AN ECONOMIC ANALYSIS OF CUSTOM SEED CLEANING OPERATIONS IN OKLAHOMA

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AN ECONOMIC ANALYSIS OF CUSTOM SEED

CLEANING OPERATIONS IN OKLAHOMA

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PREFACE

The purpose of this study was to help managers of custom seed cleaning operations in the State of Oklahoma to learn more about their plant's operating and net income position. This was accomplished by analyzing the costs and revenues of the three most prevalent sizes of seed cleaning plants. Total cost functions were determined for each size group using a modified account records method of cost measurement supplemented by synthetic data when necessary. Firm records were also employed to estimate the total revenue functions for each plant size. In the analysis, the cost and revenue estimating equations for each size of plant were compared in a breakeven volume framework in order to determine the minimum profitable volume for each plant size.

I am deeply indebted to Dr. John R. Franzmann, my major adviser, for giving so unselfishly of his time throughout this study. His counsel and guidance have been so very helpful to me, and I wish to express my thanks to him. Thanks are also due to the other members of my committee: Dr. L. A. Parcher and Dr. Richard W. Schermerhorn. Also, I want to express my appreciation to Mr. James R. Enix for his help in the initial stages of this study.

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CHAPTER I

INTRODUCTION

Since World War II, there have been numerous changes in the agri-business industry. Many of these changes have been brought about as a result of the technological advances which have occurred within the last twenty to twenty-five years. One of the most impressive changes has been the way that agri-business firms have expanded, both in size and scope of operation.

The amount and importance of new and improved farm inputs have caused the farm supply sector to amplify its efforts to furnish the farmer with the necessary materials and services. Coinciding with this advancement in the farm supply sector is the expansion in size and scope of functions in the marketing sector. Marketing processes have been improved in order that the marketing sector may handle the increased farm production and supply a growing population with needed farm products. Certain changes are also apparent in farming itself as is shown by the increased specialization of the farmer and his growing reliance on outside firms to market his produce and to supply him with adequate goods and services.

Grain elevators and seed processors are two types of agri-business firms which have undergone various changes. Grain elevators perform grain merchandising and storage as their primary functions while seed processors perform seed wholesaling and retailing functions. However, each firm has found it advantageous to add side line operations to the primary functions in order to provide more goods and services which are demanded by farmers and to enhance the firm's competitive position. Such side line operations might consist of custom feed milling, fertilizer blending, lumber supplies, and custom seed cleaning. Although these side line operations appear to be useful both to the farmer and to the firm providing them, there is still some uncertainty involved as to how the addition of a side line operation and how specific pricing decisions concerning it will affect the overall firm.

During recent years in Oklahoma, the operation of side line functions has received added discussion, and custom seed cleaning is no exception.[1] Custom seed cleaning is the process of cleaning and treating seed produced locally by farmers, most of which is returned to the farms for planting. The service feature of the seed cleaning function seems to be not only an important service to farmers but also an attraction which may result in a greater use of the total business.[2] As implied earlier, most custom seed cleaning plants in Oklahoma are operated as a part of a larger firm, and the demand for other products and services may be enhanced due to the presence of the seed cleaning operation. However, it is possible that expenses incurred by the custom seed cleaning department may become larger than any additional income which might accrue to the total business because of it, and

[1]Custom seed cleaning has been on the program of the Annual Convention of the Oklahoma Seedsmen Association for the past three years.

[2]James R. Enix and Nellis A. Briscoe, Custom Seed Cleaning Plants in Oklahoma: Model Plant Operations, Costs, and Returns. Paper presented at the Annual Convention of the Oklahoma Seedsmen Association, Oklahoma City, January 17, 1966.

managers should be aware of when this occurs.

Changing Conditions in the Industry

Recent developments in the seed and grain industry have driven the point home that each seed cleaning operation may not be contributing enough to total firm income to cover the costs incurred in providing the service. These developments have probably been responsible for much of the recent concern over custom seed cleaning in Oklahoma. Some of the most important of these developments are (1) decreased income from storage, (2) declining volume of small grains needed for planting, (3) increased labor and machinery costs, and (4) disease resistant varieties of small grains.

Grain storage was a lucrative business for grain elevators and storage warehouses in the late 1950's and early 1960's, but in January of 1961, the storage volume in Oklahoma began to fall drastically.[3] Storage volume on January 1, 1967, was approximately 35% of the 1959-62 average on similar dates and only 30% of the peak storage volume in 1961.[4] The decreased storage volume is due primarily to the reduction of Commodity Credit Corporation (CCC) stocks. This rapid decline in storage has been a growing concern to the grain storage business since so many firms have expanded their storage facilities in excess of the present storage demand.

Another changing condition that the firms in the custom seed cleaning business must face is the declining volume of small grains needed

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[3]United States Department of Agriculture, Statistical Reporting Service, Crop Reporting Board, Grain Stocks (Washington), January, 1968, and previous issues.

[4]Ibid.

for planting. The combined acreage of wheat, oats, and barley in Oklahoma did not change greatly in the years of 1962-66 and the average was still about 90% of the eight-year average prior to 1962; nevertheless, the change of the ratio of wheat to barley to oats has been a factor.[5] The reason for this is the difference in seeding rates of the three crops. At the average rates, barley is seeded at 1.5 times the rate per acre for wheat while oat acreage is seeded at twice the rate for wheat. Therefore, if oat acreage in Oklahoma dropped by 100,000 acres, wheat acreage must increase by 200,000 acres to keep the volume of planting seed the same. This is very similar to the present situation in Oklahoma except that the wheat acreage, although increasing, has not increased enough to offset the differences in the seeding rates. Thus, the required volume of small grain for seeding has been continually declining.[6]

The third recent development listed above was increased labor and machinery costs. Labor is a very important cost in custom seed cleaning, and the hourly wage rate has been increasing at a rapid pace which will make it even more important. A good indication of increased labor costs may be shown by some provisions of the Fair Labor Standards Act of 1938, as amended. The Act, as amended, has raised the minimum hourly wage rate from $1.15 per hour in 1961 to $1.60 per hour in 1968.[7]

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[5]This information was computed from the Annual Summaries of Acreage, Yield, and Production, published by the Oklahoma Crop and Livestock Reporting Service in Cooperation with the Statistical Reporting Service of the U.S. Department of Agriculture.

[6]Ibid.

[7]United States Department of Labor, Wage and Hour and Public Contracts Division, Handy Reference Guide to the Fair Labor Standards Act, as amended--1966, WHPC Publication 1159 (Washington, 1966).

Another provision of the Act requires that overtime pay of 1.5 times the regular hourly rate be paid for each hour of labor in excess of 40 hours per week. Social Security Tax is another aspect of labor cost. It, too, has been increasing over the past few years, both in the rate applied and the base salary that it affects. In 1966, the tax rate was 4.2% on a wage base of $6,600. In 1969, the proposed tax rate will be 4.8% on a wage base that is already in effect, $7,800.[8]

Increasing machinery costs are also of interest to firms containing custom seed cleaning operations. When a firm discovers that it needs to replace a large piece of equipment, it will soon find that the depreciation allowance on the older equipment falls far short of the cost of the new one. This, plus the fact that opportunity costs will also rise proportionately with the cost of equipment, brings new headaches to a manager faced with such a replacement decision.

The last development in the seed and grain industry listed previously which may have been causing some concern in custom seed cleaning departments was disease resistant varieties of small grains. This has a two-fold effect on custom seed cleaning. First of all, farmers believe that there is less need for the cleaning and treating of disease resistant varieties; therefore, many farmers will not take the time to have the operation performed. The second effect on custom seed cleaning caused by disease resistant varieties is that less farmer grown seed will be used for planting. Farmers will tend to import resistant varieties from other areas. Both of these effects will cause a decline in the volume of cleaning that is performed, and because

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[8]United States Department of Health, Education, and Welfare, Social Security Administration, Social Security Bulletin, XXXI (February, 1968), p. 16.

volume is important to any firm with high fixed costs, this decline has probably caused managers to reevaluate their position on custom seed cleaning.

The Problem and Objective

These and other recent developments have confronted managers with questions regarding the costs of seed cleaning operations and an appropriate price to charge for such service. Owners and managers have asked for help in determining the costs incurred and the revenues received from the custom seed cleaning side line operation of an overall business.[9] They indicated that they needed more information in order to answer certain questions and to make the necessary decisions concerning plant operation.[10] Thus, the primary purpose of this study is to help these managers learn more about their operating and net income position. More specifically, the objective of this research effort is to analyze the costs and revenues of the three most prevalent sizes of seed cleaning plants in Oklahoma.

With this objective in mind, the research work was organized to include mail questionnaires, personal interviews, firm accounting records, and equipment and building investment cost information from manufacturers and contractors. An attempt was made to show the potential benefits to the farmer from seed cleaning and treating and to show the present location and size of existing custom seed cleaning plants in Oklahoma. The study was made primarily during the summer and fall of 1967 and was

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[9] Interview with Mr. James R. Enix, Extension Economist, Wheat Marketing, Oklahoma State University, June 5, 1967.

[10] Ibid.

intended to cover the 1967 seed cleaning season.

No attempt will be made in this publication to present a detailed analysis of the economic theory behind the research study. Since no new concepts will be presented, such an attempt to review the pertinent economic principles would be merely a reconstruction of the textbook theory that has been presented in many writings prior to this one. However, if the reader wishes to review the economic theory on which this research was based, he should consult the works listed in the footnote at the bottom of this page.[11]

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[11] Discussions of conventional economic theory:
Sune Carlson, A Study on the Pure Theory of Production (London: P.S. King and Son, LTD., 1939).
Kenneth E. Boulding, Economic Analysis (New York: Harper and Bros., 1948).
James M. Henderson and Richard E. Quandt, Microeconomic Theory: A Mathematical Approach (New York: McGraw-Hill, 1958).
Donald S. Watson, Price Theory and Its Uses (Boston: Houghton Mifflin, 1963.)
Richard H. Leftwich, The Price System and Resource Allocation, Third Edition (New York: Holt, Rinehart, and Winston, 1966).

CHAPTER II

HISTORY, DEVELOPMENT, AND VALUE OF SEED CLEANING AND TREATING

Important to the study of custom seed cleaning operations is an understanding of the historical development and benefits of seed cleaning and treating. Seed cleaning and seed treating are not new innovations to the farming sector. Rather, they are processes that have been developed and perfected over an extended period of time.

The essence of seed cleaning and treating is to obtain pure, live crop seeds for replanting which are protected from certain seed-borne and soil-borne fungi. Seed, as it comes from the field, is never pure and disease-free. Mixed with it are trash and seeds of weeds and other plants. Also, spores of disease organisms come in contact with the seed while in the field and remain with it until removed by a treating process. The crop seed must be separated from the other weed and plant seeds, then treated, to assure seed of high germination with a minimum amount of foreign material.

History and Development

For centuries, farmers have been performing various operations on their planting seeds in order to get them free of trash and other seed. It was even a commandment of early biblical times that the farmers should strive to keep their seed pure. The Mosaic Law stated, "thou shalt not sow thy field with mingled seed."[1] However, it likely did not take a law to make people understand that they could not expect olives from fig trees or wheat seed from weed seed. The farmers realized that, "Whatsoever a man soweth, that shall he also reap."[2] Thus, seed cleaning has been an important process to farmers for many years.

The process of seed cleaning has undergone a slow, irregular development to its present level of technology. This has probably been caused by the fact that seed cleaning is characterized by only a few basic techniques, most of which were discovered, in an elementary sense, very early in the history of man. The two most important of these techniques are separation by air and separation by screens.

Ever since the first farmer discovered that he could throw his unclean grain into the air, and then have the wind blow the chaff away from the seed, air separation has been a principle method of seed cleaning. The technique of separation by screen also began as an accidental discovery of its use as a seed cleaning device. Although different machines have been built which use other methods in order to handle some specific seeds, almost all separations are made by the use of air, or screens, or both. Therefore, advancements in seed cleaning have come through improvements on the basic techniques, not with the introduction of new techniques.

Improvements in the various brands of cleaners in recent years have been primarily through the advent of better materials and methods of

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[1]Lev. 19:19b.

[2]Gal. 6:7.

manufacturing. An example of this is one of the leading seed cleaning machines of today. Although the machine was invented almost a hundred years ago, the primary design and principles have not been changed greatly. However, the continual improvement of the machinery for seed cleaning has made it possible for the construction of large-scale cleaning and processing plants.

Very little information was available on the history and development of seed cleaning, but the history of seed treating is more fully chronicled.[3] The reason for this is its more recent origin. The practice of seed treating was accidentally discovered in 1670. In that year, an Australian ship loaded with wheat encountered a storm in the Bristol Channel, England, ran aground, and was partially sunk. Farmers near the damaged vessel salvaged some of the grain for food, but they soon discovered that the grain had been saturated with salt water and was inedible. Thus, some of the farmers planted the salty seed instead of throwing it away. Much to the grower's surprise, the seed produced a crop relatively free of stinking smut or bunt, while nearby fields planted with regular seed were highly infested with the disease. This accident originated the practice of soaking seed wheat in salt brine for the control of smut. The practice was continued throughout most of the 18th century, even though the farmers did not know why it worked.

The development of improved methods and new materials for treating came slowly at first, but in the last 50 years there have been many

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[3]The remainder of the material in this section is based primarily on the two sources: Eric G. Sharvelle, The Nature and Uses of Modern Fungicides (Minneapolis: Burgess Publishing Company, 1961), and Dupont Seed Treating Manual (Wilmington, Delaware: E. I. du Pont de Nemours & Co. (Inc.), 1966).

far-reaching accomplishments. The first improvement was made in 1755 when a lye treatment was suggested to replace the previous salt treatment. It was some 50 years later when the next development was announced--the control of smut by the use of a soak treatment with copper sulphate. This was the primary treatment throughout the 19th century, although formaldehyde was used to some extent beginning in 1897.

After the turn of the century, formaldehyde became the prominent seed treating material and remained a leading seed treatment material until 1928. However, the advent of the copper carbonate dust seed treatment in 1917 captured much of the wheat treating market. Formaldehyde and copper carbonate were replaced in the 1920's when the new era of seed treating began with the development of certain organic mercurials. The mercurials not only disinfected the seed, but furnished seed protection against seed-rot and seedling blight. Another advantage of the mercurials was their fumigating action, which meant that complete coverage of the seed was unnecessary for full protection. The fumes could reach underhull parts and other areas not covered at the initial application. All of this led to smaller dosages which still gave adequate protection.

The organic mercurials were applied in dust form until 1946 when a new treatment material was introduced which could be applied as a dust or mixed with water and applied as a slurry. A special treater was needed to apply the fungicide in slurry form; therefore, the slurry treater was developed to allow this type of application. The slurry treatment method had far-reaching implications. One of these was the elimination of the dust around the treaters. The dust and fumes of fungicides are hazardous if large quantitites are inhaled and presented a real problem before the slurry method was introduced. The removal of the dust problem fostered the development of commercial seed treating plants because the operation was less hazardous and required less ventilation. A second implication of the slurry method was the ability to treat a large volume of seed per hour while still maintaining accurate application rates. It was not possible, when treating with dust, to meter in accurate dosages for every bushel that passed through the treater.

The uniqueness of the slurry treater, however, was short lived. About 1949, the Morton Chemical Company introduced the Panogen seed treater which was designed to apply liquid treatments undiluted (direct). This machine had all of the advantages of the slurry treater plus the fact that the treatment material did not have to be mixed with water. Morton Chemical also developed the first liquid mercurial to use with the Panogen treater. Soon to follow the Panogen treater and treatment material were the Mist-O-Matic treater and the "Ceresan" liquid treatments, both similar to their Panogen counterparts in that they were related to direct application. Although other seed treating products have been introduced since 1950, the last major developments in the seed treating industry were the introduction of direct seed treaters and direct seed treating fungicides. However, the scope of the diseases affected by seed treatment has changed slightly since that time as more diseases have been discovered to be somewhat controlled by treating. Diseases that can andcannot be reduced by seed treatment are presented in Appendix A.

Value of Seed Cleaning and Treating

Knowledge of the value of seed cleaning and treating is important, both to the farmer and to the cleaning plant manager. It is important to them because this information is necessary for adequate decision-making. It is necessary to the farmer in order for him to know when the cost of cleaning and treating exceeds the value gained by cleaning and treating. In other words, the farmer needs this information so that he can tell when cleaning and treating seed cease to be profitable. The cleaning plant manager needs to know the value of seed treating and cleaning because this will help him make sound decisions concerning the charges of custom handling and the optimum organization of his plant, both now and in the future. Therefore, this section has been developed in hope that farmers and seed plant managers may obtain a better understanding of the technical factors that underly the value of seed cleaning and treating.

Most of the research that has been done in order to determine the benefits of seed cleaning and treating has been performed by plant pathologists across the nation. Although many experiments have been conducted pertaining to the benefits of seed cleaning and treating since 1900, only a small percentage of them have been carried to the point of obtaining yield data. Germination studies and short-term greenhouse experiments require less research space, time and funds and yet give a fair indication of how cleaned and treated seed perform in relation to uncleaned and nontreated seed. However, to determine the added value to an acre of a crop, the increase in yield due to cleaning and treating must be known. Just to know that germination and stand are increased is not enough because some studies show that yield is not increased proportionately to germination or stand.[4]

Oklahoma has not conducted any comparative yield studies of treated versus nontreated small grain seed.[5] Therefore, state agricultural experiment stations of states in large small grain producing areas were contacted. Information gleaned from the state agricultural experiment station publications was insufficient to show changes in yield and thereby changes in value due to seed cleaning and treating.[6] Thus, other sources of information were sought.

As an alternative, leading plant pathologists in the field of seed cleaning and treating were consulted. Although many of these individuals stated that they did not have yield data available, some results of experiments showing yield increases due to seed treating were obtained from a few of the plant pathologists. However, these results were still inadequate to show the importance of seed treating for several types of grain. Another approach to discover the differences in yields from treating was to ask chemical manufacturers of leading seed treating fungicides for any data that might have been compiled while testing

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[4]For two of the studies showing no yield increase due to increased germination rates, see: O. R. Exconde and E. D. Hansing, Effects of Captan and Captan-Dieldrin Seed Treatments on Germination and Yield of Eight Varieties of Winter Wheat (Manhattan: Kansas State University, Agricultural Experiment Station Technical Bulletin 125, 1962), p. 8. C. R. Rohde and L. H. Purdy, "Effects of Seed-Treatment Fungicides on Grain Yield and Stands of Winter and Spring Wheat," Plant Disease Reporter, XLV (July, 1961), pp. 522-526.

[5]According to conversations with Dr. F. E. LeGrand, Extension Agronomist, and Dr. H. C. Young, Professor of Botany and Plant Pathology, both of Oklahoma State University, Stillwater, Oklahoma.

[6]This is not to say that experiments showing differences in yield were not conducted by the various agricultural experiment stations, but instead, it means that the results of any such experiments were not published in the form of experiment station publications.

their products. This proved to be a valuable secondary source of information as several experiments had been conducted which were carried through harvest to obtain yield data. However, the reader should be aware of two characteristics of yield data of this type.

First of all, many of the experiments do not show statistically significant increases in yields due to treating. The reason for this is that disease-free seed, when planted and not confronted by adverse conditions, if treated, would only give a small increase in yield. This increase is so small that a very large number of repetitions would be required in order to make the yield increase statistically significant. Therefore, it is very difficult to show yield increases which are reliable if the seed is of high quality to begin with. However, increases in yield, no matter how small, cause increases in value.

Secondly, the reader should note the conditions of the experiment in which large yield increases are obtained. Some experiments, conducted in a manner to escape the first problem mentioned above, used artificially diseased seed. By using heavily diseased seed, the yield of the nontreated plots was greatly reduced while the yield of the treated plots remained comparable with yields of disease-free seed under normal field conditions. This causes larger differences to exist between the two methods, thus giving statistically significant results. However, care should be taken in trying to translate the yield increases to the field. Farmers do not plant seed that is known to be disease-infested, therefore, the value imputed to seed cleaning and treating based on these data would be much larger than the actual amount obtained from a normal field situation. With these two characteristics in mind, results of experiments showing increased yields will be presented.

Very few experiments have been conducted to show yield increases due to cleaning alone. Kansas, the only State found to have such data, reports that seed cleaning will increase yields up to five bushels per acre if seed is less than 54-pound test weight.[7] In addition, it was reported that tests have given 0.5 bushel increases or more per acre in yield of wheat due to cleaning normally good seed. At present prices, this would be about a $.75 return per acre from cleaning average good seed, and more if the seed is very shriveled or cracked. South Carolina has reported increases in stand due to cleaning, but, as discussed earlier, this would not necessarily mean increases in the yield.[8]

More research has been done in the area of seed treating than seed cleaning, but seed should be cleaned prior to treating for the best yield results.[9] The only seeds that are treated by custom seed treating plants in Oklahoma are the small grains--wheat, barley, oats, and rye. Therefore, only experiments showing increased yields of these crops due to treating are given.

According to C. R. Rohde and L. H. Purdy, mean yields of Omar winter wheat treated with different seed-treatment fungicides in the years 1956-1959 were increased 3.3 bushels an acre on the average.[10]

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[7]Claude L. King, "Crop Disease Control in Kansas," Extension Pathologist Report (Manhattan: Kansas State University Cooperative Extension Service, January, 1958), p. 4; and Claude L. King, "Clean and Treat Wheat and Barley Seed," Extension Pathologist Report (Manhattan: Kansas State University Cooperative Extension Service, July-August,1963).

[8]"Seed Treatment Can Save Your Crop," Crops and Soils, March, 1960.

[9]Earle W. Hanson, Earl D. Hansing, and W. T. Schroeder, "Seed Treatments for Control of Disease," The Yearbook of Agriculture--1961, ed. Alfred Stefferud (Washington: U. S. Government Printing Office, 1961), p. 275.

[10]This average was calculated from Rohde and Purdy, p. 525.

This increase was larger than most yield studies show. For example, a study in Kansas from 1958-60 on different varieties of wheat indicated that treating seed caused an average yearly increase of 1.4 bushels per acre.[11] Thus, the increased yield of wheat obtained due to seed treating is ordinarily in excess of one bushel per acre, and it could be much higher if factors favoring disease organisms were present. This could mean an increase in the value of the farmer's product by about $1.50 or more per acre.

Results of an extended study on the benefits of treating oat seed are also favorable.[12] More than 2000 paired lots were compared for increases in yield over a 21-year period, 1934-1954. The average gain per acre for the paired yields was 3.3 bushels. This could be considered as an average gain for all of the studies that were reviewed which covered several years, but some gains did range as low as two bushels per acre. However, some yearly increases on poor seed, due to treating, have been as large as 31.7 bushels per acre.[13] These yield increases can be translated into value increases by multiplying the increase in yield in bushels by the price per bushel of oats. At an oat price of $.75 per bushel, the benefits of seed treating, implied from the above studies, could range from about $1.50 on very good seed to about $23.75 per acre on extremely poor seed.

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[11] This average was calculated from Exconde and Hansing, p. 5.

[12] C. S. Reddy, 1954 Annual Report of Seed Treatment Experiments, A Report Giving the 1954 Results of Seed Treatment Experiments Conducted by the Iowa State University Agricultural Experiment Station, Ames, Iowa, 1955.

[13] Letter written by Hugh A. Inglis, Agronomist, Seed Certification, Georgia Crop Improvement Association, Inc., Athens, Georgia, September 10, 1957.

Barley has also responded well to seed treatment fungicides according to M. B. Moore.[14] He disclosed results from an eleven year seed treatment study, 1950-1960, which showed that yields of barley were increased due to the treating of the farmer's seed lots. The average gain of over 300 separate comparisons of seed lots made during this period was 1.8 bushels per acre. An important aspect of this experiment is that the seed used came from the farmer's own seed lots; therefore, similar increases in yield could be expected in the field as well. An example of an experiment using artificially diseased seed was reported by Dr. D. C. Arny.[15] In this study described by Dr. Arny, extending from 1956 to 1959, an average yield increase of seven bushels per acre was achieved over nontreated seed known to be infected with an organism causing seedling blight. Even larger yield gains could probably be obtained if the seed were inoculated with a smut producing organism, but these gains could not be expected in the field. The increased value due to seed treating barley was computed in the same manner as that for wheat and oats, and the average increase in value per acre was approximately $2.00.

Experiments showing increased yields of rye by treating good seed were not available. Thus, increased value per acre for treating rye could not be estimated. However, seed treatment does cause increased

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[14]Letter from M. B. Moore, Instructor, Department of Plant Pathology, University of Minnesota, St. Paul, Minnesota, June 27, 1967.

[15]D. C. Arny, "New Information on Seed Treatment Materials for Small Grains," Plant Disease Notes (Madison: University of Wisconsin Agricultural Experiment Station, March, 1960), p. 2.

yields of rye as shown by a 1957 experiment in Florida.[16] Yields from infected planting seed were increased about seven bushels per acre when treated with a fungicide, nevertheless increases this great could not be expected on normal seed that are planted.

Seed treating may be profitable for the small grains, and the increased value of production is fairly well implied in the studies just cited. Only rye has not been credited with an average increased value due to seed treating. Increased yields of crops are relatively easy to see, but two other benefits accrue to seed treating that are not usually discussed. The first of these extra benefits is a reduction of the cost of seed for planting per acre. The reason for this is that increased germination and stand percentages received from treated seed allow the farmer to plant less seed per acre and still receive the same number of plants. Experiments at Kansas State University showed that treating wheat seed increased stands approximately ten percent.[17] This means that a grower will get as many plants per acre from sixty pounds of treated seed as from sixty-six pounds of the same seed not treated.[18] The six pounds of seed saved is usually worth more than what it costs to treat, and even clean, the planting seed.

The second extra benefit from seed treating is that it provides a form of insurance against losses. Although most of the small grain

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[16] H. H. Luke, W H. Chapman, and P. L. Pfahler, "Increase Rye Yields by Seed Treatment," Sunshine State Agricultural Research Report (Gainesville: Florida Agricultural Experiment Station, October, 1958), p. 3.

[17] L. E. Melchers, C. L. King, and E. D. Hansing, "A Forty-two Year History of Bunt in Kansas and a Long-Time Program of Control," Plant Disease Reporter, XL (June, 1956), p. 499.

[18] Ibid.

varieties in use today are resistant to many of the present seed-born diseases, it can never be known when a new race of a pathogen will develop that is not controlled by disease resistant varieties. Seed treating as an insurance against this and other problems does not have to pay off very often for it to be profitable over the long run. For example, the results of experiments reported by Rhode and Purdy show that yield increases from seed treating were not significant for three of the four years in the study.[19] However, the significant difference in the fourth year was large enough to make the difference in the mean yields of all four years significant. Thus, seed treating does appear to provide some insurance against unknown events of the future.

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[19]Rohde and Purdy, p. 525.

CHAPTER III

RESEARCH PROCEDURES AND COST METHODOLOGY

The purpose of this chapter is to present background information on how the research data were collected and how certain elements of the cost data were analyzed. It would be instructive, for two reasons, to understand the research procedures and cost methodology undertaken in this study. First of all, this knowledge will provide an explanation of some of the ideas and methods used to make the analyses in the following three chapters. Secondly, anyone who desires to do further research in this area could benefit from knowing the procedures that were used to obtain the results of the study.

Determination of Firm Population

When the research was undertaken, there was no information on the number, size, and location of custom seed cleaning plants in Oklahoma. In order to better select the sample firms for detailed study, it was necessary to know the location of the firms and their plant sizes.

A mail questionnaire was used to determine the number of firms doing custom seed cleaning in Oklahoma. With the use of appropriate mailing lists,[1] a letter was sent to firms in the state connected in

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[1] Essentially, there were two prominent mailing lists that were used. These two lists were the 1967 Directory of the Farmers Cooperative Grain Dealers Association of Oklahoma and the names of licensed seed

some way with seed wholesaling and retailing or grain handling in order to ascertain if they maintained a custom cleaning operation. Enclosed in the letter was a post card for reply to the questions of whether or not the firm did custom seed cleaning and/or treating and, if so, the number of cleaners used in the plant. The firm's name and location had been placed on the card prior to mailing; therefore, the manager had only to check one to three answers to complete the questionnaire.

The response was very good to this initial questionnaire, and by the deadline date, over 80 percent had returned the card. However, it was decided that this was an insufficient response for an adequate population survey. Thus, a second letter was sent to those firms not answering the first mailing. After the results had been received from the second questionnaire, over 94% of the firms contacted had responded. Out of the 285 firms which replied, 139 of them reported doing custom seed cleaning. This was 49% of the respondents. The locations of these firms and the number of cleaners contained in each plant are presented in Figure 1.[2] The percentage dropped from 49% to about 38% when custom

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dealers in Oklahoma. The latter list was supplied by Parks A. Yeats, Director of the Seed, Feed, and Fertilizer Division, State Board of Agriculture, Oklahoma City, Oklahoma. It was the opinion of Mr. James R. Enix, Extension Economist, Wheat Marketing, and Dr. Nellis A. Briscoe, late Professor, Department of Agricultural Economics, Oklahoma State University, that these two lists contained a very high percentage of all of the custom seed cleaning operations in the state. Mr. Enix and Dr. Briscoe had done some preliminary research into the custom seed cleaning business of Oklahoma in 1965.

[2]The dashed line in Figure 1 separates the state into the coarse grain producing area of the west where such grains as wheat, barley, oats, and rye are grown and the eastern portion where the same grains are grown, but in smaller volume. Limited quantities of beans, vetch, alfalfa, and sweet clover are also produced in the western section, while the eastern one-half of the state produces such legumes as lespedeza and soybeans and such grasses as fescue and rye grass. This information was taken largely from James R. Enix and Nellis A. Briscoe,

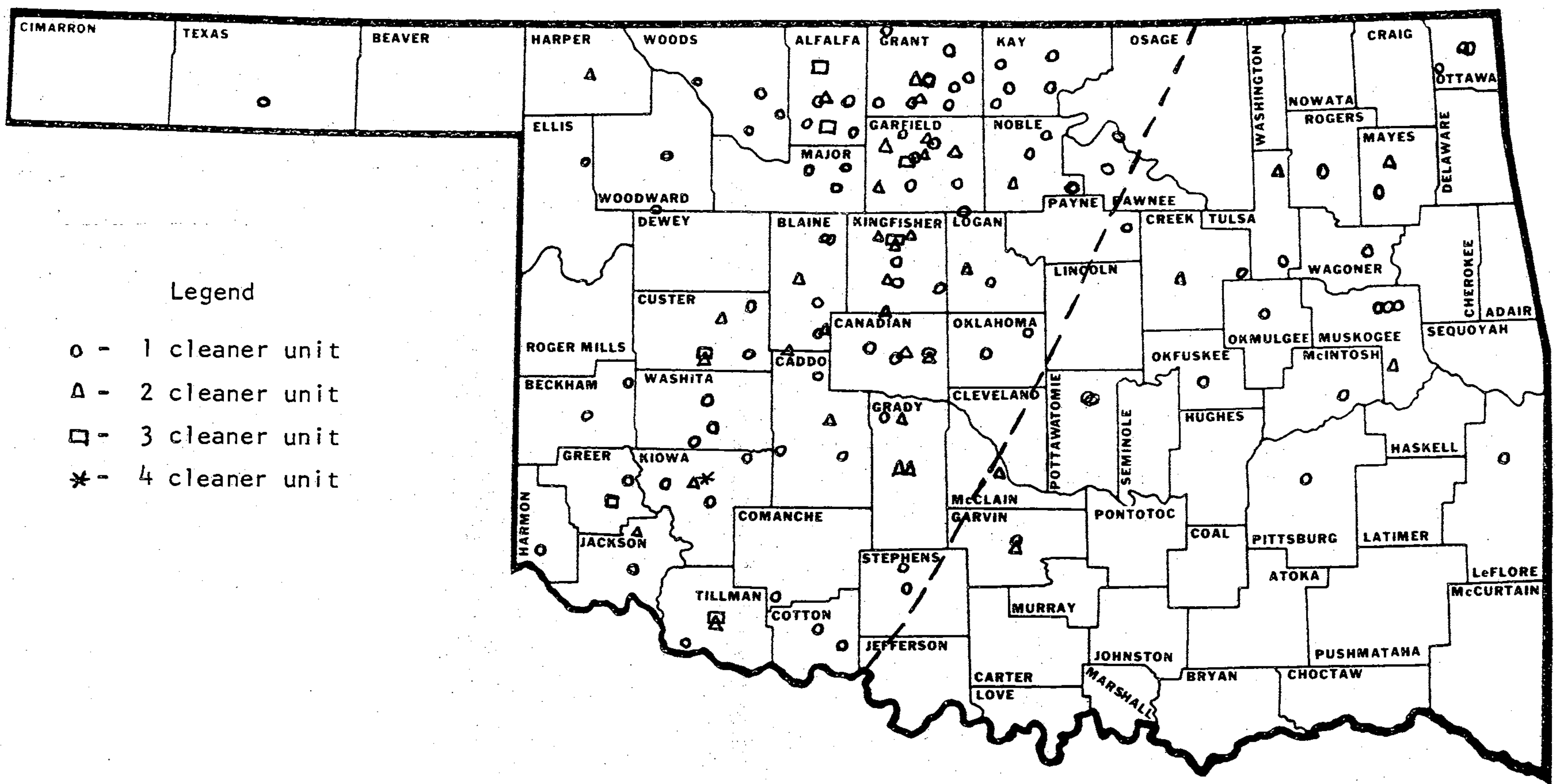

Figure 1. Location and Size of Custom Seed Cleaning Operations in Oklahoma

seed treating was considered. One hundred and seven reported carrying on this phase of the operation.

The results of the survey also showed that a large percentage of the firms in Oklahoma only had one cleaner machine, in fact, over two-thirds of all the firms reporting custom cleaning. The totals from the custom cleaning survey with respect to size are: one cleaner machine, 95 firms; two cleaner machines, 36 firms; three cleaner machines, 7 firms; and four cleaner machines, one firm. No firm reported more than four cleaner machines in their custom seed cleaning plant. It also should be noted that the number of firms doing custom seed cleaning was almost evenly divided between cooperative and noncooperative firms. However, all but two of the cooperative firms were in the western sector of the state. This would indicate that most of the cooperative plants relied heavily on small grain cleaning and treating. All of this information was used as an aid in the selection of the sample for further study.

Selection of Sample Firms

In order to make an adequate analysis of custom seed cleaning operations in Oklahoma, several firms had to be contacted and studied in detail. If the firms that were studied in detail were representative of the remainder of the firms in the state, then the information from the analysis of the sample firms would be very useful to all plant managers for decision-making. Although the goal of completely representative

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Custom Seed Cleaning Plants in Oklahoma: Model Plant Operations, Costs, and Returns, Paper presented at the Annual Convention of the Oklahoma Seedsmen Association, Oklahoma City, January 17, 1966.

firms was impossible to achieve, it was still the motive behind the selection of the firms for further study. The analysis would, therefore, still be useful to many of the plant managers.

In an attempt to select the best representative firms and because it was necessary to study all sizes in both sections of the state, a nonstatistical sampling procedure was used.[3] There were four criteria that formed the basis for the selection procedure. These criteria were (1) size, (2) location, (3) ability to act as a representative firm, and (4) willingness to cooperate. In total, 21 firms were selected for study in further detail. The following is a breakdown of the sample firms selected: (1) nine one-cleaner plants, six of which were cooperative firms; (2) six two-cleaner plants, four cooperatives; (3) five three-cleaner plants, three cooperatives; and (4) one four-cleaner plant, a noncooperative firm. All of the firms were then consulted as to whether or not they would be willing to cooperate in the study, and all of them indicated at the time that they would do so. However, the four-cleaner firm elected not to cooperate when contacted at the close of the season.

Discussion of Some Research Methods Used

From the preliminary study made by Enix and Briscoe, it was evident that, due to inadequate firm records, estimates made by the managers would have to be relied on for much of the information needed for the analysis. With this fact in mind, it was decided that the managers

[3] Mr. James R. Enix, Extension Economist, was instrumental in helping to select the sample due to his knowledge of the custom seed cleaning operations in Oklahoma.

could give more reliable estimates if they knew in advance the questions that would be asked. Therefore, a detailed questionnaire was mailed to each firm prior to the start of the major seed cleaning season, September 1 through November 1, with the hope that the managers would familiarize themselves with the information that would be needed. It was intended that the managers would be more conscious of the custom cleaning operation during the season so that better data could be obtained in the interviews that were scheduled with each firm soon after the season was over. However, only a few of the managers took the time to comply with the request. In fact, the idea would have been a total failure were it not for some volume totals received as a result of a few firms performing the suggested task of recording the daily run totals.

Most of the personal interviews with the managers were scheduled in late November and early December. From one-half of a day to a day was spent at each location, with two contacts being necessary in some cases. Initially, the interviewer asked the manager questions about the operation using the pre-mailed questionnaire as a guide. The questions that could not be answered by the manager were noted and the answers were sought later in the accounting records. The firm audits and account books were made available to the interviewer for examination, but some accounts were simply not detailed enough to be useful. Therefore, some of the questions could not be answered by all of the firms, and even some of the manager's estimates were admitted to be very rough. Before leaving the location, the interviewer observed the layout of the cleaning plant. This was helpful in establishing the model plants used in part of the analysis.

One of the most pressing problems that confronted the manager and the interviewer during the personal contacts was the determination of the custom seed cleaning's share of the expenses of certain joint accounts. This dilemma is not unique to this study but, instead, must be faced in most investigations when a section of an overall business is considered. Thus, the remaining sections of this chapter will be devoted to the discussion of cost measurement and allocation.

Methodological Approaches to Cost Measurement

The problem of measuring and comparing costs may be approached in a number of alternative ways, but the most efficient method depends upon the specific objectives of the study and the resources available for carrying out the research. The economic-engineering synthetic method and the accounting records method are two of the more frequently used methods of cost analysis. The purpose of this section is to present these two methods in a brief outline to give the relative merits of each.

The economic-engineering synthetic method of cost analysis, as an approach to the derivation of cost curves of various sized plants, is an outgrowth of industrial engineering. In this method, the production processes of a plant are analyzed to determine the resource requirements. Then, by applying costs to the resources used in the production processes of a product, per unit cost functions can be developed.

The outcome is accomplished by separating the production process into its component parts or stages. Each stage has its own input-output function, therefore with suitable rates and prices applied to it, a cost curve for each stage may be derived. The individual plant cost is then the sum of the various stage costs. The per unit cost functions are a result of performing this procedure on different sized plants.

The economic-engineering synthetic method has several advantages. Some of these are: (1) estimates of cost relationships can be provided in instances where historical records are nonexistent, (2) analysis is permitted covering the same period of time for a comparable set of plants, (3) the use of uniform rates and methods of depreciation and accounting is permitted, and (4) a basis is provided for measures of efficiency.

However, even with its many advantages, the economic-engineering synthetic method does not eliminate all of the problems in a cost analysis study. Perhaps one of the most important problems concerning the synthetic method is the fact that it is time consuming and expensive. Also, extreme care should be taken in order that all processes will be aggregated and coordinated correctly, and that no cost items are omitted. Another disadvantage of the method is that it does not lend itself to tests by the standard measures of statistical reliability. Estimates from synthetic constructions can be checked only by comparing results with alternative sources of information. The last unsolved problem of this method that will be mentioned is the arbitrary allocation of many joint and overhead costs.[4] This problem is shared with the accounting records method of cost analysis and will be discussed in a later section of this chapter.

The accounting records method of cost analysis differs substantially from the previous method outlined. The method employs the use of cost

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[4] Guy Black, "Synthetic Method of Cost Analysis in Agricultural Marketing Firms," Journal of Farm Economics, XXXVII (May, 1955), p. 276.

accounting records of already existing firms, and it is much simpler and consumes fewer research resources than the economic-engineering synthetic method. In addition to these advantages, this approach will give reliable estimates of the long-run average cost curve, or the planning curve as it is sometimes called, and the relative efficiency between various sized plants.

In order to use the accounting records method, it is necessary to obtain reliable cost records, covering a given period of time, from firms operating at varying volumes of output. This fact must be considered when selecting the sample of firms for the study so that each volume of output will be represented. The total costs of each sample firm are treated as a single observation, and a regression equation is fitted to the data providing a long-run total cost curve. This total cost curve can then be transformed into a per unit curve, the long-run average cost curve.

However, one of several drawbacks to the use of the accounting records method of cost analysis is that the planning curve estimated by statistical analysis represents an average relationship, therefore it does not indicate the least cost for producing each volume. In other words, the estimated cost curve is recognized to lie somewhere above the true planning curve, but it cannot be determined how far it lies above the actual planning curve. Thus, this method is not a very accurate measure of size relationships, however it should be noted again that the data can probably be collected by this method at only a fraction of the cost of a full-scale synthetic study.

There are still other problems in using accounting data for a cost analysis of this type. Some of these as recorded by L. D. Schnake[5] are (1) a lack of standardized accounting procedures among plants, (2) differences in quality of products and type of product mix, (3) the problem of separating scale from different levels of operating output, (4) accounting records may not express the time period in which various resources were used, (5) prices paid for the various factors of production may vary from firm to firm, (6) fixed costs taken from accounting records reflect variations in purchase data and rates and methods of depreciation, and (7) a satisfactory measure of output is difficult to establish from accounting data alone.

Nevertheless, some of the difficulties in purely accounting studies can be overcome, at least in part.[6] This can be done by direct observation and measurement of particular plant operations and by the use of physical reference data from engineering. This supporting data may be used with statistical techniques to cope with some of the problems encountered when using accounting data in a regression analysis. To what extent the supporting data is relied on depends on the nature of the problem and the types of data that are available. Of course, the cost advantage of the accounting records method is lost when very much of this supporting data is required to overcome data problems.

The method of cost analysis used in this study is essentially a combination of the accounting records method and the economic-engineering synthetic method. In fact, a good description of the method

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[5]L. D. Schnake, "Economies of Size in Non-Slaughtering Meat Processing Plants" (unpublished Master's dissertation, Department of Agricultural Economics, Oklahoma State University, 1967) p. 27.

[6]L. L. Sammet and B. C. French, "Economic-Engineering Methods in Marketing Research," <u>Journal of Farm Economics</u>, XXXV (December, 1953), p. 926.

used is that just cited above--the accounting records method, reinforced by supporting data from the synthetic method whenever it was necessary to correct serious errors. In other words, the accounting records method was used at each possible opportunity, but in some instances, the accounting data of the firm were not detailed enough or the results did not appear accurate enough to be acceptable. This modified accounting records method was chosen because it was realized that the accounting method would cause less demand on research resources, but it was also understood that certain problems in using the accounting data would have to be resolved in order to get acceptable results.

Methodological Approaches to Cost Allocation

Neither the accounting records method nor the economic-engineering synthetic method of cost analysis solves the problem of arbitrary allocation of overhead among products, operations, and over time. Overhead cost, defined as cost which is neither variable in proportion to output nor traceable back to particular output units, is very difficult to assign to individual units of product. However, this difficulty should not prevent the study of allocation procedures in order to present managers with better information for decision-making. The purpose of this section is to present some prominent bases for allocating overhead costs and how they may be determined.

Prior to discussing these various bases of allocation and their selection, the question as to why the overhead expenditures should be prorated back to the product unit should be answered. The main reason for allocating overhead costs is to aid the accountant in providing management with an average cost of production.[7] Since this figure is based on all costs, it can be used for the purpose of determining the price of the product with a fair degree of confidence as to the ultimate effect on profits.[8] The average cost of production could also provide warnings of changes in efficiency.

The second reason for the allocation of overhead costs to units of product is to estimate the profitability of each product in order to find any hidden costs.[9] Companies which show only one net profit figure in their profit-loss statement could be harboring a loss operation that they do not know exists. Losses in some product lines may cancel out profits in other lines. However, most executives are aware of the fact that some losses on certain products must be absorbed in order to fill product lines or to provide a service to a larger customer. The objective of these executives is to minimize such losses, take them knowingly, and only when they have to.[10] To achieve this goal requires some cost allocation analysis.

A third reason for the allocation of overhead to products is for the element of control. Management is concerned with keeping costs at a minimum, but a measure of the costs is necessary for control. Also, control is more efficient the closer that overhead expense can be placed

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[7]William A. Terrill and Albert W. Patrick, Cost Accounting For Management (New York: Holt, Rinehart and Winston Company, 1965), p. 77.

[8]J. M. Clark, The Economics of Overhead Costs (Chicago: The University of Chicago Press, 1923), p. 219.

[9]Philip Gustafson, "Every Sale Can Pay Its Own," Nation's Business, November, 1947, p. 58.

[10]Donald Longman and Michael Schiff, Practical Distribution Cost Analysis (Homewood, Illinois: Richard D. Irwin, Inc., 1955), p. 163.

to its cause.[11] There are others, but these are the three most important reasons for overhead cost allocation.

Various bases of distributing overhead costs have been developed over the years, but not one among them is all-inclusive or exact. Every basis of allocation is an arbitrary one, and it depends solely on the judgment of the individual performing the analysis as to which one is selected. The reader should keep this in mind when considering the "average cost of production" figures. Many a manager has been fooled into thinking that the allocation rates are precise and has made decisions without allowing for the necessary margin of error involved in them. The problem is simply this: a product that is produced jointly with another product is responsible for some part of the common cost involved in production, and this part is allocated to the product on the basis of a "fair" formula.[12] The many bases of allocating overhead costs are attempts to achieve a certain accuracy in determining this "fair" formula for cost allocation.

There are certain guidelines that may be followed in the selection of a "fair" basis for allocation.[13] The first of these is that the basis to be used in allocating common costs should be the principal causal factor.[14] For example, when water is used primarily for the

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[11] Phil Carroll, Overhead Cost Control (New York: McGraw-Hill Book Company, 1964), p. 43.

[12] P. J. D. Wiles, Price, Cost, and Output (New York: Frederick A. Praeger, 1963), p. 118.

[13] The four guidelines presented in the text are a slight modification of those cited by Roby Lee Sloan, "Relationship of Cost Characteristics of a Cooperative Association to Contracting Volumes of Grain Handled" (unpublished Master's dissertation, Department of Agricultural Economics, Oklahoma State University, 1962), pp. 26-27.

[14] Terrill and Patrick, p. 78.

personal uses of employees, the number of employees in each department would be the principal causal factor and the basis upon which to allocate the cost of water that is supplied to the firm among the various departments. However, it is very difficult to determine the primary causal factor for many costs. In such cases as these, it may be possible to use a second guideline for selecting an apportionment basis, the cost-benefit rule.[15] In applying the cost-benefit rule, charges are made to those operations which benefit from the incurrence of the cost. In other words, when it can be accurately determined, the larger share of the expense is borne by the department that receives the greater amount of service or use. An example of the employment of this guideline might be the allocating of depreciation expense to departments on the basis of the amount of floor space occupied by each department. The theory behind this basis is that each unit of space provides equal benefit.

Although many of the overhead costs may be allocated by following either of the guidelines previously mentioned, there are several types of expenses that do not lend themselves to such a simple analysis. Certain expenses are not sufficiently related to departments to be distributed on a basis selected by the principal causal factor or cost-benefit methods. Therefore, for more accurate cost distribution, other guidelines for allocation must be applied to the overhead expenses in order to apportion them among the departments. The first of these other guidelines (third in all) is allocation based on managerial analysis.

Managerial analysis encompasses two different procedures--sampling

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[15]Sloan, p. 26.

analysis and operator's estimate. The sampling analysis, used primarily by the manager for labor expenses, consists mainly of time and work sampling studies. In this procedure, the manager may allocate labor costs to departments or operations on the basis of the percentage of time spent in a particular activity determined by the analysis of a statistical sample. The second procedure, the operator's estimate method, leans heavily on the manager's ability to correctly estimate the portion of certain overhead expenses that should be assigned to each department or activity. The information gained in this manner varies considerably in accuracy, however if the manager feels that he can make a rough estimate of the allocation, this procedure may be more accurate than some more arbitrary method. By the use of close observation or time experiments, some managers can have a good understanding of how their firm's activities affect some of the overhead accounts.

However, in some instances, even the managers cannot adequately determine how some of the overhead expenses should be distributed among the activities. In these cases, a fourth guideline could be used--the expense being allocated on an ability to pay method. The ability to pay principle, as a basis of apportioning overhead cost, is that those departments having the largest income may be charged the largest portion of the overhead expenses.[16] The allocation is proportional to income, and in many situations, gross income has been used as the basis for allocation. This procedure is founded on the theory that overhead costs can be allocated on the basis of gross revenue if the product prices

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[16]Sloan, p. 27.

are properly chosen to represent long-run equilibrium conditions.[17]

However, allocating overhead on the ability to pay has been questioned whenever the objective was to measure profits.[18] When overhead costs are apportioned on a percentage of gross income, the ultimate cost of the product will depend on the price.[19] This is starting the cost-price question with price, which is in contradiction to the principle of independent determination of cost in order to measure profits.[20] In spite of its faults, the ability to pay principle of overhead allocation is used occasionally as more or less a last resort when other methods, for some reason, cannot be employed. It does have an important advantage in that it is relatively easy to apply.

The bases of overhead distribution employed in this custom seed cleaning study were selected essentially by the use of the four guidelines outlined above. Because of a lack of adequate data, the latter two guidelines, managerial analysis and ability to pay, were used more often. There are other guidelines that could have been employed just as well to determine the bases for allocation, but the four that are described have been used quite frequently in cost analyses. The overhead expenses encountered in this research were allocated to departments and to products in such a manner as to reflect, as closely as possible, the cause or effect of the outlay.

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[17] S. v. Ciriacy-Wantrup, "Economics of Joint Costs in Agriculture," Journal of Farm Economics, XXIII (November, 1941), pp. 798-799.

[18] National Association of Cost Accountants, Analysis of Non-Manufacturing Costs for Managerial Decisions, Research Series 19, 20, and 21 (New York: National Association of Cost Accountants, 1952), p. 23.

[19] T. J. Kreps, "Joint Costs in the Chemical Industry," Quarterly Journal of Economics, XLIV (1930), p. 421.

[20] National Association of Cost Accountants, p. 23.

Before leaving the discussion of overhead cost distribution, a few points should be stressed again. It should be remembered that the selection of a base is arbitrary in nature, and that more than one base may be used to apportion any particular cost. Because of the arbitrary selection of the base, any decision that must be made using the resulting cost figures should be approached with proper caution. However, the process of allocation is necessary to arrive at a reasonable cost of a product and to give more adequate information to managers for decision-making.[21]

[21]Terrill and Patrick, p. 83.

CHAPTER IV

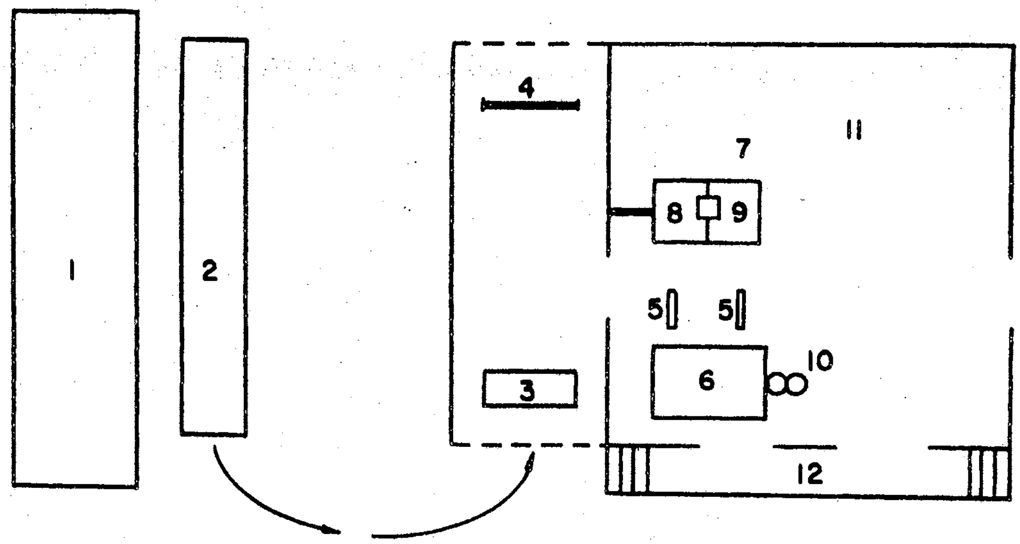
INVESTMENT REQUIREMENTS OF THREE MODEL PLANTS

The operation of a custom seed cleaning plant requires an initial investment in buildings and equipment. The fixed facilities should be coordinated in such a manner as to provide efficient and easy handling of the seeds to be processed. In some cases, the building used by the custom seed cleaning department has not been planned and built around the cleaning operation. Instead, it represents the conversion of existing space or the result of additions to a structure currently being used. However, many of the custom seed cleaning plants in Oklahoma do occupy a building separate from other operations. The object of this chapter is to present the investment and equipment requirements for three possible sizes of seed cleaning plants which would operate efficiently and be applicable to Oklahoma.

Possible Arrangement of a Seed Cleaning Plant

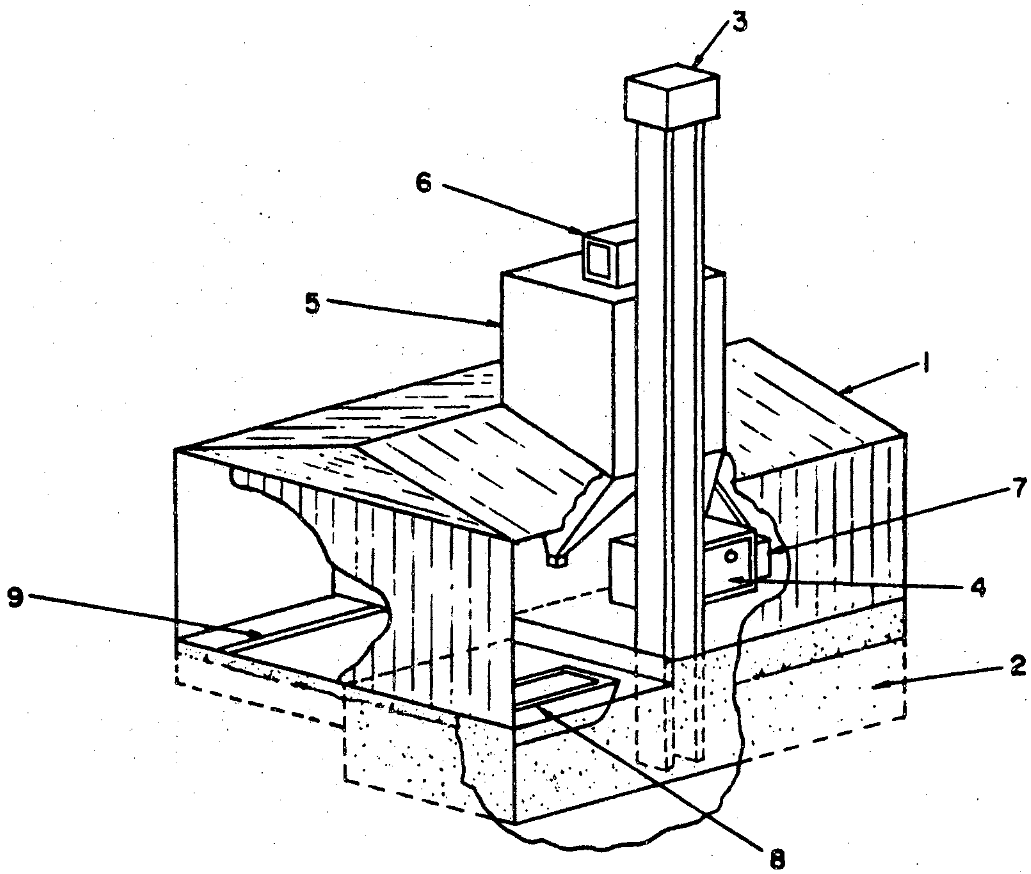
Prior to a discussion and presentation of the investment requirements, it might be helpful to describe a flow diagram of a possible plant layout of a seed cleaning operation. In this layout, it is assumed that the plant is housed separately from other operations. A diagram of the arrangement is given in Figure 2, and a cutaway drawing of the plant itself is presented in Figure 3.[1]

[1] The illustrations are taken from Enix and Briscoe, pp. 6, 8.



1. Office
2. Scales
3. Dump
4. Hoist
5. Legs
6. Cleaners
7. Treater
8. Untreated Clean Seed
9. Treated Clean Seed
10. Double Spiral Separator
11. Storage Area
12. Loading Dock

Figure 2. Diagram of a Possible Plant Layout



1. Steel building with iron cover
2. Concrete foundation and basement
3. Receiving and clean seed legs
4. Cleaner
5. Unit of square steel bins
6. Treater
7. Double spiral separator
8. Steel dump pit
9. Truck lift

Figure 3. Cutaway Drawing of a Possible Seed Cleaning Plant

Usually without appointment, the farmer brings in his seed to be processed. After the incoming conveyance containing the seed is weighed on the truck scale and that weight recorded in the office, the vehicle then moves to the cleaning plant. The vehicle is unloaded by the raising of its front end with the hoist and allowing the seed to pour into the dump pit. Following the lowering of the hoist, the farmer returns his vehicle to the truck scale to weigh empty in order that the gross weight of the seed he is to have cleaned may be determined.

Once the seed is in the dump pit it flows, either by gravity or by the aid of a vibro-pit, into the receiving elevator leg. The seed then moves by the leg into the holding bin above the cleaner. If the cleaner is not already in operation, the seed will begin to flow by gravity from the holding bin into the cleaner at a rate specified by the plant operator.

After the seed has passed through the cleaner and the trash has been removed, the cleaned seed is then picked up by the clean elevator leg. The customer has several alternatives at this point in the process. The cleaned seed may be elevated into the untreated seed bin if the customer does not want his seed treated or sacked. If he would like his material sacked, the seed is elevated, instead, into the sacking bin and sacked off at floor level. On the other hand, if the seed is to be treated, it flows from the clean grain elevator leg through the treater and into the treated seed bin or the sacking bin, depending on whether or not it is to be sacked. If the seed is sacked, the farmer can pick it up from the loading dock. But in the event that the seed is to be bulked off from either the treated or untreated clean grain bin, the customer enters the driveway and his vehicle is loaded directly from these bins. The process is thus completed.

Some seed processing plants have auxiliary equipment other than the basic cleaning line as outlined above, in order to make special separations. A very common piece of added equipment in Oklahoma is the spiral separator, which is used primarily to separate vetch from either wheat or rye. Usually, the vetch must be removed from the grain in order for the grain to be made ready for market. In this case, when neither the grain nor the vetch is to be used by the farmer for planting seed, the unseparated seed is not run through the cleaner or treater. It only goes through the spiral separator, with the rest of the procedure as discussed earlier remaining the same. However, if the wheat or vetch is to be cleaned further, it can be returned to the cleaner and be processed in the regular manner.

Of course, there is no set design for a plant layout, thus the kind of facilities and the manner in which they are coordinated varies greatly within the State. However, a plant of this type should provide adequate handling of the seeds and give satisfactory service, both to the customer and to the overall firm.

Building and Equipment Investment

Because of the variability of existing custom seed cleaning operations in Oklahoma due to the differences in the age, make, and amount of equipment, it was necessary to develop model plants in order to estimate and compare various costs of ownership and operation. The models, representing the three most frequent sizes of seed cleaning plants in Oklahoma, are presented in this section, and they are the result of engineering firm studies and cost estimates. An engineering firm and two construction firms who specialize in this type of work were consulted on the model plant specifications.[2] Equipment and construction cost estimates were made in late 1965 and were considered current enough to develop the model plants for this study, as the costs and layouts of the model plants resemble several plants included in the recent survey.

For the purposes of this study, seed cleaning plants are divided into sizes according to the number of air-screen cleaners that they contain. Cost projections for the three sizes of model plants used in this research are itemized in Tables I, II, and III respectively.[3] The building and equipment investment cost ranged from a low of $35,464.63 for the one cleaner unit to a high of $61,197.10 for the three cleaner plant. The investment requirements for the two cleaner operation entailed a cost of $49,945.80.

It should be emphasized at this point that probably no seed cleaning plant in the State has the exact specifications of any one of the three model operations given here. Certain additions to and subtractions from one of the model plants could still result in a fully functional unit, thus the model plants listed in the text are by no means recommended as "optimum" arrangements. An "optimum" combination of facilities depends on several factors; therefore, the type of equipment and arrangement considered "optimal" could vary considerably according to

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[2]The firms consulted were Process Engineering, Inc., Red Rock, D. D. Thompson, Contractor, Oklahoma City, and Balden Equipment Company, Enid. The author is indebted to Mr. James R. Enix for the use of cost projections from two of these firms which he obtained for an earlier study.

[3]For a more detailed description of some of the equipment and how it operates, many equipment manufacturers are willing to supply such information on request.

TABLE I

PROJECTED CONSTRUCTION COSTS FOR A POSSIBLE SINGLE-UNIT SEED CLEANING PLANT

General Description	Possible Price (inc. install.)
Building and Foundation 1-35' x 30' x 30' all steel building with 2 12x12 ft. overhead doors, 2 tilt out windows and a roof ventilator, erected on adequate foundation inc. all excavation, 115 yds. concrete, forming, and ground work.	$13,620.00
Dump Pit 1-Steel dump pit with 5' x 9' self-cleaning grate and vibro-pit with motor, starter, and transition to leg.	1,430.60
Truck Hoist 1-5 hp. lift with scaffold and electrical accessories.	2,426.00
Receiving Elevator Leg 1-900 bu. per hr. elevator leg with 9"x 6" cups, self-cleaning, 48' center, with motor and necessary controls, spouting, and electrical equipment.	3,124.14
Cleaner 1-Super X298D Clipper cleaner, or equivalent, with motor, drive, electrical components and all parts.	4,763.10
Clean Elevator Leg 1-approx. 800 bu. per hr. elevator leg with 5"x 4" cups, self-cleaning, with motor, distributor, necessary controls, spouting, and electrical equipment.	2,708.49
Treater 1-K55 Panogen seed treater, or equivalent, with motor, electrical parts and controls, and other accessories.	1,535.30
Spiral Separators 1-Double spiral separator with 2 bins and spouting.	1,086.00
Holding and Clean Grain Bins 1-holding bin over the cleaner and 2-clean grain bins plus a sacking bin and attachment, inc. spouting.	1,922.30
Dust System and Walkways Dust collector and bin with spouting equipment plus steel supports and walkways.	2,848.70
TOTAL	$35,464.63

TABLE II

PROJECTED CONSTRUCTION COSTS FOR A POSSIBLE DOUBLE-UNIT SEED CLEANING PLANT

General Description	Possible Price (inc. install.)
Building and Foundation 1-36'x 36'x 36' all steel building with 2 12x12 ft. overhead doors, 2 tilt out windows and a roof ventilator, erected on adequate foundation inc. all excavation, 125 yds. concrete, forming, and ground work.	$14,990.00
Dump Pits 2-Steel dump pits with 5'x 9' self-cleaning grates and 2-vibro-pits with motors, starters, and transition to legs.	2,731.00
Truck Hoist 1-5 hp. lift with scaffold and electrical accessories.	2,426.00
Receiving Elevator Legs 2-800 bu. per hr. legs with 6"x 4" self-cleaning cups, 48' centers, with motors and necessary controls, spouting, and electrical equipment.	4,984.14
Cleaners 2-Super X298D Clipper cleaners, or equivalent, with motors, drives, electrical parts, and all components.	9,476.20
Clean Elevator Legs 2-approx. 800 bu. per hr. elevator legs with 5"x 4" cups, self-cleaning, with motors, distributors, necessary controls, spouting, and electrical equipment.	4,614.18
Treaters 2-K55 Panogen seed treaters, or equivalent, with motor, electrical parts and controls, and other accessories.	2,917.60
Spiral Separators 1-Double spiral separator with 2 bins and all spouting.	1,086.00
Holding and Clean Grain Bins 2-holding bins over the cleaners and 4 clean grain bins plus a sacking bin and attachment, inc. the spouting.	3,272.90
Dust System and Walkways 1-Dust collector and a large bin with spouting equipment plus steel supports and walkways.	3,447.78
TOTAL	$49,945.80

TABLE III

PROJECTED CONSTRUCTION COSTS FOR A POSSIBLE TRIPLE-UNIT SEED CLEANING PLANT

General Description	Possible Price (Inc. install.)
<u>Building and Foundation</u> 1-36'x 40' x 36' all steel building with 2 12x12 ft. overhead doors, 4 tilt out windows and 2 roof ventilators, erected on adequate foundation inc. all excavation, 135 yds. concrete, forming, and ground work.	$16,641.70
<u>Dump Pits</u> 2-Steel dump pits with 10'x 7' self-cleaning grates and vibro-pits w/motors, starters, and transition to legs.	3,248.39
<u>Truck Hoist</u> 1-5 hp. lift with scaffold and electrical accessories.	2,426.00
<u>Receiving Elevator Legs</u> 2-900 bu. per hr. legs with 9"x 6" self-cleaning cups, 48' centers, with motors and necessary controls, spouting, and electrical equipment.	6,198.28
<u>Cleaners</u> 3-Super X298D Clipper cleaners, or equivalent, with motors, drives, electrical parts, and all components.	14,089.30
<u>Clean Elevator Legs</u> 2-approx. 1000 bu. per hr. legs with 6"x 4" cups, self-cleaning, 50' centers, complete with motors, distributors, necessary controls, spouting, and accessories.	5,084.14
<u>Treaters</u> 2-K55 Panogen seed treaters, or equivalent, with motors, electrical parts and controls, and other accessories.	3,037.60
<u>Spiral Separators</u> 1-Double spiral separator with 2 bins and all spouting.	1,086.00
<u>Holding and Clean Grain Bins</u> 2-Large holding bins over the cleaners and 2 sets of large twin bins plus spouting, sacking bin and parts.	4,470.06
<u>Dust System and Walkways</u> 2-Dust collectors and large bins, with spouting equipment, outside, plus steel supports and walkways.	4,915.63
TOTAL	$ 61,197.10

the area in which the plant is located, the types of seeds to be processed, and the year in which the plant was constructed.

A custom seed cleaning operation also requires an office, office equipment, and a truck scale. These are necessary to the cleaning operation, but in most cases, they are used to a much larger extent by other parts of the overall firm. However, these facilities do represent an overhead expense, some of which should be allocated to the custom seed cleaning department; therefore, representative investment costs are presented.

Since the size and functioning of these items depend much more on the overall business than simply on the custom seed cleaning operation, it was decided that investment costs for the office, office equipment, and the truck scale would not vary enough with the size of the cleaning plant to warrant three separate specifications of them. Therefore, only one cost estimate is given for each item, and all three estimates are 1965 figures and based on company records of the firms in the survey.

The office was assumed to be a one story, brick building measuring 35 feet by 50 feet. The estimated cost of construction was $18,100. The projected cost of the necessary investment in furniture and office machinery to furnish this office was $16,800. This figure includes desks, chairs, cash registers, account posting machines, and calculators, plus certain other equipment. The approximate salvage value of this equipment was assumed to be $1,360. Lastly, the investment in the truck scale, approximately 55 feet in length, was estimated at $9,340 including the cost of installation.

CHAPTER V

ANALYSIS OF PLANT COSTS

A knowledge of plant costs and an understanding of how they vary with certain operations is essential for competent decision-making on the part of management. Pricing and planning choices concerning a particular function of a firm depend heavily on this type of information. During the course of this study on custom seed cleaning, it was apparent that most managers were unsure of their actual cost of performing the service. However, this came as no surprise since several managers indicated earlier that they needed more information about their seed cleaning business, providing the impetus for this research. The purpose of this chapter is to present the various costs of performing custom seed cleaning and to give some analysis as to how those costs are affected by the volume handled.

Costs of Ownership and Use

The costs of ownership and use are incurred after a firm has invested capital in buildings and equipment. These costs which include depreciation, interest, insurance, taxation, and site rent are simply the expenses required of a firm in order to be equipped to perform particular functions. Ownership and use costs are costs that will be incurred irrespective of the plant's level of operation; therefore, they may be considered as fixed costs. The sum of these costs would equal the total fixed cost of the firm.

However, because these cost items varied considerably among plants of the same size group due to differences in purchase prices and specification of the facilities, model plants were developed to eliminate this dissimilarity. Thus, the ownership and use costs presented in this section are based on the three sizes of model plants that were presented in the previous chapter.

Depreciation

The services of buildings and equipment are used over a long period of time and may be considered as flow resources. The annual cost of such services may be computed by amortizing the investment in these assets over a suitable period of time.

The annual depreciation cost for the cleaner building was estimated by dividing its total cost by the number of years of estimated life of the building. It was estimated that the cleaner building had 20 years of useful life,[1] and the records of the sample plants seemed to reflect this figure. The depreciable balances of the one-cleaner, two-cleaner, and three-cleaner buildings were $26,760, $34,591, and $41,352 respectively. The computed depreciation expenses for the three separate cleaner buildings are presented in Table IV along with the other costs of ownership and use.

For the plant equipment, an estimate of the salvage value (assumed to be 10 percent of the initial cost) was subtracted from the total

[1]The useful life of the cleaner building and other buildings and equipment used in this study were estimated by use of the accounting procedures of the survey firms and according to the guidelines for depreciation given in United States Treasury Department, Internal Revenue Service, Publication No. 173, Bulletin "F"--Tables of Useful Lives of Depreciable Property (Washington, 1955), pp. 2-11.

TABLE IV

ANNUAL OWNERSHIP AND USE COSTS[1]

Cost Description	Plant Size 1 clnr	2 clnr	3 clnr
Annual Depreciation Cost			
1. Building	$1,338	$1,730	$2,068
2. Plant Equipment	784	1,382	1,786
3. Scale, Office Building, and Equipment[2]	189	193	196
Total Depreciation	$2,311	$3,305	$4,050
Interest	1,090	1,544	1,895
Insurance	96	135	165
Taxes	569	776	942
Site Rent	50	55	60
TOTAL	$4,116	$5,815	$7,112

[1]Based on model plants and equipment specifications with figures rounded to the nearest dollar.

[2]Based on model specifications in Chapter IV and manager's estimates of percentage use.

cost of new equipment before dividing by the estimated useful life. Ten years was used as the useful life of the cleaner equipment; therefore, the respective plant equipment depreciable balances, \$7,835, \$13,819, and \$17,800, were each divided by ten to get the annual cost.

The third item under annual depreciation cost in Table IV is the depreciation of the combination of the scale and office building and equipment that is allocated to the custom seed cleaning department. Each expense presented in item 3 of the table is the average cost for this category for all of the firms within that size group. The estimate of this cost for each firm is derived in the following manner: (1) using the investment cost estimates presented in Chapter IV, the annual depreciation expenses for each of the three categories, scale, office building, and office equipment, are computed; (2) the procedures used to compute these costs are the same as those outlined earlier for the cleaner building and equipment with the assumption that the useful lives of the office building and scale are twenty years and that the useful life of the office equipment is 10 years; (3) then, a portion of these annual depreciation costs are allocated to the custom seed cleaning section by multiplying each annual depreciation cost by the manager's estimate of the percentage use of the facility by custom seed cleaning on an annual basis. This was a measure of the "fair" share of joint depreciation costs that should be allocated to the custom seed cleaning department.

<u>Interest</u>

Although interest expense is not always visable in the account records, it is still an ever present cost of ownership. The firm may be able to finance a custom seed cleaning operation completely internally, but the opportunity cost of income foregone by not using the funds in another alternative use constitutes an expense to the firm. An interest expense of six percent was applied to the non-depreciating salvage value of the plant equipment. A three percent rate was applied to the depreciable balance of the cleaner building and equipment, which is the equivalent of a six percent rate being applied to the average value of the facilities over their entire life. The total interest expense ranged from $1,090 for the one-cleaner plant to $1,895 for the three-cleaner plant.

Insurance

Most custom seed cleaning firms in Oklahoma carry insurance against losses due to fire, wind or hail to protect their investment and thereby reduce some of the risk of ownership. Rates for this insurance are determined by the Oklahoma Inspection Bureau, and the rating procedure is quite detailed. The rates depend on many factors such as nearness to fire department equipment, availability to water, type of material used in construction, and the type of coverage of the particular policy.[2]

The type of coverage assumed for this study was 80% coinsurance covering damage caused by wind, fire, and hail. The coinsurance factor is an agreement on the part of the firm purchasing the insurance that it will keep the buildings and equipment under the policy insured by at least a minimum amount of the total valuation, and 80% of valuation appeared to be the most frequently used coinsurance rate among the sample plants. A high coinsurance percentage reduces considerably

[2] This information and the major part of the material in this section was obtained from the Triangle Insurance Agency, Inc., Enid, Oklahoma.

the rate applied per $1000 of insured valuation.

In computing the insurance cost of the model plants, a rate of $3.38 per $1000 was applied to 80% of the cost of the buildings and equipment. The $3.38 rate was selected because it was the rate applied to one of the sample plants whose construction closely resembled that of the model plants. The actual insurance cost of building and equipment for each model plant is listed in Table IV.

Taxes

The amount of personal property taxes to be paid is of concern to firms when examining their costs of doing business. Since the rates and the percentages of market value that are used as the base for computing these taxes vary between counties, the procedures and rates used in Payne County were arbitrarily selected in order to be consistent in the cost analysis.[3]

The assessment value of the plant and equipment was determined by assessing the model plants at 25% of the market value. The township tax rate within Payne County, $72.08 per $1000 of assessed valuation, was used in this study. A full tax rate was applied to the assessed value of the building and the salvage value of the equipment. Since the value of the equipment is decreasing over time, it would be overestimating the taxes of the firm to base them on new equipment. Therefore, one-half of the tax rate, $36.04 per $1000, was applied to the depreciable balance of the equipment. Personal property taxes must also be paid on the average inventory of product owned by the firm, but this would not apply to the custom seed cleaning department because no

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[3]Tax procedures and rates were obtained from the County Assessor's Office, Payne County Court House, Stillwater, Oklahoma.

inventories result. The taxes on building and equipment for the three model plants are presented in Table IV.

Site Rent

Many of the sample firms in this study did not own the land on which their buildings were constructed. Because of the nature of the other activities of the firms, most of them were located adjacent to railroad facilities on land that was often owned by a railroad company. Several of the firms had long term leases or rental arrangements with the landowners at very low rates. It was for this reason that site rent was used instead of imputing a value for the land as if it were owned by the firm doing the custom seed cleaning.

As stated earlier, the rent was very low; therefore, site rent costs of $50, $55, and $60 per year were used respectively for the three model plants. These figures include the land on which the building is erected plus driveways leading to and from the plant. Admittedly, these cost figures are quite low, but they represent the best available from firm records.

Operating Costs[4]

In addition to the initial investment in building and equipment, and the costs of ownership and use, the actual operation of a custom seed cleaning plant requires expenditures for labor, utilities, management, and other services and supplies. A knowledge of these costs and

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[4]In this section and throughout the remainder of this chapter, only 18 firms were included in the analysis. The four-cleaner plant elected not to cooperate, one three-cleaner plant did not have any custom cleaning in the 1967 season, and the accuracy of the data obtained from one of the one-cleaner plants was highly questionable and was excluded in this part of the analysis. This left eight one-cleaner plants, six two-cleaner plants, and four three-cleaner plants in the analysis.

how they vary is important to the understanding of how costs are affected by certain decisions of functions. This section on operating costs consists of the necessary expenses required to operate a custom seed cleaning plant and describes the manner in which these expenses were estimated for the purposes of this study.

Wages and Salaries

Wages and salaries constituted about two-thirds of the operating expenses in the sample firms. This category includes the wages paid to the laborers working in the plant, the wages of office personnel who perform the bookeeping and secretarial duties, and a portion of the manager's salary for the necessary supervision and organization to keep the plant operating.

Hired Labor

Since most of the firms have diversified operations and employ non-specialized workers who shift from department to department depending on the work load, hired labor cost for the sample plants was difficult to obtain. Although one particular worker might be assigned to operate the cleaner plant, he still might work in other departments of the business when there is a lag in the cleaning operation. This occurs especially in both the beginning and the end of the season. Even though all firms kept accurate records on how many hours each man worked, few if any, kept them in enough detail to allow the computation of labor cost from firm records.

Because of these factors, managers estimated the number of hours of labor necessary to operate their custom seed cleaning department for the entire year. The most common procedure used by the managers to make this estimate was to estimate the length of the cleaning season and then adjudge the number of hours per day each laborer worked and the average number of workers per day during the season. The managers also estimated the percentage of the total labor hours which were overtime.

Due to the variability of wage rates among the sample plants, a common wage rate for all plants was used. The wage rates of the cooperating firms ranged from a low of $1.40 per hour to a high of $3.87 per hour. To standardize the wage rate, the median rate of $1.65 per hour was used for regular hours with overtime pay at the rate of one and one-half times the regular rate, or $2.475 per hour. These rates were applied to the estimated labor hours provided by each manager.

There are other aspects of labor cost in addition to the actual wages. Social Security tax, unemployment tax, liability insurance, and workman's compensation insurance vary with the labor payroll and may be considered as part of the expense of hiring labor. Other items which could be included but which were not considered in this study are employee benefits such as vacation and holiday pay, retirement, and life and health insurance. These benefits, when wholly or in part are paid by the employer, become an addition to the labor cost.

It was assumed that each of the workers' yearly payroll did not reach the maximum amount of $6600 to which Social Security could be applied; therefore, a Social Security tax of 4.4% of the payroll was levied on the firm. This base salary and tax rate were in effect in 1967. The calculated amount of the tax was added to the labor cost imputed from the wage rates.

Another expense of this type is unemployment tax. It, too, is a percentage of the payroll, but it can vary from firm to firm within the state. Unemployment tax is applied to a business when it employs four or more workers for a portion of twenty weeks or more. All of the firms included in this study were subject to this cost. Unemployment tax is divided into Federal and state rates, with the Federal portion being .4% of a worker's annual payroll under $3,000. The state rate, as a percentage of the same base, fluctuates among the firms according to their unemployment records. In Oklahoma, the rate may vary between .2% and 2.7% of the taxable payroll. A few of the cooperating firms were paying more than the minimum rate, but the majority were only paying the .2% state rate and the .4% Federal rate on the taxable payroll. For this reason, the low rates were used in this study to compute the unemployment tax that the firm must pay.

Another important item related to labor cost is workman's compensation insurance, which provides protection against work-connected injuries and death. This item was purchased by all of the firms in the study; therefore, it was specified as a cost in the analysis. The policy rate applied was $4.33 per $100 payroll with no limit on the payroll that it applies to. Although some firms paid a slightly higher rate, the one selected was by far the most commonly used.

The last aspect of labor charges listed earlier is liability insurance, which is carried to protect the firm, its employees, and its customers. It was the common practice of the firms cooperating in this study to carry $100,000 bodily injury, $300,000 each accident, and $100,000 property damage in a comprehensive general liability policy. The premium for this policy was $6.56 per $1000 of payroll.[5] There were minimum premiums and some fees for writing the policies for workman's compensation and general liability, but they were not considered

[5]Obtained from Triangle Insurance Agency, Inc., Enid, Oklahoma.

in this study because the share attributable to the seed cleaning department would be quite small in both cases. The average hired labor costs for the plants within each size group are given in Table V.

Management

Some cost should be appropriated to the seed cleaning department for the planning and organizational talent contributed to it by the manager. This item was estimated in a similar fashion to that used for hired labor. The manager estimated the time that he spent supervising the cleaning operation each week during the season. Using the manager's salary and the estimate of his time spent, the management cost was estimated. If the firm employed an assistant manager, his contribution to cleaner expense was determined in the same manner. Management payroll is subject to the same related costs listed for hired labor. Since the combined rates for Social Security, unemployment tax, workman's compensation, and liability insurance amount to 9.986% of the affected payroll, the estimated management expense was increased by this amount. The group averages are presented in Table V.

Office Personnel

Necessarily, some bookkeping and secretarial work is done on behalf of the seed cleaning department; therefore, an attempt was made, as in the case with hired labor and management, to estimate the amount of time that the office workers devoted to seed cleaning duties. Using the same procedure as for management expense, the cost of office personnel was estimated.

There is a slight change at this point from the previous two items in this section, and that is a difference in workman's compensation rate for clerical employees. Only \$.13 per \$100 of payroll is applied in contrast to the \$4.33 rate used for plant personnel and managers,

TABLE V

OPERATING COSTS EXPRESSED AS AVERAGES OF EACH GROUP[1]

Cost Description	Plant Size		
	1 clnr	2 clnr	3 clnr[2]
Wages and Salaries			
1. Hired Labor	$2,416	$3,522	$8,723
2. Management	692	720	1,431
3. Office Personnel	274	308	640
Total Wages and Salaries	$3,382	$4,550	$10,794
Chemical Cost	1,018	1,182	1,191
Maintenance	266	375	459
Electricity	275	367	457
Advertising and Administrative Costs	200	255	650
TOTAL	$5,141	$6,729	$13,551

[1]Costs in this table are the average of the estimated costs of each firm according to size group and rounded to the nearest dollar.

[2]Some possibilities for the disproportionate increase in the costs of Group III are offered in a later portion of this Chapter.

because of the decrease in risk of injury to clerical employees. This makes the increase above wage costs due to the related costs of Social Security, unemployment tax, liability, and workman's compensation 5.786% for the clerical workers. The cost of office personnel with the related expenses included, is also listed for each size group in Table V.

Chemical Cost

Only one of the sample firms did not treat small grains for protection against disease; therefore, it was the only plant that did not incur some expense for fungicides. The cost of chemicals for each firm was calculated by multiplying the number of bushels of grain that the firm estimated it had treated by an average cost per bushel for the treating material. When bought in quantities of greater than one barrel, a sizeable discount in the price of the chemicals could be obtained by the firm. Therefore, it was assumed that the fungicides were bought in this manner. Under this assumption, the average cost for the chemicals was four cents per bushel. The average chemical costs for each group of plants are presented in Table V.

Maintenance

The third category of operating costs to be discussed is that of maintenance. Timely maintenance is essential in order to keep the equipment in good running condition. Maintenance includes regular lubrication, normal replacements due to wear, and general upkeep of the building and equipment.

Since the estimates for maintenance cost varied considerably among the plants and seemed to depend on unexpected repairs rather than normal maintenance, maintenance cost was calculated using a percentage of the replacement cost of the building and equipment. The average percentage rate used in this study as estimated by plant managers was .75%. The .75% rate was applied to the investment requirements of the three model plants in Chapter IV and the results are given in Table V.

Electricity

The model plants and all of the plants in this study were fully electric. Nevertheless, power costs were not large when compared to the other operating expenses of the seed cleaning plant. This is primarily due to the fact that the cleaning plant motors are small in contrast to other types of operations, such as feed mills for instance.

Regardless of their magnitude, however, power costs were very difficult to estimate. To economize, firms usually had only one meter registering the number of kilowatt hours (kwh) used by all of their various operations. Thus, it was virtually impossible to distribute the kilowatt hours and therefore electricity costs to the seed cleaning department. Consequently, a synthetic procedure was used to estimate the kilowatt hours consumed by a seed cleaning plant. The model plant specifications for motors and equipment were used in the procedure in order to standardize the plants.

First, it was assumed that kilowatt hours varied directly with plant volume within each size group; therefore, an attempt was made to estimate for each size of plant the average number of kilowatt hours needed to clean 1000 bushels of wheat equivalents in order that this rate might be applied to each firm's total volume.[6] Under the

[6] For the purposes of this study, the plant volumes were adjusted to wheat equivalents on the basis of operating machine capacity for each of the types of seeds cleaned. A more detailed explanation of the weighting scheme devised to adjust the volume to more homogeneous units is presented in the following chapter.

assumption that wheat could be cleaned at the rate of 250 bushels per hour, an estimate of how long each motor would have to run in order to clean a thousand bushels of wheat was multiplied by the rated horsepower of each motor after the horsepower had been divided by a .85 conversion factor to adjust the motor for average efficiency.[7]

The resulting figures were then multiplied by a kilowatt hour conversion factor of .746 to obtain the actual kilowatt hours consumed by each motor; therefore, the summation of these final computations provided an estimate of the number of kilowatt hours of electricity required to clean one thousand bushels of wheat under the specified assumptions. This summation was multiplied by each firm's adjusted volume in thousand bushels to obtain the estimated use of electricity in kilowatt hours for the year. These estimates were not very different from the assessments offered by a few of the plant managers. The number of kilowatt hours consumed per one thousand bushels for each plant size was 84.22, 82.46, and 76.66 respectively. This indicated decline in kwh consumption per unit is due to the fact that all accessory equipment has not been increased in the same proportion as the cleaners for each size of plant. In order to calculate the cost of the electricity used by each plant, their estimated kilowatt hour consumption was multiplied by the average charge of 3.25 cents per kilowatt hour.[8] However, this was not the entire electrical cost for the plant. Minimum charges per

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[7]Carl J. Vosloh Jr., et al. Custom Feed Milling in the Midwest (Washington: U. S. Department of Agriculture, Agricultural Marketing Service Research Report No. 273, 1958), p. 18.

[8]This average was calculated from the rate schedule provided by Oklahoma Gas and Electric, Enid, Oklahoma. The same average rate was also used in the study by Carl Vosloh Jr., et al.

month also had to be paid by most firms, even though the plants remained idle in the off season. The minimum rate depended on the total number of rated horsepower for all of the motors housed in the building. The rate was $1.00 for the first one-half horsepower and $.50 for each additional horsepower in the plant. The minimum rates per month for the model plants were then $11.70, $20.25, and $22.75. This charge was levied on each firm for each month that it did not do enough cleaning to reach the minimum. Thus, the estimated electricity costs for the firms in this study are a combination of the cost of the electricity used plus the monthly minimums. The average power costs for each group of plants are given in Table V.

Advertising and Administrative Expenses

Each firm in the study incurred various expenses for advertising and administration in order to keep each department of its business functioning properly. Thus, the seed cleaning enterprise should be held responsible for some of these costs. Costs included under administrative expenses are (1) telephone, (2) travel, (3) office supplies, (4) auditing and legal fees, and (5) dues, subscriptions, and donations. Some firms may not have all of these accounts just named while others may have some accounts that are not listed, but these costs appeared to be the most important administrative expenses that should have some portion allocated to the seed cleaning department.

Advertising and the various administrative expenses were allocated by distributing overhead costs on a percentage of gross revenue since the managers stated that they could not reliably estimate the portion of these expenses attributable to seed cleaning. In order to obtain the cost allocated to the seed cleaning enterprise, the total expense for the particular account given in the firm records, with the exception of telephone expense, was multiplied by the percentage of the total gross earnings credited to the custom seed cleaning department. Total gross earnings are equal to gross revenue less the cost of commodities sold. This percentage of total gross earnings was usually calculated from actual firm records, but in some instances, the percentage was estimated by the managers.

Telephone expense was treated in a slightly different manner because the total amount in the account records included charges for long distance calls as well as the charges for the monthly base rate. Since long distance calls were hardly ever used in conjunction with the custom seed cleaning department, it was necessary to separate the long distance expense from the monthly base rate so that the percentage of gross earnings could be applied to the base rate only. The summation of the results of these various computations is the advertising and administrative expense allocated to the custom seed cleaning department.

Cost Analysis

Individual costs of ownership and use and operating costs have been discussed in the two preceeding sections of this chapter. Now that these costs have been estimated for the firms in the sample, they can be used to make inferences about other cleaning plants of similar sizes. It is the purpose of this section to analyze these costs in order to develop the relationship of costs to various output levels of the three sizes of plants.

The presentation of the costs in the previous two sections would indicate that fixed ownership and use cost does play a major role in the total cost of operation. Of course, the percentage varies among the firms, but on the average, fixed cost is about 40% of the total.

The most important cost of ownership is depreciation, with interest expense being the next most important fixed cost factor. Depreciation in every case was over one-half of the annual ownership and use costs. The most important operating expense was the cost of wages and salaries with hired labor contributing about 75% of this category. In fact, hired labor cost was usually greater than 50% of the total operating costs. The second largest operating cost item other than wages and salaries was chemical cost.

In order to make a cost analysis, factors that have a significant affect on variable costs should be determined.[9] Volume in wheat equivalent bushels, unused capacity in bushels of wheat on a yearly basis, and the percentage of the seed that must be sacked before it leaves the cleaner building were hypothesized to have an effect on costs.

Following the theory behind variable cost which states that it should be zero when volume is zero, cost functions passing through the origin were estimated. Various combinations of the above three variables in several alternative equation forms were investigated, but volume was the only variable that would "explain" with any degree of certainty the fluctuations in cost.[10] The estimated cost-volume

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[9] Only variable costs were considered here because the fixed data for the operations were based on model plants; therefore, the fixed costs were constant for each group.

[10] All possible combinations of the sacking and unused capacity variables were attempted with the volume variable raised to powers from 1.0 through .4 in increments of one-tenth. Neither the capacity variable nor the sacking variable had a significant affect on variable costs. In fact, some of the sacking variable coefficients were negative, which was illogical from knowledge of the actual operation.

relationships for one-cleaner, two-cleaner, and three-cleaner plants are, respectively,

$$\hat{Y}_1 = .46763X_1^{.6} \qquad r^2 = .9386 \quad t = 9.57996 \tag{5.1}$$

$$\hat{Y}_2 = 1.25046X_2^{.4} \qquad r^2 = .8533 \quad t = 4.82431 \tag{5.2}$$

$$\hat{Y}_3 = .13350X_3 \qquad r^2 = .9706 \quad t = 8.12186 \tag{5.3}$$

where,

Y_j = variable cost of each size group in thousands, and

X_j = annual volume of seed cleaned in thousand bushel wheat equivalents for each size group.

Each of the coefficients was significant at the 99% level.

After the total variable cost equations had been estimated using the data of the sample plants, they were then adjusted to total cost equations by adding the calculated fixed costs of the appropriate model plant to the equation as a constant term. The total cost relationship for each plant size then becomes:

$$\hat{Y}_1 = 4.116 + .46763X_1^{.6} \tag{5.4}$$

$$\hat{Y}_2 = 5.815 + 1.25046X_2^{.4} \tag{5.5}$$

$$\hat{Y}_3 = 7.112 + .13350X_3 \tag{5.6}$$

Equations 5.4-5.6 are graphed in Figure 4, and the short run average cost curves derived from them are presented in Figure 5.

Although the correlation coefficients for the three equations were statistically signficant, the relationship of the average curves to one another in Figure 5 are not consistent with the logic of economic theory. When $SRAC_1$ and $SRAC_2$ are isolated from $SRAC_3$, the results appear more logical. The one-cleaner plant operates with a lower average cost in the lower ranges of output than does the two-cleaner plant. However, as

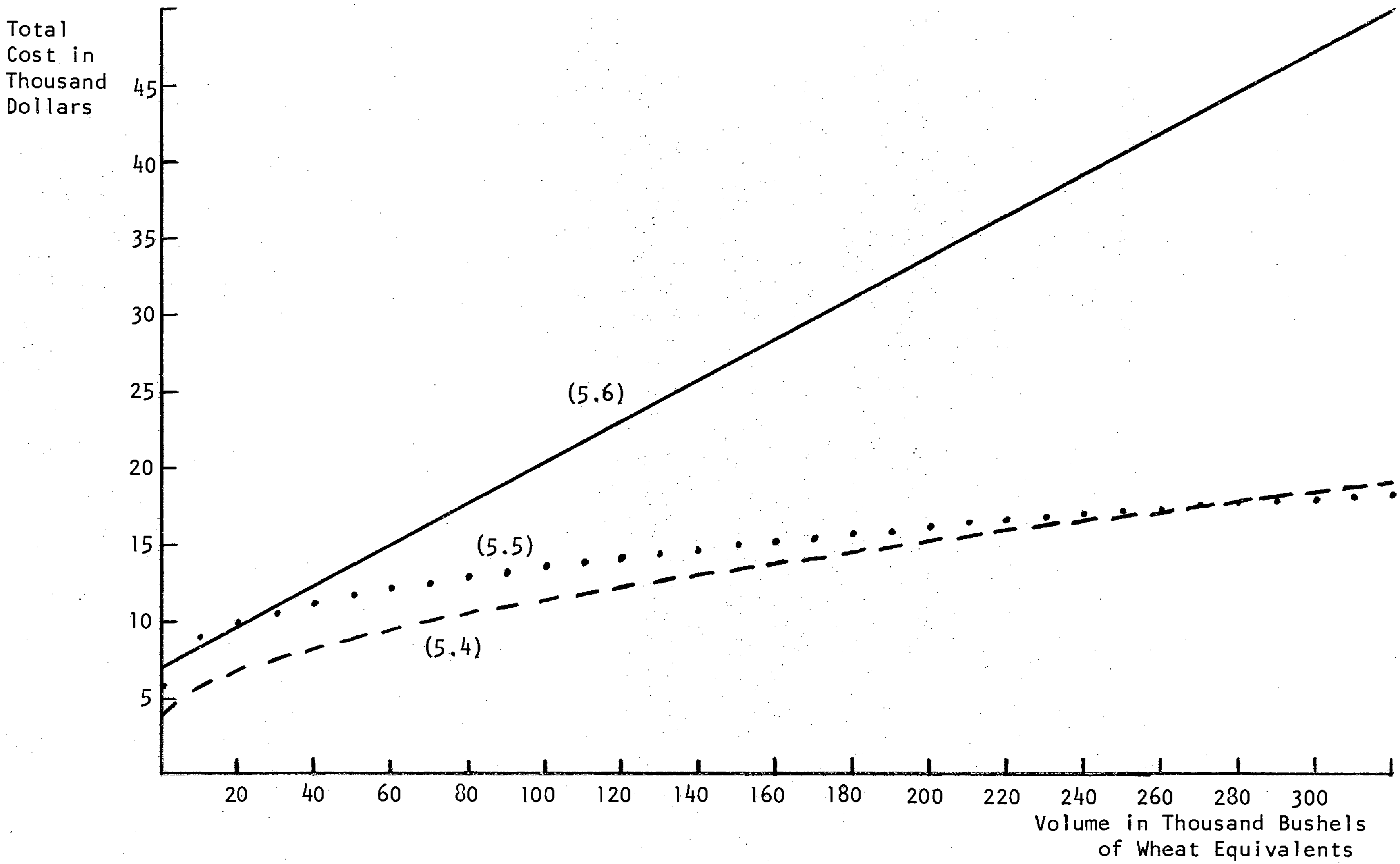

Figure 4. Estimated Total Cost Curves of the Three Plant Sizes

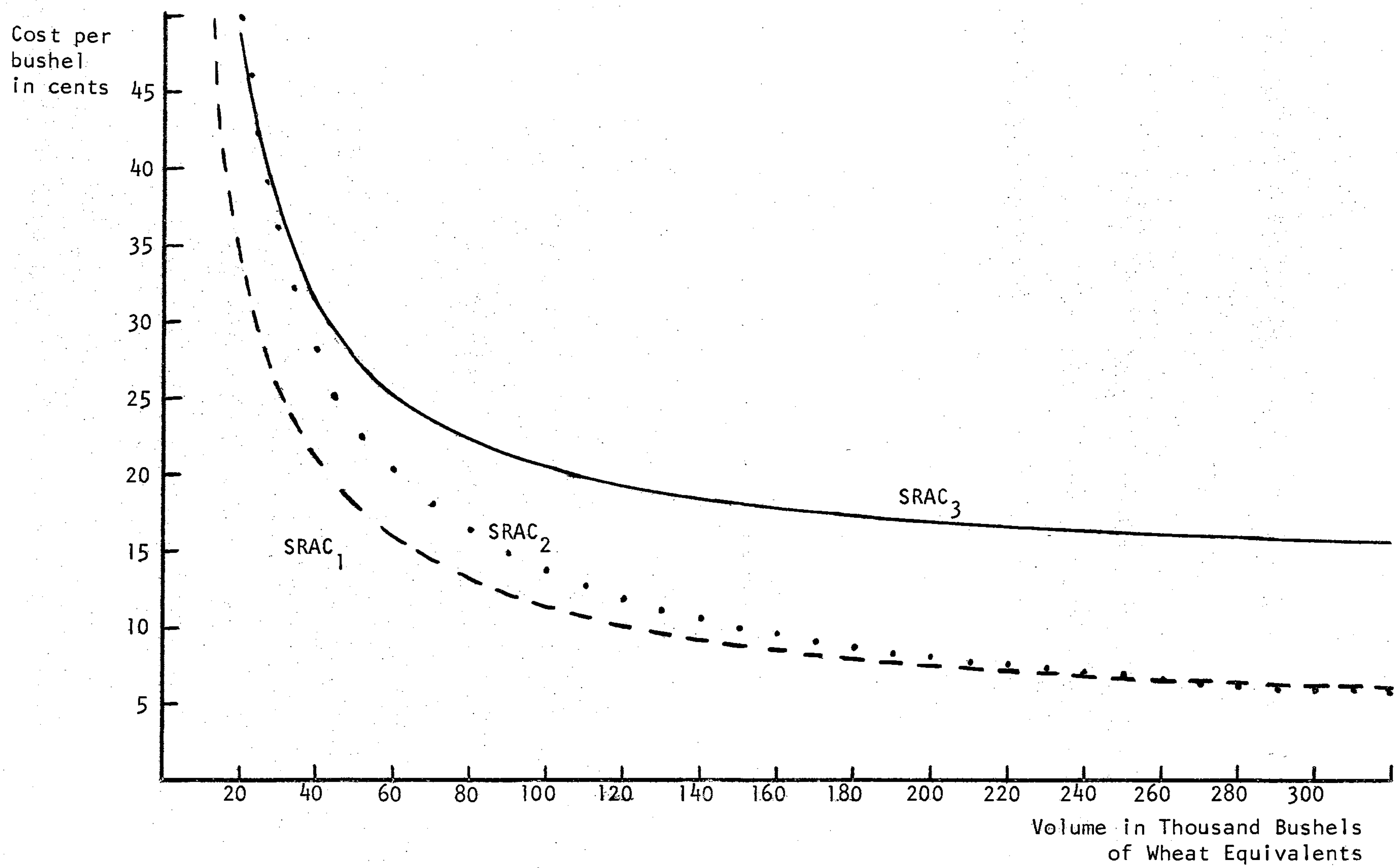

Figure 5. Estimated Average Cost Curves for the Three Plant Sizes

volume increases, the average costs draw closer together until finally, just before the output reaches 300,000 bushels of wheat equivalents, the two-cleaner plant becomes the more optimum size operation and can operate at lower average costs.

However, when $SRAC_3$ is included, a measure of inconsistency is introduced. At a volume less than 20,000, the three-cleaner plant can operate more economically than the two-cleaner plant but not at higher volumes. This is certainly in contradiction to the expected size economies, at least in the lower range of output.

Several reasons might be offered to explain the inconsistency. First, Group III contains only four firms with the volume of the largest 137,000 wheat equivalent bushels more than that of the second largest. The other firms are congregated in the lower end of the volume range beginning at 40,000 wheat equivalent bushels. Therefore, the firms' volumes are not distributed along the estimated curve, thus an error in the estimation of one of the observations, especially in the high volume firm, could cause the estimating equation to be in large error.

The second reason for questioning the validity of the Group III curve is that the quality of the data did not appear to be equal with the quality of data obtained from Groups I and II. This was noted by the managers' hesitancy to make important estimates about their costs and their inferred margins of error which could significantly change the measured cost of the firm.

A third reason offered for the discrepancy of the $SRAC_3$ is the significantly higher labor cost estimated by the high volume firm. The higher labor cost is difficult to explain without revealing the identity of the particular firm, but it might be the result of a unique local labor situation. In view of the reservations concerning the Group III regression equation, extreme care should be exercised in its use. More information is needed in order to make inferences about the three-cleaner plant costs.

CHAPTER VI

ANALYSIS OF REVENUE AND VOLUME

In order to complete the economic analysis of custom seed cleaning operations in Oklahoma begun on the sample cost data in the previous chapter, it is necessary to analyze the revenue and volume characteristics of existing firms. By studying revenue and volume in conjunction with plant costs, some estimate of the firm's profit position can be determined. Reflected in this figure would be the manager's ability both to estimate his cost of operation and to price the service in such a manner as to cover those costs of operation. Although, there may be objectives for the firm other than profit, the existence of other objective functions do not preclude a revenue, cost, and profit type of analysis. The purposes of this chapter are to discuss the charges for the various seeds, provide some volume information, and present a simple breakeven analysis.

Price Characteristics

The charges assessed by the custom seed cleaning firms are almost always levied on the basis of the uncleaned weight of the seed. There are some exceptions to charging in this manner such as mungbeans and lovegrass, but this is a small portion of the total cleaning. The reasons for charging on an uncleaned basis are two-fold. First of all, it is much more expedient for the seed cleaning plants since they are not required to weigh the grain after cleaning. Secondly, this method of handling the charges is more equitable for the firm and for the seed owner. Since the charge is made on the "dirty" weight, the cleaner the seed is when it arrives at the plant the lower the cost will be per unit of clean seed. Also, since the entire load must go through the cleaner regardless of the amount of impurities, it would be unfair to the cleaner plant to receive payment only for the clean seed that remains. Charging on the basis of gross weight is also an incentive to the farmer to bring in cleaner seed.

The basis upon which the cleaning charge was levied remained much the same among the sample plants, but the actual charges for each kind of seed varied considerably. In order to show this variability and to present the average charges for the most common seeds which are custom cleaned, Table VI has been developed. The high, low, average, and median charges for each seed are presented in this table. The table is self-explanatory, but some points of analysis should be made. The fact that the average of the charges is larger than the median in most cases would indicate that a few firms with charges toward the high end of the price range were more than offsetting the larger number of firms in the lower end of the range. The median, therefore, may be a more representative price than the average of all of the prices. Only four of the sample plants indicated that they had a minimum charge per lot. Many of the managers felt that it was poor public relations to invoke a minimum charge. Most of the firms charged 10 cents per hundredweight for sacking.

Although it is not apparent in Table VI, there has been an upward trend in the charges made for custom cleaning over the past few years.

TABLE VI

SEED CLEANING AND TREATING CHARGES FOR THE SAMPLE PLANTS

Kind of Seed	No. of Plants Reporting	Charges in dollars per cwt.[1] High	Low	Average	Median
Cleaning:					
Wheat	19	.55	.09	.21	.13
Barley	19	.55	.09	.23	.19
Oats	19	.55	.10	.30	.28
Rye	4	.35	.13	.22	.25
Alfalfa	10	2.00	.35	1.16	1.00
Sweet Clover	9	1.00	.25	.65	.75
Mungbeans[2]	7	.75	.20	.52	.50
Separation From Vetch	8	1.00	.15	.54	.50
Soybeans	7	.55	.12	.29	.20
Cowpeas	8	.85	.12	.41	.50
Fescue	5	3.00	1.00	2.20	2.00
Lovegrass[2]	5	3.50	2.00	2.80	3.00
Hop Clover	3	4.00	3.00	3.67	4.00
Korean Lespedeza	3	2.00	.35	1.20	1.25
Vetch	6	1.00	.12	.51	.50
Millet	3	1.00	.40	.72	.75
Treating:					
Wheat	18	.35	.08	.14	.10
Barley	18	.35	.10	.16	.13
Oats	17	.45	.10	.21	.19
Sacking	18	.10	.00	.06	.10
Minimum Charge	4	20.00	5.00	10.00	5.00

[1]Charges are rounded to the nearest cent and based on inweight of the uncleaned seed.

[2]Charges for this kind of seed are based on cleaned weight instead of inweight.

Several of the managers indicated that they had raised their prices over that for the 1966 season. Competition appeared to be an important factor in establishing the cleaning charges of a particular firm. The different prices for the different kinds of seed appear to reflect the extra time and effort involved in cleaning certain types of seeds, and this was a factor in establishing a price.

The annual custom cleaning incomes of the survey plants ranged from a low of $2,700 to a high of $32,318. However, the incomes of plants which processed their own seed were adjusted to take into account their extra volume. This adjustment of volume and income made the upper end of the income range $41,363. The average income was $13,208 and the median income was $9,303. True, the firms doing their own processing did not actually receive this extra revenue for cleaning per se, but it was assumed that the custom charges were included in the markup before resale. By including this additional volume of these plants in the study, a better estimation of how costs are affected by volume could be determined.

By arranging the cleaning and treating income of the firms into size groups, it was found that Group I ranged from $2,700 to $23,850, Group II ranged from $4,313 to $30,352, and Group III ranged from $3,044 to $41,363. The average income of each group was $9,706, $14,774, and $17,865 respectively.

Volume Characteristics

A manager must know the volume of the product that he produces in order to determine the average cost of production. When average cost of production is compared with the price charged for the product, the manager can assess the nature in which profits of the firm are affected. Therefore, it is important for the manager to have a good idea of his volume.

However, the managers of the firms in this study for the most part could not estimate their volume with any assurance of accuracy.[1] It was the regular procedure of only two firms to keep records of the custom seed cleaning volume. Nevertheless, some of the firms did keep volume totals for the 1967 season at the request of this author. All of the firms were asked to keep volume records in order that the analysis might be more accurate.

In those cases where possible, the interviewer went through the sales tickets of those firms which did not know their volume in order to compute the volume of custom cleaning, but eight of the plant volumes used in this study were estimated by the manager or owner. Errors in the estimation of these volumes could have a serious affect on the estimated cost functions and thereby affect the breakeven analysis presented in a later portion of this chapter.

The kinds and relative amounts of seeds cleaned changed from plant to plant causing a "product mix" problem in defining a measure of volume suitable for analytical purposes. The volume needed to be expressed in similar units in order that interplant comparisons could be made concerning cost and revenue. It was for this reason that a procedure was developed to make the volume units more homogeneous.

Since wheat was cleaned by all firms in the study and because in some plants it was cleaned in a much larger proportion than other seeds,

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[1] One manager even indicated that volume was not important, only the revenue that it brought in.

the volume of each plant was adjusted to equivalent bushels of wheat. The reasoning behind this adjustment is based on the assumption that costs of cleaning varied in direct proportion to the time required for the seed to pass through the cleaner. Estimates of the operating capacity rates in bushels per hour were obtained from each firm for each kind of seed cleaned. This information along with the measurements of the volumes of each kind of seed were used to make the adjustment.

A formula was devised to make the adjustment of each particular volume to wheat equivalents. The formula was:

$$\frac{\text{operating capacity of wheat in bu./hr.}}{\text{operating capacity of seed to be adjusted in bu./hr.}} \times \text{Volume of seed to be adjusted in bu.}$$

$$= \text{wheat equivalent bushels.}$$

This procedure was performed on all kinds of seeds cleaned by the firm, and the resulting sum was the adjusted plant volume.

Using these adjusted volumes, the range of volumes over all eighteen firms was from 25,099 wheat equivalent bushels to 231,234 wheat equivalent bushels, with the overall average being 77,720 bushels of wheat equivalents. The average of each size group was 63,348, 75,078, and 110,425 wheat equivalent bushels respectively from Group I to Group III. In order for a manager to compare his firm with the results of this study, he must adjust his own volume to wheat equivalents.

Breakeven Analysis

The last phase of the inquiry into the custom seed cleaning operations in Oklahoma is the presentation of a breakeven analysis for the one-cleaner, two-cleaner, and three-cleaner size plants. This type of analysis should be enlightening to the managers of seed cleaning departments, and its use should be a helpful tool for decision-making.

In order to figure the breakeven point of an operation, a relationship must be established between costs, income, and output. The relationships of costs to volume were determined for the three size groups in Chapter V. However, the relationship of income to volume has not yet been determined. The procedure used for estimating the revenue function was to regress plant volume on total revenue for the data within each size group. The equations were specified to pass through the origin, and the resulting functions were:

$$\hat{Y}_1 = .16194X_1 \qquad r^2 = .9359 \quad t = 9.3561 \qquad (6.1)$$

$$\hat{Y}_2 = .19149X_2 \qquad r^2 = .7334 \quad t = 3.3176 \qquad (6.2)$$

$$\hat{Y}_3 = .17302X_3 \qquad r^2 = .9839 \quad t = 11.0715 \qquad (6.3)$$

where,

Y_j = seed cleaning income for each size group in thousand dollars, and

X_j = annual plant volume of seed cleaned in thousand bushels of wheat equivalents, for each size group.

The coefficients on volume for Groups I and III were significant at the 99% level and the coefficient of Group II was significant at the 95% level. Linear functions were used for the estimation procedure to reflect the competitive nature of the market for these services. A straight line total revenue function emanating from the origin is the result.

The appropriate cost and revenue functions are plotted in Figures 6, 7, and 8 by respective size groups.[2] By comparing the total cost

[2]Although it is much more common to see a breakeven analysis with both income and cost functions linear, the breakeven concept is

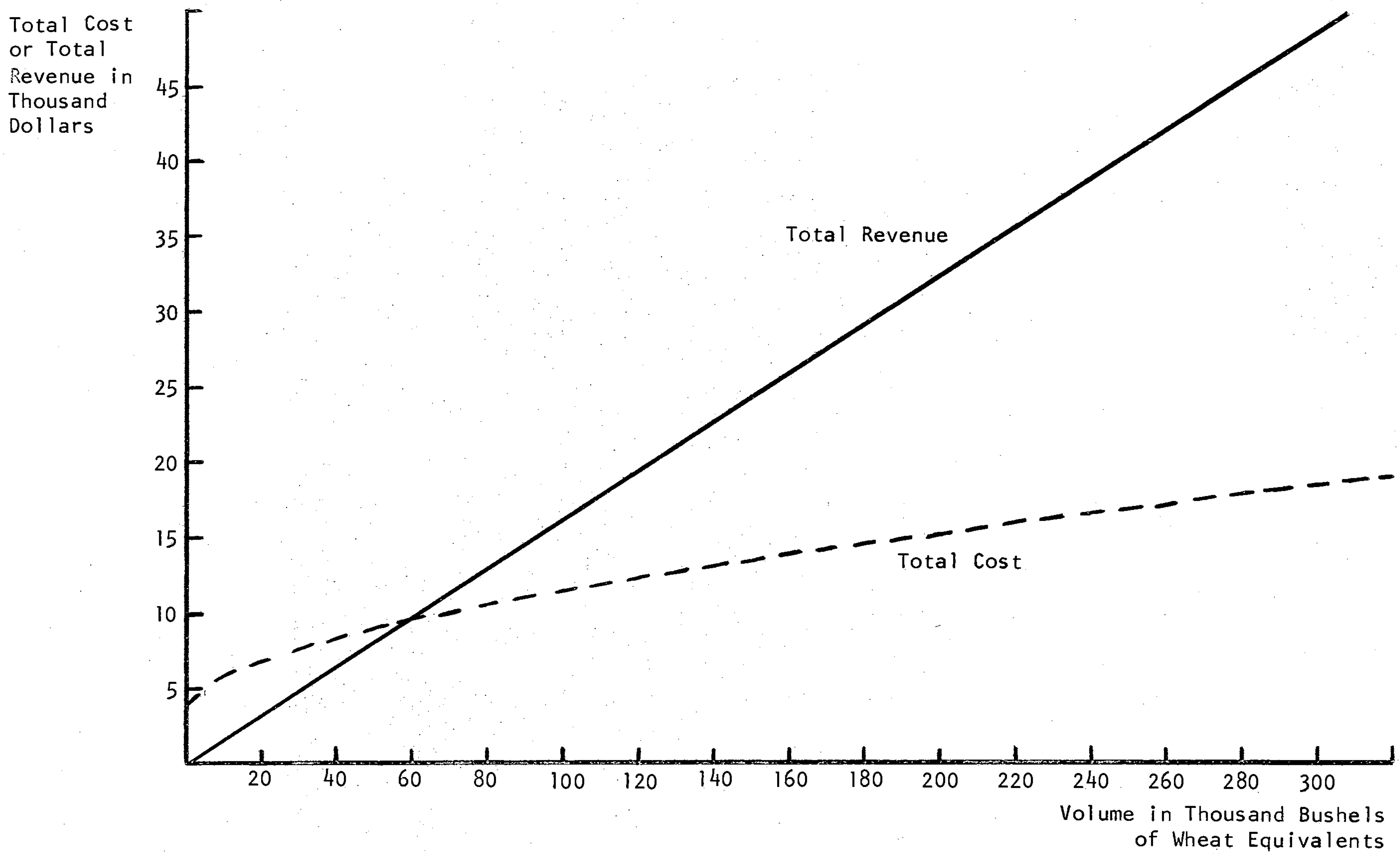

Figure 6. Breakeven Analysis for the One-Cleaner Operations

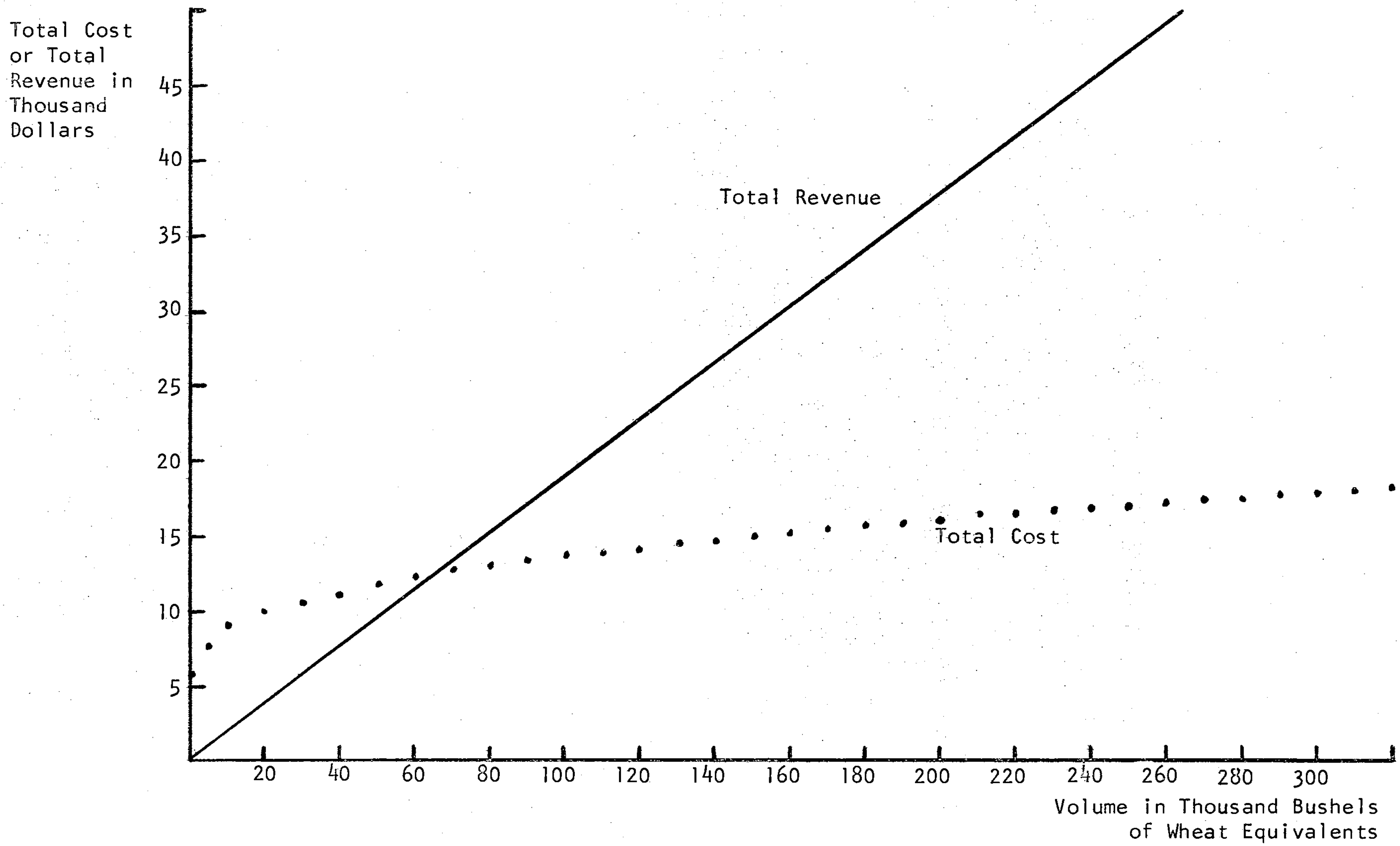

Figure 7. Breakeven Analysis for the Two-Cleaner Operations

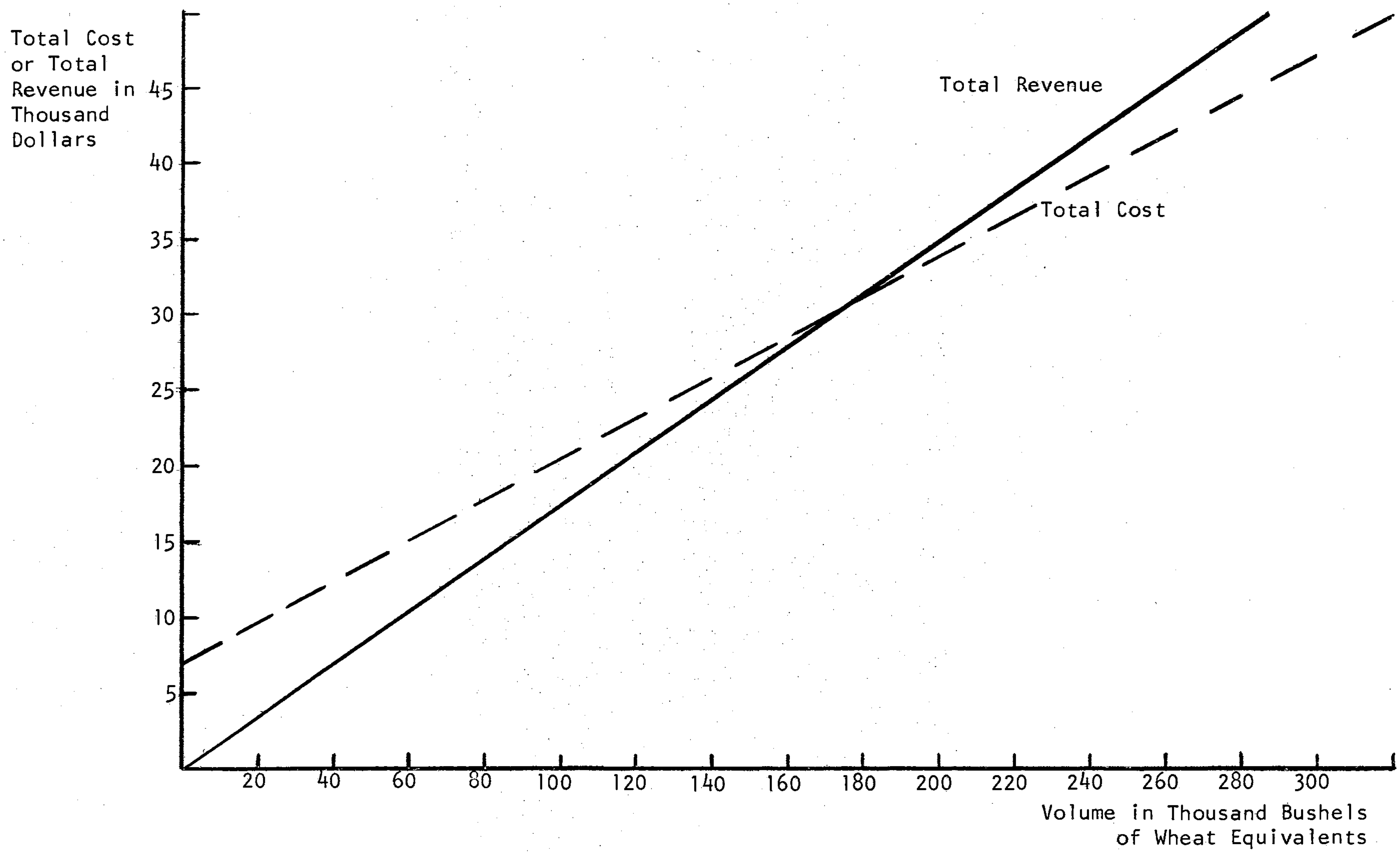

Figure 8. Breakeven Analysis for the Three-Cleaner Operations

and total income estimates for each size group, the different volumes which are required for the plant to break even can be determined. According to the diagrams, any firm that is operating at a volume level greater than the breakeven point should be earning some profit; and the profit increases as the volume is expanded beyond this point. A volume smaller than the breakeven volume will require that some of the costs be carried by some other part of the business. The breakeven point is defined as the volume where total cost is equal to total revenue, and this occurs at the intersection of the two functions on each graph. Any influence that may cause a change in the position of either curve will affect the breakeven point and the realized profit per unit.

The corresponding breakeven volumes for each plant size appear to be around 60,000 wheat equivalent bushels for a one-cleaner plant, 66,000 for a two-cleaner plant, and 178,000 bushels of wheat equivalents for a three-cleaner unit. Judging from the volume data of the sample firms, not all plants are meeting their total costs of operation. However, interpretations from this analysis are difficult to conclude because of the possibility of errors in the functions as discussed in Chapter V and in the first part of this chapter.

Nevertheless, this breakeven analysis should give an approximation of the minimum profitable volume of custom cleaning. The breakeven points appear within reach of all of the firms; however, due to external factors, it may not be possible for the small volume firms to increase

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applicable to curvilinear costs as well as to linear costs. W. E. Paulson, Income and Cost Analysis: Cooperative Cotton Gins and Cooperative Supply Association of Texas, Season 1949-50 (College Station, Texas: Texas A & M University Agricultural Experiment Station Bulletin 803, 1955), p. 11.

their volumes to the breakeven levels. In this case, the custom seed cleaning department's contribution to the overall firm would have to be considered in order to ascertain whether the plant should continue operating at a loss or shut down. A breakeven analysis, such as those presented in this chapter, can be an important management aid in pricing and operating decisions, but one must keep in mind that it is only an approximation of the true situation.

CHAPTER VII

SUMMARY AND CONCLUSIONS

Changes in conditions surrounding the seed and grain industry have probably been responsible for the questions being raised recently concerning custom seed cleaning operations in Oklahoma. Owners and managers of these side line operations of overall firms appear to be "in the dark" when it comes to knowing their costs of operation; therefore, they have asked for assistance in determining some of the information necessary for adequate decision-making. Thus, the primary purpose of this study was to help these managers learn more about their operating and net income position by analyzing the costs and revenues of the three most prevalent sizes of seed cleaning plants in Oklahoma.

To establish a background upon which to build this study, an understanding of the historical development and value of seed cleaning and treating is useful. A short history of the events leading up to the establishment of seed cleaning operations was presented, along with the recent improvements in technology. Various yield studies were given to show some of the benefits of seed treating and cleaning.

At the time the research was undertaken, information concerning the number, location, and size of existing seed cleaning plants in Oklahoma was lacking. In order for the results of the study to be applicable to Oklahoma conditions, information on the population of firms had to be obtained before the representative plants could be selected for the sample. The results of the survey to determine the population of seed cleaning plants were summarized in Figure 1 of Chapter III.

Alternative methodological approaches to the estimation of cost relationships and cost allocation were examined to determine the procedures to be used in this study. The method selected for cost measurement was the use of plant accounting records supplemented, when necessary, by engineering and construction cost data. Several guidelines for cost allocation, their advantages and disadvantages, were also discussed.

Model plants were used to determine the costs of depreciation, interest, insurance, and taxes. The investment and equipment requirements for a one-cleaner, a two-cleaner, and a three-cleaner plant were presented based on engineering firm studies and cost estimates. Also given were the investment costs for the scale and office building and equipment. Annual fixed cost was about 40% of the total cost in most plants, and depreciation expense was the largest single fixed cost item. This should have some implications on pricing and planning decisions of the managers since there would be a large difference between average cost and average variable cost at lower volumes.

The operating costs of the sample plants were obtained from plant records and manager estimates. The most important variable cost item was hired labor, which was usually greater than 50% of the total operating expenses. The importance of labor to total operating expense suggests that even small improvements in labor efficiency could materially influence profits.

Once the operating or variable cost total was determined, factors believed to have an affect on its variation were investigated. Analysis revealed that volume was the only variable that significantly reduced the error sum of squares in the regression equations attempted. After the estimated variable cost-volume relationships giving the "best fit" were determined, they were adjusted to total cost equations by adding the calculated fixed costs of the appropriate model plant to the equation as a constant term. The short run average cost curves for each plant size were derived from these total cost functions. The short run average cost curve for Group III was not consistent with the logic of economic theory, and reasons were offered to explain this inconsistency. Caution should be used when employing the total cost function for the three-cleaner plants.

Price and income characteristics of the sample firms were presented, along with a discussion of the plant volumes. A method was devised to adjust the various volumes of different seeds to more homogeneous units. Volume and income relationships were then combined with the cost functions to present a breakeven analysis for each size of plant showing the minimum profitable volume of custom seed cleaning operations. This tool of analysis should be of considerable help to managers of seed cleaning plants in order that they might better understand their operating and net income position.

From the breakeven charts, the manager can obtain a good estimate of how his firm's profits will be affected by certain decisions or unplanned occurrences. He can determine how a change in any of the components of the breakeven analysis (cost, revenue, or volume) will change his profit position.

Suggestions for Further Studies

As with most research, this study could be improved and extended by further studies. A refinement of several problem areas in this work could enhance the application of the study. There are several alternatives of approach that one might consider in order to accomplish this refinement.

First, another study could be made including more three-cleaner operations in the sample in order to check the validity of the functions estimated in this research, and at the same time, have more degrees of freedom with which to test the statistical significance of the results. A second avenue of approach might be to use work sampling techniques or other methods to get a more accurate estimate of the actual wages and salaries expense for hired labor, management, and office personnel. A third refinement that would be of benefit to the analysis of this research effort is the measuring of actual plant volume and determining the real affect that each type of seed has on total variable cost. This would reinforce the breakeven levels derived in this study.

By branching out from this study, other useful information could be added to the subject of custom seed cleaning. A study could be made to estimate the demand for custom seed cleaning and treating. This information would be enlightening to managers of plants in making decisions concerning charges for the cleaning service and how their decisions might affect plant revenue and volume. Tied to a demand concept, another investigation might be a feasibility study for a particular location or a study to determine the optimum location and size of plants in the state.

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APPENDIX A

APPENDIX A, TABLE I

SELECTED PLANT DISEASES THAT CAN AND CANNOT BE REDUCED BY CHEMICAL SEED TREATMENT

Crop	Diseases That Can Be Reduced By Chemical Seed Treatment	Diseases That Cannot Be Reduced By Chemical Seed Treatment
Barley	Fusarium blight	Ergot
	Net blotch	Loose smut
	Spot blotch	Stem rust
	Septoria leaf blotch	Leaf rust
	Black smut	
	Covered smut	
	Scab	
Oats	Helminthosporium leaf blotch	Ergot
	Helminthosporium blight	Stem rust
	Septoria leaf blotch	
	Black loose smut	
	Covered smut	
Rye	Fusarium blight	Ergot
	Stalk smut	Leaf rust
	Anthracnose	Stem rust
	Scab	
Wheat	Fusarium blight	Ergot
	Crown rot	Take-all
	Septoria leaf blotch	Stem rust
	Glume blotch	Leaf rust
	Bunt (stinking smut)	Wheat streak mosaic
	Flag smut	Loose Smut
	Anthracnose	
	Scab	

Sources: Leon Wood, _Seed Treatment for Small Grains and Other Field Crops_ (Brookings, South Dakota: South Dakota State College Cooperative Extension Service Fact Sheet 193, 1964), and _Seed Treatment_ (Chicago: Morton Chemical Company, 1965), pp. 7-13.

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