An Economic Analysis of Custom Seed Cleaning Operations in Oklahoma

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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. Grain elevators and seed processors are two types of agri-business firms which have undergone such expansion. 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.

During recent years in Oklahoma, the operation of side line functions has received added discussions, 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] 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 managers should be aware of when this occurs.

Because 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. They indicated that they needed more information in order to answer certain questions and to make the necessary decisions concerning plant opera-

Research reported herein was conducted under Oklahoma Station Project No. 1254.

[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.

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

tion. 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. The study was intended to cover the 1967 season.

Research Procedures

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,[3] a letter was sent to firms in the state connected in some way with seed wholesaling and retailing or grain handling in order to determine if they maintained a custom seed cleaning operation.

The response to the questionnaire was very good, and the final tabulation showed that over 94 percent of the firms contacted had answered. Out of the 285 firms which replied, 139 of them reported doing custom seed cleaning. This was 49 percent of the respondents. The locations of these firms and the number of cleaners contained in each plant are presented in Figure 1.[4] The percentage dropped from 49 percent to about 38 percent when custom 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.

[3]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 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 Agricutural 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 prelimiary research into the custom seed cleaning business of Oklahoma in 1965.

[4]The dashed line in Figure 1 separates the state roughly 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 obtained from James R. Enix and Nellis A. Briscoe.

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 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 non-statistical sampling procedure was used. 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, (2) six two-cleaner plants, (3) five three-cleaner plants, and (4) one four-cleaner plant.

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 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.

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.

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 section 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.[5]

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 sale 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. When the cleaning is started, the seed will begin to flow by gravity from the holding bin into the cleaner at a rate specified by the plant operator.

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

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 otherhand, 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. However, 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.

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. 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 1, 2, and 3 respectively. 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

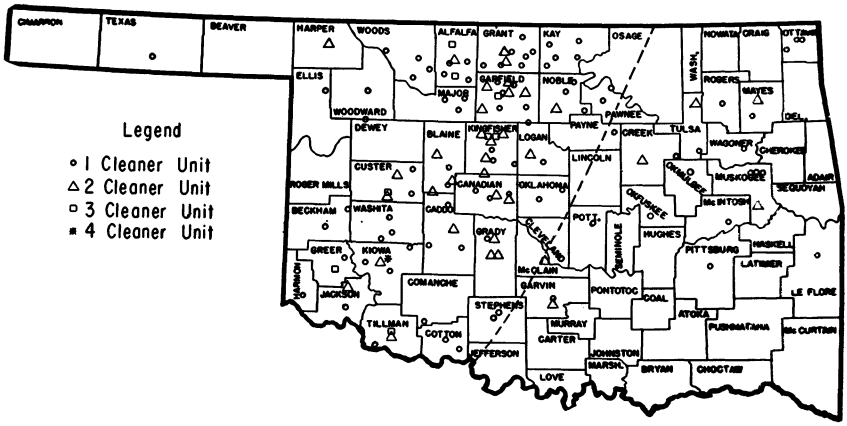
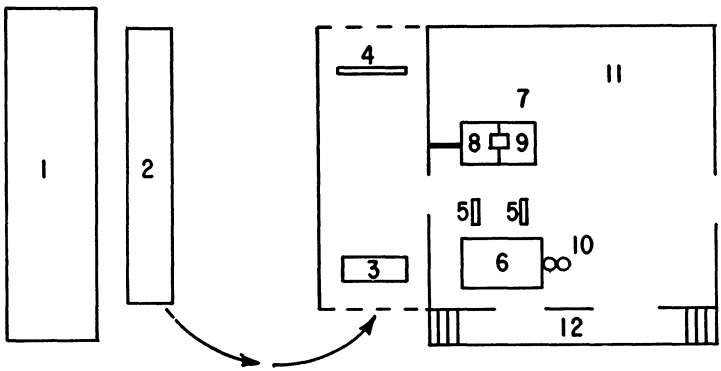


Figure 1. Location and size of most of the custom seed cleaning operations in Oklahoma.



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.

Table 1. 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 2. 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 equip-drives, electrical parts, and all components.	
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-cleannig, 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 3. Projected Construction Costs For A Possible Triple-Unit Seed Cleaning Plant

General Description	Possible Price (inc. install.)
Building and Foundation 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
Dump Pits 2-Steel dump pits with 10′ x 7′ self-cleaning grates and vibro-pits w/motors, starters, and transition to legs.	3,248.39
Truck Hoist 1-5 hp. lift with scaffold and electrical accessories.	2,426.00
Receiving Elevator Legs 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
Cleaners 3-Super X298D Clipper cleaners, or equivalent, with motors, drives, electrical parts and all components.	14,089.30
Clean Elevator Legs 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
Treaters 2-K55 Panogen seed treaters, or equivalent, with motors, electrical parts and controls, and other accessories.	3,037.60
Spiral Separators 1-Double spiral separator with 2 bins and all spouting.	1,086.00
Holding and Clean Grain Bins 2-Large holding bins over the cleaners and 2 sets of large twin bins plus spouting, sacking bin and parts.	4,470.06
Dust System and Walkways 2-Dust collectors and large bins, with spouting equipment, outside plus steel supports and walkways.	4,915.63
TOTAL	$61,197.10

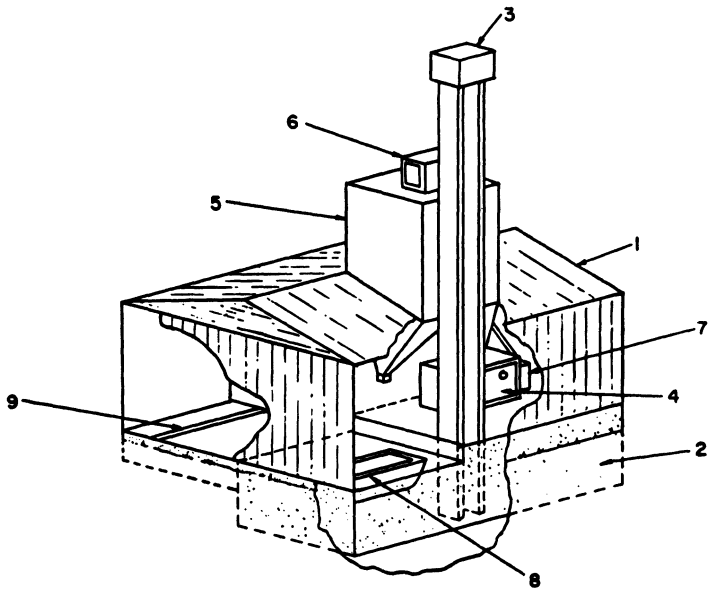


Figure 3. Cutaway drawing of a possible seed cleaning plant.

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 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, investment costs for the office, office equipment, and the truck scale should 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.

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.

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.

DEPRECIATION

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, 20 years. 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 were presented in Table 4 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 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 was derived in the following manner: (1) using the investment cost estimates presented earlier, the annual depreciation expenses for each of the three categories, scale, office building, and office equipment, were computed; (2) the procedures used to compute these costs were the same as those outlined previously for the cleaner building and equipment with the assumption that the useful lives of the office building and scale were twenty years and that the useful life of the office equipment was 10 years; (3) then, a portion of these annual depreciation costs were 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.

INTEREST

Although interest expense is not always visible 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.

INSURANCE

The type of coverage assumed for this study was 80 percent 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 that least a minimum amount of the total valuation. A high coinsur-

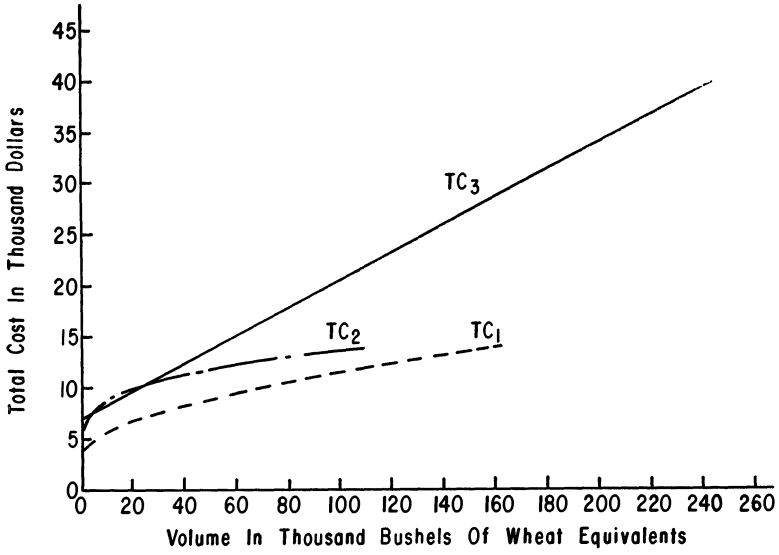


Figure 4. Estimated total cost curves of the three plant sizes.

Table 4. 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.

ance percentage reduces considerably 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 percent 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 4.

TAXES

Because the rates and the percentages of market value that are used as the base for computing personal property taxes vary among counties, the procedures and rates used in Payne County were arbitrarily selected in order to be consistent in the cost analysis. The assessment value of the plant and equipment was determined by assessing the model plants at 25 percent 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 equipment is decreased 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. The taxes on building and equipment for the three model plants are presented in Table 4.

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, rental rate 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. Firms which actually own the land would incur a much larger cost for this item.

Operating Costs[6]

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 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 bookkeeping 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.

[6]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.

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 being one and one-half times the regular rate. 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.

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 percent 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. The minimum rate in Oklahoma was used in this study, 6 percent, of a worker's annual payroll under $3,000. A majority of the cooperating firms were paying this minimum rate.

Another important item related to labor cost is workman's compensation insurance, which provides protection against work-connected injuries and death. 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 to be discussed 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. The average hired labor costs for the plants within each size group are given in Table 5.

MANAGEMENT

Some cost should be appropriated to the seed cleaning department for the planning and organizational talent contributed to it by the

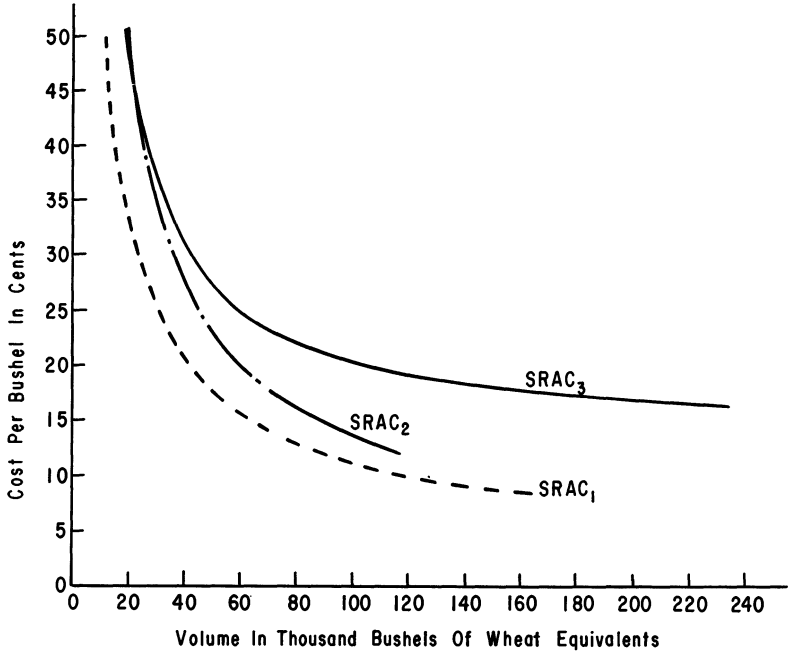


Figure 5. Estimated average cost curves for the three plant sizes.

Table 5. Operating Costs Expressed As Averages Of Each Group[1]

Cost Description	Plant Size 1 clnr	2 clnr	3 clnr
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.

manager. This item was estimated in a similar fashion to that used for hired labor. 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. Since management payroll is subject to the same related costs listed for hired labor, the estimated management expense was increased by 9.98 percent. The group averages are presented in Table 5.

OFFICE PERSONNEL

Necessarily, some bookkeeping 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, because of the decrease in risk of injury to clerical employees. This makes the increase above wage cost due to the related costs of Social Security, unemployment tax, liability, and workman's compensation 5.786 percent for the clerical workers. The cost of office personnel with the related expenses included, is also listed for each size group in Table 5.

CHEMICAL COST

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 large quantities, 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 chemical costs for each group of plants are presented in Table 5.

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 was .75 percent. The .75 percent rate was applied to the investment requirements of the three model plants and the results are given in Table 5.

ELECTRICITY

Power costs of the sample plants 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.[7] Under the assumption that wheat could be cleaned at the rate of 250 bushels per hour, it was estimated that the number of kilowatt hours consumed per one thousand bushels for each plant size was 84.22, 82.46, and 76.66 respectively. The 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 electricity used by each plant, their estimated kilowatt hour consumption was multiplied by the average charge of 3.25 cents per kilowatt hour.

However, this was not the entire electrical cost for the plant. Minimum charges per 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

[7]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 a later section.

of the electricity used plus the monthly minimums. The average power costs for each group of plants are given in Table 5.

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.

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 conjuction 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

Now that costs of ownership and use and operating 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 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 percent of this category. In fact, hired labor cost was usually greater than 50 percent of the total operating costs.

In order to make a cost analysis, factors that have a significant affect on variable costs should be determined.[8] Volume in wheat equivalent bushels, unused capacity in bushels of wheat in yearly basis, and the percentage of the seed that must be sacked before it leaves the cleaner building were hypothesized to have and effect on costs.

Following the logic concerning 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.[9] The estimated cost-volume relationships for one-cleaner, two-cleaner, and three-cleaner plants are, respectively,[10]

$$\hat{Y}_1 = .46763X_1^{.6} \qquad r^2 = .9386 \quad t = 9.57996 \qquad (1)$$

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

$$\hat{Y}_3 = .13350X_3 \qquad r^2 = .9706 \quad t = 8.12186 \qquad (3)$$

where,

Y_j = variable cost of each size group in thousands of dollars, 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 percent 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:

$$\hat{Y}_1 = 4.116 + .46763X_1^{.6} \qquad (4)$$

$$\hat{Y}_2 = 5.815 + 1.25046X_2^{.4} \qquad (5)$$

$$\hat{Y}_3 = 7.112 + .13350X_3 \qquad (6)$$

Equations 4—6 are graphed in Figure 4, and the short-run average cost curves derived from them are presented in Figure 5.

[8]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.

[9]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.

[10]The reader should be careful to note the limitations given in text in regard to the use of the Group III equation.

Although the correlation coefficients for the three equations were statistically significant, 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 volume increases, the average costs draw closer together until finally, just before the output reaches 280,000 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 capacity for the three cleaner plants.

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 the 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.

Analysis Of Revenue And Volume

In order to complete the economic analysis of custom seed cleaning operations in Oklahoma, 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. Although, there may be objectives for the firm other than profit, the existence of other objective functions does not preclude a revenue, cost, and profit type of 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 of most firms.

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 6 has been developed. The high, low, average, and median charges for each seed are presented in this table. 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 6, there has been an upward trend in the charges made for custom cleaning over the past few years. 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.

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. It was the regular procedure of only two firms to keep records of the custom

Table 6. 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.

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 acurate.

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.

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 season 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,

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 have already been determined for the three size groups. Lacking, however, is the relationship of income to volume. The procedure used for estimating the revenue function was to regress total revenue on plant volume for the data within each size group. The equations were specified to pass through the origin, and the resulting functions were:

$$\hat{Y}_1 = .16194X_1 \qquad r^2 = .9359 \quad t = 9.3561 \qquad (7)$$

$$\hat{Y}_2 = .19149X_2 \qquad r^2 = .7334 \quad t = 3.3176 \qquad (8)$$

$$\hat{Y}_3 = .17302X_3 \qquad r^2 = .9839 \quad t = 11.0715 \qquad (9)$$

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 percent level and the coefficient of Group II was significant at the 95 percent 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 beginning at the origin is the result.

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

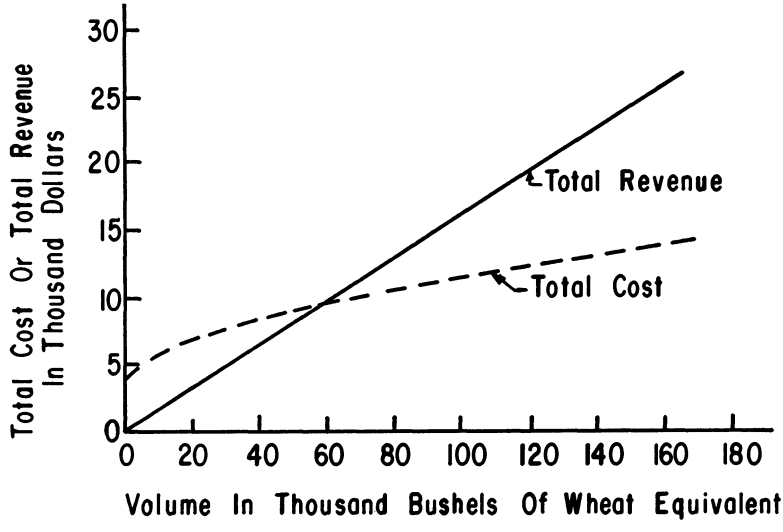


Figure 6. Breakeven analysis for the one-cleaner operations.

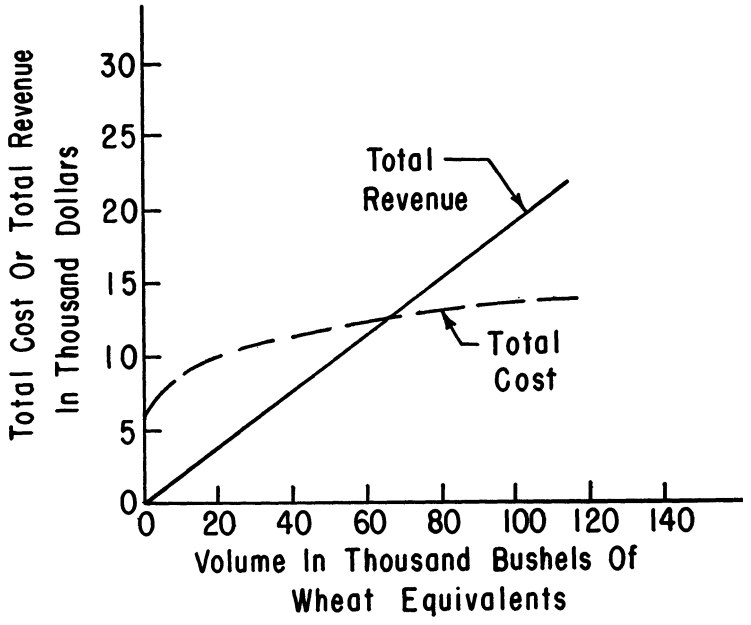


Figure 7. Breakeven analysis for the two-cleaner operations.

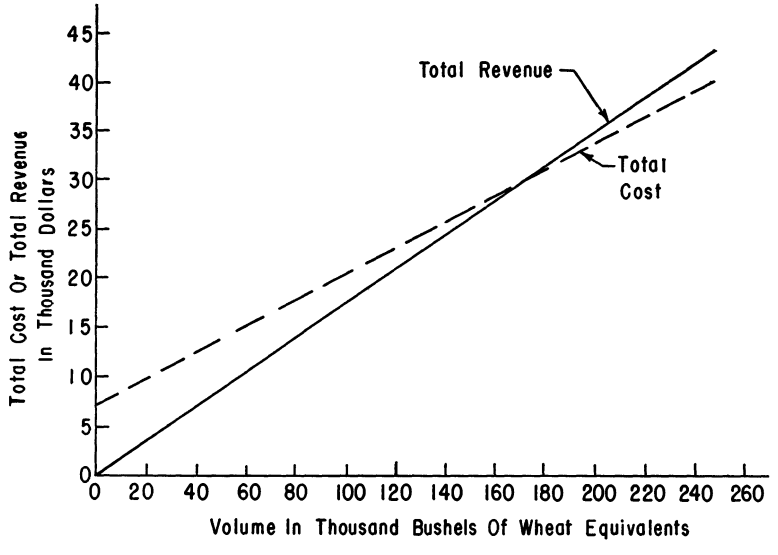


Figure 8. Breakeven analysis for the three-cleaner operations.

The corresponding breakeven volumes for each plant size appears 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, especially in Group III, as discussed earlier.

Nevertheless, this breakeven analysis should give some 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 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.

Summary

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 accounting records method of cost measurement supplemented by synthetic data when necessary. 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. Company accounts were used to obtain some of the operating costs. 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.

Approximately 140 firms in Oklahoma were found to be doing some custom seed cleaning. Over two-thirds of the existing firms had only one air-screen cleaner, while about 25 percent had two cleaners. One four-cleaner unit was reported, and it was the largest in the State.

In analyzing the costs of the firms, it was found that, on the average, annual fixed costs were about 40 percent of the total cost of operating each plant. Hired labor was the most significant variable cost item, and its importance to total operating expense suggests that even small improvements in labor efficiency could materially influence profits. The

average of the total cost observations for each group of plants was $9,257, $12,544, and $20,663 respectively. Some possibilities for the disproportionate increase in the costs of the largest size group were offered. It was concluded that volume was the only variable to significantly affect costs.

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; however, caution should be used when employing the 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.

In the final analysis, breakeven volumes were estimated to be about 60,000 bushels of wheat equivalents for the one-cleaner plants and 66,000 bushels of wheat equivalents for the two-cleaner plants. The breakeven volume for the three-cleaner plants were reported, but the results were questionable.

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