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Title COSTS AND EFFICIENCY IN THE OPERATION OF OREGON SEED PROCESSING WAREHOUSES

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It was the purpose of this study to develop data relating to comparative costs of different handling methods, annual volumes, and product mixes in seed processing warehouses. Basic input-output data were obtained and cost estimates were synthesized from work sampling studies, production studies, and plant record data in a sample of seed processing warehouses in western Oregon.

The five handling methods studied varied widely in the proportions in which they utilized labor and machinery. Yet the synthesized cost estimates were similar in magnitude. The conclusion is that non-cost considerations such as convenience and timing are more important criteria than average annual cost in selection of a handling method to be used in a particular warehouse.

It was possible to demonstrate that substantial economies to

size (in terms of annual output) exist in the seed industry. Thus, substantial savings could accrue to the industry if larger and fewer plants were to develop. There are at least two factors which will tend to deter such development. The first is the existence in the industry of a large number of grower operated plants. The second is the fact that certain enterprises such as grain handling and feed manufacturing and selling are carried on jointly with seed processing. Inasmuch as these can use many of the same inputs as seed processing, expansion in the seed processing enterprise may be tempered by expansion or the lack of it in complementary enterprises.

Analysis of multiple product processing costs was hampered by the problem of joint use of inputs in the processing of the various seeds. Single product cost estimates were not obtained for multiple product plants because of the problem of allocation of joint costs of production. However, it was possible to demonstrate that multiple product processing tends to reduce total processing costs below what they would be if each kind of seed were processed in a single product plant.

COSTS AND EFFICIENCY IN THE OPERATION OF OREGON SEED PROCESSING WAREHOUSES

by

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IN MEMORIAM

George B. Davis

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COSTS AND EFFICIENCY IN THE OPERATION OF OREGON SEED PROCESSING WAREHOUSES

Chapter I

INTRODUCTION

Production of grass and legume seeds has been an important enterprise in Oregon's agriculture for many years. The years since 1945 have been a period of increasing production. Concurrent with that development has been the evolution of a large seed processing industry.

The 400 or so seed processing warehouses which make up this industry may be roughly divided into two categories: grower-operated and commercial. The grower-operated plants may be further subdivided as farm plants, which process only the seed of the grower-operator, and semi-commercial plants, which process varying proportions of seed on a custom basis in addition to their own seed. These two make up about 65 percent of the number of firms in the industry. Although commercial plants are outnumbered two-to-one, they process the greater part of the seed (8).

Commercial and semi-commercial warehouses process seed on a custom basis, that is, the grower delivers his seed to the warehouse, where it is weighed, recorded, and placed in temporary storage. Later, usually at the convenience of the warehouse operator, the seed is cleaned of impurities and bagged. The clean seed is again placed in temporary storage while waiting for sampling and analysis to determine purity, germination, and other qualities of the lot of seed. The grower has retained ownership throughout this procedure.

When the quality characteristics of the seed are indicated by the analysis, a sale may take place. Oftentimes, the warehouse operator will buy the seed. Otherwise, the operator acts as the grower's agent in selling the seed, obtaining a commission for his services. The interval from harvest to final sale may be as little as two weeks or more than six months.

For the services the processor performs, he charges the grower a fee. In most cases, a flat rate is charged per ton of field run seed delivered to the warehouse. The charge varies by kind of seed. A minority of processors assess their fees on the basis of the length of time required to actually clean the seed. That is, a set fee per hour of machine time is supposed to cover the cost of most services. The services excluded from the inweight or hourly basis are those connected with selling. As indicated above, the processor receives a commission if he acts as the grower's agent. If he buys the seed from the grower, he may or may not deduct the commission from the proceeds. If the grower withdraws his seed from the warehouse after cleaning and without allowing the processor to participate in its sale, the grower is usually assessed a handling fee equal to the usual commission.

In addition to cleaning charges and sales commissions, the grower pays for bags, insurance on the seed, purity and germination tests, and sometimes storage when the seed remains unsold for an extended period.

In addition to differences in organization, wide variations in methods used, length of season, rates of output, and plant sizes in terms of fixed volume are found in seed processing warehouses in Oregon (8). The presumption therefore exists that operating costs vary between plants. Further strength is added to this presumption by the fact that most seed warehouses process several different types and varieties of seeds, and the product mix differs between plants both as to volume and kind.

Many of the plants are using methods and technologies that are quite efficient for the particular conditions under which they must operate. Others are operating with considerably less efficiency than could be achieved. This is partly due to innovations and changes which were unforeseen or unrecognized by the operators at the time of initiation of the business. Also, new technologies tend to be adopted slowly in existing plants as old equipment wears out. Perhaps equally as important in slowing down adoption of new technology is lack of information. Operators may not be aware of the cost relations involved in comparing new to old. Or they may sometimes be completely unaware of the new technologies.

Most management decisions involve both short run and long run considerations.

Management in seed processing warehouses, as in other enterprises, is involved in short, intermediate, and long-run decision making. It is a difficult problem to separate the length of run into exact time periods. For the purposes of this study, the general theme shall be that short-run decisions are those whose implementation requires no alteration of fixed facilities, i. e. short-run decisions require no capital outlay.

Putting an intermediate or long run decision into effect would, on the other hand, require some outlay of capital funds. The length of time required to put a decision into effect is not important in the above distinction between lengths of run.

The intermediate and the long run are more difficult to define than the short run. An example of an intermediate run decision would be when a special purpose separator is added to the cleaning line to allow flexibility in product mix, but storage and other facilities remain unaltered. Increasing the capacity of the cleaning operation by the addition of more lines, so that annual volume could be increased without altering storage or other facilities, would be an intermediate run decision.

Major alterations in plant size (annual volume) or product mix may be achieved through changes in the capacity of the cleaning line or the machinery complement of the line. When these are accompanied by changes in storage facilities, the decision to do so may be termed of the long run.

Short-run aspects of decision making have not been neglected, but the major emphasis in this study is toward intermediate and long run decisions from the point of view of the industry as a whole. This thesis is an attempt to provide managers of existing warehouses and those contemplating construction of new facilities, with information concerning construction and operating costs. No published information is available that is designed to provide management in the seed industry with these basic tools for decision making. Specifically, information is needed concerning the input-output relationships of the various factor inputs, the optimum (least cost) combinations of resources, and how departures from optimum affect (total annual fixed plus variable) costs per unit of output.

It will therefore be the objectives of this study to:

1. Estimate comparative costs of different methods, annual volumes, and product mixes in seed processing.

2. Relate the results from objective 1 to known characteristics of the Oregon seed processing industry.

Procedures used to accomplish these objectives are detailed in the next four chapters. First of all, the background and methodology for synthesizing cost estimates will be presented. Basic assumptions concerning the behavior of costs under synthesized conditions will be elucidated. Cost estimates and comparisons will be made for five different methods of handling seed in seed processing warehouses. Cost estimates and comparisons will be made for three plant sizes in terms of fixed annual volume. Finally, cost estimates and comparisons will be made for eight different product mixes. In all of the above cases, conceptual problems will be dealt with as they arise.

In the final chapter, cost estimates and comparisons will be related to known characteristics of the Oregon seed industry.

Chapter II

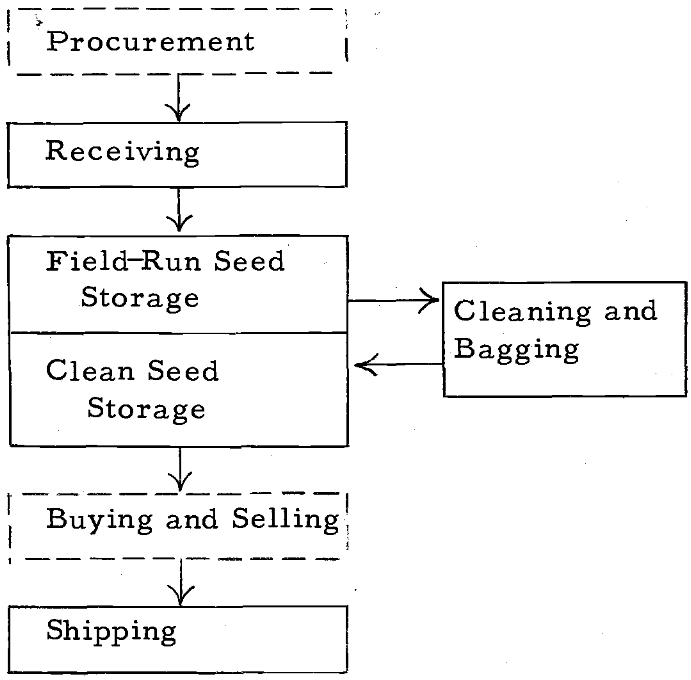
ENGINEERING AND ECONOMIC BASES OF COST ESTIMATES

This chapter will be concerned with the engineering and economic bases for developing cost estimates for different handling methods, various volume levels and product mixes in seed process ing warehouses. First a description of the stages within a seed processing plant is given. Second the methodology of obtaining cost estimates for each stage and aggregating them to form a single estimate of total annual cost per ton of clean seed output is presented. Total annual costs are shown in Chapter III by handling method for various fixed outputs. Similarly, cost estimates are shown in Chapter IV by different volume levels and in Chapter V for various product mixes at fixed output levels.

Stages in Seed Processing

Seed processing can conveniently be divided into six distinct but interrelated stages: procurement; receiving; storage; cleaning and bagging; shipping; and buying and selling. This study was concerned with the receiving, storage, cleaning and bagging and shipping stages (Figure 1). Procurement, buying and selling were not included because: (1) buying and selling functions are not carried out by every individual seed processor; (2) seed processing is often carried out jointly with other enterprises;[1] and (3) the functions of procurement and buying and selling do not lend themselves to the economic engineering approach.

Figure 1. Typical flow chart of stages in seed processing warehouses



The arrows indicate the direction of flow between stages. Solid blocks indicate stages studied and broken blocks indicate stages not studied.

The receiving stage consists of those operations involved in accepting delivery of field-run seed to the warehouse. These include

[1] Examples are: a commercial seed processing warehouse which also carries on a grain and feed enterprise; and a farm plant under management of the grower-operator.

weighing and/or recording the amount of each delivery, assigning a lot number and storage position, unloading the delivery truck, and placing the seed into storage.

Storage is simply a temporary holding operation to even out the flow of product between the other stages. Three storage operations are distinguishable within the storage stage itself. First there is storage of the field run seed. When the field run seed is delivered and handled in bags the volume of field run seed sets the total storage requirements for warehouse space. When the field run seed is delivered and handled in bulk, separate storage facilities are needed for field run and clean seed. Field run and clean seed could utilize the same storage facilities when field run seed is delivered in pallet boxes, but pallet boxes of field run seed can be stored in a pole type shed. This reduces total storage costs from what they would be if the pallet boxes were stored in the more expensive enclosed warehouse.

The second storage operation is needed for the clean seed during the interval between bagging and performance and reporting of the analysis. This analysis, required by Oregon law on all agricultural seeds offered for sale, is used to indicate the kind of seed, and certain quality characteristics. When the results of the analysis are known, the seed may be transferred to a temporary and more economical holding storage[1] (the third storage operation), or it may directly enter the shipping stage.

The cleaning and bagging stage includes removal of the field run seed from storage and transferring it to the cleaning line. The seed is processed through the appropriate machinery and placed in burlap or cotton bags. Also included is transferal of clean bagged seed from the cleaning line to test storage.

The shipping stage involves removal from storage, placing of the required analysis tag on each bag,[2] and placing the seed on rail cars for shipment. (Truck shipments were not prevalent enough to warrant analysis at the time of this study.)

Characteristics of the Seeds Affecting the Processing

Oregon farmers produce a great variety of seeds. For purposes of analysis this study was restricted to those eight seeds which are in largest supply at the present (1962). These are: annual ryegrass, perennial ryegrass, alta fescue, crimson clover, chewings fescue, red creeping fescue, bentgrass, and merion bluegrass. The generic, specific, and/or varietal differences represented here are

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1 In test storage, the bags must be stacked so that the person taking the analysis sample has access to each bag. A more compact stacking method is employed in holding storage.

2 These two operations may be done in reverse order when bags of seed are stored and handled on pallets.

reflected in differences in costs of handling and processing of the seeds.

Even within a given kind or variety of seed, there are characteristics which contribute to differences in handling and processing costs. For example, kind and amount of contaminants affect hourly capacity of the cleaning line. If processing costs are constant per unit of time, costs per unit of output will fluctuate as these conditions change. Certain standardizing assumptions concerning these and other conditions are presented in Table 1.

The assumptions concerning cleanout and density are based on observations taken in commercial warehouses in 1960, as well as conversations with warehouse operators and cleanermen. They represent average conditions in the Willamette Valley.

Relative cleaning rates reflect average conditions of cleanout (percentage yield of clean seed from a given unit of field run seed) as well as varietal differences which affect the rate at which the seed can be cleaned through a given set of machinery. Also, the rate is affected by the kind and amount of contaminants.

The dates given for harvesting seasons are approximate. Both beginning and ending dates would depend on weather conditions preceding and during the harvest period. The usual pattern of harvest for any particular seed is one which starts slowly, building up to a

Table 1. Characteristics of the Seeds Which Affect the Cleaning Process.

Kind of Seed	Density[a] Field run	Density[a] Clean	Cleanout[b]	Relative cleaning rate[c]	Harvest season[d] Beginning date	Harvest season[d] Ending date	Proportion certified[e]
	(Pounds per bushel)		(Percent)				(Percent)
Annual ryegrass	24	24	90	1.00	July 8	Aug. 8	0
Perennial ryegrass	24	24	90	1.00	July 15	Aug. 15	90
Alta fescue	23	24	85	.77	July 1	July 15	70
Crimson clover	50	60	70	.77	June 20	July 10	40
Chewings fescue	17	20	75	.32	Aug. 15	Sept. 25	0
Red fescue	17	20	75	.33	Aug. 15	Sept. 25	80
Bentgrass	27	32	70	.35	Sept. 1	Oct. 1	85
Merion bluegrass	15	22	50	.14	July 15	July 25	60

[a] Average pounds per bushel

[b] Average percentage yield of clean seed from the field run input.

[c] Index based on survey results (7) and plant record data. The cleaning rate of annual ryegrass is used as the base of this index.

[d] Approximate - varies with weather and other conditions

[e] That which meets certification standards. Data are based on historical records of certification officials (16).

peak volume about midway in the season, and declines. It is assumed that the capacity of the receiving activity will need to be at least twice that required if the seed were received in an even flow throughout its harvest period.

The proportions of certified seed shown in the table are approximations based on historical records of certification officials. Certified seed requires more handling labor than non-certified, hence its inclusion as a factor affecting costs.

Estimation of Costs for Each Stage

Generally, costs can be separated into fixed and variable components. Variable costs are easily separated at each stage. There are some fixed costs which are peculiar to a single stage - these are ascertainable. However, there are other fixed costs common to two or more stages. The level of these costs is determined by the overall requirements of the several stages but are inseparable in any analysis of total costs for any stage.[1]

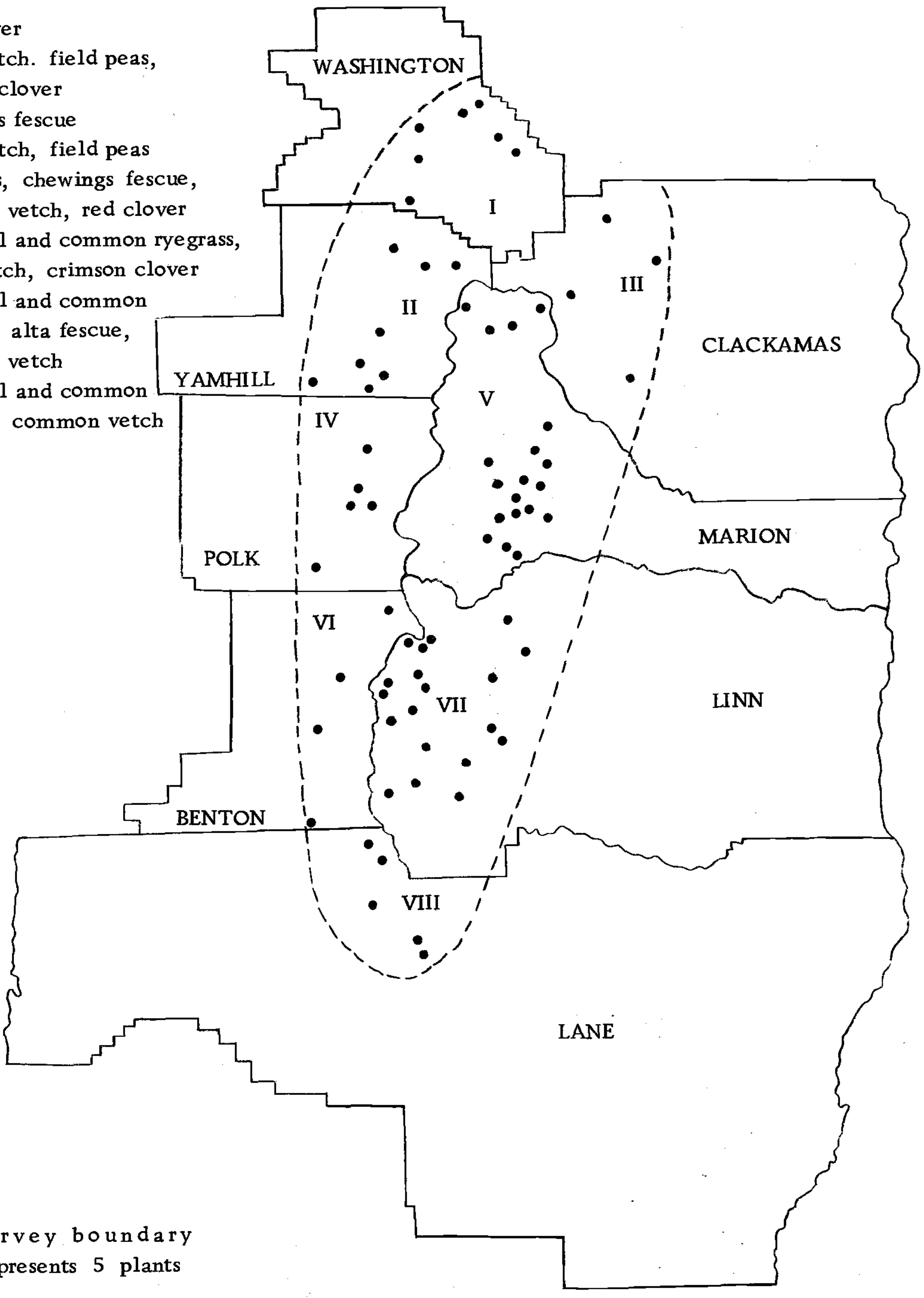
In order to obtain information on the physical requirements for inputs of the various stages, case studies were conducted in seed processing warehouses. In late 1958 and early 1959, the author conducted a survey of 70 seed processing warehouses in the Willamette

[1] The same problem of joint costs exists when considering multiple product plants. This will be discussed in Chapter V.

Figure 2. Willamette Valley counties, showing seed producing area, approximate location and concentration of seed processing warehouses, and major production of specified seed crops by counties.

Production areas:

I. Red clover
II. Hairy vetch. field peas, crimson clover
III. Chewings fescue
IV. Hairy vetch, field peas
V. Bentgrass, chewings fescue, common vetch, red clover
VI. Perennial and common ryegrass, hairy vetch, crimson clover
VII. Perennial and common ryegrass, alta fescue, common vetch
VIII. Perennial and common ryegrass, common vetch



KEY

----- Survey boundary
● Represents 5 plants

Source: (8. p. 20)

Valley (8) (Figure 2). Information gained from that survey was used to select a smaller number of plants for more intensive study. Selection was based on methods used, annual volume, and kinds of seed processed. Initially, cooperation was secured from 20 warehouses. Preliminary studies were made of the various stages in each plant. The purpose of the preliminary studies was to provide a basis for selecting the two or three plants which appeared to be achieving the greatest output per unit of input within a particular stage. Thus a plant may have been selected for studies of its receiving setup, but further studies may not have been made of its cleaning or shipping stages. A total of eleven warehouses was selected each of which had one or more unique methods of performing the requisite processing operations.[1] The plants are enumerated below with the operations studied.

1. Bulk receiving, hand truck handling of clean seed
2. Lift truck handling of clean seed (use of pallet dolly in carloading)
3. Bulk receiving, lift truck handling of clean seed (use of ramp to enter car in carloading)
4. Receiving field run seed in bags

[1] For the purposes of this study, "method" is defined as a particular way of performing an operation in seed handling and cleaning. It may therefore refer to crew organization, equipment used, or type of container in which the seed is stored or handled.

5. Cleaning and intermittent bagging (holding bin over bagging station)
6. Receiving field-run seed in pallet boxes, lift truck handling
7. Receiving field-run seed in pallet boxes, lift truck handling
8. Cleaning and bagging chewings and red fescue, bent, crimson clover
9. Cleaning and bagging, receiving field-run seed in bags
10. Cleaning and continuous bagging (no holding bin over bagging station)
11. Pallet box receiving, bulk receiving

Time and motion studies, work sampling studies, and production studies were conducted on the methods used at the various stages (1, 2, 9, 14). In this way, input-output data, in terms of labor and equipment requirements per unit of output of seed, were derived for the methods (Appendix Tables 16-19). These requirements, or standards, have been published in part by the Oregon Agricultural Experiment Station (7).

The standards represent higher than average levels of efficiency which can be (and are) achieved in well-organized, well-managed plants. Since the standards apply to separate operations, they may be combined in various ways to form a synthesis of a total plant--a model of efficiency. When cost data are applied to these standards, the resulting models represent low cost combinations of inputs. These are theoretical models and should not be identified with actual warehouses. Rather, they should be taken as indicative of what can be achieved under ideal conditions.

Rather than obtaining the information from accounting data and warehouse records, the economic engineering approach was used because of the following reasons:

1. Accounting data are usually such that fixed and variable costs are not easily separable.[1] Under the economic engineering approach, if the stages are independent in their use of variable inputs, variable costs are separable by stages. Fixed costs can be aggregated separately from variable costs.
2. Accounting and record data provide averages for a group of plants. Economic engineering studies, abstracting single stages from a group of plants, can provide data on the most efficient method of carrying out the operations in any stage. These can then be used to synthesize a least cost estimate for an entire operation.
3. In addition to the advantages of the method itself, certain characteristics of seed processing lend themselves to the economic engineering approach. For example, the presence of the storage

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1 Accounting data in seed processing warehouses are not available in sufficient detail in enough plants to allow an accurate estimate of the costs of processing.

stage means that the total costs associated with discontinuities in product flow between the other stages are easily separated from the costs of the other stages. In case of a commodity where the quality of the product may suffer from discontinuities in product flow between stages, the costs directly or indirectly associated with this quality loss may not be directly allocable to a single stage.

Components of Cost Estimates

Separation of seed processing operations into stages was convenient from the standpoint of obtaining the physical input-output data. Because of the problem of joint use of certain inputs by two or more stages the cost estimates in this study are presented as estimates of total annual fixed plus variable costs for all stages of processing seed under specified conditions.

In general, fixed costs consist of depreciation, interest on investment, insurance, taxes, and maintenance. Variable costs include labor, fuel and power, lubricants, and variable repairs.

Fixed Costs

Depreciation is calculated on a straight line basis with no salvage value allowed. Useful life of the machinery and other facilities is based on estimates of warehouse operators, as well as the recommendations of equipment manufacturers.

Annual interest on investment is calculated as three percent of the replacement cost of the building or equipment. This amounts to about 5.5 percent on the average value of an item having a depreciable life of 10 years. Replacement cost includes purchase price F.O.B. the seed warehouse plus installation.

Insurance and taxes are each computed at one percent of the replacement cost annually. Fixed maintenance is calculated as 1.5 percent of replacement cost per year.

Variable Costs

Labor charges are assessed at the uniform rate of $1.75 per hour, except for temporary labor, whose rate is $1.50 per hour. The above rates are fairly representative averages for the industry, and include overhead charges for social security, pension plans, and employee compensation plans. Jobs have not been given a more detailed classification because of the overlapping of functions which occurs in most seed plants. For example, a cleaner man will normally spend a good deal of time at jobs other than tending the cleaning line and bagging clean seed.

Fuel, power and labor requirements are based on manufacturer's recommendations. Fuel and lubricant prices were obtained from petroleum distributors. Power costs are based on the industrial rate schedules of electrical power distributors. Variable repairs are calculated at five percent of replacement cost per 1000 hours annual operation of the equipment.

Basic Plant

In order to arrive at estimated annual processing costs, hypothetical plants were synthesized from the physical data. The models are presented in detail in the relevant chapters on handling methods, volume-cost relationships, and product mixes. In each of these chapters, the cost estimates are based on three levels of annual volume: 1000 tons, 2500 tons, and 5000 tons. The lowest level represents the average size of commercial seed warehouse as found in the Willamette Valley. The intermediate level approximates the largest plant encountered in the Valley. The 5000 ton model was synthesized to investigate the possibilities of economies to larger size plants than now exist in the local industry.

Physical requirements were determined for storage space for both field run and clean seed handling equipment, and cleaning equipment. For a fixed output, storage requirements depend on method of handling the seed, the kind of seed, the conditions and seed characteristics presented in Table 1, and the amount of seed cleaned during the receiving period. Handling equipment requirements are dictated by method of handling and kind of seed.

The basic cleaning line, used on all seeds, is made up of an air-screen cleaner, an indent disc-cylinder separator, and another air-screen cleaner. Seed flow through these machines is in the order named. Auxiliary equipment, which may be utilized as required, includes a revolving screen (squirrel cage or rat-tail reel) used to remove rat-tail fescue (F. myuros) from ryegrasses; a debearder for bluegrass--also used to break up "doubles" in chewings and red fescues and bentgrass; and a specific gravity separator for use on bluegrass and crimson clover. Other special purpose machines, such as electrostatic and electro magnetic separators, have not been included, though they may be desirable in individual situations.

Seed flow between the above machines is by elevators and conveyors. Gravity flow is utilized where feasible. The cleaning line is designed as a single story installation (Figure 3).

The capacity of this line is assumed to be 1250 pounds per hour when used on ryegrass seed. Capacities on the other seeds, in line with the relative cleaning rates presented in Table 1, are (in pounds per hour):

Alta fescue	962
Crimson clover	962
Chewings fescue	400

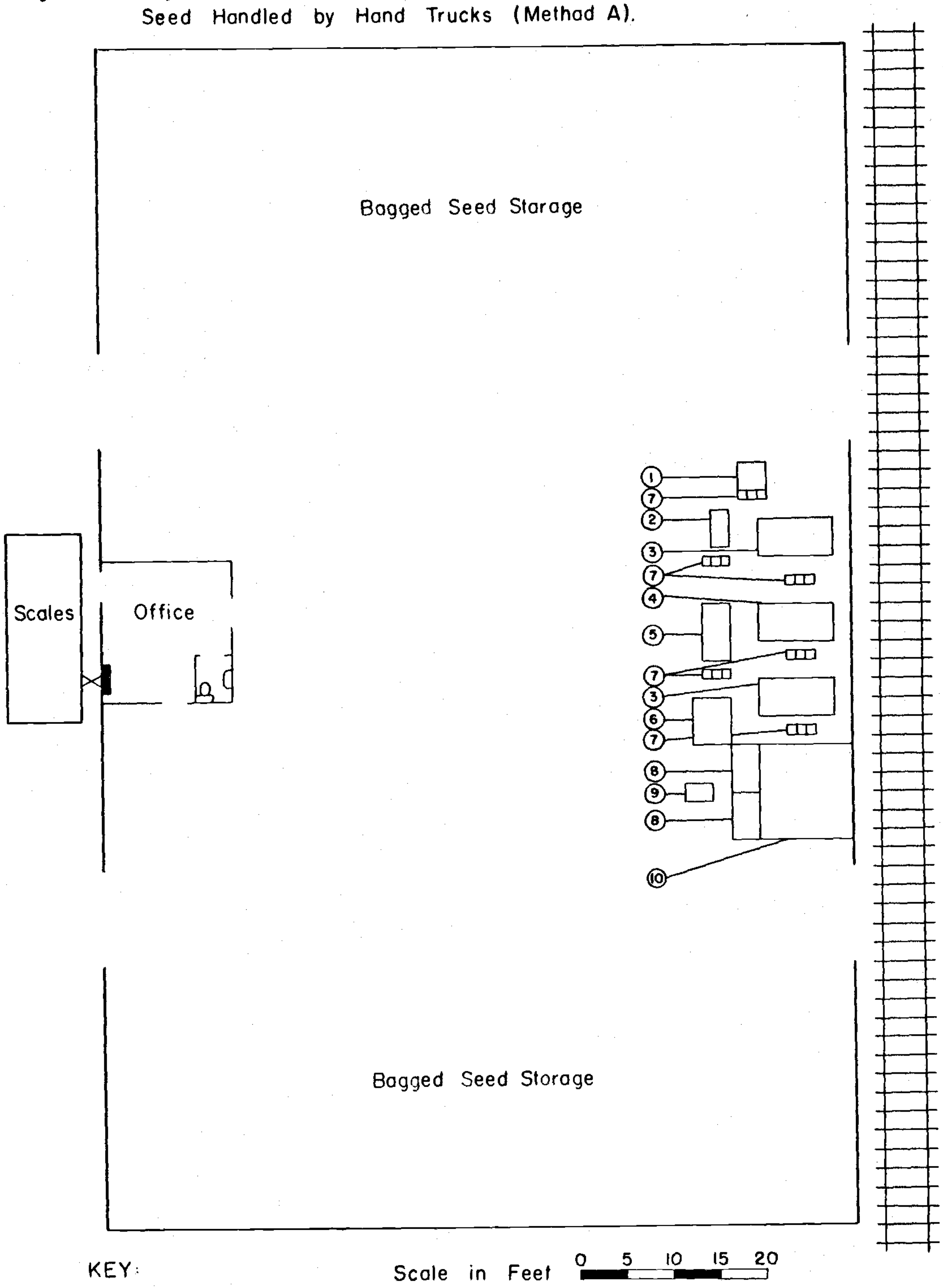
Red fescue	425
Bentgrass	438
Merion bluegrass	175

Because the cleaning line is common to all models, its estimated annual costs are presented in this section (Table 2).

Total investment in basic cleaning equipment is \$20,019.30. This includes conveyors, scales, sewing machines, and other items necessary to clean and bag the seed. It does not include special purpose separators and cleaners which are required for certain seeds. Depreciation, insurance, taxes, interest on investment, and maintenance combine for total fixed costs of \$3,300.55.

Hourly operating costs for this set of equipment amount to \$1.05396. Variable costs of the cleaning line may be more useful if put in terms of cost per unit of output of clean seed. This may be done by dividing the hourly cost by the number of units of output per hour. For example, the hourly output of ryegrass was assumed to be 1250 pounds or .625 tons. Dividing \$1.05396 by .625, the cost per ton of ryegrass is found to be \$1.68634 for the basic line. To this should be added the costs incurred through use of the rat-tail reel ($\frac{\$.0175}{.625} = \$.028$) plus the cost of thread for closing the bags (estimated at \$.05 per ton) for a total of \$1.76434 per ton of clean ryegrass seed processed.

Figure 3. Layout of Seed Processing Warehouse, 1000 Tons Annual Volume, Seed Handled by Hand Trucks (Method A).



KEY:

1. Floor Hopper, 2' x 3' x 3', Input to Line
2. Debearder
3. Air-screen Cleaner, Four Screens
4. Indent Disc-cylinder Separator
5. Rat-tail Reel
6. Specific Gravity Separator
7. Elevator, 100 bu. per Hour Capacity
8. Clean Seed Bagging Bins
9. Bag Scales, 500 lb. Capacity
10. Screenings Bin

Table 2 Estimated Costs of the Basic Cleaning Line.

Item	Number Used	Replacement cost[a]	Fixed costs: Depreciation[b]	Fixed costs: Other fixed costs[c]	Fixed costs: Total annual fixed costs	Variable cost per hour: Repairs[d]	Variable cost per hour: Power[e]	Variable cost per hour: Total
Airscreen cleaner	2	$ 8,000.00	$ 800.00	$ 520.00	$1,320.00	$ .40	$ .15	$ .55
Disc-cylinder separator	1	4,000.00	400.00	260.00	660.00	.20	.03	.23
Elevator 100 bu.. 15'. 1/2 HP	5	2,240.00	224.00	145.60	369.60	.112	.025	.137
Elevator 50 bu.. 15'. 1/2 HP	5	2,100.00	210.00	136.50	346.50	.105	.025	.130
Distributing pipe. 6"	100'	350.00	35.00	22.75	57.75	---	---	---
Valves. 2-way. 6"	5	150.00	15.00	9.75	24.75	---	---	---
Input hopper. 2 x 3 x 3	1	25.00	1.67	1.62	3.29	---	---	---
Screenings bin. 1000 bu.	1	30.00	1.20	1.95	3.15	---	---	---
Extra screens, discs and cylinders[f]	--	2,756.80	275.68	179.19	454.87	---	---	---
Associated Equipment								
Sewing machine. portable .4 HP	1	300.00	30.00	19.50	49.50	.00529	.00167	.00696
Bag scales. 500 lb. cap.	1	67.50	6.75	4.39	11.14	---	---	---
Total for basic line	--	$20,019.30	$1,999.30	$1,301.25	$3,300.55	$ .832	$ .222	$1,05396
Auxiliary cleaners[g]								
Specific gravity separator	1	$ 4,500.00	$ 450.00	$ 292.50	$ 742.50	$ .225	$ .100	$ .325
Rat-tail reel	1	150.00	15.00	9.75	24.75	.0075	.010	.0175
Debearder	1	1,486.00	148.60	96.59	245.19	.0743	.105	.1793

a 1960 prices, estimated from equipment dealers catalogs, tax assessors files, and warehouse records. Includes installation.

b Based on useful life: 10 years for cleaning machinery and conveying equipment; 15 years input hopper, and 25 years for screening bins.

c Includes the following percentages of replacement cost: interest,3 percent; taxes and insurance, 1 percent each; maintenance,1.5 percent.

d Calculated at .005 percent per hour of operation. e Electricity cost calculated at 1 cent per horsepower per hour of operation.

f Fifteen extra screens for each air-screen cleaner, at $28.56 per screen; 2 extra sets of discs at $500 each and 2 extra cylinders at $450 each for the disc-cylinder separator.

g Specific gravity separator used only on crimson clover and merion bluegrass; rat-tail reel used only on annual and perennial ryegrass; debearder used only on chewings and red fescue, bentgrass, and merion bluegrass.

The basic cleaning line is the nucleus of all the cost estimation models. One cleaning line is budgeted for those models centered on 1000 tons annual output. A second line is added for the models with an annual output of 2500 tons, and a third for the 5000 ton models.

Summary

This chapter has demonstrated the advantages of considering seed processing as being composed of several distinct but interrelated stages. These advantages are primarily of interest in obtaining physical input-output data by means of economic engineering studies.

Joint use of certain inputs by more than one stage within the process makes it more convenient to estimate fixed costs for the aggregate of inputs, rather than by stages. Variable costs, however, may be estimated by stages and then aggregated.

Also presented were certain standardizing assumptions concerning characteristics of the different seeds. These characteristics are among those which cause variations in output with a given set of equipment.

Cost estimates are based on case studies of separate stages abstracted from a number of seed processing warehouses in the Willamette Valley. Annual fixed costs were estimated for depreciation, interest on investment, insurance, taxes, and maintenance of equipment requirements so determined. Variable costs of fuel, power, and repairs were estimated. The other component of variable costs is labor, which was also estimated from the engineering studies.

Chapter III

SEED HANDLING METHODS

Two major items in variable costs arise from handling--transportation of seed within the warehouse--and operation of the cleaning line. Variable costs of the cleaning line depend on capacity of the machinery, kind of seed being processed, and the kinds and amounts of contaminants present in the seed. Variable costs of handling depend mainly upon the type of equipment and to some extent on kind of seed being handled. Because of the importance of type of equipment on handling costs, this is singled out here for major emphasis.

The major influence of type of handling equipment on variable costs is through the amount of labor used. (Crew sizes for certain handling equipment are variable within limits, but an optimum crew size can be determined.) Labor requirements are in turn a function of the container or form in which the seed is handled, i. e., bags, bulk, or pallet boxes. The following general cases can be differentiated:

1. Bagged seed handled with two-wheel hand trucks
2. Bagged seed handled on pallets with fork-lift trucks
3. Bulk seed handled by conveyor and elevator
4. Bulk seed handled in boxes by fork-lift truck

In the warehouse, these can be intermingled and combined in several ways. The following combinations were considered in this study:

A. Field-run seed and clean seed handled in bags by two-wheel hand trucks.

B. Field run and clean seed handled in bags on pallets by fork-lift truck.

C. Field-run seed handled in bulk by elevators and conveyors; clean seed handled in bags by hand truck.

D. Field-run seed handled in bulk by elevators and conveyors; clean seed handled in bags on pallets by fork-lift truck.

E. Field-run seed handled in pallet boxes by fork-lift truck; clean seed handled in bags on pallets by fork-lift truck.

These combinations are termed "handling methods" for convenience in presentation. Appendix Tables 17 to 21 give the performance rates used in synthesizing each method.

Description of Seed Handling Methods

Method A: Field Run and Clean Seed Handled in Bags by Two-wheel Hand Truck

Field-run seed is delivered to the warehouse in bags on trucks, 150 bags per truck. At the receiving dock, a five man crew unloads the bags and transfers them to temporary storage. It is assumed that the bags will be placed in 20 high piles, about 400 to 500 bags per pile, with the use of a belt-type, portable elevator. Three men operate hand trucks, moving five bags per load. Each hand truck operator sets his load off on the elevator, one bag at a time. Two men on top of the pile take the bags off the elevator and place them into position on the pile.

When the seed is to be cleaned, bags are broken out of the piles and transferred to the cleaning line on hand trucks. There they are opened and emptied into a floor hopper, from which the seed is elevated to the cleaning line. After it is processed through the appropriate machines, it flows into burlap or cotton bags. Net weight of the filled bags is 100 pounds, except for merion bluegrass. Because of its bulk it is packed 50 pounds to the bag. The bags are closed by means of a hand portable electric stitcher.

The bags are placed on hand trucks and transferred in five bag loads to test storage, where they are placed into rows of five high piles so that the seed tester has access to each bag. If the seed sample meets minimum legal quality standards, the seed may be shipped or transferred to 20 high piles for later shipment. If the sample fails to meet the standards, it may be reprocessed, or it may be held for blending with a seed lot which exceeds the standards. In this report, it will be assumed that all seed lots meet or exceed the

the standards so that no reprocessing or blending is required.

At the time of shipment, an analysis tag is attached to each bag of seed. If it is certified seed, a certification tag is attached also. In some Oregon counties, this tag is affixed by certification officials. In others, it is affixed by warehouse labor. In this study labor charges for attaching certification tags are included for seed which meets certification standards (Table 1).

As mentioned above, the seed may be shipped from test storage or from holding storage. Shipment from holding storage involves an extra movement of the seed, but this must be balanced against the greater storage space requirements of test storage. For simplicity, it will be assumed here that half the seed is moved into holding storage prior to shipment, with the remainder being shipped directly from test storage.

Pretagged bags are moved directly from test storage into the rail car by hand truck. Inside the car, a small sack elevator is used to assist in piling the bags high enough to fill the car. The elevator is set up three times in each end of the car, once for each tier of sacks. The door or center section is filled last, with the top bags thrown up by hand.

Bags in holding storage are broken out of the piles and moved by hand truck to an intermediate tagging station. There the hand truck operator affixes the tags and moves the seed into the rail car. From this point, loading proceeds as above.

As indicated above, each bag must have an analysis tag attached when it is shipped. Seed shipped from test storage can be tagged before it is moved. Seed that is moved to holding storage and then shipped is tagged during the loading process to prevent loss of tags during movement and handling of the bags. Pretagging requires less labor time than tagging during loading.

Method B: Field Run and Clean Seed Handled in Bags on Pallets by Lift Truck

Field run seed is received in bags on farm trucks. At the warehouse it is transferred to pallets, which are then transferred to storage.[1] The use of pallets and lift truck represents an additional investment over Method A, but crew sizes, and thus the total labor bill, are reduced. Storage space requirements are also reduced when palletized seed is stored three or four pallets high.

All movement of bagged seed in the warehouse is by pallet and lift truck. Clean seed in test storage is placed two pallets high with clearance on all sides for the seed tester. Clean seed in holding

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[1] A pallet is a four foot by five foot double-faced two-way entry wooden device on which the bags of seed are stacked for transportation or storage. The lift truck picks up the pallet with the stack.

storage is four pallets high, with access aisles so that the lift truck operator does not have to penetrate more than four pallets deep within a row.

Labor and equipment requirements for this method and Methods A and C are based on a warehouse having a floor height level with the floor in a rail car. This provides for ease of entry into rail cars for shipment.

All sacks may be pretagged before loading when seed is moved on pallets, because the individual sacks are not handled and loss of tags is minimized. The pretagged seed is moved directly into the rail car on the pallet. Bags are transferred by hand from the pallet. An elevator is not required to place the upper layers in the tiers under this method, as the pallet height is governed by the lift truck.

Method C: Field-Run Seed Handled in Bulk by Elevator and Conveyor, Clean Seed Handled in Bags by Hand Truck

This method differs from Method A only in the handling of field-run seed, which is delivered in bulk on highway trucks. The average truck load is 400 bushels -- this figure has been used in computing labor and equipment requirements and costs.

After being weighed and recorded, the seed is dumped from the truck into a hopper set in the ground. Dumping is accomplished by raising the front end of the truck in a cradle hoist to approximately a 40 degree angle with the ground. Infrequently a grower will have a dumping mechanism installed on his truck bed. Those who have a self-dumping truck feel that the extra expense is offset by avoiding the wear and tear on the truck frame and motor mounts caused by the cradle hoist method. Self-dumping is also quicker than cradle hoist dumping.

A third dumping method, not observed in Oregon, is worthy of consideration. It is utilized in other areas, e. g. , to receive rice at commercial dryers in Texas, Arkansas, and Louisiana (18). It is termed "hook-hoisting". The truck bed is hinged at the rear, and fastened at the front with a latch. Hooks on either side of the front of the truck bed are engaged by a hoist to raise the bed to the required angle of elevation. This method requires less labor time and less heavy machinery, and also is not as hard on the trucks as cradle hoisting. "The cost of adapting a farm truck to this method is much less than for the self-dumping method" (18, p. 3).

In the study cited, the computed costs to the dryer for receiving an annual volume of 2, 000 truck loads of rice by the three methods were:

Method	Cost per Truckload
Self-dumping	$1.64
Hook hoisting	1.77
Cradle hoisting	1.81

Comparable cost figures are not available for seed processing warehouses, but the three methods would be expected to bear the same cost relationship to one another even if the level of costs were different. Because of the lack of data, only the cradle hoisting method was considered here.

The receiving set-up includes a receiving hopper large enough to hold the average load -- 400 bushels. It is assumed that the hopper is double-hoppered, i. e., tapered from the sides and one end to the exit gate at the outlet end. The elevator entrance is positioned next to the hopper outlet to eliminate a difficult-to-clean conveyor.

The bulk seed is elevated to a spout selector controlled from the dumping area. From here it is directed to the various bulk bins. The bins, constructed of low-grade, laminated 2" x 4" and 2" x 6" dimension lumber, have hoppered bottoms for ease in cleaning. From the bins the seed is directed by conveyors and elevators to the cleaning line. From this point the procedure is as described under Method A above.

Though the bulk receiving method required additional expense in machinery and facilities over the two methods described above

(A and B) crew size is reduced to one pit man. The weighmaster is eliminated by having the receiving hopper set into the truck scales and having the pit man perform the weighing and recording.

Method D: Field-Run Seed Handled in Bulk by Elevators and Conveyors, Clean Seed Handled in Bags on Pallets by Lift Truck

This method is essentially the same as Method C above except that the clean seed is transported by lift truck rather than hand truck, and the warehouse is assumed to be at ground level rather than car level.

A ground level plant requires a variation in loading method from a car level plant. A concrete ramp may be used to enter the car, or a pallet dolly may be used inside the car.[1] The ramp method will be utilized in this analysis. Labor requirements are about 10 percent lower (7.54 man-hours per 1000 bags for the ramp method, versus 8.36 for the pallet dolly). The extra cost of the ramp method over the pallet dolly is offset by this labor advantage at an annual volume of about 2,500,000 pounds of clean seed. Below that volume the pallet dolly method becomes the more economical based on total direct and indirect labor costs of $1.75 per hour (at lower wage

[1] A pallet dolly is a small platform with casters used to move the pallets.

rates the break even volume is correspondingly higher).[1]

Other than the use of the ramp, car loading is as described above under Method B.

Method E: Field-Run Seed Handled in Pallet Boxes by Lift Truck, Clean Seed in Bags on Pallets Handled by Lift Truck

Pallet boxes used in Oregon are usually of plywood construction built upon a two way entry pallet. Three sizes are in general use: 4' x 4' x 4', 4' x 6' x 3', and 4' x 6' x 4'. The largest size is preferable for grass seeds and the smallest for legume seeds. The intermediate size proves useful for grass seeds in plants with less than 4000 pound capacity lift trucks.

When the field-run seed is delivered in pallet boxes, the weight of seed and number of boxes are recorded and the boxes are removed to storage under a pole type shed. Empty boxes are then placed on the truck for the next load.

At cleaning time, the boxes are moved to the cleaning line and

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1 The annual cost of the ramp is \$42.00; that of the pallet dolly is \$6.60. To compute the break even volume for the two methods at different wage rates, use the formula

$$x = \frac{\$42.00 - \$6.60}{.82\, w},$$

where x is the break even volume, w is the labor cost in dollars, and .82 is the labor time differential between the two methods.

dumped by means of an inversion type mechanical dumper; the seed flows into a hopper and thence into the cleaning line. Clean seed handling and shipping are identical with the other methods utilizing lift trucks.

Comparative Costs of Seed Handling Methods

Cost estimates were developed for three levels of annual volume -- 1000, 2500, and 5000 tons clean seed. Within these volume levels, estimates are presented for five handling methods as applied to annual ryegrass. The procedures used in arriving at estimated costs for these models are presented below.

Labor and equipment performance standards developed under this project and previously published (7) were used to establish a physical basis for the cost estimates (Appendix Tables 17 to 21). Prices were then applied to the equipment items to determine the investment in fixed factors. Ownership costs, on an annual basis, were computed from depreciation schedules. Ownership or fixed costs also include interest on the investment, taxes, insurance, and maintenance. Variable or operating costs include fuel or power costs and repairs.

To illustrate the procedures, cost computations will be presented for Method A at the 1000 ton volume level (Table 3). The optimum

Table 3. Calculation of Annual Costs for a Seed Processing Warehouse Handling 1,000 Tons Annual Ryegrass per Year by Hand Truck (Method A).

Item	No. used[a]	Total Re-placement cost[b]	Annual fixed costs[b]	Annual variable costs	Total annual cost
Truck Scale	1	$ 6,026.00	$ 692.99	$ ---	$ 692.99
Hand trucks	10	500.00	82.50	---	82.50
Dock plate	2	100.00	16.50	---	16.50
24' sack elevator, 3 HP	2	3,200.00	528.00	90.40	618.40
10' sack elevator, 1 HP	1	850.00	140.25	8.56	148.81
Warehouse (sq. ft.)	10,000	22,500.00	2,362.50	---	2,362.50
Cleaning line	1	20,169.30	3,325.30	1,764.34	5,089.64
Handling labor (hrs.)	2,385	---	---	3,609.00	3,609.00
Cleaning labor (hrs.)	1,600	---	---	2,800.00	2,800.00
Sub-totals	---	$53,343.30	$7,148.04	$8,272.30	$15,420.34
Misc. and overhead 10%	---	---	714.80	827.23	1,542.03
Total	---	$53,343.30	$7,862.84	$9,099.53	$16,962.37
Cost per ton	---	---	$ 7.86	$ 9.10	$ 16.96

[a] Based on the following: five man receiving crew, 40 days or 400 hours; one man on cleaning line; four man crew on car loading (included in handling labor); cleaning line, capacity 1,250 pounds clean seed per hour, operates 1,600 hours; warehouse space for half the total annual volume of clean seed, or for the amount of field run seed not cleaned during receiving, whichever is larger, plus 800 square feet used by cleaning line.

[b] From Appendix Table 1

crew size of five (optimum in the sense that a larger or smaller crew cannot handle as much seed per man-hour) was assumed for receiving field run seed and for shipping of clean seed. It was assumed that the receiving season would extend from about July 10 to around August 25, approximately 40 working days or 400 hours. Since the receiving crew must be on hand during the full receiving period, a total of 2000 man-hours is charged to receiving. During slack hours in receiving this crew is available for warehousing and shipping of the clean seed after the receiving period.

A cleaning line with a capacity of 1250 pounds clean seed per hour was assumed to operate 16 hours per day until about October 1, and eight hours per day thereafter, for a total of 1600 hours. One man can tend the cleaning line and move seed out of and into storage.

The amount of seed cleaned out during the receiving period is 800,000 pounds or 400 tons (1250 pounds per hour times 16 hours per day times 40 days). Hence, storage space is required for 600 tons. On the basis of 26.12 sacks field-run seed per ton of clean seed, and .585 square feet per bag in 20 high piles, this is 9168 square feet, rounded to 9200. Allowing 800 square feet for the cleaning line and bagging equipment, the total warehouse space is 10,000 square feet.

Two 24 foot sack elevators for making and breaking 20-high piles, one 10-foot sack elevator for use in carloading, ten hand trucks and two dock-plates complete the equipment requirements.

These last equipment items were also used in the models for Method A at 2500 and 5000 tons annual volume. The major changes in the model to accommodate the higher volume level were in storage requirements, hours operated, and the addition of a cleaning line and a cleaner man for each increase in plant size.

Computing annual costs was the next step in the procedure. Fixed and variable costs were used from Appendix Table 16. Variable costs shown in that table are on an hourly basis. Thus it was necessary to calculate the number of hours each item was in operation. This was done by taking the appropriate labor standard (or standards, if the items were used in more than one operation), and putting it on the basis of hours per ton of cleaned seed. Multiplying hours per ton by total volume handled and then by the hourly cost yields the annual variable cost for that item. When machinery was used to handle field-run seed, the volume of clean seed was converted to a field run basis by dividing by the appropriate clean-out percentage.

After finding a total for fixed and variable costs, an allowance of 10 percent was added to include land charges and miscellaneous tools and supplies.

The above procedures were followed for each handling method for the three volume levels.

Table 4. Estimated Costs per Ton of Clean Seed for Each of Five Handling Methods in Processing Annual Ryegrass Seed at Specified Volume Levels

Method of handling	Cost components	Annual Volume Clean Seed Processed		
		1000 tons	2500 tons	5000 tons
		Dollars per ton of clean seed		
A	Fixed	$ 7.86	$ 5.13	$ 4.07
	Variable	9.10	6.79	6.13
	Total	16.96	11.92	10.20
B	Fixed	8.04	5.07	4.17
	Variable	8.14	6.56	6.06
	Total	16.18	11.63	10.23
C	Fixed	11.05	7.64	4.71
	Variable	6.27	5.76	5.59
	Total	17.32	13.40	10.30
D	Fixed	11.64	7.77	4.87
	Variable	6.00	5.47	5.30
	Total	17.64	13.24	10.17
E	Fixed	11.12	8.92	5.13
	Variable	5.50	5.22	5.23
	Total	16.62	14.14	10.36

There is relatively little difference in cost per ton of clean seed between the five methods at any of the three volume levels (Table 4). This suggests that handling method is relatively unimportant as a factor in processing costs. Before accepting this conclusion, it is desirable to investigate more closely the composition of these cost estimates.

Handling and Cleaning Components

Table 5 shows the fixed and variable costs for the five methods broken down into handling and cleaning components at the three levels of annual volume.

Cleaning costs per ton are constant for all methods within a given volume level, by assumption. The diminution of cleaning cost from one volume level to the next highest is entirely due to spreading of fixed costs over more units, since variable cleaning costs do not change with volume.

Since cleaning costs are constant between methods, differences in total average cost are due entirely to differences in handling costs.

In terms of long range planning, total unit costs are one criterion by which the optimum profit point is selected. On this basis, Method B is slightly more attractive as an alternative.

Table 5. Fixed and Variable Components of Handling and Cleaning Costs for Specified Volumes of Ryegrass Seed, for Each of Five Methods

Method of handling	Cost component	1000 Tons			2500 Tons			5000 Tons		
		Handling	Cleaning	Total	Handling	Cleaning	Total	Handling	Cleaning	Total
		(Dollars per ton clean seed)								
A	Fixed	4.20	3.66	7.86	2.20	2.93	5.13	1.87	2.20	4.07
	Variable	4.08	5.02	9.10	1.77	5.02	6.79	1.11	5.02	6.13
	Total	8.28	8.68	16.96	3.97	7.95	11.92	2.98	7.22	10.20
B	Fixed	4.38	3.66	8.04	2.14	2.93	5.07	1.97	2.20	4.17
	Variable	3.12	5.02	8.14	1.54	5.02	6.56	1.04	5.02	6.06
	Total	7.50	8.68	16.18	3.68	7.95	11.63	3.01	7.22	10.23
C	Fixed	7.39	3.66	11.05	4.71	2.93	7.64	2.67	2.20	4.71
	Variable	1.25	5.02	6.27	.74	5.02	5.76	.28	5.02	5.59
	Total	8.64	8.68	17.32	5.45	7.95	13.40	2.95	7.22	10.30
D	Fixed	7.98	3.66	11.64	4.84	2.93	7.77	2.67	2.20	4.87
	Variable	.98	5.02	6.00	.45	5.02	5.47	.28	5.02	5.30
	Total	8.96	8.68	17.64	5.29	7.95	13.24	2.95	7.22	10.17
E	Fixed	7.46	3.66	11.12	5.99	2.93	8.92	2.93	2.20	5.13
	Variable	.48	5.02	5.50	.20	5.02	5.22	.21	5.02	5.23
	Total	7.94	8.68	16.62	6.19	7.95	14.14	3.14	7.22	10.36

Consideration of Convenience and Timing

There are other considerations, however, which are not reflected in the cost estimates presented here. For instance, the greater part of the variable costs in Method A are labor costs. The actual quantity of labor needed is 3,600 man-hours for the 1000 ton plant, 6,000 man-hours for the 2500 ton plant, and 10,000 man-hours for the 5000 ton plant. This labor demand is seasonal and is no longer in dependable supply in Oregon or in other areas.

From the standpoint of seed growers, Methods A and B may both be rejected. Present day large scale seed producers need handling methods which will permit them to harvest their crop and transfer it to the processing plant with a minimum of delay. Producers are also faced with a seasonal labor shortage. These and other considerations are prompting the trend to bulk handling in the field and in field to plant transportation. To provide their customers with the fast efficient service they need and want, commercial processors are having to change to bulk handling methods in their receiving set ups.

Time and labor considerations, as well as convenience, have caused growers who operate their own processing facilities to change to bulk handling methods. The use of bulk facilities enables an individual operator to perform all or most of his own field-run seed handling chores and thereby reduce cash costs for hired labor. (The question of economic efficiency in grower-operated seed warehouses will be explored in a later chapter.)

Of the three bulk handling methods (C, D, E), Method E cannot compete on a cost basis except at the lowest volume level considered. In an analysis presented before the Oregon Seed Processor's Short Course in 1961 it was demonstrated that pallet box receiving of rye-grass is lower in cost than bulk receiving, up to about 1625 tons of clean seed annually (6). The comparison there was only for receiving and storing field-run seed. Inclusion of other warehouse operations, as in this study, might change the breakeven volume between bulk and pallet box receiving. However, since Methods D and E use the same crew organization and equipment for clean seed handling, and Methods C and D have very similar annual costs, it is doubtful that the break even point is changed much.

Chapter IV

VOLUME-COST RELATIONSHIPS

The emphasis in the preceding chapter was on comparative costs for different handling methods. Some indication was given of the interaction of method and annual volume of seed processed. In this chapter, the emphasis is shifted to the relationship of annual costs to variations in annual volume.

Seed processors are vitally interested in volume-cost relationships both from a long range and short run point of view. The long range aspects are considered first in deference to the fact that they are important in plant design -- that is, in selecting or attempting to achieve an optimum scale of output or plant size (optimum in the profit maximizing sense). The discussion here will center around the models developed for Method D at the three specified volume levels (See Tables 4 and 5).

Long Range Volume-Cost Relationships

As indicated previously, a constant output rate is assumed for all operations except cleaning. When volume increased from 1000 to 2500 tons, it was found to be feasible to increase the hourly capacity of the cleaning operation by adding a second cleaning line. This reduced storage requirements and thus decreased total costs for the 2500 ton level. Adding a third cleaning line increased total costs at the 2500 ton level, but reduced total costs at the 5000 ton level. Further additions to the cleaning line were not feasible at the higher volume.[1] This in no way changes the conclusions to be drawn from the reduction in cost per ton as volume increases (Tables 4 and 5). The reader is cautioned that the construction of these models is such as to prevent interpolation between cost points within a given method.[2]

Most economies to size are evidently exhausted in the move from 1000 tons to 2500 tons. Further reductions in unit costs could very well be possible at volumes greater than 5000 tons, though costs were not estimated at larger volumes, for several reasons. One of the most important reasons is that the 5000 ton plant is larger than any encountered in Oregon. Secondly, the geographical pattern of seed production in the state is such that some difficulty might be experienced in accumulating larger volumes. Concurrent with this is the fact that, of the crops considered, only the ryegrasses are in sufficient supply to warrant such a large plant. Also, the large

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1 The question of optimum capacity of the cleaning line within a fixed plant is different from the long range viewpoint expounded here.

2 For an interesting and detailed discussion of this point see Hutchings' unpublished Ph. D. thesis (12, p. 177-182).

number of grower-operated warehouses would tend to make it difficult for a larger plant to attract sufficient customers to supply its seed requirements.

Short-Run Volume-Cost Relationships

Once the decision as to plant size has been made, the processor is concerned with the short-run aspects of the volume-cost relationships. Consideration must be given to historical trends and fluctuations in seed production. A warehouse processing a single product is particularly vulnerable to year-to-year variations in annual volume.

An illustration of the effect of variations in annual volume from the optimum is provided by the examples below. First, consider a warehouse designed for 1000 tons, using Method D. Using the data in Appendix Table 4, fixed costs are $11, 641. 44 and variable costs are $6003. 51 or a total of $17, 644. 96. If volume in any year fell ten percent to 900 tons, variable costs would be reduced to $5, 480. 17, but fixed costs remain the same, so that total costs become $17, 121. 61. Dividing this sum by 900 tons, total cost per ton is found to be $19. 02 versus the original $17. 64 if 1000 tons were processed. The percentage increase in total cost is found to be 7. 4 percent. In almost any industry, this could be the difference between profit and loss from that year's business.

Now consider the opposite case, where volume increases above that for which the warehouse was designed --1000 tons, using Method D. Again, the original situation is $11,641.44 fixed costs and $6,003.51 variable costs for a total of $17,644.96. If total volume were to increase to 1100 tons, total variable costs would now be $6,526.86. Fixed costs could not be held at the same level ($11,641.44), because storage facilities are designed to handle only 1000 tons. Additional storage must be provided. This could mean construction of additional facilities, either permanent or temporary. Construction of permanent facilities could only be justified if the warehouse operator considered the long run profit possibility.

An alternative solution would be to sack the extra field run seed at the warehouse. This is a common practice in Oregon warehouses. This involves additional labor, construction and maintenance of sacking facilities, and either rental of additional bagged seed storage or overcrowding of existing facilities. Just the extra labor amounts to $1.65 per ton of seed handled in this way.[1]

Even without budgeting costs for sacking facilities or additional storage, the evidence is sufficient to indicate that volumes higher

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[1] Based on a labor requirement of .865 man-hours per ton for sacking and placing the seed in storage at the warehouse, and .236 man-hours per ton for removing it from storage and transferring it to the cleaning lines with labor at $1.50 per hour.

than the optimum (for which the plant was designed) cause costs per ton to be higher than for the optimum volume. Since it was also shown that costs per ton are higher for lower than optimum volumes, it is obvious that annual volume is a critical factor in the short run. One means of protecting income under conditions of varying volume would be for the processor to utilize methods which have a high proportion of variable costs to fixed costs. A cursory inspection of Table 4 reveals that of the five methods analyzed there, only Methods A and B have that characteristic at the lowest volume level (1000 tons) and at the intermediate volume level (2500 tons). All methods exhibit this characteristic at the 5000 ton level. Even here, the variable costs represent only 52 to 55 percent of the total annual costs.

Since the ratio of fixed to variable costs for a seed plant offers little income protection from variations in annual volume, some means must be sought to protect against volume variations. Other than contractual arrangements with growers, the most obvious solution is to operate a multiple product plant. Different varieties of seeds rarely fluctuate in production simultaneously in magnitude and direction. Thus deviations in production of one seed crop would be expected to be offset by other seeds, in terms of annual volume coming to the warehouse. The next chapter of this report elucidates this theme.

Chapter V

PRODUCT MIX AND COST RELATIONSHIPS

It is apparent that product mix in multiple product plants is not necessarily an independent decision on the part of management. Seed production follows certain geographical patterns of adaptation, including climatic factors. Even within a major seed producing region such as the Willamette Valley, certain seed crops tend to become localized. Thus, the southern end of the valley is most specialized in ryegrass production, while the northern half tends to specialize in fine fescues and bent. Every county in the Willamette Valley seed producing area produces some of each of the eight seeds considered in this report (Figure 2), but seed plants must rely on the local specialties for the greater part of their volume. The number of seed warehouses within the valley precludes any major movement of field run seed.

Within the context of local production patterns, however, managers do have the option of varying their product mix if they so desire. Once they have established the kinds of seed they will handle, they have another set of strategies to consider. One strategy would be to solicit a group of customers and accept passively the yearly fluctuations in volume caused by production shifts and changes due to climatic and other conditions. Another strategy would be to focus on a predetermined volume level, and accept or refuse customers on this basis. The latter strategy may be more appealing from the standpoint of its effect on processing costs, inview of the high proportion of fixed costs in seed processing. However, it may not be feasible from the standpoint of customer relations and long term operations. Other strategies might revolve around selection of products on a continuous basis to take advantage of production fluctuations. All these strategies provide some degree of flexibility in plant operation. This is always desirable, but flexibility generally is available only at some expense.

The organization of processing in multiple-product seed plants is generally around a constant mix in terms of the products processed, with the proportions of the seeds varying from year to year. The various commodities are handled and processed with the same or slightly altered facilities in separate time periods. When this is so, products may be added with relative ease, sometimes requiring only an additional small investment in special separating machines.

Problems of Allocation of Joint Costs

There are problems in obtaining cost estimates for multiple-product plants which do not appear in analyzing specialized processing facilities. The most obvious comes in allocating costs to the various products. So long as the products use separate facilities, or the same facilities in alternate time periods, variable or operating costs are easily allocable.

There are inevitably joint costs, such as common storage, management, and other fixed inputs used by all products. These joint costs can be allocated in some manner to the various products. All such allocations are arbitrary to some degree.[1] A few allocations which suggest themselves are: (1) on the basis of the proportion of total input; (2) on the basis of the proportion of total output; (3) on the basis of number of hours the cleaning line is operated for each product. Because of varying densities and handling characteristics among the various seeds, each of these will result in different cost estimates for each product. Selection among alternative allocations would be on individual plant basis.

An illustration of how different methods of allocation affect the resulting cost per ton is provided by Table 6. This also illustrates the point that arbitrary allocations of fixed costs may be misleading

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[1] "If this fundamental characteristic of joint production were perfectly clear to all contributors to cost accounting literature, most of the futile discussion of how general costs shall be allocated to different products would vanish, and one would instead concentrate on the really important problem of the behavior of the marginal costs" (3, p. 82n).

Table 6. Comparison of Three Methods of Allocating Joint Costs in Multiple Product Seed Processing Plants.

Kind of seed	Annual volume of clean seed	Annual fixed costs per ton of clean seed when allocated according to: [a]			
		Field run weight[b]	Clean Weight	Cleaning hours [c]	Variable costs [d]
	(Tons)	(Dollars per ton of clean seed)			
Annual ryegrass	1000	$ 7.52	$ 7.77	$ 7.33	$ 5.55
Perennial ryegrass	1000	7.52	7.77	7.33	5.57
Alta fescue	250	7.93	7.75	9.50	7.51
Crimson clover	250	16.16	14.28	16.03	8.25
Composite[e]	2500	$ 8.42	$ 8.42	$ 8.42	$ 6.02

[a] Total fixed cost = $21,051.24, based on Method D. product mix 4 (Appendix Tables 9 and 9a)

[b] Total is 2,873 tons field run seed: 1,111 tons annual ryegrass, 1,111 tons perennial ryegrass, 294 tons alta fescue. and 357 tons crimson clover.

[c] Total is 2,120 hours: 800 hours for annual ryegrass, 800 hours for perennial ryegrass. 260 hours for alta fescue. and 260 hours for crimson clover.

[d] Total variable costs are $15,054.74, assigned to each seed as incurred.

[e] Composite costs are found by dividing total fixed or variable costs by total volume of clean seed.

from the standpoint of decision making.

The cost conditions underlying these data are those for Method D at the 2500 ton level of annual volume. The product mix is 40 percent annual ryegrass, 40 percent perennial ryegrass, 10 percent alta fescue and 10 percent crimson clover. Total annual cost is $36,105.98 or $14.44 per ton of clean seed. Fixed costs are $21,051.24, of which $27.22 are directly allocable to each of the ryegrasses as fixed cost associated with the use of the rat-tail reel on those seeds. Another $1633.50 is directly attributable to cleaning of crimson clover with a specific gravity separator. The remaining $19,363.30 was allocated among the four seeds. The results were divided by the clean weight of the respective seeds to obtain the figures in the table. Variable costs are included for comparison in a separate column of the table -- they are constant for each seed however fixed costs are allocated.

Allocation on the basis of field run input gives lower estimates for the ryegrasses than allocation on the basis of clean seed output, but higher than for cleaning hours. Alta fescue has the highest estimate under the cleaning hour allocation, and lowest under the field run input allocation. Crimson clover has the lowest cost per ton under the clean weight allocation and highest under the field run allocation. It has the highest density and the lowest percentage cleanout of clean seed, but the capacity of the cleaning line was assumed to be the same on crimson clover as on alta fescue.

These costs apply only to this volume and this product mix. If the volume of any or all seeds changes so that the relative proportions of the different seeds change, then the total costs using these figures would be different than computing them from the raw data. For instance, consider a case where the volume of crimson clover is cut in half and the other seeds remain at their former level. If the total annual costs per ton are taken directly from Table 6, total annual costs would be $34, 288. 80 for the field run allocation: $34, 566. 40 for the clean seed allocation; and $34, 526. 40 for the cleaning hours allocation. This compares with $35, 835. 24 as computed by taking the total of fixed costs and adding to that the variable costs incurred by each seed. In other words, each of the allocation methods understated total annual costs by $1546. 44, $1268. 84, and $1308. 84 respectively.

The point is that the fixed cost functions of the various seeds are not independent of each other, but depend on the relative proportions between the various seeds. Ideally, costs per ton should be recomputed whenever product mix changes. In practice, if the processor accepts seed in the proportions offered by the growers, this would not be feasible, since it could not be done in advance of the cleaning season. Another case would be when a product mix objective is set prior to the season. In this case the processor would need an active procurement stage which would increase costs. Even this strategy breaks down unless the goal is achieved.

An alternative to this would be to have cleaning charges set at some level above actual costs i. e., compute the costs for a range of expected volumes and set cleaning charges on the basis of the highest expected costs. This provides protection against volume reductions and adverse product mix changes. The extent to which this is possible would depend on the competitive structure of the processing industry, as well as the bargaining strength of processors in relation to that of growers.

Consideration of other alternatives would extend this study far into the complex subject of pricing in the seed processing industry. This is not only beyond the scope of this study but the inadequacy of data makes such a study unlikely to succeed. It will be more fruitful to examine some of the relationships between product mix and total annual cost.

Product Mix and Annual Costs

Several models were synthesized to demonstrate the interrelationship of product-mix and annual costs. The basic construction of these models is that explained in Chaper III on volume-cost relations. Physical requirements were budgeted and prices applied. The basic model was arbitrarily selected as a plant specializing in cleaning annual ryegrass. Any other commodity could have been selected. However, there are existing plants which are similar to the basic plant in volume and specialization.

The second model considered equal proportions of annual and perennial ryegrass, since the two are so similar in handling characteristics. Alta fescue, crimson clover, chewings fescue, red fescue, bentgrass, and merion bluegrass were then introduced into the model, one at a time. Total volume, within any one volume level, was held constant. Each new seed which entered in after perennial ryegrass, was introduced at a volume which represented ten percent of the total volume of the model.[1] The proportions of each seed for eight product mixes considered are shown in Table 7.

The analytical procedure was followed for all five handling methods at three volume levels. When a new seed was entered into the model, the physical requirements were altered according to whether that seed took more or less of a particular input than the ryegrass it replaced. Labor requirements and operating hours were adjusted to conform to the new product mix. Cleaning line

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[1] An alternative approach would have been to add each seed as an increment to the volume of ryegrass in the basic models. See Appendix III for discussion of that approach.

capacities, storage facilities and special equipment requirements were also considered.

Storage Facilities

The additions of alta fescue and crimson clover to the basic model required no increase in field run storage facilities. This is true because their harvesting seasons are earlier than ryegrass and thus the original storage facilities suffice. It was assumed that these two seeds are marketed in early summer so that no conflict arises in clean seed storage facilities.

The overlapping of ryegrass cleaning season and fine fescue receiving season requires that additional storage be added when chewings and red fescue are entered into the model. Storage requirements are further increased by the additions of bentgrass and merion bluegrass.

Storage requirements may be estimated by the following formula:

$$W = (T_r - T_c)\ S,$$

Where W is the warehouse space required; T_r is the tons of a particular seed received (clean basis); T_c is the tons (clean basis) of a particular seed cleaned during the receiving season; and S is the storage requirement per ton of seed (Table 8).

Table 7. Product Mix Proportions Used in Estimating Costs For Multiple Product Seed Processing Plants

Kind of Seed	Product Mix 1	2	3	4	5	6	7	8
	(Percentage of Total Volume)							
Annual ryegrass	100	50	45	40	35	30	25	20
Perennial ryegrass	---	50	45	40	35	30	25	20
Alta fescue	---	--	10	10	10	10	10	10
Crimson clover	---	--	--	10	10	10	10	10
Chewings fescue	---	--	--	--	10	10	10	10
Red fescue	---	--	--	--	--	10	10	10
Bentgrass	---	--	--	--	--	--	10	10
Merion bluegrass	---	--	--	--	--	--	--	10
Totals	100	100	100	100	100	100	100	100

Table 8. Total Storage Requirements Per Ton of Clean Seed Output for Specified Seeds and Five Handling Methods.[a]

Kind of Seed	Method of Handling				
	A sq. ft.	B sq. ft.	C bu.	D bu.	E boxes
Annual Ryegrass	15.28	9.80	92.6	92.6	1.39
Perennial Ryegrass	15.28	9.80	92.6	92.6	1.39
Alta fescue	16.24	10.41	102.2	102.2	1.48
Crimson clover	18.57	11.90	57.1	57.1	1.24
Chewings fescue	20.74	13.30	156.9	156.9	2.67
Red fescue	20.74	13.30	156.9	156.9	2.67
Bentgrass	22.31	14.30	105.8	105.8	1.40
Merion bluegrass	39.08	25.05	222.2	222.2	4.44

[a] Based on the data in Table 1 above, and reference material (7) Tables 1 and 2, page 5.

Cleaning Line Capacities

The effect of different output proportions for the various seeds was to lengthen the operating season for the cleaning line. This is so because ryegrasses have a higher output rate than any of the six other seeds considered (Table 1). The increase in total cleaning hours would have been even greater had the total volume been increased by the amount of each seed added, rather than being held constant.

An upper limit of 6000 hours per year was placed on the cleaning season. This is less than the total number of hours in a year (8760), but it allows for holidays, vacations, and unpredictable breakdown of the machinery. This 6000 hour maximum was not limiting to the product mixes, except at the 5000 ton level of annual volume. When merion bluegrass was added to the product mix, total cleaning hours exceeded the 6000 hour limit. The product mix could have been altered as to the proportions of the various seeds, but the results would not then have been consistent with the other models. The excess over 6000 hours was charged as overtime at 1.5 times the normal hourly wage of $1.75.

The optimum product mix to utilize all available hours in the cleaning season, within the constraints of available storage, receiving facilities, and other considerations can be solved for the individual warehouse, given the costs and returns structure for that warehouse. More general solutions are possible, but convey little information of value to the industry. Hence they are not attempted here.

Special Cleaning Equipment

In addition to adjustments in operating hours to correspond to differences in cleaning rates of the various seeds, the cleaning facilities were modified by the addition of special purpose machines. Alta fescue requires no additional machines. Crimson clover requires the addition of specific gravity separation machinery. A debearder for each cleaning line was added to use on chewings and red fescue and bentgrass to break up "doublets". Doublets are two or more seeds which remain attached to each other and would be rejected from the clean seed if not separated. Merion bluegrass utilizes the specific gravity separator(s) and the debearder(s) in addition to the regular line.

Multiple Product Processing Costs

Seeds were added to the initial single-product plant in ascending order in terms of their processing cost per ton. That is, if each seed was processed in a single-product plant, alta fescue would be more expensive to process than ryegrass, crimson clover would be more costly than alta fescue and so forth. Differences in processing costs between the various seeds are caused by several factors. Among these are: different densities; different shapes; differences in texture of seed coat; difference in kind and amount of contaminants. All these affect handling characteristics and therefore labor and equipment requirements and cleaning capacity on a

Table 9. Estimated Total Annual Cost per Ton of Clean Seed Output for Various Product Mixes at Specified Annual Outputs by Seed Handling Method

Annual output (tons)	Handling Method	Product Mix 1	2	3	4	5	6	7	8
		(Dollars per ton clean seed output)							
1000	A	16.96	16.97	17.53	18.98	20.94	22.53	24.08	28.82
	B	16.18	16.21	16.61	17.90	19.66	21.07	22.49	26.85
	C	17.32	17.35	17.62	18.78	20.50	21.96	23.14	27.52
	D	17.64	17.66	17.91	19.05	20.75	22.19	23.36	27.71
	E	16.62	16.63	16.78	17.60	19.78	21.42	23.02	28.79
2500	A	11.92	11.95	12.44	13.66	14.92	15.94	16.89	19.56
	B	11.63	11.66	12.08	13.28	14.52	15.48	16.46	19.31
	C	13.40	13.43	13.67	14.63	15.88	16.88	17.74	20.93
	D	13.49	13.50	13.73	14.69	15.94	16.91	17.77	20.96
	E	14.14	14.14	14.29	14.64	15.99	17.06	17.98	21.33
5000	A	10.20	10.23	10.56	11.44	13.10	14.39	15.63	19.67
	B	10.23	10.26	10.54	11.38	12.91	14.18	15.42	19.48
	C	10.30	10.33	10.54	11.29	12.95	14.49	15.85	19.94
	D	10.17	10.18	10.37	11.13	12.79	14.20	15.56	19.66
	E	10.36	10.36	10.51	11.16	13.12	14.76	15.91	20.28

given set of machinery.

Cost estimates were computed for each of eight product mixes at the three volume levels -- 1000, 2500, and 5000 tons (Table 9). This procedure was followed for each of the five handling methods discussed in Chapter III.

From Table 9 it can be seen that Method B is the least costly for all product mixes except mix 4 at the lowest volume level. When volume is increased to 2500 tons, Method E becomes the least costly for all product mixes. Method D becomes the least costly method of handling seed in all product mixes at the 5000 ton level of annual volume.

It will be noted that the cost spectrums for product mix 8 at level three overlap those at level two. This is true since overtime charges were necessary in order to process 5000 tons of these seeds within the limits of the maximum cleaning season (120 hours per week, 50 weeks).

Summary

This chapter has been concerned with cost relationships in multiple product seed processing warehouses. The problem of allocation of joint costs was explored, and several alternative methods of allocations were presented.

Because of the joint cost problem, cost estimates for eight product mixes were shown as composites of the annual cost per ton for the total volume. No estimates were computed for the annual cost per ton of the individual seeds.

For each of the eight product mixes, cost estimates were developed for three volume levels and five handling methods. The procedure for each volume level was to hold total volume fixed and introduce the seeds one by one, replacing the ryegrass in the original model at the rate of 10 percent of total volume.

Within each volume level, and for each of the eight product mixes, estimates were developed and compared for five handling methods. The results did not differ materially from those obtained for a single product warehouse (Chapter 3). It was pointed out, however, that when output is held constant, input volume is influenced by differences in density and cleanout. As ryegrass was replaced by the other seeds, the input volume was a major factor in determining the least cost handling method for a particular product mix.

Chapter VI

IMPLICATIONS OF THE STUDY TO THE OREGON SEED PROCESSING INDUSTRY

Review of Findings

It was the purpose of this study to develop data relating to comparative costs of different handling methods, annual volumes, and product mixes in seed processing warehouses. The procedure was to synthesize cost estimates from economic and engineering data obtained through time and motion studies, work sampling, production studies, and plant record data. Supporting data were obtained through interviews with plant managers, building contractors, equipment salesmen, and the Oregon State Tax Commission.

Briefly, the analysis showed that substantial economies to size exist in the seed industry.

Though not identical, the cost estimates developed for five handling methods were sufficiently similar in magnitude to make annual costs a doubtful criterion for selection among methods.

Aggregate total annual cost in multiple product plants will be greater than in single product plants. However, the sharing of joint costs can effect savings in cost per ton of output of the different seeds making up the product mix. Thus the fixed cost functions of the different seeds are not independent.

These results will be interpreted for the Oregon seed processing industry. Before drawing such implications from these results, it is desirable to describe some of the known characteristics of the industry. This will put the results into proper perspective. The discussion which follows draws heavily on previously published materials from this project (8).

Review of Seed Processing Industry

Production

The seed producing region in western Oregon lies in the Willamette Valley. It covers an area of approximately 3600 square miles (Figure 2). This region has a mild winter climate with moist springs and generally dry summers. These are ideal conditions for seed production: Oregon is the source of about 25 percent of the nation's supply of turf, forage, and cover crop seeds, most of which is produced in the Willamette Valley (15, 20, 21).

Within this seed producing region, production of certain seed crops has become localized to some extent. The most important crops in each county are indicated in Figure 2. All counties included in the region produce several different kinds of seed, so that the local seed production areas tend to overlap. For example, Linn county produces 75 percent of the ryegrass seed, but some ryegrass is produced in each of the other counties (15).

Processing

The dots in Figure 2 indicate the approximate number and dispersal of plants throughout the valley. The exact number of seed processing warehouses in the region is unknown. It is estimated that there are at least 350. Approximately 100 of these are commercial warehouses, with the remainder being operated by seedgrowers. Over two-thirds of the grower-operated warehouses process only the seed of the owner. These are designated as farm plants. The others process some quantity of seed on a custom basis in addition to that of the owner. These are designated as semi-commercial warehouses.

The average annual volume of all plants is about 750,000 pounds clean seed. Farm plants range in size from less than 50,000 pounds to over one million pounds, averaging about 200,000 pounds per year. Semi-commercial plant sizes lie in about the same range, but have a mean volume of around 450,000 pounds per year. Commercial plants average about one-and-one-half million pounds per year, ranging in size from less than 50,000 pounds to over five million.

Willamette Valley seed plants are grouped in several size classifications in Table 10. The table shows the percentage of warehouses falling in each size group and the percentage of total production which is processed by each group. The larger plants process the majority of the seed, even though they represent only a small percentage of the total number of plants. On the other hand, large number of small plants process only a minor percentage of total production.

Some plants process only one or two different kinds of seed, while others clean as many as fifteen. There appears to be no relationship between plant size in terms of annual volume and the number of different seeds processed by any one warehouse, though the commercial plants as a whole tend to have a greater variety. Geographical location within the valley (with respect to local seed production patterns) appears to be the major factor which has bearing on the kinds of seed which a plant processes.

A common characteristic of Oregon seed processing warehouses is the coexistence of the seed processing enterprise with one or more other enterprises. In the case of the farm plants, they present an example of vertical integration of seed growing with seed processing. The same is true of the semi-commercial warehouses.

Table 10. Percentage of Warehouses and Volume of Clean Seed Processed by Specified Volume

Season's Volume	Percentage of Warehouses	Percentage of Total Volume
(pounds)	(percent)	(percent)
Under 50,000	19	1
50,000 to 100,000	9	1
100,001 to 200,000	16	3
200,001 to 500,000	21	10
500,001 to 1,000,000	11	11
1,000,001 to 2,000,000	14	26
Over 2,000,000	10	48
Total	100	100

Source: (8) Table 2, p. 4.

Few if any of the commercial warehouses have integrated seed growing with their processing operations. Rather, they have undertaken such enterprises as the sale of fertilizers, herbicides, and insecticides; cleaning and handling of cereal and feed grains; and the manufacture of livestock and poultry feeds. In many instances, it is the seed processing which is or was originally supplementary to one or more other enterprises.

Although over 80 percent of the warehouses store field run-seed in bulk storage bins or pallet boxes, over one-third of the plants use handling methods which require manual handling of the field-run seed into or out of storage (Table 11). A small percentage do not use the handling methods described in Chapter III. Only about 15 percent use a fork-lift truck in handling clean seed. Size of plant (annual volume) and type of plant -- farm, semi-commercial, or commercial -- has no discernible bearing on seed handling methods, except the farm plants have a lower percentage using fork-lift trucks.

Marketing

Very little published information is available on seed marketing in Oregon. The following discussion stems mainly from personal observations of the author. It is a composite of bits and pieces of information gleaned from conversations with seed growers, dealers and processors, from attendance at meetings of seed industry people, from discussions with county extension agents and Mr. Ray Teal, seed marketing extension specialist, Oregon State University, and from the survey of seed processing warehouses.

Table 11. Seed Handling Methods Used by Seed Processing Warehouses: Percentages of Warehouses Using Each Method, Willamette Valley, Oregon, 1957 [a]

	32 Farm plants	13 Semi-commercial plants	25 Commercial plants
	(percent)	(percent)	(percent)
1. Both field-run and clean seed handled in sacks moved by hand truck (A).	25	15	12
2. Field-run seed stored in bins, moved to line by conveyors and gravity flow; sacks of clean seed moved by hand truck (C).	60	39	40
3. Same as (2) above, except sacks of clean seed moved by fork-lift truck (D).	--	--	4
4. Field-run seed stored in boxes, moved to line by fork-lift truck; sacks of clean seed moved by fork-lift truck (E).	--	8	16
5. Part of field-run seed stored in bins, part stored in boxes; moved to line by gravity flow and conveyors, and by fork-lift truck. Clean seed moved by fork-lift truck (D, E).	--	15	8
6. Field-run seed stored in bins, removed by gravity or conveyor into hand cart and thence to line; sacks of clean seed moved by hand truck.	9	15	16
7. Same as (6) above, except sacks of clean seed moved by fork-lift truck.	--	--	4
8. Others	6[b]	8[c]	--
	100	100	100

[a] Capital letters in parenthesis indicate conformity of the described method with one or more of the handling methods considered in Chapter III.

[b] All seed handled in bulk.

[c] Field-run seed in large wheeled boxes. Clean seed in bags handled by hand truck.

Source: 8, Table 5, p. 11.

Seed marketing channels are summarized in the following tabulation:

Grower - Local Dealer - Retailer
Grower - Local Dealer - Wholesaler - Retailer
Grower - Local Dealer - Broker - Retailer
Grower - Local Dealer - Broker - Wholesaler - Retailer
Grower - Local Dealer - Local Dealer - .....

Sales to local dealers are the most important method of selling used by farm and semi-commercial processors.[1] For the commercial processors, sales to local dealers are of equal importance to sales through the plant's parent company or subsidiary outlets. Since the local dealers are actually the larger commercial warehouses, the majority of the seed passes through the hands of the commercial processors.

The majority of farm plants often contract for sale at some time prior to cleaning, usually after harvest. These contracts are with local dealers, and usually call for future delivery of a specified kind and quantity of seed. However, in some cases the quantity may be determined at a later date.

Direct sales to seed dealers in other areas are practiced by a small number of semi-commercial and commercial processors. These are generally the larger processors, so that this is

[1] Local dealers are commercial processors in most cases. They buy the seed from their customers after it is cleaned.

an important method in terms of the volume sold.

Commercial warehouses also sell seed through parent companies or subsidiary outlets, as well as directly to retailers. A smaller volume passes through the hands of brokers and speculators.

Buying activity for the current crop may begin as early as the start of the harvest season. This takes the form of contracting for future delivery. Specifications of such a contract are usually rather loose. That is, the price may be set at that time, but the quantity may be left open. The quantity may refer to the production from a given acreage. When a quantity of seed is specified, it is usually set at a level which understates the grower's expected production, and provision may be made for any excess.

More commonly, contracts may be entered into between grower and dealer after harvest but prior to cleaning. Whether the contract is made before or after harvest, no sale is consummated before the seed is in cleaned condition and analysis results are known. Advances may be made to the grower prior to this.

There are no data available which would indicate how much of the volume of seed is sold under contract as described above. The importance of contract sales should not be underestimated, however. For the processor, it provides a means of assuring himself of seed to process. For the seed grower it provides an assured market for his output. It is also a convenience for the grower who processes his own seed to have a ready market.

Relation of Findings to Seed Industry

It was demonstrated that there are considerable economies to size (in terms of annual volume) in seed processing. The number and size of plants in the Willamette Valley indicate that these economies are not being taken advantage of by the industry. If the industry consisted only of plants of the size of the largest model presented here (5000 tons), there would need to be only around 20 plants to process the valley's annual production (based on 1960 production of 200, 894, 000 pounds (15).

Twenty warehouses would represent a dispersal of one plant for each 180 square miles in the production area. This is opposed to the present situation in which there is approximately one plant for each 10 square miles. It is thus apparent that any increase in average size of warehouse accompanied by a decrease in number of warehouses would increase transportation costs for the field-run seed. The hypothesis that the result would be a net decrease in total processing costs for Oregon's seed production can only be tested by further research. Hence no comment will be tendered here on the subject.

The importance of local production patterns on warehouse product mixes would be minimized if larger plants were the order of the day. Warehouse managers could initiate an active procurement policy directed toward some product mix goal. The costs of such a procurement policy could be defrayed by savings in processing costs arising out of the larger volume.

There are also problems connected with larger volumes and fewer plants. The increase in field-run transportation costs mentioned above is one example. Another problem is the effects of variations in annual seed production. Variations arising from natural conditions -- climate, insects, disease -- and variations due to market conditions may be either general or specific in their effects. That is, they may affect all or only a few seed crops. General variations would be shared by all seed processing warehouses, whereas specific variations might be confined to only a small segment of the industry. Integration or combination of seed processing with other enterprises would provide some income protection against general variations.

Variations which are specific to a locality or only a few kinds of seed present a different sort of problem from more general variations. Diversification of enterprises would provide some income protection. Warehouses specializing in seed processing would require an active procurement policy if they wished to maintain their volume or product mix. The success of this policy would depend on how many warehouses were competing for a particular kind of seed, and also on the relative bargaining strength of the competitors.

An active procurement policy would have to be based on the individual warehouse manager's knowledge of costs and returns at various volume levels and for various product mixes.

Past experience in warehouse operation might provide the manager with sufficient knowledge to set product mix and volume goals. However, a solution arrived at by formal budgeting or programming would be expected to strengthen knowledge gained by experience. Budgeting and programming are means of considering alternative combinations of inputs and selecting that combination which is least costly or most profitable under given conditions of costs and returns, i. e., the optimum solution.

Management, to solve for an optimum product mix and volume level, would need data on supplies of various kinds of seed; expected return for processing each kind of seed (cleaning charges per unit of seed less any procurement costs); supplies of inputs such as labor, storage space, cleaning season hours, receiving season hours, shipping season hours; costs of the various inputs (per unit of seed); and the input-output coefficients of the various inputs.

Note that the data do not include costs and returns from marketing the seeds. These should be included if the warehouse operator intends to participate in the marketing of his customer's seed. If the marketing problem is not kept separate from the processing operations, however, it would tend to disguise the true cost and return picture of the processing operations.

A processor could use the knowledge gained from a programmed solution to aid in setting up contracts with growers to supply his seed requirements. Contracting is a device which is more powerful and more flexible for large processors than for small ones. Conceivably, large processors could contract in advance and on a continuing basis for the total quantity and kinds of seed they would process each year, similar to what is being done currently in vegetable processing.

Market conditions would of course play an important role in such contracting. Contracts would transfer the risks (and the benefits) of unforeseen price changes from the producer to the processor. Large processors, as first handlers, would be in position to deal directly with retailers and wholesalers. They would thus be sensitive to changing market conditions and could adjust their operations accordingly.

Barriers to the Evolution of Large Plants

Expansion in numbers of grower-operated warehouse was concurrent with expansion of seed production during and after World War II. Apparently, commercial warehouse operators did not or were not able to expand their facilities to accommodate the increased production. This, simultaneous with a change to bulk handling methods, created a bottleneck at the commercial warehouses. Delays in harvesting due to inadequate receiving facilities were experienced. To avoid such delays, many growers set up their own processing facilities. Another factor which contributed to the establishment of grower-operated warehouses was a desire on the part of many growers to have their seed cleaned quickly to provide flexibility in marketing their product.

In many instances, farm plants were set up in existing buildings, such as unused horse barns or dairy barns. Investment in facilities was thus minimized. Major outlays were for cleaning and handling equipment. In most cases, these farm plants utilized labor of the operator and his family, or labor which was already hired for farm operations. The seed processing enterprise provides a means of utilizing labor which at this time of year (fall and winter) might otherwise be unemployed.

Grower operated seed processing warehouses are at present using depreciated buildings and facilities which were purchased at a much lower price level than now exists. The grower's slack season labor supply is often not charged against the processing enterprise. Thus they tend to view their processing costs as only those cash costs incurred for operation of the machinery, repairs, and supplies. These costs are invariably less than what the grower would have to pay to have his seed crop cleaned at a commercial warehouse. Even when fixed costs are included, they are based on original investment or its present value, rather than what would be the current replacement cost of the inputs.

The obvious economies to size demonstrated herein provide no economic basis for the existence of grower-operated seed processing warehouses. If they are justified on the basis of their utilizing off-season farm labor, then that justification must include some estimate of the opportunity costs of other alternative uses. If they are justified on the basis of providing flexibility in marketing the seed, then quantification must be made of the costs and benefits of such flexibility. Farm plants can continue to exist within the seed industry only so long as they are not required to replace (or value) their facilities at current replacement costs.

Because seed processing charges have not enjoyed the same upward trend as prices of inputs over the past fifteen years, the same statement can be made about small commercial warehouses not supported by other enterprises.

The present importance of small warehouses in the seed processing industry must not be underestimated. Through the existence of excess capacity in cleaning facilities, they are capable of processing much more seed than they presently process. However, their very existence presents a barrier to evolution of larger plants. On the other hand, the possibility of cost savings (per unit of output) from processing larger volumes, and the fact that marketing channels favor the larger warehouses make it likely that the future trend will be toward larger warehouses.

No great differences were found between estimated costs of the various methods of seed handling. However, there was a slight cost advantage in favor of Method D (bulk receiving, with clean seed handled in bags on pallets). Thus the present trend toward bulk handling of field-run seed and the adoption of more mechanized clean seed handling methods appears likely to continue. This hypothesis is further supported by the shortage of seasonal laborers required for other methods.

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APPENDICES

Appendix I

Equipment Requirements and Estimated Annual Costs for Five Handling Methods and Eight Product Mixes at Three Levels of Annual Volume

Appendix Table 1. Calculation of annual costs for warehouse handling 1000 tons annual ryegrass per year by handtrucks (Method A)

Item	No used	Replacement cost	Annual fixed cost	Annual variable cost	Annual Total cost
Handtrucks	10	500.00	82.50		82.50
Dock plate	2	100.00	16.50		16.50
Truck scale	1	6,026.00	692.99		692.99
24' Sack elevator 3 H P	2	3,200.00	528.00	90.40	618.40
10' Sack elevator 1 H P	1	850.00	140.25	8.56	148.81
Warehouse	10,000	22,500.00	2,362.50		2,362.50
Cleaning line	1	20,169.30	3,325.30	1,764.34	5,089.64
Handling labor	2,406			3,609.00	3,609.00
Cleaning labor	1,600			2,800.00	2,800.00
Subtotal			7,148.04	8,272.30	15,420.34
Misc. & overhead 10%			714.80	827.23	1,542.03
Total		53,345.30	7,862.84	9,099.53	16,962.37
Cost per ton			7.86	9.10	16.96

Appendix Table 1a. Calculation of additional annual costs for a multiple product seed processing warehouse handling 1000 tons per year by hand truck (Method A)

	Product Mix							
Cost Item	1	2	3	4	5	6	7	8
Hand trucks								
Dock plate								
24' sack elevator. 3 H. P.			.53	1.83	3.04	3.03	3.91	13.22
10' sack elevator. 1 H. P.								
Warehouse					118.12	118.12	118.12	590.62
Cleaning line			47.24	857.27	688.02	406.77	390.28	1,608.71
Handling labor		7.50	375.00	375.00	375.00	375.00	375.00	375.00
Cleaning labor			84.00	84.00	595.00	544.00	520.00	1,720.00
Subtotal		7.50	506.77	1,318.10	1,779.18	1,446.92	1,407.31	4,307.55
10% misc. and overhead		.75	50.68	131.81	177.92	144.69	140.73	430.76
Total		8.25	557.45	1,449.91	1,957.10	1,591.61	1,548.04	4,738.31
Additional cost per ton clean seed		.00825	.557	1.45	1.96	1.592	1.548	4.738
Total annual cost per ton clean seed	16.96	16.97	17.53	18.98	20.94	22.53	24.08	28.82

Appendix Table 2. Calculation of annual costs for multiple product seed processing warehouses handling 1000 tons per year by lift truck (Method B).

Item	No. used	Replacement cost	Annual fixed costs	Annual variable costs	Total annual costs
Handtrucks	2	100.00	16.50		16.50
Dock plate	2	300.00	49.50		49.50
Truck scale	1	6,026.00	629.99		629.99
Pallets, 4' X 5'	1,000	3,500.00	453.33		453.33
Warehouses	8,000	18,000.00	1,890.00		1,890.00
Fork lift truck, 4000 lb.	1	5,700.00	940.50	436.72	1,377.22
Cleaning line	1	20,169.30	3,325.30	1,764.34	5,089.64
Handling labor	1,600			2,400.00	2,400.00
Cleaning labor	1,600			2,800.00	2,800.00
Subtotal			7,305.12	7,401.06	14,706.18
10% misc. & overhead			730.51	740.11	1,470.62
Total		53,795.30	8,035.63	8,141.17	16,176.80
Cost per ton clean seed			8.04	8.14	16.18

Appendix Table 2a. Estimated additional costs for cleaning and handling 1000 tons of specified product mixes using pallets and hand trucks (Method B)

Cost Item	Product Mix 1	2	3	4	5	6	7	8
Hand trucks								
Dock plate								
Pallets								45.00
Warehouse					82.69	94.50	141.75	330.75
Fork-lift truck		8.78	2.70	4.72	12.83	13.50	16.10	37.90
Cleaning line			47.24	857.27	688.02	406.76	390.27	1,608.71
Handling labor		22.75	225.00	225.00	225.00	225.00	225.00	225.00
Cleaning labor			84.00	84.00	595.00	544.00	520.00	1,720.00
Subtotal		31.53	358.94	1,170.99	1,603.54	1,283.76	1,293.12	3,967.36
10% misc. and overhead		3.15	35.89	117.10	160.35	128.38	129.31	396.74
Total		34.68	394.83	1,288.09	1,763.89	1,412.14	1,422.43	4,364.10
Additional cost per ton clean seed		.035	.395	1.288	1.764	1.412	1.422	4.364
Total cost per ton clean seed	16.18	16.21	16.61	17.90	19.66	21.07	22.49	26.85

Appendix Table 3. Calculation of annual costs for a seed processing warehouse handling 1000 tons of annual ryegrass per year by bulk and hand truck (Method C)

Item	No. used	Replacement cost	Annual fixed cost	Annual variable cost	Total annual cost
Hand trucks	5	250.00	41.25		41.25
Dock plate	1	50.00	8.25		8.25
Bulk bins (2 X 6 cribbing)	55,560 cu.ft.	22,668.48	2,230.73		2,230.73
Warehouse	7,000 sq. ft.	15,750.00	1,653.75		1,653.75
Receiving setup	1	16,000.00	2,385.60	80.00	2,465.60
Sack elevator, 24', 3 H P	1	1,600.00	264.00	32.50	296.50
Sack elevator, 10', 1 H P	1	850.00	140.25	8.56	148.81
Cleaning line	1	20,169.30	3,325.30	1,764.34	5,089.64
Handling labor	607 mh			1,010.50	1,010.50
Cleaning labor	1,600 mh			2,800.00	2,800.00
Subtotal			10,049.13	5,695.90	15,745.03
10% misc. & overhead			1,004.91	569.59	1,574.50
Total		77,337.78	11,054.04	6,265.49	17,319.53
Cost per ton			11.05	6.27	173.20

Appendix Table 3a. Estimated additional costs for cleaning and handling 1000 tons of specified product mixes using hand truck and bulk bins (Method C)

Cost Item	Product Mix 1	2	3	4	5	6	7	8
Hand truck								
Dock plate								
Bulk bins					168.50	256.77	56.17	517.55
Warehouse								
Receiving set-up			10.00	10.00	10.00	10.00	10.00	10.00
Sack elevator. 24', 3 H. P.								
Sack Elevator. 10', 1 H. P.								
Cleaning line			47.24	857.27	688.02	406.76	390.27	1,608.71
Handling labor		29.10	103.70	103.70	101.90	105.50	92.30	125.30
Cleaning labor			84.00	84.00	595.00	544.00	520.00	1,720.00
Subtotal		29.10	244.94	1,054.97	1,563.42	1,323.03	1,068.74	3,981.56
10% misc. and overhead		2.91	24.49	105.50	156.34	132.30	106.87	398.16
Total		32.01	269.43	1,160.47	1,719.76	1,455.33	1,175.61	4,379.72
Additional cost per ton clean seed		.032	.269	1.160	1.720	1.455	1.176	4.380
Total cost per ton clean seed	17.32	17.35	17.62	18.78	20.50	21.96	23.14	27.52

Appendix Table 4. Calculation of annual costs for a seed processing warehouse handling 1000 tons seed by bulk and lift truck (Method D)

Item	No. used	Replacement cost	Annual fixed costs	Annual variable costs	Total annual costs
Bulk bins	55, 560	22, 668. 48	2, 230. 73		2, 230. 73
Warehouse	6, 000	13, 500. 00	1, 417. 50		1, 417. 50
Receiving setup	1	11, 000. 00	2, 385. 60	80. 00	2, 465. 60
Lift truck	1	5, 700. 00	940. 50	113. 40	1, 053. 90
Dock plate	1	150. 00	16. 50		16. 50
Pallets	500	1, 750. 00	225. 00		225. 00
Ramp, car loading	1	400. 00	42. 00		42. 00
Cleaning line	1	20, 169. 30	3, 325. 30	1, 764. 34	5, 089. 64
Handling labor	400			700. 00	700. 00
Cleaning labor	1, 600			2, 800. 00	2, 800. 00
Subtotals			10, 583. 13	5, 457. 74	16, 040. 87
10% misc. & overhead			1, 058. 31	545. 77	1, 604. 08
Total		80, 337. 78	11, 641. 44	6, 003. 51	17, 644. 95
Cost per ton			11. 64	6. 00	17. 64

Appendix Table 4a. Estimated additional annual costs for cleaning and handling 1000 tons of specified product mixes using lift trucks and bulk bins (Method D)

	Product Mix							
Cost Item	1	2	3	4	5	6	7	8
Bulk bins					168.50	256.77	56.17	517.55
Receiving set-up			10.00	10.00	10.00	10.00	10.00	10.00
Lift truck		2.02				2.02	1.36	14.17
Cleaning line			47.24	857.27	688.02	406.76	390.27	1,608.71
Handling labor		13.50	87.50	87.50	87.50	87.50	87.50	87.50
Cleaning labor			84.00	84.00	595.00	544.00	520.00	1,720.00
Subtotal		15.52	228.74	1,038.77	1,549.02	1,307.05	1,060.53	3,957.93
10% misc. and overhead		1.55	22.87	103.88	154.90	130.70	106.05	395.79
Total		17.07	251.61	1,142.65	1,703.92	1,437.75	1,171.35	4,353.72
Additional cost per ton clean seed		.017	.252	1.143	1.70	1.438	1.171	4.354
Total cost per ton clean seed	17.64	17.66	17.91	19.05	20.75	22.19	23.36	27.71

Appendix Table 5. Calculation of annual costs for seed warehouse handling 1000 tons per year by pallet box and lift truck (Method E)

Item	No. used	Replacement cost	Annual fixed costs	Annual variable costs	Total annual costs
Receivingapron, concrete	1	1,400.00	147.00		147.00
Truck scales	1	6,026.00	692.99		692.99
Pallet box	600	15,000.00	2,720.00		2,720.00
Pallet box storage	4,500	6,750.00	708.75		708.75
Pallets	500	1,750.00	225.00		225.00
Warehouse	5,000	11,250.00	1,181.25		1,181.25
Pallet box dumper	1	750.00	98.25	1.75	100.00
Fork-lift truck	1	5,700.00	940.50	182.92	1,123.42
Cleaning line	1	20,169.30	3,325.30	1,764.34	5,089.64
Handling labor	168			252.00	252.00
Cleaning labor	1,600			2,800.00	2,800.00
Ramp, concrete	1	400.00	42.00		42.00
Dock plate	1	150.00	24.75		24.75
Subtotal			10,105.79	5,001.01	15,106.80
10% misc. & overhead			1,010.58	500.10	1,510.68
Total		69,345.30	11,116.37	5,501.11	16,617.48
Cost per ton clean seed			11.12	5.50	16.62

Appendix Table 5a. Estimated additional annual costs for cleaning and handling 1000 tons of specified product mixes using pallet boxes and fork-lift truck (Method E)

Cost Item	Product Mix 1	2	3	4	5	6	7	8
Receiving apron								
Pallet box				(-127.50)	528.00	400.95	412.00	1,258.12
Pallet box storage				(-65.68)	151.20	114.95	118.12	360.28
Pallets								
Warehouse								
Pallet box dumper					2.00	2.00	2.00	4.00
Fork-lift truck		2.03	2.03	(-.68)	6.08	6.75	2.70	91.80
Cleaning line			47.24	857.27	688.02	406.76	390.27	1,608.71
Handling labor		4.50	4.50		13.50	15.00	6.00	204.00
Cleaning labor			84.00	84.00	595.00	544.00	520.00	1,720.00
Ramp, concrete								
Dock plate, lift truck								
Subtotal		6.53	134.77	747.41	1,983.80	1,490.41	1,451.09	5,246.91
10% misc. and overhead		.65	13.48	74.74	198.38	149.04	145.11	524.69
Total		7.18	148.25	822.15	2,182.18	1,639.45	1,596.20	5,771.60
Additional cost per ton clean seed		.007	.148	.822	2.182	1.639	1.596	5.772
Total cost per ton clean seed	16.62	16.63	16.78	17.60	19.78	21.42	23.02	28.79

Appendix Table 6. Equipment requirements and estimated costs for handling and cleaning 2500 tons annual ryegrass per year by hand trucks (Method A)

Item	No. used	Replacement cost	Annual fixed costs	Annual variable costs	Total annual costs
Hand trucks. 2-wheel	10	500.00	82.50		82.50
Dock plate	2	100.00	16.50		16.50
Truck scales	1	6,026.00	692.99		692.99
10 ft. sack elevator	1	850.00	140.25	21.40	161.65
24 ft. sack elevator	2	3,200.00	528.00	222.20	750.20
Warehouse	1,500 sq. ft.	33,750.00	3,543.75		3,543.75
Cleaning line	2	40,338.60	6,650.60	4,410.85	11,061.45
Handling labor	2,517 hrs.			3,775.50	3,775.50
Cleaning labor	4,000 hrs.			7,000.00	7,000.00
Subtotals			11,654.59	15,429.95	27,084.54
10% misc. & overhead			1,165.46	1,543.00	2,708.45
Totals		84,764.60	12,820.05	16,972.95	29,792.99
Cost per ton clean seed			5.13	6.79	11.92

Appendix Table 6a. Estimated additional annual costs for cleaning and handling 2500 tons of specified product mixes using hand trucks (Method A)

	Product Mix							
Cost Item	1	2	3	4	5	6	7	8
Hand trucks. 2-wheel								
Dock plate								
10 ft. sack elevator								
24 ft. sack elevator			1.35	4.65	7.52	7.58	9.78	33.04
Warehouse				36.25	118.12	118.12	118.12	118.12
Cleaning line			118.10	1,771.95	1,597.46	1,016.92	975.70	4,021.78
Handling labor		73.50	789.50	750.00	745.50	840.00	762.00	94.50
Cleaning labor			210.00	210.00	393.75	329.00	301.00	1,799.00
Subtotal		73.50	1,118.95	2,772.85	2,862.35	2,311.62	2,166.60	6,066.44
10% misc. and overhead		7.35	111.90	277.28	286.24	231.16	216.66	606.64
Total		80.85	1,230.85	3,050.13	3,148.59	2,542.78	2,383.26	6,673.08
Additional cost per ton clean seed		.032	.492	1.220	1.259	1.017	.953	2.669
Total cost per ton clean seed	11.92	11.95	12.44	13.66	14.92	15.94	16.89	19.56

Appendix Table 7. Equipment requirements and estimated costs for handling and cleaning 2500 tons annual ryegrass per year by pallet fork-lift truck (Method B)

Item	No. used	Replacement cost	Annual fixed costs	Annual variable costs	Total annual costs
Hand trucks. 2-wheel	2	100.00	16.50		16.50
Dock plate	2	300.00	49.50		49.50
Truck scales	1	6,026.00	692.99		692.99
Pallets. 4' X 5'	1,800	6,300.00	816.00		816.00
Warehouse	10,000	22,500.00	2,362.50		2,362.50
Fork lift truck. 4000 lb.	1	5,700.00	940.50	1,091.80	2,032.30
Cleaning line	2	40,338.60	6,650.60	4,410.85	11,061.45
Handling labor	1,600			2,400.00	2,400.00
Cleaning labor	2,000			7,000.00	7,000.00
Subtotal			11,528.59	14,902.65	26,431.24
10% misc. & overhead			1,152.86	1,490.26	2,643.12
Total		81,264.60	12,681.45	16,392.91	29,074.36
Cost per ton clean seed			5.07	6.56	11.63

Appendix Table 7a. Estimated additional annual costs for cleaning and handling 2500 tons of specified product mixes using fork-lift truck and pallets (Method B)

	Product Mix							
Cost Item	1	2	3	4	5	6	7	8
Hand trucks, 2-wheel								
Dock plate								
Pallets, 4' X 5'				112.50			112.50	
Warehouse					118.12	118.12	118.12	118.12
Fork-lift truck, 4000 lb.		21.95	6.75	11.80	32.08	33.74	40.26	94.74
Cleaning line			118.10	1,771.95	1,597.46	1,016.92	975.70	4,021.78
Handling labor		48.75	615.00	625.00	671.25	675.00	690.00	210.00
Cleaning labor			210.00	210.00	393.75	329.00	301.00	1,799.00
Subtotal		70.70	949.85	2,731.25	2,812.66	2,172.78	2,237.58	6,243.64
10% misc. and overhead		7.07	94.98	273.12	281.27	217.28	223.76	624.36
Total		77.77	1,044.83	3,004.37	3,093.93	2,390.06	2,461.34	6,868.00
Additional cost per ton clean seed		.031	.418	1.202	1.237	.956	.984	2.747
Total cost per ton clean seed	11.63	11.66	12.08	13.28	14.52	15.48	16.46	19.31

Appendix Table 8. Equipment requirements and estimated costs for handling and cleaning 2500 tons annual ryegrass per year by bulk and hand truck (Method C)

Item	No. used	Replacement cost	Annual fixed costs	Annual variable costs	Total annual costs
Hand trucks. 2-wheel	5	250.00	41.25		41.25
Dock plate	1	50.00	8.25		8.25
Bulk bins	120,380	49,115.04	4,829.65		4,829.65
Warehouse	9,000 sq.ft	20,250.00	2,126.25		2,126.25
Receiving setup	1	20,416.00	3,043.24	102.83	3,146.07
24 ft. sack elevator	2	3,200.00	528.00	81.25	609.25
10 ft. sack elevator	1	850.00	140.25	21.40	161.65
Cleaning line	2	40,338.60	6,650.60	4,410.85	11,061.45
Handling labor	917 mh			1,475.50	1,475.50
Cleaning labor	2,000 mh			7,000.00	7,000.00
Subtotal			17,367.49	13,091.83	30,459.32
10% misc. & overhead			1,736.75	1,309.18	3,045.93
Total		134,469.64	19,104.24	14,401.01	33,505.25
Cost per ton clean seed			7.64	5.76	13.40

Appendix Table 8a. Estimated additional annual costs for cleaning and handling 2500 tons of specified product mixes using bulk and hand truck (Method C)

	Product Mix							
Cost Item	1	2	3	4	5	6	7	8
Hand trucks, 2-wheel								
Dock plate								
Bulk bins					644.93	644.93	462.40	1,299.88
Warehouse								
Receiving set-up				25.71	25.71	25.71	25.71	25.71
24 ft. sack elevator								
10 ft. sack elevator								
Cleaning line			118.10	1,771.95	1,597.46	1,016.92	975.70	4,021.78
Handling labor		73.50	215.50	175.00	170.50	265.00	187.00	94.50
Cleaning labor			210.00	210.00	393.75	329.00	301.00	1,799.00
Subtotal		73.50	543.60	2,182.66	2,832.35	2,281.56	1,951.81	7,240.87
10% misc. and overhead		7.35	54.36	218.27	283.24	228.16	195.18	724.09
Total		80.85	597.96	2,400.93	3,115.59	2,509.72	2,146.99	7,964.96
Additional cost per ton clean seed		.032	.239	.960	1.246	1.003	.859	3.186
Total cost per ton clean seed	13.40	13.43	13.67	14.63	15.88	16.88	17.74	20.93

Appendix Table 9. Equipment requirements and estimated costs for handling and cleaning 2500 tons annual ryegrass per year by bulk and fork-lift truck (Method D)

Item	No. used	Replacement cost	Annual fixed costs	Annual variable costs	Total annual costs
Bulk bins	120, 380	49, 115. 04	4, 829. 65		4, 829. 65
Warehouse	6, 500	14, 850. 00	1, 559. 25		1, 559. 25
Receiving setup	1	20, 416. 00	3, 043. 24	102. 83	3, 146. 07
Fork-lift truck, 4000 lb.	1	5, 700. 00	940. 50	222. 75	1, 163. 25
Dock plate	1	150. 00	24. 75		24. 75
Pallets, 4' X 5'	1, 250	4, 375. 00	562. 50		562. 50
Loading ramp, concrete	1	1, 400. 00	42. 00		42. 00
Cleaning line	2	40, 338. 60	6, 650. 60	4, 410. 85	11, 061. 45
Handling labor	400			700. 00	700. 00
Cleaning labor	4, 000			7, 000. 00	7, 000. 00
Subtotal			17, 652. 49	12, 436. 43	30, 088. 92
10% misc. & overhead			1, 765. 25	1, 243. 64	3, 008. 89
Total		136, 344. 64	19, 417. 74	13, 680. 07	33, 097. 81
Cost per ton clean seed			7. 77	5. 47	13. 24

Appendix Table 9a. Estimated additional annual costs for cleaning and handling 2500 tons of specified product mixes using bulk and lift truck (Method D)

Cost Item	Product Mix 1	2	3	4	5	6	7	8
Bulk bins					644.93	644.93	462.40	1,299.88
Warehouse								
Receiving set-up			25.71	25.71	25.71	25.71	25.71	25.71
Fork lift truck, 4000 lb.		4.05	1.35	1.35	1.35	2.70	2.70	28.35
Dock plate								
Pallets. 4' X 5'								
Loading ramp, concrete								
Cleaning line			118.10	1,771.95	1,597.46	1,016.92	975.70	4,021.78
Handling labor		10.50	178.00	178.00	178.00	182.00	182.00	73.50
Cleaning labor			210.00	210.00	393.75	329.00	301.00	1,799.00
Subtotal		14.55	533.16	2,187.01	2,841.20	2,201.26	1,949.51	7,248.22
10% misc. and overhead		1.45	53.32	218.70	284.12	220.13	194.95	724.82
Total		16.00	586.48	2,405.71	3,125.32	2,421.39	2,144.46	7,973.04
Additional cost per ton clean seed		.006	.234	.962	1.250	.969	.858	3.189
Total cost per ton clean seed	13.24	13.25	13.48	14.44	15.69	16.66	17.52	20.71

Table 10. Equipment requirements and estimated costs for handling and cleaning 2500 tons annual ryegrass per year by pallet boxes and lift truck (Method E)

Item	No. used	Replacement cost	Annual fixed costs	Annual variable costs	Total annual costs
Receiving apron, concrete	1	1,400.00	147.00		147.00
Pallet box, plywood	1,800	45,000.00	7,425.00		7,425.00
Truck scale	1	6,026.00	692.99		692.99
Pallet box storage shed	13,500	20,250.00	2,126.25		2,126.25
Pallets, 4' X 5'	1,250	4,375.00	566.67		566.67
Warehouse	6,600	14,850.00	1,559.25		1,559.25
Pallet box dumper	1	750.00	98.25	4.75	103.00
Fork lift truck, 4000 lb.	1	5,700.00	940.50	457.30	1,397.80
Cleaning line	2	40,338.60	6,650.60	4,410.85	11,061.45
Handling labor- Cleaning labor-	4,000	7,000.00		7,000.00	7,000.00
Ramp, concrete	1	400.00	42.00		42.00
Dock plate	1	150.00	24.75		24.75
Subtotal			20,273.26	11,872.90	32,146.16
10% misc. & overhead			2,027.33	1,187.29	3,214.62
Total		146,239.60	22,300.59	13,060.19	35,360.78
Cost per ton clean seed			8.92	5.22	14.14

Appendix Table 10a. Estimated additional annual costs for cleaning and handling 2500 tons of specified product mixes using pallet boxes and lift truck (Method E)

Cost Item	Product Mix 1	2	3	4	5	6	7	8
Receiving apron, concrete								
Pallet box, plywood				(-899.25)	825.00	825.00	618.75	1,208.70
Pallet box storage shed				(-296.49)	236.25	236.25	177.19	354.38
Warehouse								
Pallet box dumper					5.00	5.00	4.50	10.00
Fork-lift truck. 4000 lb.		5.08	5.08	(-1.70)	15.20	16.85	6.75	229.50
Cleaning line			118.10	1,771.95	1,597.46	1,016.92	975.70	4,021.78
Handling labor Cleaning labor			210.00	210.00	393.75	329.00	301.00	1,799.00
Ramp, concrete								
Dock plate								
Subtotal		5.08	333.18	784.51	3,072.66	2,429.02	2,083.89	7,623.36
10% misc. and overhead		.51	33.32	78.45	307.27	242.90	208.39	762.34
Total		5.59	366.50	862.96	3,379.93	2,671.92	2,292.28	8,385.70
Additional cost per ton clean seed		.002	.147	.345	1.352	1.069	.917	3.354
Total cost per ton clean seed	14.14	14.14	14.29	14.64	15.99	17.06	17.98	21.33

Appendix Table 11. Equipment requirements and estimated costs for handling and cleaning 5000 tons annual ryegrass per year by handtruck (Method A)

Cost Item	No. used	Replacement cost	Annual fixed costs	Annual variable costs	Total annual costs
Hand truck, 2-wheel	10	500.00	82.50		82.50
Dock plate	2	100.00	16.50		16.50
Truck scales	1	6,026.00	692.99		692.99
24 ft. sack elevator	2	3,200.00	528.00	434.44	962.44
10 ft. sack elevator	1	850.00	140.25	42.80	183.05
Warehouse	30,000	76,500.00	7,087.50		5,197.50
Cleaning line	3	60,507.90	9,975.90	8,821.70	18,797.60
Handling labor	3,034			4,551.00	4,551.00
Cleaning labor	8,000			14,000.00	14,000.00
Subtotal			18,523.65	27,849.94	46,373.59
10% misc. & overhead			1,852.37	2,784.99	4,637.36
Total		147,683.90	20,376.02	30,634.93	51,010.95
Cost per ton clean seed			4.07	6.13	10.20

Appendix Table 11a. Estimated additional annual costs for cleaning and handling 5000 tons of specified product mixes using handtruck (Method A)

Cost Item	Product Mix 1	2	3	4	5	6	7	8
Hand truck. 2-wheel								
Dock plate								
24 ft. sack elevator			2.60	9.30	15.04	15.16	20.56	66.08
10 ft. sack elevator								
Warehouse					866.25	173.25	259.88	945.00
Cleaning line			236.20	2,081.40	2,949.72	2,033.85	1,951.40	8,043.55
Handling labor		147.00	831.00	750.00	741.00	930.00	794.00	189.00
Cleaning labor			420.00	420.00	2,992.50	2,703.75	2,609.25	9,111.50
Subtotal		147.00	1,486.20	3,980.70	7,564.51	5,856.01	5,635.09	18,355.13
10% misc. and overhead		14.70	148.62	398.07	756.45	585.60	563.51	1,835.51
Total		161.70	1,634.82	4,378.77	8,320.96	6,441.61	6,198.60	20,190.64
Additional cost per ton clean seed		.032	.327	.876	1.664	1.288	1.240	4.038
Total cost per ton clean seed	10.20	10.23	10.56	11.44	13.10	14.39	15.63	19.67

Appendix Table 12. Equipment requirements and estimated costs for handling and cleaning 5000 tons annual ryegrass per year by pallets and fork-lift truck (Method B)

Cost Item	No. used	Replacement cost	Annual fixed costs	Annual variable costs	Total annual costs
Hand trucks. 2-wheel	2	100.00	16.50		16.50
Dock plate	2	300.00	49.50		49.50
Pallets. 4' X 5'	3,000	10,500.00	1,360.00		1,360.00
Truck scales	1	6,026.00	692.99		692.99
Warehouse	25,000	56,250.00	5,906.25		5,906.25
Fork-lift truck, 4000 lb.	1	5,700.00	940.50	1,350.00	2,290.50
Cleaning line	3	60,507.90	9,975.90	8,821.50	18,797.40
Handling labor	2,255			3,382.50	3,382.50
Cleaning labor	8,000			14,000.00	14,000.00
Subtotal			18,941.65	27,554.00	46,495.65
10% misc. & overhead			1,894.17	2,755.40	4,649.57
Total		139,383.90	20,835.82	30,309.40	51,145.22
Cost per ton clean seed			4.17	6.06	10.23

Appendix Table 12a. Estimated additional annual costs for cleaning and handling 5000 tons of specified product mixes using pallet and fork lift truck (Method B)

Cost Item	Product Mix 1	2	3	4	5	6	7	8
Hand trucks, 2-wheel								
Dock plate								
Pallets, 4' X 5'								
Warehouse					259.88	259.88	259.88	945.00
Fork-lift truck, 4000 lb.		43.88	13.50	23.60	64.16	67.50	81.00	121.50
Cleaning line			236.20	2,801.40	2,949.72	2,033.85	1,951.40	8,043.55
Handling labor		97.50	617.50	592.50	691.50	705.00	720.00	235.00
Cleaning labor			414.75	414.75	2,992.50	2,703.75	2,609.25	9,111.50
Subtotal		141.38	1,281.95	3,832.25	6,957.76	5,769.98	5,621.53	18,456.55
10% misc. and overhead		14.14	128.20	383.22	695.78	577.00	562.15	1,845.66
Total		155.52	1,410.55	4,215.47	7,653.54	6,346.98	6,183.68	20,302.21
Additional cost per ton clean seed		.031	.282	.843	1.531	1.269	1.237	4.06
Total cost per ton clean seed	10.23	10.26	10.54	11.38	12.91	14.18	15.42	19.48

Appendix Table 13. Equipment requirements and estimated costs for handling and cleaning 5000 tons annual ryegrass per year by bulk and hand truck (Method C)

Cost Item	No. used	Replacement cost	Annual fixed costs	Annual variable costs	Total annual costs
Hand trucks. 2-wheel	5	250.00	41.25		41.25
Dock plate	1	50.00	8.25		8.25
Bulk bins	96,500 bu.	39,372.00	3,871.58		3,871.58
Warehouse	15,000 sq.ft.	33,750.00	3,543.75		3,543.75
Receiving set-up	1	22,000.00	3,279.36	126.00	3,405.36
24 ft. sack elevator	2	3,200.00	528.00	161.50	689.50
10 ft. sack elevator	1	850.00	140.25	42.80	183.05
Cleaning line	3	60,507.90	9,975.90	8,821.50	18,797.40
Handling labor	1,434			2,251.00	2,251.00
Cleaning labor	8,000			14,000.00	14,000.00
Subtotal			21,388.34	25,402.80	46,791.14
10% misc. & overhead			2,138.83	2,540.28	4,679.11
Total			23,527.17	27,943.08	51,470.25
Cost per ton clean seed			4.71	5.59	10.30

Appendix Table 13a. Estimated additional annual costs for cleaning and handling 5000 tons of specified product mixes using bulk and hand trucks (Method C)

Cost Item	Product Mixes 1	2	3	4	5	6	7	8
Hand trucks, 2-wheel								
Dock plate								
Bulk bins					1,404.20	1,444.32	1,401.20	1,203.60
Warehouse								
Receiving set-up			31.50	31.50	31.50	31.50	31.50	31.50
24 ft. sack elevator								
10 ft. sack elevator								
Cleaning line			236.20	2,801.40	2,949.72	2,033.85	1,951.40	8,043.55
Handling labor		147.00	256.00	166.00	184.00	346.00	199.00	189.00
Cleaning labor			414.75	414.75	2,992.50	2,703.75	2,609.25	9,111.50
Subtotal		147.00	938.45	3,413.65	7,561.92	6,559.42	6,192.35	18,579.15
10% misc. and overhead		14.70	93.84	341.37	756.19	655.94	619.24	1,857.92
Total		161.70	1,032.29	3,755.02	8,318.11	7,215.36	6,811.59	20,437.07
Additional cost per ton clean seed		.032	.206	.751	1.664	1.443	1.36	4.087
Total cost per ton clean seed	10.30	10.33	10.54	11.29	12.95	14.49	15.85	19.94

Appendix Table 14. Equipment requirements and estimated costs for handling and cleaning 5000 tons annual ryegrass per year by bulk and lift truck. (Method D)

Cost Item	No. used	Replacement cost	Annual fixed costs	Annual variable costs	Total annual costs
Bulk bins	96,500 bu.	39,372.00	3,871.58		3,871.58
Warehouse	12,000	27,000.00	2,835.00		2,835.00
Receiving set-up	1	22,000.00	3,279.36	126.00	3,405.36
Fork-lift truck. 4000 lb.	1	5,700.00	940.50	445.50	1,386.00
Dock plate	2	300.00	49.50		49.50
Pallets. 4' X 5'	2,500	8,750.00	1,133.33		1,133.33
Loading ramp. concrete	1	400.00	42.00		42.00
Cleaning line	3	60,507.90	9,975.90	8,821.50	18,797.40
Handling labor	400			700.00	700.00
Cleaning labor	8,000			14,000.00	14,000.00
Subtotal			22,127.17	24,093.00	46,220.17
10% misc. & overhead			2,212.72	2,409.30	4,622.02
Total			24,339.89	26,502.30	50,842.19
Cost per ton clean seed			4.87	5.30	10.17

Appendix Table 14a. Estimated additional annual costs for cleaning and handling 5000 tons of specified product mixes using bulk and lift truck (Method D)

Cost Item	Product Mix 1	2	3	4	5	6	7	8
Bulk bins					1, 404. 20	1, 444. 32	1, 401. 20	1, 203. 60
Warehouse								
Receiving set-up			31. 50	31. 50	31. 50	31. 50	31. 50	31. 50
Fork-lift truck, 4000 lb.		8. 10	2. 70		2. 70	5. 40	5. 40	56. 70
Dock plate								
Pallets, 4' X 5'								
Loading ramp, concrete								
Cleaning line			236. 20	2, 801. 40	2, 949. 72	2, 033. 85	1, 951. 40	8, 043. 55
Handling labor		18. 00	175. 00	172. 30	175. 00	175. 00	175. 00	175. 00
Cleaning labor			414. 75	414. 75	2, 992. 50	2, 703. 75	2, 609. 25	9, 111. 50
Subtotal		26. 10	860. 15	3, 419. 95	7, 555. 62	6, 393. 82	6, 173. 75	18, 621. 85
10% misc. and overhead		2. 61	86. 02	342. 00	755. 56	639. 38	617. 38	1, 862. 18
Total		28. 71	946. 17	3, 761. 95	8, 311. 18	7, 033. 20	6, 791. 13	20, 484. 03
Additional cost per ton clean seed		. 006	. 189	. 755	1. 662	1. 406	1. 358	4. 096
Total cost per ton clean seed	10. 17	10. 18	10. 37	11. 13	12. 79	14. 20	15. 56	19. 66

Appendix Table 15. Equipment requirements and estimated costs for handling and cleaning 5000 tons annual ryegrass per year by pallet boxes and lift truck (Method E)

Cost item	Number used	Replacement cost	Annual fixed cost	Annual variable cost	Total annual cost
Receiving apron, concrete	1	1, 400.00	147.00		147.00
Truck scales	1	6, 026.00	692.99		692.99
Pallet box, plywood	1, 400	35, 000.00	5, 775.00		5, 775.00
Pallet box storage shed	10, 500	15, 750.00	1, 653.75		1, 653.75
Pallets, 4' X 5'	2, 500	8, 750.00	1, 133.33		1, 133.33
Warehouse	12, 000	27, 000.00	2, 835.00		2, 835.00
Pallet box dumper	1	750.00	98.25	9.75	108.00
Fork-lift truck, 4, 000 lb.	1	5, 700.00	940.50	944.60	1, 885.10
Cleaning line	3	60, 507.90	9, 975.90	8, 821.50	18, 797.40
Handling labor Cleaning labor	8, 000			14, 000.00	14, 000.00
Ramp, concrete	1	400.00	42.00		42.00
Dock plate	1	150.00	24.75		24.75
Subtotal			23, 318.47	23, 775.85	47, 094.32
10% misc. & overhead			2, 331.85	2, 377.59	4, 709.43
Total		161, 433.90	25, 650.32	26, 153.44	51, 803.75
Cost per ton clean seed			5.13	5.23	10.36

Appendix Table 15a. Estimated additional annual costs for cleaning and handling 5000 tons of specified product mixes using pallet boxes and lift truck (Method E)

	Product Mix							
Cost Item	1	2	3	4	5	6	7	8
Receiving apron, concrete								
Pallet box, plywood				(-168.30)	2,268.20	2,062.50	412.50	2,062.50
Pallet box storage shed				(-77.50)	649.69	590.62	118.13	590.63
Pallets, 4' X 5'								
Warehouse								
Pallet box dumper				(-.93)	10.00	10.00	10.00	20.00
Fork-lift truck, 4000 lb.		10.13	10.13	(-2.60)	30.40	33.70	13.50	45.90
Cleaning line			236.20	2,801.40	2,949.72	2,033.85	1,951.40	8,043.55
Handling labor Cleaning labor			414.75	414.75	2,992.50	2,703.75	2,609.25	9,111.50
Subtotal		10.13	661.08	2,966.82	8,900.51	7,434.42	5,114.78	19,874.08
10% misc. & overhead		1.01	66.11	296.68	890.05	743.44	511.48	1,987.41
Total		11.14	727.10	3,263.50	9,790.56	8,177.86	5,726.26	21,861.49
Additional cost per ton clean seed		.002	.145	.653	1.958	1.636	1.145	4.372
Total cost per ton clean seed	10.36	10.36	10.51	11.16	13.12	14.76	15.91	20.28

Appendix Table 16. Estimated replacement costs and fixed and variable annual costs for seed handling equipment and facilities

Equipment, item	Replacement cost[a]	Useful life	Depreciation	Other fixed cost[b]	Total fixed costs	Fuel and power[c]	Repairs[d]	Total variable costs[e]
	(Dollars)	(Years)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)	(Dollars)
Hand truck, two wheel	50.00	10	5.00	3.25	8.25	---	---	---
Dock plate, hand truck	50.00	10	5.00	3.25	8.25	---	---	---
Dock plate, lift truck	150.00	10	15.00	9.75	24.75	---	---	---
24' sack elevator, 3 HP	1,600.00	10	160.00	104.00	264.00	.033	.08	.113
10' sack elevator, 1 HP	850.00	10	85.00	55.25	140.25	.011	.0425	.0535
Warehouse (sq. ft.)	2.25[f]	25	.09	.14625	.23625	---	---	---
Shed, pallet box storage (sq. ft.)	1.50[g]	25	.06	.0975	.1575	---	---	---
Bulk bins[h] (per 1,000 bu.)	408.00[h]	30	13.60	26.52	40.12	---	---	---
Pallet box, plywood								
4' x 4' x 4'	20.00	10	2.00	1.30	3.30	---	---	---
4' x 6' x 3'	22.50	10	2.25	1.4625	3.7125	---	---	---
4' x 6' x 4'	25.00	10	2.50	1.625	4.125	---	---	---
Pallet box dumper	750.00[i]	15	50.00	48.25	98.25	.00825	.0375	.04575
Pallet, wood	3.50	15	.233	.22	.453	---	---	---
Pallet, dolly	40.00	10	4.00	2.60	6.60	---	---	---
Fork-lift truck, 4,000 lb.	5,700.00	10	570.00	370.50	940.50	.39	.285	.675
Receiving apron, concrete	1,400.00[j]	25	56.00	91.00	147.00	---	---	---
Loading ramp, concrete	400.00[j]	25	16.00	26.00	42.00	---	---	---
Truck hoist, with cradle	1,500.00[k]	15	100.00	97.50	197.50	.055	.075	.13
with hook	1,250.00	15	83.33	81.25	164.58	.044	.0625	.1065
Platform scale, 50 T. Cap.	6,026.00[l]	20	301.30	391.69	692.99	---	---	---
with dump pit	8,826.00[k]	20	441.30	573.69	1,014.99	---	---	---
Bucket elevator, 9"x5"	2,980.00[m]	20	149.00	193.70	342.70	.055	.149	.204
11"x 7"	3,672.00[n]	20	183.60	238.68	422.28	.0875	.1836	.2711
14"x 7"	4,019.00[o]	20	200.95	261.24	461.29	.11	.201	.311

Footnotes on following page

Appendix Table 16. (Footnotes)

[a] F. O. B. the warehouse, plus installation.

[b] Includes the following percentages of replacement cost: Interest -3%, Insurance - 1%, Taxes - 1%, Maintenance -1.5%

[c] Electricity at $.011 per horsepower per hour; gasoline at $.30 per gallon, oil at $.40 per quart

[d] Repairs computed as .005% of replacement cost per hour of operation.

[e] Per hour of operation converted to cost per ton by the following formula: $C_T = \frac{C_H}{V}$, where C_T = variable cost per ton, C_H = variable cost per hour, and V = tons of seed handled per hour.

[f] Warehouse costs based on the following specifications: Concrete floor, wire reinforced - $.55 per square foot, Frame sidewalls and truss roof, sheet metal covered - $1.70 per square foot of area enclosed.

[g] Pole type shed, sheet metal roofing, asphalt floor

[h] Cribbed bin costs based on the following specifications: Concrete footings - $1.75 per square foot under the bins, Laminated 2" x 4" and 2" x 6" lumber - $89 per 1,000 board feet in place, Sheet metal siding - $.25 per square foot of area covered, Frame roof, sheet metal clad - $.65 per square foot of area covered.

[i] Steel frame, inversion dumper, .75 horsepower, portable

[j] Based on concrete cost of $33 per cubic yard, in place, including excavation and forms.

[k] Used for Methods C and D at all volume levels

[l] Used for Methods A, B, and E at all volume levels

[m] Used for Methods C and D at 1,000 tons annual volume

[n] Used for Methods C and D at 2,500 tons annual volume

[o] Used for Methods C and D at 5,000 tons annual volume

Appendix II

Labor Performance Rates in Seed Processing Warehouses

Appendix Table 17. Performance rates for lift truck operations in seed processing warehouses.

Operation [a]	Performance rate [b]	Handling method [c]
	(Boxes per man hour)	
A. Bags of seed on pallets		
1. Receive bags on truck, transfer to pallet and store 3 pallets high: 3-5 man crew.		
Bag (20/pallet)	156.5	B
Bag (25/pallet)	163.4	B
2. Transfer palletized bags of field-run seed from storage to cleaning line and dump bags by hand into hopper:		
20 bags per pallet	83.0	B
25 bags per pallet	107.9	B
3. Transfer clean seed from cleaning line to test storage: stack 2 pallets high.	833.3	B, D, E
4. Transfer clean seed from test storage to permanent storage, 3 or 4 pallets high.	1010.1	B, D, E
5. Carloading from ground level plant using ramp and entering car. [d]		
Pretagged noncertified	163.4	B, D, E
Pretagged certified	132.6	B, D, E
6. Carloading from ground level plant using pallet dolly in car. [d]		
Pretagged noncertified	144.1	
Pretagged certified	119.6	
7. Carloading from car level plant. entering car. [d]		
Pretagged noncertified	179.2	
Pretagged certified	142.9	
B. Pallet boxes		
8. Receive boxes, store in open side shed, replace empties on truck.	23.75	E
9. Remove boxes from storage to cleaning line and dump with mechanical dumper	27.51	E
10. Move boxes from storage to cleaning line and dump with turnhead on fork lift	29.68	

Table 17 (Footnotes)

[a] Transportation distances have been standardized at 60 feet one way

[b] Based on one man crew unless otherwise specified in description of operation

[c] Operations designated with capital letters in this column were used in estimating annual costs for the five handling methods considered in this study

[d] Additional labor is required for car preparation and closing. See Appendix Table 4.

Appendix Table 18. Performance rates for hand truck operations in seed processing warehouses

Operation [a]	Performance rate [b]	Handling method [c]
	(Bags per man hour)	
1. Unload bags of field-run seed or clean seed from highway truck. transport to storage and pile on floor; 20% of bags loaded on hand truck by hand. 80% by stacking load. Bags moved from truck to storage. unloaded and piled by hand.		
Piled on floor 5 sacks high	275.5	
Piled on floor 6 sacks high	164.2	
Piled on floor 7 sacks high	157.5	
Piled on floor 8 sacks high	149.7	
2. Unload bags of field run or clean seed from highway truck. transport to storage and high pile with drag chain or belt elevator. 20% of bags are loaded on hand trucks by hand, all are unloaded and placed on elevator by hand. Five man crew. [d]	102.8	A
3. Transport bags of field-run seed from storage to cleaning line. open bag and dump into floor hopper.		
Bags in storage are 5 high	73.3	
Bags in storage are 6 high	71.9	
Bags in storage are 7 high	68.2	
Bags in storage are 8 high	66.7	
Bags in storage are high piled. 20 high [d]	63.7	A
4. Transport bags of clean seed from cleaning line to storage. Load bags by hand on hand truck.		
Unload by hand onto sack elevator. Two man crew.	87.6	A, C
Buck 5 bag load onto floor stacks.	180.1	A, C
5. Move bags of clean seed from test storage to high pile. Two man crew. [d]	112.7	A, C
6. Load rail car with 100# bags clean seed from 5-high test storage; includes tagging. Four man crew. [e]		
Noncertified seeds.		
Pretagged	138.1	A, C
Tagged by loaders	109.5	A, C
Certified seeds,		
Pretagged	115.5	A, C
Tagged by loaders	83.0	A, C

Appendix Table 18. (continued)

Operation [a]	Performance rate [b]	Handling method [c]
	(Bags per man hour)	
7. Load rail car from high piled storage; includes tagging. Four man crew. [d, e]		
Noncertified seed,		
Tagged by loaders	92.2	A, C
Certified seed,		
Tagged by loaders	72.6	A, C

[a] Transportation distances have been standardized at 60 feet one way.

[b] Based on one man crew unless otherwise specified in description of operation.

[c] Operations designated with capital leters in this column were used in estimating annual costs for the five handling methods considered in this study.

[d] Requires use of 24 foot bag elevator.

[e] Additional labor is required for car preparation and closing, and for setting up, moving and removing 10 foot bag elevator used in car. See Appendix Table 4.

Appendix Table 19. Performance rates for bulk receiving operations in seed processing warehouses.

Operation [a]	Performance rate [b]	Handling method [c]
	(Bags per man hour)	
Maximum possible receiving rate including weigh in, select bin, clean up, lift and lower truck, convey seed to bins with 10000 bu. elevator	4800	C, D
Weigh in, select bin, lift and lower truck, clean up, convey seed to bins with 5000 bu. elevator	2400	C, D
Weigh in, select bin, lift and lower truck, clean up, convey seed to bins with 1600 bu. elevator	1200	C, D
Weigh in, select bin, lift and lower truck, clean up, convey seed to bins with 500 bushel elevator.	400	

[a] Receiving set up includes scales, 400 bu. dump pit, cradle hoist, and designated elevator.

[b] Based on average load size of 400 bushels

[c] Operations designated with capital letters in this column were used in estimating annual costs of the handling methods considered in this study.

Appendix Table 20. Labor requirements for miscellaneous operations in seed processing warehouses.

Operation	Labor requirement
1. Place bag on hopper, fill with clean seed, weigh, and place on hand truck or pallet, record and stencil.	
Bags sewn by hand	.037
Bags sewn by portable stitcher	.032
2. Prepare car for loading, close and seal doors, handle dock plate.	
For hand truck loading	.900
For lift truck loading	.759
3. Place conveyor in car or remove from car.	.038
4. Reset car conveyor for next tier loading	.009
5. Place pallet dolly in car or remove from car with lift truck	.008

Appendix III

Alternative Approaches to Cost Estimation

APPENDIX III

Alternative Approaches to Estimation of Multiple Product Processing Costs

The approach to multiple product processing cost estimation in the text was to hold annual volume constant and replace original ryegrass volume with new seeds at the rate of ten percent of the fixed volume. There are at least two alternatives to this approach.

One alternative would have been to postulate a fixed plant processing a certain volume of ryegrass. Then the ryegrass could have been replaced with different seeds until excess capacity in the receiving and cleaning stages had been utilized to the fullest possible extent. Such an approach would be essentially a short-run decision-making process and would be meaningful only in the context of net returns (cleaning charges less processing costs). It would not yield result applicable to the long run or industry problem which is the main subject of this study.

Another alternative would have been to add each new seed as an increment to total annual volume. The following discussion compares this "incremental" approach to the "replacement" approach presented in the text.

Method D was selected for the comparison. The procedure for the replacement approach is given in the text. Procedures for the incremental approach are given here. Equipment requirements and costs for 2500 tons annual ryegrass were taken from Appendix Table 9. The first revision of the model was to replace half the volume of annual ryegrass with perennial ryegrass and estimate the additional annual costs incurred. Then 250 tons of alta fescue was added to the product mix and its additional costs were estimated. This procedure was followed until crimson clover, chewings fescue, red fescue, bentgrass and merion bluegrass were all included (Appendix Table 21).

The addition to total annual cost from the incremental approach is greater than was the case under the replacement approach used in the text. Yet the cost per ton of clean seed is less for all product mixes except those containing only the ryegrass, as shown below:

Product Mix	Cost per ton of Clean Seed	
	Incremental	Replacement
1	$13.24	$13.24
2	13.25	13.25
3	12.74	13.48
4	12.92	14.44
5	13.76	15.69
6	14.28	16.66
7	14.69	17.52
8	16.52	20.71

The differences in cost per ton are explainable from the fact that the increases in cost due to 250 tons of each of the seeds are spread in the incremental treatment over an increasing volume. In

Appendix Table 21. Estimated annual costs for a multiple product seed processing warehouse when seeds are added as increments to total annual volume

Cost Item [c]	Original[a] Model Annual Ryegrass [c]	Seeds Added to Product Mix [b] Perennial Ryegrass	Alta Fescue	Crimson Clover	Chewings Fescue	Red Fescue	Bent-grass	Merion Bluegrass
Bulk bins	$ 4829.65	$ ---	$ ---	$ ---	$ 1020.67	$ 1020.67	$ 945.36	$ 1782.84
Warehouse	1559.25	---	---	---	1002.48	1002.48	1002.48	1002.48
Receiving setup	3146.07	---	25.71	25.71	25.71	25.71	25.71	25.71
Fork-lift truck	1163.25	4.05	23.62	23.62	23.62	24.97	24.97	50.62
Dock plate	24.75	---	---	---	---	---	---	---
Pallets	562.50	---	43.75	43.75	43.75	43.75	43.75	87.50
Loading ramp	42.00	---	---	---	---	---	---	---
Cleaning line	11061.45	---	559.18	1470.53[f]	1548.17[g]	1458.00	1416.78	4462.75
Handling labor	700.00	10.50	178.00	178.00	179.00	178.00	182.00	73.50
Cleaning labor	7000.00	---	910.00	910.00	1093.75	1029.00	1001.00	2500.75
Sub-total	30088.92	14.55	1740.26	3394.11	5426.53	4782.58	4642.05	9986.15
10% misc. and overhead	3008.89	1.46	174.03	339.41	542.65	478.26	464.20	998.62
Total[d]	33097.81	16.01	1914.29	3733.52	5969.18	5260.84	5106.25	10984.77
Cumulative total cost	$ 33097.81	$ 33113.82	$ 35028.11	$ 38761.63	$ 44730.81	$ 49991.65	$ 55097.90	$ 66082.67
Cumulative volume (tons)	2500	2500	2750	3000	3250	3500	3750	4000
Cost per ton of clean seed[e]	$ 13.24	$ 13.25	$ 12.74	$ 12.92	$ 13.76	$ 14.28	$ 14.69	$ 16.52

[a] Based on Method D. Original volume is 2500 tons. [b] Perennial ryegrass replaced half the volume of annual ryegrass. The other seeds were added in 250 ton increments. [c] From Appendix Table 9. [d] For annual ryegrass. total cost figure is for 2500 tons. For seeds added. total cost represents the additional total annual cost incurred through inclusion of 250 tons of each seed as an addition to the product mix.

[e] Cost per ton of clean seed is found by dividing cumulative total costs by cululative volume.

[f] Includes total annual cost of specific gravity separators, which is shared with merion bluegrass when the latter is added to the product mix.

[g] Includes total annual cost of debearders, which is shared with red fescue, bentgrass, and meriond bluegrass when these seeds are added to the product mix.

the replacement treatment, volume remains constant throughout.

Either approach might have been used. However, it was decided to hold total volume constant (the replacement approach) in order to compare annual unit costs at the same volume level. The incremental approach, as it is expansionary, would not allow this.