# THE COST OF HANDLING AND STORING GRAIN

# IN MANITOBA COUNTRY GRAIN ELEVATORS

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A Thesis

Presented to

The Faculty of Graduate Studies and Research

University of Manitoba

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In Partial Fulfilment

of the Requirements for the Degree

Master of Science

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by

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May 1967

ACKNOWLEDGMENTS

The author wishes to express his deep debt of gratitude to all those persons to whom he is indebted in the preparation of this thesis.

Special thanks go to his thesis supervisor, Professor Om P. Tangri, whose kind words, constructive criticisms and encouragement made the undertaking and completion of this work a pleasant memory. I would also like to thank Professor A.W. Wood and Professor A.K. Storgaard who took time from their busy schedules not only to read the draft but also to offer invaluable suggestions. Many thanks go out to my fellow graduate students and the secretarial staff of the Department of Agricultural Economics who helped in many technical matters.

Financial assistance was provided by the Department of Agricultural Economics and is gratefully acknowledged.

Thanks are also due to Mr. Niel Longmuir who graciously consented to undertake the drawing of the figures.

Last but by no means least I would like to express my sincerest appreciation to Mr. S. Searle Jr., Mr. W. MacDonnell and to Mr. J. Candlish for their undivided attention in matters concerning the collection of data at their respective companies.

TABLE OF CONTENTS

## LIST OF TABLES

LIST OF FIGURES

ABSTRACT

THE COST OF HANDLING AND STORING
GRAIN IN MANITOBA COUNTRY
GRAIN ELEVATORS

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1967

Branch line abandonment as proposed by the Royal Commission on Transportation in 1961 has concerned farmers, grain handling firms and others who are dependent upon the services provided by the railways. To the grain elevator companies rail line abandonment will mean a loss of revenue producing sites. In order for these firms to make rational decisions about the size and location of grain elevators, information on the cost of handling and storing grain is essential. This study was set up to analyze the cost structure of the Manitoba grain elevator industry for the crop years 1961/62, 1962/63 and 1963/64. The basis for the study is cost and grain handlings for the above three year period. The mathematical tool employed to discover functional relationships is regression analysis.

The study was designed to discover the average cost for the entire industry for this period as well as to analyze what effect size, utilization and annex capacity have upon the cost structure.

In order to study the effect of size it was necessary to stratify the grain elevators into five size groups. Costs were then studied for each group as well as for the industry as a whole.

Major findings of the study are:

1. The estimated total average cost of handling and storing grain for the entire industry, during this period, was 9.54 cents per bushel per year with a standard error of 2.39 cents.
2. The most important single cost reducing factor in the grain elevator industry is the handling to capacity ratio.
3. For the industry as a whole the average per bushel cost of handling and storing grain decreases by one-half cent when the annex to capacity ratio increases by ten per cent.
4. For the industry as a whole the average per bushel cost of handling and storing grain decreases by approximately three-tenths of a cent when the utilization of the plant increases by ten per cent.

# CHAPTER I

## INTRODUCTION

### (A) SETTING FOR THE PROBLEM

The application for railway branch line abandonment is a current matter of concern affecting the entire grain industry of Western Canada. The railway companies contend that some branch lines have become uneconomic to maintain because of the low density of traffic on them. They argue, therefore, that they must either abandon these lines or be subsidized for the continued use of the uneconomic lines.

The low density of traffic on many branch lines is partly the result of the advances made in highway construction, and trucks which are capable of carrying a large payload. If there is an adequate network of good roads, the advantage that trucks have over rail, for relatively short hauls, is a low handling charge attributable to fixed facilities. This point is shown in Figure 1 below.[1] Overhead costs are substantially less for trucks than for railroads, whereas the opposite is true for the variable hauling cost. The result is that trucking operations have a competitive advantage over railroads for relatively short hauls.

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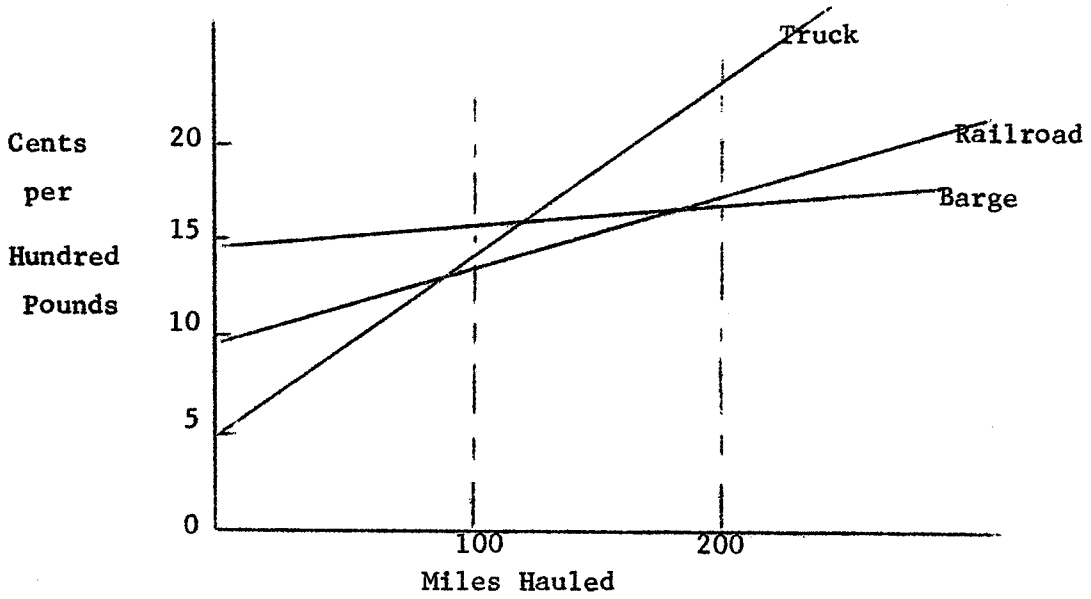
[1] C.P. Kindleburger, International Economics, Third Edition, Richard D. Irwin, Inc., Homewood, Illinois 1963, p. 145.

Figure I - Effect of Length of Haul Upon Average Cost of Hauling




Abandonment is of concern not only to the railroad companies but also to government agencies, farmers and farm organizations and last, but not least, to the grain elevator companies. Farmers and farm organizations are concerned with branch line abandonment because it will create hardships on towns and villages which rely upon the railways and may also force some farmers to drive unduly long distances in order to arrive at the nearest elevator unaffected by abandonment. The following passages are representative of farm organization views on the subject.

> We want to be sure that any decision made regarding the abandonment of branch lines takes into consideration, not only the dollar and cent effects on the railways, but also the economic and social effects on rural people and their communities. It must not be permitted to happen that farmers are left out in the

> wilderness having to drive unduly long distances to get to the closest place of business.[2]
>
> This policy (of abandonment on the part of the railways) will cause hardships in some communities and create difficulties in transporting goods to markets in other areas ..... Every attempt (should) be made by the Manitoba Government to provide all weather market roads for farmers in these areas prior to abandonment of the branch line.[3]
>
> We recommend that the government and Board of Transport Commissioners insist that a long range plan for abandonment and relocation of displaced elevators and other facilities should be developed that will embrace in one plan the operations of both railways.[4]

The grain elevator companies are concerned about railway line abandonment since it will mean the loss of revenue producing sites plus a possible loss of aggregate patronage if a producer, under changed circumstances, should select a site at which any particular grain elevator company is not represented. Since the grain elevator industry operates as a regulated oligopoly[5], the average revenue or demand curve for the services of any particular firm, at

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[2] Submission to the Government of Canada by the National Farmers Union, Jan. 31, 1962 as quoted by B.G. Lagace: Some Implications of Railway Branch Line Abandonment for Location and Capacity of Country Elevators in Western Canada. Unpublished Master's Thesis, The University of Manitoba, March 1963, pp. 42-43.

[3] Ibid., p. 43, Presentation to the Premier and Members of the Cabinet by the Manitoba Federation of Agriculture, Feb. 3, 1961.

[4] Loc. cit.

[5] The industry is termed oligopolistic since there is only a small number of independent grain elevator companies and because there are limited substitutes to handling and storing grain other then at country elevators.

a given site, is perfectly elastic.[6] If it is assumed that the average total cost curve of any grain elevator is a monotonic decreasing function of total grain handled, over all ranges of handling, then in order for grain elevator firms to maximize profits, it is essential that they maximize their total handling. It follows then that no firm would wish to lose a present or potential customer because of rail line abandonment. The grain elevator companies would tend to resist a change unless they were represented at every point and could be confident in not losing a patron because of any changes.

The government and its agencies are concerned with the problems of all parties involved since it either determines or negotiates the returns allocated to the various interested parties. Besides, the social and political implications of rail line abandonment may be too important for the governments at the municipal, provincial and national levels to either treat the issue in strictly economic terms or take a neutral position of non-interference.

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[6]The demand curve is perfectly elastic since the service rates are fixed regardless of the total amount of grain handled.

## (B) OBJECTIVES AND SCOPE OF THE STUDY

The grain elevator industry is a necessary and integral part of the marketing system for Western Canada's large cereal grain crops. Over the past twenty years, technical advances in agricultural machinery, seed and fertilizer have enabled or forced farmers to plant larger crops, undertake more diverse enterprises and to perform farm operations more quickly than ever before. The operators of country grain elevators in turn are continually pressed to provide faster, cheaper and more efficient handling and storing facilities. In planning any changes in the size and location of grain elevators, therefore, the need for reliable information on costs pertaining to the major factors of handling and storing grain will be crucial for the elevator industry if the proposed rail line abandonment is carried through, either partly or completely.

Specifically, questions arising out of the present problems are:

1) To what extent will rail line abandonment take place?
2) How will this affect the farmers and communities of the abandoned lines?
3) What changes, if any, must the grain elevator companies make in order to cope with the grain handling and delivery problems which may arise due to rail line abandonment?

These are questions of great concern and importance to all those who will be affected, either directly or indirectly, by any program of rail line abandonment.

The third problem has been estimated, to some extent, by

Lagace.[7] Lagace based his estimates of the amount of capacity that must be replaced on the basis of various handling to capacity ratios that would be achieved in the event of abandonment. It should be noted that the definition of a grain elevator's handle differs between Lagace's thesis and this study. In the former it is defined as the volume of grain received at country elevators from producers.[8] In the present study, as defined on page 12, the amount handled includes the grain placed into the elevator plus the amount taken out; the sum of which is divided by two. The difference between the two definitions, can be up to one-half the capacity of the country elevator.

Lagace shows that in Manitoba 105 points or 68.2 per cent of the total number of Manitoba points, will be affected either directly or indirectly by proposed railway branch line abandonment.[9]

Under the various handling to capacity ratios considered by Lagace, the following table shows his estimates of lost capacity that would have to be replaced.[10] These figures are estimates for Manitoba only, although Lagace developed estimates for all three prairie provinces.

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[7] Lagace, op. cit., pp. 69-79.

[8] Ibid., p. 12.

[9] Ibid., p. 30.

[10] Ibid., pp. 72-78.

TABLE I

RECONSTRUCTION MADE NECESSARY BY BRANCH LINE ABANDONMENT AS ESTIMATED BY LAGACE

| | Handling-Capacity Ratio | | |
|---|---|---|---|
| | 4.0 | 3.0 | 2.0 |
| % Reconstruction of lost capacity | 15.3 | 35.4 | 98.5 |
| Reconstruction in Millions of bushels | 1.5 | 3.6 | 9.9 |

It is unfortunate that the estimates do not go beyond a handling to capacity ratio of four. A ratio of five might show that no reconstruction would be necessary. Historically, a ratio of four or greater, as pointed out by Lagace, is rare. He shows that only 3.8 per cent of the grain elevators achieved such a high handling to capacity ratio.[11] In the present study this group accounts for approximately thirteen per cent of all observations of handling to capacity ratios. It is possible that grain elevators can be operated more efficiently with a higher handling to capacity ratio. One of the purposes of this study is to investigate this point.

In view of the complex and multi-faceted situation confronting the grain industry today, this study is designed to focus attention on one aspect, and perhaps the most important aspect, of the over-all problem of railway branch line abandonment, namely, the grain elevator industry itself. Specifically, we will examine the cost of handling and storing grain in Manitoba country grain elevators.

[11] Ibid., p. 56.

Empirical results contained in other studies[12] have shown that economies of scale exist in the grain elevator industry. Therefore, assuming a uniform handling to capacity ratio for all elevators, the larger elevators will have a lower average total cost for handling and storing grain than will smaller elevators. By relaxing the assumption of a fixed handling to capacity ratio, it would seem that large capacity elevators will achieve low costs of handling and storing grain with a smaller turnover[13] than will low capacity elevators. This seems to be due to the high degree of fixity in the total cost of operating grain elevators. Some evidence of this is given on pages 70-71.

The degree of utilization[14] of the fixed facilities will also have an important bearing upon the average total cost of handling and storing grain. In other words the per bushel total cost of handling and storing grain will be affected not only by the amount of grain handled in a fiscal year, but also by the degree of utilization of the grain elevator.

This study examines the cost-output relationships as they existed in the grain handling years 1961/62, 1962/63 and 1963/64.[15]

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[12] United States Department of Agriculture. Costs of Storing Reserve Stocks of Corn. Market Research Report No. 93. Washington, D.C., June 1955. Also see Washington Agricultural Experiment Station. Handling-Storing Costs of Country Grain Warehouses in Washington. Bulletin No. 536. Washington State College, June 1952.

[13] Turnover is used synonymously with handling to capacity ratio.

[14] The degree of utilization refers to the average monthly inventory of any particular grain elevator relative to its capacity.

[15] The grain handling year begins in August and ends in July of the next year.

More specifically, the following relationships are examined:

1) How costs are affected by different handling to capacity ratios.
2) How costs are affected by the utilization of the available space.
3) How costs are affected by the amount of annex space available.
4) How costs are affected by the size of an elevator.

In addition to examining the above relationships, the study also attempts to supply answers to the following questions:

1) Depending upon the total handling expected at any grain elevator, what is the most efficient size of elevator for that site?
2) Assuming that some grain elevators, due to rail line abandonment, will have to be relocated, of the various possible relocation sites, where should the affected elevators be placed?

An important theoretical construct which would help answer some, and perhaps most of the major questions posed above, is the long run average cost or planning curve. The long run average cost curve, as defined by Stigler, is "the lowest curve touching the short-run average cost curves."[16] In mathematical terms, it is called the envelope of the short-run average cost curve.

Regression techniques are used in order to obtain the least squares estimates of the partial regression coefficients which explain variation in total cost of handling and storing grain in country elevators. The analysis makes it possible to estimate the probable

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[16] G.J. Stigler, The Theory of Price, Revised Edition, The Macmillan Co., New York, 1952, p. 141.

variations in cost resulting from changing the values of any one or all of the independent variables. It is therefore possible to estimate the planning curve for the grain elevator industry by holding all independent variables constant at certain specified levels while allowing the capacity measure to increase up to and including the largest size contained within the sample. It should be noted, however, that any curve developed by regression analysis is, by its very nature, only an estimate of the true planning curve of the industry for two main reasons:

1) Since regression analysis is an averaging process, the curve so developed must also be an average of the available cost data. The coefficient of determination ($R^2$) having a value of unity would be highly unlikely in a study such as this because the data were collected from grain elevators built in different time periods and of differing technologies. Therefore, a statistical curve, estimating the true planning curve, obtained through regression analysis will be composed of both positive and negative deviations. If there are any negative deviations, apparently the curve cannot represent the true planning curve since there must be a plant which has a cost level below that represented by the planning curve. This would contradict the definition.
2) As stated earlier, the planning curve is the locus of the most efficient or least cost plants. It is highly unlikely, however, that a random selection of grain elevators would contain only the most efficient plants.

Therefore, unless both conditions one and two above were satisfied simultaneously, the curve developed by regression analysis is, at best, only a close approximation of the true planning curve of the industry.

## (C) DEFINITIONS

It is useful at this point to explain some of the terminology that will be used throughout the thesis.

Point; is a location where one or more country grain elevators exist.

Site; a location of any one particular country grain elevator.

Capacity; relates to the total rated storage space available at any particular country grain elevator.

Handling[17]; is equal to the amount of grain placed into the elevator plus the amount of grain taken out of the elevator and the sum divided by two.

Handling to capacity ratio; is the handling, as defined above, divided by the rated capacity of the grain elevator.

Annex; additional storage space which is, in most cases, attached to the main elevator house by augers.

Annex to capacity ratio; is the annex capacity divided by the total rated capacity of the grain elevator.

Grain; refers to wheat, oats and barley.

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[17] The term "handle" is often used for handling by persons in the trade.

## (D) DATA: SOURCE AND COLLECTION

The cost and handling data collected for this study are for the province of Manitoba. Since the collection of the data necessitated visits to the head offices of the contributing companies, similar trips to the other two large grain producing provinces were not necessary nor were they feasible, considering time and resource limitations. However, since the system of handling and storing grain is fairly similar in all three prairie provinces, the cost estimates developed for Manitoba in this project might be reasonably comparable to those in the other two prairie provinces.

The method of sample selection has a great bearing upon the reliability of the results of any study based upon statistical methods. If no information is available for the population parameters, which is likely to be the case for most cost studies, it is necessary to run a pilot study in order to obtain estimates of the parameters. To obtain the sample size necessary for the degree of reliability desired, the correct procedure would be to calculate the variance of each cost element, thereby allowing the element of greatest variance to determine the sample size required. Although the above method of sample size selection is the correct one, time and cost considerations often make it difficult to follow this procedure completely. The method followed for the present study, therefore, was to select a sample and then work back to discover the degree of confidence of the estimated coefficients. Although the method is not entirely statistically valid, it is an economic necessity. An important question that must be considered is: would the time and cost involved in following the proper statistical

methods add anything significant to the study? In many cases the answer is probably no. This is because the pilot study is actually large enough to allow for the degree of confidence desired, even though the research worker is deciding upon the confidence level after, rather than before, examining the data.

The method of verifying what degree of confidence may be attributed to the sample is explained below. The formula used for calculating the sample size necessary for a given degree of confidence is:

$$N = \frac{t^2 s^2}{d^2}$$

where:

N = sample size

t = student "t" book value

$s^2$ = variance in the sample of any particular cost element for any strata

d = chosen margin of error

This calculation has been carried out for all ten cost categories used in the study and for each of the five strata within a category for various values of "t" and "d". The values of "t" used are 0.95, 0.90, 0.80 and 0.70 confidence levels. The values of "d" (margin of error) used are 5%, 10%, 15% and 20%. By calculating all possible combinations of "t" and "d", it can be found what values of the sample size are necessary for these combinations. Appendix A, page 96, shows one example of this calculation. It was decided to omit the cost category, interest on investment, from this type of calculation because the method of calculating this cost item lent itself to high variance. It was calculated on the basis of the undepreciated value of the asset. Since

the sample contained grain elevators of different ages, the high variance was an indication of the different ages of elevators rather than the cost involved in operating elevators of different sizes.

The cost item which demands the largest sample size for any particular combination of "t" and "d" will determine the level of confidence which the selected sample would allow. By following the calculation, as explained above, this cost item is "Repairs", for the strata less than 40,001 bushel capacity. The degree of confidence is 70 per cent that the sample mean does not differ by more than 25 per cent from the population mean.

In Manitoba there are approximately 675 country grain elevators. The method of sampling used in this study could be referred to as a two stage purposive technique. The first stage was to reduce the population from 675 to 499 grain elevators. This was done by selecting the three major grain companies in Manitoba and thereby limiting the sample to come from this group. This was done to facilitate the collection of data and to minimize the effects of differences in accounting practices between the various contributing firms. It was also felt that this group of 499 elevators would provide an adequate or representative cross section of cost and handling data.

The second stage of the sample selection was to choose fifty-one out of the remaining 499 elevators. The fifty-one elevators selected ultimately yielded 140 observations, since the data was collected for a three year period. Thirteen observations were unavailable because of a lack of adequate data. The sample of fifty-one elevators was chosen with the use of a random number table[18], and

[18] R.D.G. Steel and J.H. Torrie, Principles and Procedures of Statistics, McGraw-Hill Book Co., Inc., Toronto 1960, p. 428.

was proportional with respect to the size distribution of the population as well as the distribution of ownership of grain elevators amongst the three companies from which data was obtained. The distribution is shown in Tables II and III.

The method of sample selection with the use of random number tables is as follows. Assume that the population consists of ten elevators and that the desired sample size is three. Assign a number from one to ten to each of the elevators. The first three numbers in the random table are:[19] eighty-six, thirty-five and twenty-six. Now multiply as follows:

$$10 \times 0.86 = 8.6$$

$$10 \times 0.35 = 3.5$$

$$10 \times 0.26 = 2.6$$

Rounding off to the nearest whole number, the sample will consist of the grain elevators numbered nine, four and three. The above figures are only an example of the procedure followed and therefore do not correspond to the actual sample.

Upon selection of the sample, it was found that in some cases, certain grain elevators had to be replaced because of two main reasons:

1) Cost and handling records were not available for that particular grain elevator.[20]

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[19] Loc. cit.

[20] This situation occurs when there is more than one elevator at a point and the cost and handling data correspond to the point rather than to any particular grain elevator.

2) The grain elevator was not considered typical or representative of those in the industry.[21]

TABLE II

PROPORTION OF ELEVATOR POPULATION AND OF SAMPLE BY FIRM

| Firm | % of Population[22] | % of Sample |
|---|---|---|
| A | 69.0 | 67.0 |
| B | 26.0 | 27.0 |
| C | 5.0 | 6.0 |
| Total | 100.0 | 100.0 |

TABLE III

PROPORTION OF ELEVATOR POPULATION AND OF SAMPLE BY SIZE STRATIFICATION

| Size Stratification in Bushels | % of Population | % of Sample |
|---|---|---|
| <40,001 | 23.0 | 20.7 |
| 40,001 - 60,000 | 28.2 | 26.4 |
| 60,001 - 80,000 | 16.2 | 13.1 |
| 80,001 - 100,000 | 13.6 | 16.4 |
| >100,001 | 19.0 | 23.4 |
| Total | 100.0 | 100.0 |

[21]Discussion of the sample with informed persons in the trade supported this decision.

[22]The term population in these tables refers to the 499 grain elevators considered for the selected sample rather than to the 675 elevators that exist in Manitoba.

The time period of the study is the crop years 1961/62, 1962/63 and 1963/64. The purpose of using three years data for the study was to develop cost estimates which would depict normal conditions of handling and storing grain. The crop years 1961/62 and 1962/63 were years of low and high grain handlings respectively. In Manitoba, the total production of wheat was 34 million bushels in 1961/62 and 80 million bushels in 1962/63. The corresponding figure for the 1963/64 crop year was 61 million bushels[23] and it is considered a normal year. Although the choice of using three years of data is somewhat arbitrary, the difficulty of obtaining complete records prior to the crop year 1961/62, necessitated this decision.

Of the independent variables used in the study, only one presented a problem in collection. This was the measure of per cent utilization of the grain elevator. Per cent utilization was estimated by dividing the average monthly inventory figure by the capacity of the grain elevator. However, in the case of the largest data-contributing firm, the figure for average monthly inventory was not readily available. The method of arriving at this figure was to add to the beginning monthly inventory (stocks as of July 31 of the previous crop year) all receipts of grain for that month and subtracting from this total all shipments of grain out of the elevator for that month. The

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[23]Source: Yearbook of Manitoba Agriculture, Manitoba Department of Agriculture and Conservation, Winnipeg, Manitoba. Although these figures are only for wheat, it is felt that since wheat is the largest crop produced in Manitoba that uses the country elevator system, the figures were indicative of the relative magnitudes of total grain moving through the country elevators for the years of the study.

monthly figures were then summed up and divided by twelve to calculate the average monthly inventory. Perhaps better results could be achieved by analyzing monthly figures for costs and handling, but the current accounting methods in the trade do not permit the use of this method.

Cost accounting which is carried out by many large industrial concerns attempts at even finer breakdowns than monthly cost and output figures. The idea behind modern cost accounting procedures is to attach a cost to each unit of output. This is really the accountant's attempt to estimate the economist's "marginal cost" which indicates the cost attributable to each additional unit of output. However, such finely divisible accounting practices are not followed by the grain elevator industry, probably because the cost of keeping such records would be greater than the possible benefits. If such records were available then statistical studies, such as the present one, would not have to be carried out in an attempt to examine the cost structure of the grain elevator industry.