changed. Costs on a per acre basis dropped as size increased from Group I to Group IV, and increased slightly from Group IV to Group V. However, on a per seventy-five pound bag basis, costs continued to fall from Group I through Group V. This reduction in cost was significant at the 0.01 level when based on the comparison of calculated and table values of "F" as determined by the analysis of variance.[1]

Examination of the individual inputs revealed that labour costs were the main reason for the significant decrease in costs as size increased. On the average, total labour cost decreased from $68.55 for Group I, to $14.82 for Group V.[2] This decrease in the cost per acre of labour was the result

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[1] Appendix F, Table XLIV. [2] Ibid.

of utilizing capital in the form of machinery rather than labour. Cost reductions were achieved by the larger enterprizes using larger machinery as compared to the smaller enterprizes, and also because larger enterprizes used machines which the others did not use.

It is apparent that the smaller sized production units will find it increasingly difficult to compete with the larger operators. This will be true unless they are willing to accept a lower return for labour and/or a number of small producers are willing to combine, and perhaps relocate their potato enterprizes to make a larger production unit which can take advantage of the savings associated with mechanization. This difficulty will become more acute if the cost of labour increases at a faster rate than costs associated with using other techniques, such as mechanization, to do the job, and if unskilled labour becomes increasingly difficult to obtain and manage, particularly in the harvest period.

In contrast to labour costs, fertilizer, chemical, equipment repairs, and general overhead increased, on the average, as size increased. However, the increase in cost of these inputs was more than offset by the decreasing labour cost. This was true for all groups on a per seventy-five pound bag basis and for four of the five groups on a per acre basis with the largest group being the exception.[3]

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[3]Appendix F, Tables XLIII and XLIV.

Cost of land rent, interest on investment in machinery, depreciation on machinery, and custom and rental fees were not significantly different as size changed.[4] Cost of seed was lower for large enterprizes when compared on a yield of seventy-five pound bags per acre base.

Although there was a significant change in per acre cost of production as size changes, the variation between individual growers within the group was larger. When the extreme variation between individuals for each of the five groups was compared, Group I had a variation of $91.08, and Group V a variation of $39.25.[5]

With these factors in mind, consider hypothesis one and two which were proposed in Chapter I. It was hypothesized that: "1. Growers who produce large acreages of potatoes incur a lower cost of production than do growers who produce small acreages of potatoes."[6]

This hypothesis is accepted, based on the results of analysis of variance which indicated significant reduction, on the average, in costs of production per acre and per seventy-five pound bag as size of enterprize increased. However, it must be noted that costs per acre appeared to rise as the size increased from Group IV to Group V, and that some individual

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[4]Appendix F, Table XLIV. [5]Chapter VI, Table X.

[6]Chapter I, p. 8.

growers achieved comparatively low costs of production with small enterprizes. It was also hypothesized that:

"2. Substitution of capital for labour reduces the cost of production of potatoes."[7]

This hypothesis is accepted with the modification that equipment employed to reduce the labour input be utilized at levels of output approaching optimum capacity. When this condition exists, the cost of owning and operating equipment is more than offset by the reduced cost of labour. The analysis revealed the dominating influence of labour costs in the relatively unfavourable cost picture of smaller producers. While it might be argued that larger enterprizes, using labour rather than equipment, might not incur the same high unit cost of production as do the small enterprizes, it is extremely unlikely that the reduction in labour costs would be as great as reductions in costs associated with mechanization.

It is important to realize that the dollar return to the family labour input for the small potato grower is a major source of income from this enterprize. In contrast, family labour income is of very little significance to the operator of a large potato enterprize. For this reason, the smaller grower incurs a smaller percentage of the total cost

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[7] Ibid.

as a cash cost when compared to the large enterprize.

The results of the regression analysis indicated that costs of production and harvesting can be estimated with reasonable accuracy by considering a small number of the inputs used in these operations. The inputs which provided the basis of estimation were: hours of production labour, fertilizer cost, seed cost, yield, harvest labour cost, and harvest machinery repair cost. The estimated costs were particularly good for the non-mechanized producers and the major reason for this was the dominant influence of labour. In all cases, the "R^2" values are higher for the per seventy-five pound bag relationships than the per acre relationships. The increase in "R^2" is particularly large for the harvesting cost of the mechanized group, and does not appear to be completely logical from a theoretical point of view. This is because one would expect that mechanized harvesting costs should be more closely related to acres harvested than yield per acre. The reason is mechanized harvesting would cost almost as much for a low yielding crop as for a high yielding crop. However, it is possible that high yields were directly correlated with other factors not included in the analysis, resulting in the more acceptable fit on seventy-five pound bag basis. If the above were true, inclusion of these other variables should reduce the difference between the "R^2" values on a per bag and per acre basis.

II. COSTS OF MARKET PREPARATION

Costs of market preparation per seventy-five pound bag decreased as the number of bags prepared for market increased. The calculated "F" value was significant at the 0.01 level.[8] As was the case with production costs, the labour input was the major factor contributing to this trend. Labour costs for market preparation, including grading, loading, and delivery to market, decreased from $0.28 for Group A, to $0.13 for Group C. The cost of labour for loading was significant at the 0.01 level. As size of enterprize increased, transport labour costs decreased and were significant at the 0.01 level, even though the mileage from storage to market was greater for the large group.[9]

With these factors in mind, consider hypothesis three. It was hypothesized that:

"3. Producers with large volumes of table stock potatoes incur a lower per seventy-five pound bag cost of market preparation than do growers who produce a small volume of table stock or seed potatoes."[10]

This hypothesis is accepted, based on the results of the analysis of variance tests. As was the case with

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[8]Appendix F, Table XLVI. [9]Ibid.

[10]Chapter I, p. 8.

hypothesis two, it must be recognized that individual growers with relatively small volumes of potatoes to prepare for market incurred costs of preparation which were similar to growers with much larger quantities of product.

III. RESOURCE REQUIREMENTS AND CULTURAL PRACTICES

Resources used by producers show considerable variation. While the majority of production took place on soils which were of a texture suited to a mechanized harvest of the crop, there was considerable acreage produced on soils which had a texture relatively unsuited for a mechanized harvest operation. The majority of all growers, and particularly those in Group I and Group II, were in this latter category. However, these producers grew the minority of the total product. In view of the physical characteristics of the soil, it is unlikely that consolidation of these enterprizes will take place on these fine textured soils. Relocation may be an alternative these growers should consider prior to changing to a mechanical harvesting procedure. In many instances, the requirements of soil texture for mechanical harvesting could be met by producers renting land within a twenty-five to thirty mile radius of present storage facilities. This would necessitate a higher than average transport cost from field to storage, but would allow the producers to continue to ulitize existing storages, and to

live in their familiar community surroundings. Producers who intend to remain in the potato production enterprize for a number of years, and who require additional or new storage structures, should examine very closely the advantages and the disadvantages of locating the new structure in an alternate production area.

Labour was a major input in the production and market preparation of potatoes, particularly for the small enterprize. Large production units had succeeded in utilizing machines to replace labour. As a result, Group I required, on the average, 51.7 hours of labour per acre for production, as compared to 9.7 for Group V. Of this requirement, the family supplied 52 percent of the production labour for Group I and only 0.9 percent for Group V.

Labour requirements increased gradually from the start of the production season until harvest. Harvesting and placing potatoes into storage required from 63 to 74 percent of the total labour hours. This operation is usually accomplished in approximately 20 percent of the production season.[11]

Labour was also a major component of market preparation inputs. In the same way as it was with production labour, family labour made up a large proportion of the total required for the small enterprizes.

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[11]Chapter V, Figure 8.

Capital requirements were divided up into long-term, intermediate-term, and short-term periods. In the study, the only requirement for long-term capital was that required to build the potato storage. The range in investment for this purpose was from $1.08 to $0.52 per seventy-five pound bag for Groups A and C, respectively.[12] Investment in production equipment was put into the intermediate category and group averages ranged from $72.62 to $81.12 per acre. Investment in market preparation equipment ranged from $0.38 to $0.09 per seventy-five pound bag. Short-term production capital requirements were the largest of the three and, on a per acre basis, ranged from $139.47 to $90.63 for Groups I and V, respectively.[13]

The range of short-term capital for market preparation was from $0.31 to $0.16 per seventy-five pound bag for Group A and Group C, respectively. These short-term capital requirements included a charge for rental of land.

The relative quantity of capital required in the three categories is important for growers and credit agencies to recognize. The heavy requirements for short-term and intermediate-term capital, coupled with the possibility of a poor

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[12]Appendix C, Table XL.

[13]These short-term capital requirements included a charge for land rental.

crop, particularly in the first year of operations, requires careful planning so that producers do not find themselves short of operating capital which may increase the risk involved the following year.

Growers tended to follow a two to four year rotation when planting potatoes on their own land. Some producers indicated that they would not plant potatoes after a crop of potatoes, sugar beets, sunflowers, or flax. The concern expressed was associated with diseases that are common to these crops and potatoes. The majority of potatoes were planted on cereal stubble which had been cultivated or plowed in the fall, and cultivated again in the spring. Ninety percent of the producers applied fertilizer with their potatoes and one-half of these applied potassium along with nitrogen and phosphorous. The majority of those who applied potassium were located on light soils.

Seed planted on the majority of the acreage in the survey had passed the requirements of a certification program and had been treated with a dry fungicide. However, a substantial number of the smaller producers used some tubers for seed which were "one year removed" from a seed certification program in combination with certified seed. Some producers did not use any certified seed in 1968.

Potatoes are an intertilled crop and, on the average, growers cultivated the potatoes 4.1 times. In addition,

harrows or mulchers were used early in the production season to control small weeds. Large enterprizes used this technique to a greater extent than small enterprizes. Smaller growers tended to hoe a greater portion of their acreage. Hand hoeing is an expensive method of weed control, and there are numerous herbicides available which growers could use to advantage in reducing the need for hoeing. In many instances, this would require the use of materials on cereal crops a year in advance of planting potatoes in the field, but such a practice would be advantageous.

Growers applied insecticides and fungicides to the potato crop to control pests, and there was greater use of insecticides than fungicides. In addition, the larger enterprizes applied more chemicals, on the average, as compared to the smaller enterprizes.

Growers used four systems for harvesting potatoes. The most popular in terms of use by number of growers and acreage harvested, was the direct harvesting method. This was closely followed by the digger, hand picking, and sacks method in terms of the number of growers, although the acreage harvested in this manner was not large. The mechanized piling method was used to put the majority of potatoes into storage and it was used by the majority of growers.

Growers used different types of storage structures to store their crop. However, the most popular storage was

of the above ground design. Approximately one-third of the growers graded their potatoes by hand. However, less than 5 percent of the volume of potatoes were graded in this manner. Of the remaining growers, just under 10 percent washed their product; the remainder graded on a dry basis using a machine. The 10 percent of the growers who washed potatoes prepared 38 percent of the total volume for the market.

Delivery of the crop was accomplished in all cases by truck with the majority of producers using open boxes with tarpaulins, etc., to provide insulation for the potatoes during cold weather. However, this only represented 10 percent of the total volume delivered with the remainder being hauled in closed-in vans.

This chapter has summarized the results of the project and outlined the conclusions based on data obtained from the survey. Chapter VIII discusses some of the limitations of the project and suggests additional areas for further study.

CHAPTER VIII

LIMITATIONS OF THE STUDY AND SUGGESTIONS FOR FURTHER RESEARCH

As is the case with many agricultural crops, the majority of the potatoes are produced by relatively few producers. The present study confirms this fact, but no attempt was made to indicate the ramifications, or analyze the results of such a situation.

When producers choose, or are requested to express their recommendations in connection with matters which affect the overall industry, the question arises as to the significance of the relatively few large producers versus the importance of the large number of small producers in making a decision. A study to evaluate whether or not the position of the small producers is the same or different as compared to the position of the large producers could be a significant guide to policy makers in rationalizing the influence these groups should have in making decisions which affect future development of the industry.

In determining costs of potato production and market preparation, this study did not consider the contribution of management to the enterprize and its effect on cost. Likewise, no evaluation was made of risk and the effects of risk with respect to production of potatoes for various market

outlets. The effect of these two factors may be considerable, particularly in years of relatively adverse production conditions. Additional information would be helpful in this area.

Although some information was collected and analysed in connection with market preparation of potatoes, several major aspects were not evaluated. No attempt was made to determine the amount or cause of shrinkage during the storage period; the relative advantages, if any, of washing versus dry grading potatoes; or the economies, if any, of bulk hauling for table stock. These questions are all of importance to the potato industry but are beyond the scope of this study.

The majority of the total production in the province is sold to the processing firms. Some producers sell their potatoes directly from the field to the processor. Others have constructed and use storage facilities of their own. Processors make an allowance in their pricing schedule for costs associated with these services, but growers have requested additional information on the costs of providing these services. This study did not undertake to provide information in this area, although it is becoming increasingly important.

Producers who followed the practice of planting some or all of their crop with potatoes from non-certified

sources may have, or could easily become, a serious source of infection for the disease Bacterial Ring Rot. This concern arises because many growers delivered potatoes to the same "first receivers", thus creating a "community contamination source". In addition, some producers purchased containers which had been used by other growers. These are well known methods of spreading this problem, and although the study did not examine any of the aspects of this situation, this indicates another area of concern to the potato industry.

Within the study itself, there are a number of areas where additional background information would have been valuable. A considerable amount of time and effort was devoted to developing the model for the calculation of repair costs. However, for a number of the machines there was no basic engineering data available. In addition, the relative costs of using equipment, potato harvesters in particular, on various soil textures was not available. These two factors are important but could not be quantified within the scope of this study.

Similarly, costs associated with depreciation posed problems in the analysis. Some equipment which was still in use on an annual basis would have been considered obsolete in terms of age. In some instances, the machine was no longer manufactured and growers purchased used models for use

as a supply of parts. However, the depreciation charge included in these instances was small and contributed only a small portion to the total cost.

In some instances, particularly with seed production, there are costs which are not typical of production for other outlets. Examples of this are the time and expense incurred in cleaning and disinfecting machinery and equipment to prevent contamination of seed stocks, and the roguing required to stay within disease tolerances required for seed production. Again, this study does not provide detailed information on costs related to such special types of production.

It was indicated that there were five possible techniques or systems used to harvest potatoes. Four of these were found in the survey. The obvious question is "What is the range of acreage suitable in terms of cost, for each system?" Harvesting costs, as indicated from the survey, were highly variable. In addition, the number of observations for some harvesting systems was small. As a result, it was impossible to develop a functional relationship for the various systems on the basis of the data available from the survey. This limitation points out the need for a study involving economics and engineering disciplines to fill the gap.

In some instances, the functional relationships

developed in the study are not as good as one would like to see. These could be improved by more detailed analysis of individual inputs and their function in the production of potatoes. This, however, would require additional data and perhaps modifications in the models used.

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APPENDIXES

APPENDIX A

QUESTIONNAIRE

I. General Information

Number _____

Crop Acreage Owned _____

Potato Acreage on Owned Land _____

Potato Acreage on Rented Land _____

Rental Arrangements - Time Period _____

Cash Rent _____ Rate _____

Other _____

If other, please specify _____

Potato Acreage Produced for: A Processors _____

B Table stock _____

C Seed - Not under contract _____

D Seed under contract _____

Portion of total farm income made up from potato sales in 1967 _____%

Portion of total net income received from off farm employment in 1967 _____%

Working time spent in off farm employment in 1967 was _____ hrs./wk.

On your farm, has the yield average per acre changed?

_____

If yes, Up or Down? _____ What has caused this change?

_____

II. Cropping Pattern

A. Usual Crop Rotation Followed _____

B. Potato Acreage Planted in 1967

1. Cereal or special crop stubble _____

2. Summerfallow _____

3. Vegetable crop land _____

4. Potato crop land _____

5. Sugar beets, sunflower or flax _____

III. Production Information

A. Seed Bed Preparation for 1968

1. List, in order of sequence, the tillage practices ordinarily carried out in preparation for potatoes

(a) Land Cropped in 1967

Tillage Machine	Tractor	Times Over	Fall	Spring	Acres per Hour	Labour		
						Rate	Family	Hired

(b) Summerfallow in 1967

Tillage Machine	Tractor	Times Over	Acres per Hour	Labour		
				Rate	Family	Hired

B. Planting Operation for 1968

1. What were the varieties, acreage, use, cost of seed, seeding rates, and sources of seed planted?

Variety	Acreage	Use	Value of Seed	Seeding Rate	Seed Treatment	
					Yes No	Wet Dry

Seed Source			
Certified		One Year From Cert.	Over 1 Year From Cert.
Canada	United States		

2. Seed Cutting and Treatment

a) What portion of the seed planted is cut _____%

b) What portion of the cut seed planted is

1. Custom cut _____%cost _____/75#bag

2. Mechanically cut on the farm _____%

3. Hand cut on the farm _____%

c) What amount of (home cut) seed is cut per hour _____75#bags

d) What staff is required to operate the equipment?

i. Men _____ rate/hr _____ Family ___ Hired ___

ii. Women _____ rate/hr _____ Family ___ Hired ___

e) What material is used to treat the seed?

_____

Rate of application _____

Cost of material _____

f) What portion of the seed is handled?

i. in bulk _____%

ii. in bags _____%

3. Fertilizer

a) What portion of the potato crop is fertilized

_____%

b) What portion of the fertilizer as applied on the basis of "soil test" recommendations

_____%

c) If "soil test" recommendations are not used, what are the main analysis and rates used?

Soil Type	Analysis	Rate of Application	Cost per Ton

d) Application Method

i. What proportion of acreage is fertilizer (some or all) applied with the planter

_____%

ii. What proportion of acreage is fertilizer

(some or all) broadcast _____%

e) Handling Methods

i. What portion of fertilizer used do you handle in bulk _____%

ii. What portion of the fertilized used do you handle in bags _____%

f) What portion of the 1968 potato acreage has had manure applied and in what volume?

i. in 1967 _____ acres at _____ tons/acre

ii. in 1966 _____ acres at _____ tons/acre

iii. in 1965 _____ acres at _____ tons/acre

4. Trucking seed and fertilizer to the field and loading the planter

a) What is the average distance to the field?

_____ miles

b) How many trucks are used to haul fertilizer and seed? _____

c) List the labour involved in trucking fertilizer and seed? _____ men

@ _____/hr. Family _____ Hired _____

d) List the labour involved in filling the planter? _____ men

@ _____/hr. Family _____ Hired _____

5. Planting

a) Size of planter _____ rows

b) Rate of travel _____ m.p.h.

c) Width of row _____ inches

d) Labour required

i. Tractor driver @ _____ /hr.

Family _____ Hired _____

ii. Planter rider @ _____ / hr.

Family _____ Hired _____

e) Acres planted per day _____

f) Tractor used on planter _____

C. Summer Operations for 1967

1. Weed Control

a) List in sequence tillage operations carried out during the time after planting to immediately before harvest?

Tillage Machine	Tractor	Times Over	Acres per Hour	Labour		
				Rate	Family	Hired

b) What portion of the crop is hand weeded?

_____ %

What is the cost of labour per acre? _____

2. List the spraying or dusting operations used to control insects and diseases during the growing season.

a) Chemical used and application rates

Materials Used	Insects or Diseases Controlled	Application Rate/Acre

b) Custom spraying or dusting

Dust or Spray	No. of Applications			Custom Cost/ Acre/Application	Cost of Chemicals /Year		
	High	Ave.	Low		High	Ave.	Low

c) Spraying or dusting done by grower

Dust or Spray	No. of Applications			Acres Covered/Hr.
	High	Ave.	Low	

Cost of Chemicals/Year		Labour	
	Rate	Family	Hired

d) Where method of application is spraying:

i. How many gallons of water per acre are applied? _____

ii. How many trucks are used to haul water?

_____

iii. How much water is hauled per trip?

_____

iv. What is the average distance water is hauled? _____

v. What are the labour requirements for hauling water _____ men @ _____ /hr. for _____ hrs.

Family _____ Hired _____

3. Itemize any costs not already included above which are normally incurred in the production of certified seed stock, i.e., roguing (indicate family and hired labour). _____

_____

D. Harvest Operation for 1967

1. Harvest preparation

a) What portion of the crop is usually treated with vine killers? _____ %

Materials Used	Rate of Application		Acres per Hour	Cost of Materials
	Chemical	Water		

Men	Labour Required			If Custom Done, What is Rate per Acre
	Rate/ Hour	Family	Hired	

b) Rotobeating

i. What portion of the crop is rotobeat

_____ %

ii. If the rotobeater is rented, what is the rate _____ /acre

iii. What is the acreage completed/hour

_____

iv. What tractor is used for rotobeating

_____

v. What are the labour requirements

_____ men @ _____/hr. Family _____

Hired _____

2. Harvesting

a) Which of the following methods of harvest are used on your crop? (check appropriate method).

i. Mechanical digger, pickers, sacks and truck _____

ii. Mechanical digger, pickers, bulk trucks

_____

iii. Indirect mechanical harvesting, bulk trucks _____

iv. Direct two or one row mechanical harvesting, bulk trucks _____

v. Four or six row direct, indirect mechanized harvest bulk trucks _____

b) What is the acreage harvested per day per crew _____ hrs./day

i. High _____ acres

ii. Average _____ acres

iii. Low _____ acres

c) What the labour requirements (include truck-driver, pickers, tractor drivers, harvester workers)

____ men @ ____/hr. Family ____ Hired ____

____ men @ ____/hr. Family ____ Hired ____

____ women @ ____/hr. Family ____ Hired ____

____ women @ ____/hr. Family ____ Hired ____

d) What are costs of sacks or picking baskets/ acre _____

e) Transportation

i. How many trucks are used during harvest

_____

ii. What is the load capacity carried to storage

_____ at _____ 75#bags

_____ at _____ 75#bags

iii. What is the average distance to storage

_____

iv. What are the normal repair costs/season

a) on digging equipment _____

b) on trucks _____

v. What tractor is used

a) to pull the harvester(s) _____

b) to operate the digger(s) _____

vi. If any trucks are rented what are the costs and what items must be supplied by the grower _____

vii. If custom harvesting is hired, explain arrangements and provide costs _____

_____

f) Filling storage

i. What method is used in piling?

mechanized _____ manual _____

ii. What are the labour requirements

___ men @ _____/hr. Family ___ Hired ___

___ women @ ___/hr. Family ___ Hired ___

g) Storage running costs

i. If storage is rented, what is the rate

_____ /season

ii. What is the cost of labour for supervision _____ /season

iii. What are costs for heating _____ _____ /season

h) By variety what is the total yield per acre on potatoes going into storage or direct delivery to processors

Variety	Soil Type	Acreage for		Yield
		Processor	Storage	

IV. Marketing Information (Table Stock Only) for 1967

A. Wash Pack

1. What proportion of the sales are made as wash packs _____ %

2. What is the pack out percentage?

High _____

Average _____

Low _____

3. What are the packing costs:

a) Rate of custom pack _____ /75#bag

b) Do you pre-grade at home for custom pack?

_____

What is output/hr. _____ /75#bags

c) Farm plant costs

i) Rate of pack out/hr. _____ 75#bags

ii) Labour requirements

___ men @ _____/hr. Family ___ Hired ___

___ women @ ___/hr. Family ___ Hired ___

iii) Materials - Sacks _____ ¢ each

Ties _____ ¢ each

B. Dry Pack

1. What proportion of the sales are made as drypack?

_____%

2. What is the packout percentage (Canada No.1 and Canada No.2)?

High _____

Average _____

Low _____

3. Packing costs

a) What is packing rate? _____75#bags/hr.

b) Labour requirements

___ men @ _____/hr. Family ___ Hired ____

___ women @ ___/hr. Family ___ Hired ____

c) Materials - Sacks _____ ¢ each

Ties _____ ¢ each

C. Transportation

1. Loading

a) Labour ___ men @ ___/hr. Family ___ Hired ___

b) Materials _____(flats, etc.)

c) Rate of loading/hr._____ 75#bags

2. Hauling

a) Type of truck

i) permanently closed top _____

ii) semi-permanent closed top _____

iii) open box with rugs _____

b) Average distance to market _____ miles

c) Size of load carried _____ 75#bags

d) Labour ___ men @ ___/hr. Family ___ Hired ___

e) Truck used _____

D. What is done with cull material and what are disposal costs? _____

V. Overhead Costs

A. Insurance

1. Field equipment $ _____ /yr.

2. Storage equipment $ _____ /yr.

3. Grading equipment $ _____ /yr.

4. Product $ _____ /yr.

5. Trucks $ _____ /yr.

B. Taxes (Where storages are located off of productive land) _____

C. Phone costs assigned to potatoes _____ /yr.

D. Hydro costs assigned to potatoes _____ /yr.

E. License costs (trucks, etc.) _____ /yr.

F. Supervisory labour _____ /yr.

G. Total cost hired labour (except F.) _____ /yr.

VI. Inventory of Equipment Used on Potatoes

A. Equipment used on potatoes only

Machine	Make and Model	% Used on Potatoes	Share Owned	Size	Original Cost	Year Purchased	Expected Life	Annual Repair Cost
Tractors								
Trucks								
Seed Cutter								
Treatment								
Equipment								
Planters								
Harrows								
Plows								
Cultivator								
Disc								
Fertilizer Broadcaster								
Trailer								
Row Crop Cultivator								
Sprayers and Dusters								
Rotobeaters								

Machine	Make and Model	% Used on Potatoes	Share Owned	Size	Original Cost	Year Purchased	Expected Life	Annual Repair Cost
Diggers								
Harvesters								
Bulk Boxes								
Binpiler								
Washing Equipment								
Dry Grader								
Conveyor								
Fork Lift Equipment								
Storage Structure								

APPENDIX B

TABLE XIV

NUMBER AND PERCENT OF GROWERS AND NUMBER AND PERCENT OF ACREAGE IN POPULATION AND SAMPLE BY GROUP

Group	Population				Sample			
	Growers		Acreage		Growers		Acreage	
	No.	%	No.	%	No.	%	No.	%
I	138	50.6	1,237	5.6	15	25.0	124	1.2
II	61	22.3	2,068	9.4	12	20.0	449	4.2
III	28	10.3	2,801	12.7	9	15.0	706	6.6
IV	29	10.6	6,204	28.2	14	23.3	3,249	30.3
V	17	6.2	9,676	44.1	10	16.7	6,188	57.7
All	273	100.0	21,986	100.0	60	100.0	10,716	100.0

NOTE: Percent figures are rounded to nearest tenth.

TABLE XV

NUMBER AND PERCENT OF GROWERS AND NUMBER AND PERCENT OF ACRES PRODUCED FOR TABLE AND SEED, CONTRACT AND COMBINATION OF TABLE, SEED AND CONTRACT BY SIZE GROUP

Group	Growers Producing for								Acres of Production for							
	Table		Seed		Contract		Combination		Table		Seed		Contract		Combination	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
I	15	25.0	0	0.0	0	0.0	0	0.0	124	1.2	0	0.0	0	0.0	0	0.0
II	11	18.3	1	1.7	0	0.0	0	0.0	405	3.8	44	0.4	0	0.0	0	0.0
III	5	8.3	0	0.0	2	3.3	2	3.3	363	3.4	0	0.0	190	1.8	153	1.4
IV	0	0.0	1	1.7	10	16.7	3	5.0	0	0.0	200	1.9	2,419	22.6	630	5.9
V	0	0.0	0	0.0	5	8.3	5	8.3	0	0.0	0	0.0	2,685	25.0	3,503	32.7
All	31	51.7	2	3.3	17	28.3	10	16.7	892	8.3	244	2.3	5,294	49.4	4,286	40.0

NOTE: Percent figures are rounded to nearest tenth.

APPENDIX C

TABLE XVI

ACREAGE AND NUMBER OF GROWERS PRODUCING FOR PROCESSING, TABLE STOCK AND SEED BY GROUP

Group	Number of Growers Producing for				Number of Acres for		
	Processing Only	Seed Only	Table Only	Combination	Processing	Seed	Table
I	0	0	15	0	0	0	124
II	0	1	11	0	0	44	405
III	2	0	5	2	295	0	411
IV	10	1	0	3	2,859	200	190
V	5	0	0	5	4,677	701	810
All	17	2	31	10	7,831	945	1,940

TABLE XVII

NUMBER AND PERCENT OF TOTAL GROWERS AND NUMBER AND PERCENT OF TOTAL POTATO ACRES ON MODERATELY COARSE AND MODERATELY FINE TEXTURED SOILS BY GROUP

Group	Growers on				Acreage of Potatoes on			
	Moderately Coarse		Moderately Fine		Moderately Coarse		Moderately Fine	
	No.	%	No.	%	No.	%	No.	%
I	1	1.7	14	23.3	10	0.1	114	1.1
II	2	3.3	10	16.7	74	0.7	375	3.5
III	5	8.3	4	6.7	398	3.7	308	2.9
IV	12.5	20.8	1.5	2.5	2,944	27.5	305	2.8
V	10	16.7	0	0.0	6,188	57.7	0	0.0
All	30.5	50.8	29.5	49.2	9,614	89.7	1,102	10.3

NOTE: Percent figures are rounded to nearest tenth.

TABLE XVIII

NUMBER OF GROWERS, RANGE AND AVERAGE POTATO ACREAGE, PERCENT OF OWNED CROPLAND IN POTATOES AND PERCENT OF POTATO ACREAGE ON RENTED LAND

Grower Size Group	Actual Range in Potato Acreage	Number of Growers	Average Potato Acreage	Percent of Owned Cropland in Potatoes	Percent of Potatoes on Rented Land
I	4 - 16	15	8.3	6.0	7.8
II	20 - 58	12	37.4	21.1	35.9
III	60 - 130	9	78.4	19.8	38.4
IV	190 - 285	14	232.1	16.7	64.1
V	360 - 1,540	10	618.8	19.6	78.7
All	4 - 1,540	60	178.6	18.5	68.3

TABLE XIX

ACREAGE AND PERCENT OF TOTAL ACREAGE PLANTED ON CEREAL, VEGETABLE, SUMMERFALLOW, POTATO, AND SUGAR BEET, SUNFLOWER OR FLAX LAND BY GROUP

Group	Potato Acreage	Potatoes Planted on: Cereal Acreage	Cereal %	Vegetable Acreage	Vegetable %	Summerfallow Acreage	Summerfallow %	Potato Acreage	Potato %	Sugar Beets, Sunflower & Flax Acreage	Sugar Beets, Sunflower & Flax %
I	124	109	1.0	10	0.1	5	0.0	0	0.0	0	0.0
II	449	372	3.5	4	0.0	7	0.1	56	0.5	10	0.1
III	706	608	5.7	18	0.2	30	0.3	25	0.2	25	0.2
IV	3,249	3,199	29.8	0	0.0	0	0.0	50	0.5	0	0.0
V	6,188	6,188	57.8	0	0.0	0	0.0	0	0.0	0	0.0
All	10,716	10,476	97.8	32	0.3	42	0.4	131	1.2	35	0.3

NOTE: Percent figures are rounded to nearest tenth.

TABLE XX

NUMBERS AND PERCENT OF GROWERS PRACTISING ONE, TWO, THREE AND FOUR OR MORE YEAR ROTATIONS BY GROUP

Group	Number of Growers[a] Who Follow a Rotation of							
	One Year		Two Years		Three Years		Four or More Years	
	No.	%	No.	%	No.	%	No.	%
I	0	0	4	7.7	7	13.4	4	7.7
II	1	1.9	4	7.7	4	7.7	1	1.9
III	0	0	2	3.8	4	7.7	3	5.8
IV	0	0	1	1.9	7	13.4	4	7.7
V	0	0	3	5.8	1	1.9	2	3.8
All	1	1.9	14	26.9	23	44.2	14	26.9

[a]Growers who rent their total land requirements are not included in the table.

NOTE: Percent figures are rounded to nearest tenth.

TABLE XXI

NUMBER AND PERCENT OF GROWERS USING CULTIVATOR, HARROWS, PLOW, AND DISK IN PREPARATION FOR PLANTING BY GROUP AND SEASON

	FALL TILLAGE														SPRING TILLAGE											
	Growers Using														Growers Using											
	No Preparation		Harrows				Cultivator				Plow		Other		Harrows		Cultivator				Plow		Other		No Preparation	
			Once		Twice		Once		Twice						Once		Twice									
Group	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
I	2	3.3	2	3.3	0	0	0	0	6	10.0	6	10.0	1	1.7	8	13.3	1	1.7	9	15.0	6	10.0	0	0	0	0	0	0
II	1	1.7	0	0	0	0	0	0	7	11.7	2	3.3	2	3.3	7	11.7	1	1.7	10	16.7	1	1.7	0	0	0	0	1	1.7
III	0	0	2	3.3	0	0	1	1.7	6	10.0	1	1.7	1	1.7	6	10.0	0	0	5	8.3	1	1.7	0	0	2	3.3	1	1.7
IV	0	0	2	3.3	0	0	8	13.3	3	5.0	2	3.3	1	1.7	10	16.7	0	0	11	18.3	0	0	2	3.3	0	0	1	1.7
V	1	1.7	2	3.3	1	1.7	4	6.7	4	6.7	0	0	1	1.7	6	10.0	0	0	8	13.3	1	1.7	0	0	1	1.7	0	0
All	4	6.7	8	13.3	1	1.7	13	21.7	26	43.3	11	18.3	6	10.0	37	61.7	2	3.3	43	71.7	9	15.0	2	3.3	3	5.0	3	5.0

NOTE: Percent figures rounded to nearest tenth.

TABLE XXII

NUMBER OF GROWERS APPLYING NITROGEN, PHOSPHORUS AND POTASH BY SOIL TYPE AND METHOD OF HANDLING BY GROUP

Group	Total No. of Growers	No. of Growers on Heavy Soil Applying			No. of Growers on Heavy Soil	No. of Growers on Light Soil Applying			No. of Growers on Light Soil	No. of Growers Not Applying Fertilizer		No. of Growers Handling Fertilizer by	
		N	P	K		N	P	K		Light Soil	Heavy Soil	Bulk	Bag
I	15	9	9	2	14.0	1	1	0	1.0	0	5	2	8
II	12	9	9	2	10.0	2	2	1	2.0	0	1	0	11
III	9	4	4	0	4.0	5	5	3	5.0	0	0	2	7
IV	14	1	1	0	1.5	13	13	12	12.5	0	0	8	6
V	10	0	0	0	0 0	10	10	7	10.0	0	0	8	2
All	60	23	23	4	29.5	31	31	23	30.5	0	6	20	34

TABLE XXIII

QUANTITY AND PERCENT OF TOTAL QUANTITY OF REGISTERED, ONE YEAR REMOVED AND MORE THAN ONE YEAR REMOVED SOURCES OF POTATOES FOR PLANTING BY SIZE GROUP

Group	Registered Source		Non-Registered Source	
	Quantity in Cwt.	% of Total Quantity	Quantity in Cwt.	% of Total Quantity
I	554	0.6	703	0.8
II	2,910	3.2	2,137	2.3
III	4,673	5.1	2,704	2.9
IV	23,085	25.2	643	0.7
V	54,273	59.2	0	0.0
All	85,495	93.3	6,187	6.7

NOTE: Percent figures are rounded to nearest tenth.

TABLE XXIV

NUMBER AND PERCENT OF GROWERS AND NUMBER AND PERCENT OF ACRES WHICH ARE PLANTED TO SEED OF REGISTERED SOURCE ONLY, REGISTERED AND NON-REGISTERED, AND NON-REGISTERED ONLY BY SIZE GROUP

Group	Registered Source Only				Registered and Non-Registered				Non-Registered Only			
	No. of Growers	% of Total Growers	No. of Acres	% of Total Acres	No. of Growers	% of Total Growers	No. of Acres	% of Total Acres	No. of Growers	% of Total Growers	No. of Acres	% of Total Acres
I	5	8.3	44	0.4	5	8.3	44	0.4	5	8.3	36	0.3
II	5	8.3	191	1.8	6	10.0	223	2.1	1	1.7	35	0.3
III	2	3.3	190	1.8	6	10.0	446	4.2	1	1.7	70	0.7
IV	12	20.0	2,969	27.7	2	3.3	280	2.6	0	0.0	0	0.0
V	10	16.7	6,188	57.7	0	0.0	0	0.0	0	0.0	0	0.0
All	34	56.6	9,582	89.4	19	31.6	993	9.3	7	11.7	141	1.3

NOTE: Percent figures are rounded to nearest tenth.

TABLE XXV

SEED CUTTING, TREATMENT AND HANDLING PRACTICES BY GROUP

Group	Whole Seed		Cut Seed		Combination		Wet Treatment		Dry Treatment		No Treatment		No. of Seed Cutters per Grower	No. of Seed Cutters per 100 Acres	Cwt. of Seed Handled in Bulk		Cwt. of Seed Handled in Bags		Growers Handling Seed By Bulk		Growers Handling Seed By Bags	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%			No.	%	No.	%	No.	%	No.	%
I	1	1.7	14	23.3	0	0.0	0	0.0	2	3.3	13	21.7	.27	.31	0	0.0	1,257	1.4	0	0.0	15	25.0
II	0	0.0	11	18.3	1	1.7	0	0.0	2	3.3	10	16.7	.46	.82	0	0.0	5,047	5.5	0	0.0	12	20.0
III	0	0.0	8	13.3	1	1.7	0	0.0	3	5.0	6	10.0	.78	.99	1,330	1.4	6,047	6.6	2	3.3	7	11.7
IV	0	0.0	14	23.3	0	0.0	1	1.7	13	21.7	0	0.0	.93	.31	15,898	17.3	7,830	8.5	10	16.7	4	6.7
V	0	0.0	10	16.7	0	0.0	0	0.0	10	16.7	0	0.0	1.40	.22	50,823	55.4	3,450	3.8	9	15.0	1	1.7
All	1	1.7	57	95.0	2	3.3	1	1.7	30	50.0	29	48.3	.68	.38	68,051	74.2	23,631	25.8	21	35.0	39	65.0

NOTE: Percent figures are rounded to nearest tenth.

TABLE XXVI

PLANTER SIZES AND AVERAGE ACRES PLANTED PER PLANTER ROW BY GROUP

Group	Number of Planters with			Average Acreage Planted Per Row of Planting Equipment
	One Row	Two Rows	Four Rows	
I	4	11	0	4.77
II	0	12.5[a]	0	17.96
III	0	7	2	32.09
IV	0	1	13	60.17
V	0	0	13	119.0
All	4	31.5	28	59.87

[a]One grower has 50% ownership in a planter.

TABLE XXVII

AVERAGE NUMBER OF WEED CONTROL OPERATIONS PER GROWER BY GROUP

Group	Average Number of			
	Harrowings per Grower	Cultivations and Hillings per Grower	Hoeings per Grower	Weed Control Operations per Grower
I	0.07	3.93	.73	4.73
II	0.08	4.75	.67	5.50
III	1.33	3.56	.59	5.48
IV	1.78	4.21	.11	6.10
V	3.00	4.10	.10	7.20
All	1.14	4.13	.45	5.72

TABLE XXVIII

AVERAGE NUMBER OF PEST CONTROL OPERATIONS PER GROWER BY GROUP

Group	Average Number of Applications of		Average Number of Applications per Grower
	Insecticides	Fungicides	
I	1.67	0.40	1.67
II	1.67	0.33	1.67
III	1.78	1.11	1.78
IV	2.00	2.07	2.07
V	2.90	3.00	3.00
All	1.97	1.31	2.00

TABLE XXIX

NUMBER AND PERCENT OF GROWERS USING VINE KILLERS, ROTOBEATERS, NO PREPARATION OR A COMBINATION OF TECHNIQUES AS PREPARATION FOR HARVEST BY GROUP

Group	Vine Killing		Rotobeating		No Preparation		Combination of Vine Killing and Rotobeating		Combination of Vine Killing and no Preparation	
	No.	%	No.	%	No.	%	No.	%	No.	%
I	0	0	14	23.3	0	0.0	1	1.7	0	0.0
II	0	0	12	20.0	0	0.0	0	0.0	0	0.0
III	0	0	8	13.3	1	1.7	0	0.0	0	0.0
IV	0	0	8	13.3	6	10.0	0	0.0	0	0.0
V	0	0	3	5.0	2	3.3	0	0.0	5	8.3
All	0	0	45	75.0	9	15.0	1	1.7	5	8.3

NOTE: Percent figures rounded to nearest tenth.

TABLE XXX

NUMBER AND PERCENT OF GROWERS USING THE FIVE ALTERNATIVE METHODS OF HARVEST BY GROUP

Group	Harvesting Methods[a]									
	One		Two		Three		Four		Five	
	No.	%	No.	%	No.	%	No.	%	No.	%
I	13	21.7	2	3.3	0	0.0	0	0.0	0	0.0
II	8	13.3	2	3.3	0	0.0	2	3.3	0	0.0
III	0	0.0	6	10.0	0	0.0	3	5.0	0	0.0
IV	0	0.0	1	1.7	0	0.0	12	20.0	1	1.7
V	0	0.0	0	0.0	0	0.0	8	13.3	2	3.3
All	21	35.0	11	18.3	0	0.0	25	41.7	3	5.0

[a]For a description of harvesting methods see Chapter V, p. 74.

NOTE: Percent figures are rounded to nearest tenth.

TABLE XXXI

HARVESTER AND DIGGER SIZES AND AVERAGE ACRES HARVESTED PER ROW OF MACHINE BY GROUP

Group	No. of Harvesters with			No. of Diggers with		Average Acreage Lifted/Row of	
	One Row	Two Rows	Two Rows and Windrower(s)	One Row	Two Rows	Harvester and Windrower	Digger
I	0	0	0	8	7	0	5.64
II	1	1	0	2	7	25.67	22.00
III	0	2	0	0	6	50.00	37.17
IV	0	12	1	0	1	108.54	105.00
V	0	20	2	0	0	134.52	0
All	1	35	3	10	21	114.71	18.58

TABLE XXXII

NUMBER AND PERCENT OF GROWERS PILING POTATOES MANUALLY AND MECHANICALLY BY GROUP

Group	Growers Piling				No. of Seventy-five Pound Bags Handled			
	Manually		Mechanically		Manually		Mechanically	
	No.	%	No.	%	No.	%	No.	%
A	11	25.6	5	11.6	12,770	2.5	7,612	1.5
B	1	2.3	11	25.6	6,880	1.3	54,716	10.5
C	1	2.3	14	32.6	9,976	1.9	428,888	82.3
All	13	30.2	30	69.8	29,626	5.7	491,261	94.3

NOTE: Percent figures are rounded to nearest tenth.

TABLE XXXIII

NUMBER AND PERCENT OF GROWERS OWNING AND RENTING STORAGES, WITH ABOVE GROUND, BELOW GROUND AND HOUSE BASEMENT STORAGE, AND NUMBER AND PERCENT OF SEVENTY-FIVE POUND BAGS IN ABOVE GROUND, BELOW GROUND AND BASEMENT STORAGE BY GROUP

Group	Growers Using Storage									Seventy-five Pound Bags Stored					
	Owning Storage		Renting Storage		Above Ground		Below Ground		House Basement		Above Ground		Below Ground		House Basement	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
A	16	37.2	0	0.0	4	9.3	5	11.6	7	16.2	6,241	1.2	7,386	1.4	6,755	1.3
B	12	27.9	0	0.0	3	7.0	9	21.0	0	0.0	14,880	2.8	46,761	9.0	0	0.0
C	13	30.2	2	4.7	11	25.6	4	9.3	0	0.0	351,426	67.5	87,438	16.8	0	0.0
All	41	95.3	2	4.7	18	41.9	18	41.9	7	16.2	372,547	71.5	141,585	27.2	6,755	1.3

NOTE: Percent figures are rounded to nearest tenth.

TABLE XXXIV

NUMBER AND PERCENT OF ALL GROWERS GRADING BY HAND, MACHINE DRY AND MACHINE WASHED AND NUMBER OF ALL SEVENTY-FIVE POUND BAGS GRADED BY HAND, MACHINE DRY AND MACHINE WASHED BY GROUP

Group	Growers Grading By Hand		Growers Grading by Machine						75 lb. Bags Graded By Hand		75 lb. Bags Graded by Machine					
			Dry		Washed		Total Machine				Dry		Washed		Total Machine	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
A	11	25.5	5	11.6	0	0.0	5	11.6	12,497	2.4	7,885	1.5	0	0.0	7,885	1.5
B	3	7.0	8	18.6	1	2.3	9	20.9	12,979	2.5	44,662	8.6	4,000	0.8	48,662	9.3
C	0	0.0	12	27.9	3	7.0	15	34.9	0	0.0	244,464	46.9	194,400	37.3	438,864	84.3
All	14	32.6	25	58.1	4	9.3	29	67.4	25,476	4.9	297,011	57.0	198,400	38.1	495.411	95.1

NOTE: Percent figures are rounded to nearest tenth.

TABLE XXXV

NUMBER AND PERCENT OF TOTAL GROWERS AND NUMBER AND PERCENT OF TOTAL PRODUCTION DELIVERED IN TRUCKS WITH OPEN BOXES AND INSULATED VANS BY GROUP

Group	Growers Delivering with				Number of 75 Pound Bags Delivered with			
	Open Box		Insulated Van		Open Box		Insulated Van	
	No.	%	No.	%	No.	%	No.	%
A	11	26.8	5	12.2	11,949	2.5	8,433	1.8
B	5	12.2	6	14.6	25,374	5.4	33,920	7.1
C	13	31.8	1	2.4	10,450	2.2	384,414	81.0
All	29	70.7	12	29.3	47,773	10.1	426,767	89.9

NOTE: Percent figures are rounded to nearest tenth.

TABLE XXXVI

POTATO PRODUCTION LABOUR USE IN HOURS PER ACRE BY GROUP

	Seed Bed Preparation			Cutting and Planting			Weed Control and Hilling			Spraying			Harvesting Operations			
Group	Family	Hired	Total	Family	Hired	Total	Family	Hired	Total	Family	Hired	Total	Family	Hired	Total	Total
I	1.92	0.0	1.92	7.05	0.39	7.44	9.40	0.0	9.40	0.45	0.0	0.45	8.19	23.85	32.04	51.25
II	1.30	0.05	1.35	2.51	0.71	3.22	4.48	0.38	4.86	0.22	0.03	0.25	5.41	21.15	26.56	36.24
III	1.12	0.0	1.12	1.54	0.31	1.85	2.73	0.87	3.60	0.27	0.01	0.28	3.77	10.22	13.99	20.84
IV	0.16	0.24	0.40	0.67	1.05	1.72	0.58	0.50	1.08	0.12	0.01	0.22	1.36	7.38	8.74	12.16
V	0.05	0.42	0.47	0.13	0.97	1.10	0.08	0.75	0.83	0.12	0.30	0.51	0.25	7.21	7.46	10.37
All	0.23	0.32	0.55	0.57	0.93	1.50	0.70	0.66	1.36	0.19	0.21	0.40	1.13	8.24	9.37	13.18

NOTE: Weighted averages.

TABLE XXXVII

MARKET PREPARATION LABOUR USE IN HOURS PER SEVENTY-FIVE POUND BAG BY GROUP

Group	Grading and Loading			Transport			Total
	Family	Hired	Sub-Total	Family	Hired	Sub-Total	
A	.152	.011	.163	.037	.002	.039	.202
B	.108	.019	.127	.015	.001	.016	.143
C	.016	.087	.103	.003	.006	.009	.112
All	.032	.076	.108	.006	.005	.011	.119

NOTE: Weighted averages.

TABLE XXXVIII

INVESTMENT, DEPRECIATION, INTEREST, AND GENERAL OVERHEAD FOR PRODUCTION EQUIPMENT PER ACRE BY GROUP

Group	Investment	Depreciation	Interest	General Overhead
I	$ 81.12	$ 12.97	$ 6.49	$ 7.63
II	72.25	11.38	5.78	4.72
III	76.38	12.50	6.11	3.87
IV	74.50	12.71	5.96	2.12
V	71.62	12.71	5.73	5.26
All	$ 73.00	$ 12.64	$ 5.84	$ 4.22

NOTE: Weighted averages.

TABLE XXXIX

VARIABLE COSTS OF PRODUCTION PER ACRE BY SIZE GROUP

Group	Equipment Repairs	Seed	Fertilizer	Chemicals	Labour	Fuel & Oil	Land Rental	Custom and Rentals	Sub-Total	Interest	Total
I	$ 4.74	$ 30.38	$ 6.20	$ 3.65	$ 68.87	$ 4.50	$ 12.56	$ 0.94	$ 131.84	$ 5.27	$ 137.11
II	5.48	30.89	8.23	3.17	46.39	3.98	10.63	0.84	109.61	4.38	113.99
III	6.52	28.67	10.94	2.84	29.38	3.52	10.32	3.52	95.71	3.84	99.55
IV	8.21	23.40	14.81	5.85	16.25	2.96	10.72	2.91	85.11	3.40	88.51
V	9.99	27.89	14.51	7.65	14.70	3.05	13.59	1.82	93.20	3.73	96.93
All	$ 8.97	$ 26.73	$ 14.01	$ 6.55	$ 18.09	$ 3.11	$ 12.37	$ 2.21	$ 92.04	$ 3.68	$ 95.72

NOTE: Weighted averages.

TABLE XL

ORIGINAL STORAGE AND EQUIPMENT INVESTMENT, AND FIXED STORAGE AND EQUIPMENT COSTS FOR SEVENTY-FIVE POUND BAG STORED BY GROUP

	Storage			Equipment		
Group	Original Investment	Depreciation	Interest	Original Investment	Depreciation	Interest
A	$ 1.08	$ 0.054	$ 0.032	$ 0.400	$ 0.056	$ 0.028
B	0.72	0.036	0.021	0.262	0.023	0.012
C	0.52	0.026	0.016	0.212	0.015	0.007
All	$ 0.57	$ 0.028	$ 0.017	$ 0.212	$ 0.015	$ 0.008

NOTE: Weighted averages.

TABLE XLI

VARIABLE COSTS OF MARKET PREPARATION PER SEVENTY-FIVE POUND BAG BY SIZE GROUP

Group	Storage Repairs	Equipment Repairs	Grading & Loading Labour	Transport Labour	Sub-Total	Interest	Sub-Total	Containers	Total
A	$ 0.023	$ 0.021	$ 0.230	$ 0.057	$ 0.331	$ 0.007	$ 0.338	$ 0.166	$ 0.504
B	.014	.019	.188	.022	.243	.005	.248	.162	.410
C	.010	.011	.122	.014	.157	.003	.160	.181	.341
All	$ 0.011	$ 0.012	$ 0.134	$ 0.016	$ 0.173	$ 0.003	$ 0.176	$ 0.178	$ 0.354

NOTE: Weighted averages.

APPENDIX D

TABLE XLII

ANALYSIS OF VARIANCE, ONE-WAY CLASSIFICATION WITH UNEQUAL NUMBERS IN THE GROUPS

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F (Calculated)
Between groups ...	G - 1	$\sum \frac{X_G^2}{n_G} - C$ = Between SS	$\frac{\text{Between SS}}{G - 1}$ = Between MS	$\frac{\text{Between MS}}{\text{Within MS}} = f$
Within groups	n - G	Total SS - Between SS = Within SS	$\frac{\text{Within SS}}{n - G}$ = Within MS	
Total	n - 1	$\sum_{ij} X_{ij}^2 - C$ = Total SS		

APPENDIX E

TABLE XLIII

CURRENT VALUE PER DOLLAR OF ORIGINAL INVESTMENT IN EQUIPMENT BY YEARS SINCE PURCHASE WAS MADE

Year	Equipment Type[a]					
	A	B	C	D	E	F
1	.800	.750	.800	.850	.700	.900
2	.680	.600	.640	.722	.560	.810
3	.578	.480	.512	.614	.448	.729
4	.491	.384	.410	.522	.381	.656

[a]Type "A" includes equipment with a reducing balance depreciation rate of 50 percent for the first year, and 15 percent for each year thereafter. Type "B" includes equipment with a reducing balance depreciation rate of 25 percent for the first year, and 20 percent for each year thereafter. Type "C" includes equipment with a reducing balance depreciation rate of 20 percent each year. Type "D" includes equipment with a depreciation rate of 15 percent for each year. Type "E" includes equipment with a depreciation rate of 30 percent for the first year, 20 percent for each of the next two years, and 15 percent for each year thereafter. Type "F" includes equipment with a reducing balance depreciation rate of 10 percent each year.

Type "A" includes tractors, generators, and fork lifts bought new in 1968, or trucks which were purchased in 1968 as "used" equipment which was originally new in 1966. Type "B" includes harvesters, diggers, and windrowers bought new in 1968. Type "C" includes seed cutters, planters, fertilizer boxes, sprayers, and "B" type equipment bought "used" and which was originally "new" in 1967. Type "D" includes tillage equipment, pilers, sack loaders, bulk loaders, graders, washers, brushers, tractors bought as "used" equipment which was at least three years old at the time of purchase by the grower. Type "E" includes "new" trucks. Type "F" includes potato bulk boxes, pallet movers, scales, box dumpers, and vans.

TABLE XLIII (continued)

Year	Equipment Type[a]					
	A	B	C	D	E	F
5	.418	.307	.328	.444	.324	.590
6	.355	.246	.262	.377	.275	.531
7	.320	.197	.210	.320	.234	.478
8	.256	.157	.168	.272	.199	.430
9	.218	.126	.134	.232	.169	.387
10	.185	.101	.107	.197	.144	.349
11	.158	.080	.086	.167	.122	.314
12	.134	.064	.069	.142	.104	.282
13	.114	.052	.055	.121	.088	.254
14	.097	.041	.044	.103	.075	.229
15	.082	.033	.035	.087	.064	.206
16	.070	.026	.028	.074	.054	.185
17	.059	.021	.022	.063	.046	.167
18	.050	.017	.018	.054	.039	.150
19	.043	.014	.014	.046	.033	.135
20	.036	.011	.012	.039	.028	.122
21	.031	.009	.009	.033	.024	.109
22	.026	.007	.007	.028	.020	.098
23	.022	.006	.006	.024	.017	.088
24	.019	.005	.005	.020	.014	.080
25	.016	.004	.004	.017	.012	.072

APPENDIX F

TABLE XLIV

GROUP MEANS, CALCULATED "F" VALUE, AND SIGNIFICANCE LEVEL FOR FACTORS OF POTATO PRODUCTION PER ACRE

Factor	Mean Values for the Groups					Calculated "F"	Significance Level[a]
	I	II	III	IV	V		
Land rent ($)	12.13	10.21	10.33	10.79	13.20	1.57	ns
Quantity of registered seed (cwt.)	4.12	6.14	6.56	6.86	8.36	2.24	ns
Quantity of non-registered seed (cwt.)	6.01	3.45	3.05	0.23	0.00	7.37	**
Registered seed cost ($)	15.38	20.34	21.25	23.02	27.18	1.58	ns
Non-registered seed cost ($)	14.74	10.72	8.03	0.63	0.00	6.70	**
Total seed cost ($)	29.96	29.84	27.22	23.65	27.18	1.44	ns
Fertilizer cost ($)	6.00	8.22	10.89	14.84	14.21	11.13	**
Hours of labour for cutting seed	5.47	1.84	0.80	0.73	0.34	10.16	**
Hours of labour for planting	1.97	1.27	1.11	0.74	0.76	10.20	**
Hours of labour for weed control	9.00	6.70	3.75	1.12	0.79	6.69	**
Hours of labour for spraying	0.48	0.25	0.26	0.22	0.56	2.67	*
Hours of labour for harvesting	32.70	26.31	14.30	9.00	7.31	24.61	**
Family hours of labour prior to harvest	18.68	8.46	5.90	1.38	0.57	43.27	**
Hired hours of labour prior to harvest	0.21	0.86	1.22	1.73	2.31	5.32	**
Family hours of labour for harvest	8.67	5.53	3.71	1.39	0.31	19.59	**
Hired hours of labour for harvest	24.02	20.78	10.60	7.41	7.00	14.06	**
Total hours of family labour for production	26.95	13.99	9.67	2.80	0.88	45.54	**
Total hired hours of labour for production	24.24	20.62	11.82	9.21	9.78	10.81	**
Total labour hours for production	51.66	36.00	21.43	12.83	9.53	51.48	**
Family labour cost prior to harvest ($)	26.93	11.76	8.20	2.04	0.93	32.29	**
Hired labour cost prior to harvest ($)	0.18	1.53	1.48	2.33	3.29	5.17	**
Family labour cost for harvest ($)	13.27	8.65	5.95	1.95	0.55	14.34	**
Hired labour cost for harvest ($)	28.17	24.81	11.85	10.17	10.06	13.21	**
Total harvest labour cost ($)	41.44	33.46	17.81	12.12	10.60	24.92	**
Family labour cost for production ($)	40.20	20.41	14.16	3.99	1.47	30.41	**
Hired labour cost for production ($)	28.35	26.34	13.34	12.50	13.35	10.89	**
Total cost of labour for production ($)	68.55	46.76	27.51	16.42	14.82	47.18	**
Seed treatment chemical cost ($)	0.08	0.14	0.38	1.17	1.26	26.51	**
Insecticide cost ($)	1.92	2.37	1.78	2.08	2.74	0.70	ns

[a] ** = Calculated "F" value significant at the 1 percent level.
* = Calculated "F" value significant at the 5 percent level.
ns = Calculated "F" value not significant at the 5 percent level.

TABLE XLIV (continued)

Factor	Mean Values for the Groups					Calculated "F"	Significance Level
	I	II	III	IV	V		
Fungicide cost ($)	0.30	0.54	0.65	2.50	3.54	11.66	**
Total cost of chemicals ($)	2.29	3.06	2.81	5.75	7.54	7.81	**
Machinery depreciation ($)	13.09	11.16	12.11	12.56	12.87	0.21	ns
Interest on machinery investment ($)	6.55	5.71	5.96	5.92	5.84	0.18	ns
Repair cost on machinery ($)	4.62	5.47	6.98	8.26	9.86	11.69	**
Repair cost on harvest equipment ($)	0.46	1.45	2.26	5.71	6.82	25.37	**
Custom and rental cost (except land) ($)	1.18	1.45	4.49	2.89	1.66	0.64	ns
General overhead costs ($)	8.06	4.91	3.96	2.19	5.38	5.42	**
Fuel and oil cost ($)	4.46	4.02	3.49	2.99	2.99	7.21	**
Cost of machinery investment to potatoes if all equipment was new ($)	1,226.87	518.75	370.78	231.00	183.40	32.07	**
Total harvesting cost ($)	45.96	44.63	32.10	30.82	29.03	9.81	**
Total cost of production ($)	162.39	135.40	119.65	109.78	119.43	13.35	**
Yield per acre (seventy-five pound bags)	152.60	158.58	164.67	177.86	200.00	5.11	**
Fixed cost of production ($)	27.96	21.97	22.19	20.72	24.30	1.21	ns
Variable cost of production ($)	134.43	113.43	97.46	89.06	95.13	12.12	**

TABLE XLV

GROUP MEANS, CALCULATED "F" VALUE AND SIGNIFICANCE LEVEL FOR FACTORS OF POTATO PRODUCTION PER SEVENTY-FIVE POUND BAG

Factor	Mean Values for the Group					Calculated "F"	Significance Level[a]
	I	II	III	IV	V		
Land rent ($)	0.082	0.067	0.064	0.061	0.066	1.66	**
Quantity of registered seed (cwt.)	0.027	0.041	0.041	0.039	0.043	0.92	ns
Quantity of non-registered seed (cwt.)	0.040	0.022	0.019	0.002	0.000	7.39	**
Registered seed cost ($)	0.101	0.136	0.129	0.131	0.139	0.55	ns
Non-registered seed cost ($)	0.097	0.076	0.049	0.004	0.000	6.49	**
Total seed cost ($)	0.196	0.201	0.168	0.135	0.139	3.90	**
Fertilizer cost ($)	0.039	0.055	0.067	0.084	0.071	6.56	**
Hours of labour for cutting seed	0.035	0.013	0.005	0.004	0.002	11.87	**
Hours of labour for planting	0.013	0.009	0.007	0.004	0.004	10.45	**
Hours of labour for weed control	0.060	0.053	0.023	0.007	0.004	4.05	**
Hours of labour for spraying	0.003	0.002	0.002	0.001	0.003	2.65	*
Hours of labour for harvesting	0.214	0.181	0.091	0.052	0.037	23.98	**
Family hours of labour prior to harvest	0.123	0.059	0.037	0.008	0.003	31.36	**
Hired hours of labour prior to harvest	0.002	0.006	0.008	0.010	0.011	2.72	*
Family hours of labour for harvest	0.057	0.038	0.023	0.008	0.002	17.54	**
Hired hours of labour for harvest	0.157	0.143	0.068	0.043	0.036	14.27	**
Total family hours of labour for production	0.178	0.097	0.060	0.016	0.005	33.17	**
Total hired hours of labour for production	0.159	0.139	0.076	0.053	0.050	12.16	**
Total labour hours for production	0.340	0.249	0.136	0.076	0.048	40.65	**
Family labour cost prior to harvest ($)	0.178	0.082	0.051	0.012	0.005	28.97	**
Hired labour cost prior to harvest ($)	0.002	0.011	0.009	0.013	0.016	3.21	*
Family labour cost for harvest ($)	0.088	0.058	0.038	0.011	0.003	14.18	**
Hired labour cost for harvest ($)	0.185	0.171	0.076	0.058	0.051	13.75	**
Total harvest labour cost ($)	0.273	0.229	0.114	0.070	0.054	24.32	**
Family labour cost for production ($)	0.265	0.140	0.088	0.023	0.008	27.95	**
Hired labour cost for production ($)	0.187	0.181	0.086	0.071	0.067	12.04	**

[a] ** = Calculated "F" value significant at the 1 percent level.
* = Calculated "F" value significant at the 5 percent level.
ns - Calculated "F" value not significant at the 5 percent level.

TABLE XLV (continued)

Factor	Mean Values for the Group					Calculated "F"	Significance Level
	I	II	III	IV	V		
Labour cost for production ($)	0.452	0.321	0.173	0.094	0.075	40.63	**
Seed treatment chemical cost ($)	0.000	0.001	0.002	0.007	0.006	19.23	**
Insecticide cost ($)	0.013	0.015	0.011	0.011	0.014	0.57	ns
Fungicide cost ($)	0.002	0.003	0.003	0.013	0.018	11.01	**
Total chemical cost ($)	0.015	0.019	0.016	0.032	0.038	6.21	**
Machinery depreciation ($)	0.086	0.076	0.075	0.071	0.065	0.53	ns
Interest on machinery investment ($)	0.043	0.039	0.037	0.033	0.030	0.86	ns
Repair cost on machinery ($)	0.031	0.038	0.043	0.047	0.049	3.49	**
Repair cost on harvesting equipment ($)	0.003	0.011	0.013	0.032	0.035	18.19	**
Custom and rental costs (except land)	0.008	0.008	0.023	0.016	0.009	0.61	ns
General overhead cost ($)	0.054	0.033	0.025	0.012	0.027	5.62	**
Fuel and oil cost ($)	0.030	0.028	0.021	0.017	0.015	9.93	**
Machinery investment cost to potatoes if all machinery was new ($)	0.080	0.036	0.023	0.013	0.009	35.87	**
Total harvesting cost ($)	0.304	0.305	0.197	0.175	0.148	13.30	**
Total cost of production ($)	1.072	0.917	0.736	0.622	0.603	17.45	**
Fixed cost of production ($)	0.185	0.150	0.138	0.117	0.122	2.20	ns
Variable cost of production ($)	0.887	0.767	0.598	0.505	0.481	17.23	**

TABLE XLVI

GROUP MEANS, CALCULATED "F" VALUE WITH SIGNIFICANCE LEVEL FOR FACTORS OF POTATO MARKET PREPARATION PER SEVENTY-FIVE POUND BAG

Factor	Mean Values for the Groups			Calculated "F"	Significance Level[a]
	A	B	C		
Total storage cost (all growers)($)	0.097	0.095	0.060	0.98	ns
Total storage cost for those growers with potato storages ($)	0.172	0.095	0.063	8.19	**
Depreciation on equipment ($)	0.053	0.021	0.014	2.47	ns
Interest on equipment ($)	0.300	0.011	0.007	2.80	ns
Repairs to equipment ($)	0.023	0.020	0.010	1.69	ns
Total labour for grading	0.131	0.135	0.093	2.28	ns
Total labour hours for transport	0.039	0.015	0.012	6.95	**
Labour cost for grading ($)	0.200	0.179	0.109	4.78	*
Labour cost for grading and loading ($)	0.218	0.193	0.116	5.31	**
Labour cost for transport ($)	0.058	0.021	0.016	6.09	**
Labour cost for those who do their own trucking ($)	0.057	0.023	0.020	4.60	*
Total labour cost for market preparation ($)	0.280	0.214	0.133	8.16	**
Total market preparation cost less bags ($)	0.483	0.361	0.226	13.63	**
Total market preparation cost ($)	0.647	0.519	0.407	11.56	**
Fixed cost of market preparation ($)	0.161	0.108	0.072	3.15	ns
Variable cost of market preparation (less bags) ($)	0.322	0.253	0.154	9.93	**

[a] ** = Calculated "F" value significant at the 1 percent level.
* = Calculated "F" value significant at the 5 percent level.
ns = Calculated "F" value not significant at the 5 percent level.

APPENDIX G

EQUIPMENT REPAIR COSTS

Given:

$$T.A.R. = A(X)^t,$$

where T.A.R. = total accumulated repairs as a percent of manufacturers suggested retail price,

A = a coefficient which is expressed in percent and changes as the type of equipment analysed differs,*

t = a coefficient which changes as the type of equipment analysed differs,*

X = total accumulated hours as a percent of life-time hours.

Then:

$$RT = P_r(A(X)^t)$$

where RT = total accumulated repair cost in dollars,

P_r = current replacement cost in dollars.

Assume equipment is used the same number of hours each year.

Then:

$$HT = Y(HO)$$

where HT = total hours of operation,

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*The American Society of Agricultural Engineers, Agricultural Engineers Yearbook (St. Joseph, Michigan: American Society of Agricultural Engineers, 1966), Figure 4, p. 257.

Y = age of equipment in years,

HO = annual operation hours;

and

$$X = 100(HT/HW)$$

where HW = total life-time hours.

Therefore, for a given year:

$$R = P_r(A/100)\left[\left(\frac{(HO)(Y)(100)}{HW}\right)^t - \left(\frac{(HO)(Y-1)(100)}{HW}\right)^t\right]$$

where R = the annual repair cost of equipment.