2-1-1955

A study of the cost of processing seed in Mississippi

Woodson W. Moffett

W. E. Christian Jr.

BULLETIN 528 FEBRUARY, 1955

A Study of the

COST OF PROCESSING SEED IN MISSISSIPPI

MISSISSIPPI STATE COLLEGE
AGRICULTURAL EXPERIMENT STATION
CLAY LYLE, Director

STATE COLLEGE MISSISSIPPI

TABLE OF CONTENTS

LIST OF TABLES

APPENDIX TABLES

A Study of the Cost of Processing Seed in Mississippi

By WOODSON W. MOFFETT, JR. and W. E. CHRISTIAN, JR.

Several factors account for the increasing importance of the seed industry[1] to the economy of Mississippi. Among the more important ones are (1) the increased emphasis on grassland farming, (2) acreage controls, and (3) changes in technology of production which have caused shifts to crops better adapted to the soil and topography of the state. The rapidly increasing importance of the seed industry has emphasized the need for economic research information. However, since the industry is relatively young, there is very little such information available. Only two economic studies relating to the Mississippi seed industry have been completed and the results published[2]. One of these surveyed the size of the industry, the processing facilities available, and some of the major problems confronting seed processors in the state. The other was concerned primarily with the supply side of the industry. It analyzed the production trends, the prospective demand, the production pattern (with particular emphasis on the competitive position of seed production versus grazing for livestock), and the marketing practices followed by seed producers.

As noted above, the survey of the seed industry in Mississippi, made in 1949, included a list of the major problems confronting seed processors. It was not surprising that many of these problems were present because of a limited knowledge of both the technical aspects of processing seed and the actual cost involved in operating processing plants. The Regional Seed Processing Research Laboratory at Mississippi State College was established to help the processor overcome the technical problems, but no data have been made available on the actual cost of processing these seed. This study was designed to furnish such information.

Objectives

The objectives of this study were:

1. To determine the cost of operating different types and sizes of seed processing equipment most suitable for use in Mississippi processing plants of different sizes.
2. To determine the effect of physical

[1] The "seed industry" as the term is used in this publication refers to the production and marketing of seeds such as pasture grass seed, (including clovers and lespedeza) and small grains, but does not include cotton, horticultural or forestry seed. The "cost of processing" has been studied on the same basis.

[2] Christian, W. E., Jr., and Doyle, B. K., **Mississippi Seed Industry,** Mississippi Agricultural Experiment Station Circular 153, June, 1950; and Christian, W. E. Jr., **Some Factors Affecting the Competitive Position of Mississippi Seed Producers,** Mississippi Agricultural Experiment Station Technical Bulletin 36, April, 1953.

ACKNOWLEDGEMENT

This is one of a number of studies being conducted by the Agricultural Experiment Station in connection with the Regional Seed Processing Laboratory. Funds are made available for this study through Title II of the Research and Marketing Act.

Appreciation is extended to members of the Agronomy Department and Agricultural Engineering Department of the Experiment Station along with members of the Agricultural Economics staff for their assistance and helpful suggestions during the planning and development of this study. The authors are especially grateful to Dr. R. J. Saville, Head, Department of Agricultural Economics, not only for his helpful suggestions during the time the study was conducted, but also for critically reading the manuscript.

Acknowledgement is also due the owners and managers of seed processing plants who cooperated in this study. Without the data supplied by these individuals this study would not have been possible.

volume, equipment and building arrangement, condition and quality of seed to be processed, and different combinations of machines on the cost of processing seeds.

Scope and Method of Obtaining Data

Ten plants were originally selected for study. However, one was not used because sufficient data were not obtained on the time required to perform the various operations. The nine remaining plants were divided into three groups as follows: (1) Group I—plants having facilities for handling seeds received in bulk; (2) Group II—plants comparable in size to those in Group I but having no facilities for handling seed received in bulk; and (3) Group III—small plants with only one screen machine for which time data were not obtained.

Data were obtained by personal interview in the Spring of 1953 from each of the plants in question on (1) the original cost of the buildings and equipment used in seed processing, (2) the cash expenses incurred by the plant during 1952, such as utilities expenses, and the cost of maintenance and repair on equipment, (3) general information on the labor force required at minimum operation and maximum operation, (4) machine capacity for different kinds of seed, and (5) quantity of seed cleaned during 1952. After the beginning of the 1953 cleaning season, i.e. beginning in June, the plants were re-visited and data taken to determine the time required to perform various operations with different facilities for receiving and handling the seed and different arrangements of machines. Time data were taken in five of the plants for three days each and in one plant for four days. It was felt that observation for this period would give a fairly representative picture of the time required to perform different operations within the plant.

The Approach to the Problem

Nature of Problem: The most desirable result of a study of this nature would be to obtain data showing the cost of processing each kind of seed with different machines and different arrangements of machines. However, early in the planning stages of the study it was recognized that certain characteristics of the seed processing industry kept such an approach from being feasible. Most important in this respect was the wide variation in the quantity of seed that can be cleaned on any given machine as a result of the condition of the seed when received by the plant. Also of importance was the efficiency of the machine attributable to the operator.

It was considered desirable to determine the cost of operating the machine for a given period of time. The operator could then determine the cost of processing any given lot of seed by estimating the time to process it. The only practical approach seemed to be a computation of the cost of operating the "primary" machine in the plant. Since the screen and air machine is considered by most operators to be a general purpose machine and the others to be more specialized in nature—the per-hour operating costs were computed for only the screen and air machine. The annual fixed costs were computed for the length separating, the specific gravity, and other specialized machines; but only the pro rata building costs for the space actually occupied by the machine was included in these annual fixed costs. That is, no building charge was made to the specialized machines for the storage space occupied by the seed prior to and after processing and no attempt was made to compute the labor cost involved in the operation of the specialized machines.

Another problem peculiar to this industry was the highly seasonal nature of plant operation. Some plants operated at "full capacity" for only three or four months in the year, at reduced capacity during three or four months, and only occasionally during the remainder of the year. Such a seasonal pattern

generally makes it desirable for plant operators to have a supplementary enterprise in conjunction with the processing plant. In some plants this was a feed crushing and mixing enterprise, in others a retail seed and fertilizer store, and in others a general farm supply store with a full line of feed, seed and fertilizer. Some plants were actually supplementary enterprises to some other operation. For example, two small plants were located on farms and were supplementary to the farming operations, and two larger plants were supplementary to general farm supply stores.

The data have been computed to show operating costs when the total building costs are charged to processing and when a proportion of the total cost (as estimated by the owner or operator) is charged to other enterprises using the same building and facilities. In some instances this allocation of costs made considerable difference in the total fixed costs; whereas, in others it made very little.

The computation of overhead labor costs, on the other hand, was based on the operator's statement relative to the minimum labor force maintained regardless of volume of seed cleaned. Since seed processing is a specialized industry, many of the operators feel that it is necessary to keep at least one, and in some cases two laborers, in addition to the plant foreman or superintendent as a nucleus for his labor force. This expenditure for labor was computed as overhead labor costs. However, because of the wide variation among plants in the amount of the foreman's or superintendent's time devoted to seed processing, it was necessary to omit his salary from the overhead labor costs.

Determining Capital Investment: The general price level at the time the plant was constructed and equipped materially affected the total capital investment in plants of comparable size and design. Since this was true, it became necessary to relate all of the costs to a common base, and in order to do this some type of index was needed. Several indexes of building costs were available.[3] The one which seemed most suitable was an index of the cost of constructing commercial and factory buildings, prepared by E. H. Boeckh and associates.

No index was available on the cost of equipment used in seed processing plants, but the Bureau of Agricultural Economics (now the Agricultural Marketing Service) supplied an index of farm machinery costs. Since the machinery used in seed processing is very similar to that used on farms, it was concluded that this index would be representative of the seed processing equipment costs. (Both indexes are shown in Appendix Tables 1 and 2.)

By using the two indexes it was possible to show two factors which were considered important in determining cost of processing by those who participated in planning this study. First, it was possible to give an indication of the capital outlay required to construct a plant at about the present price level, an important phase of the study for those who may be contemplating the construction of a seed processing plant; and second, it showed the effect of the general price level, which existed at the time the plant was constructed and equipped, on the cost per hour of machine operation.

Allocation of Capital Expense: In order to determine areas in which individual plants were most efficient, costs were classified as: receiving, processing, shipping and miscellaneous. The fixed costs included depreciation, interest, taxes, insurance, and an allocation for building expenses chargeable to the classified function.

Depreciation, interest, taxes, and insurance were allocated on the basis of the original cost of the equipment used in each function. (A schedule of depre-

[3] National Production Authority, **Construction and Building Materials, Statistical Supplement,** May 1952. United States Department of Commerce, Washington, D. C.

ciation rates is given in Table 3 of the Appendix.) Interest charges were computed at 5 percent on one-half of the investment in buildings and equipment and on the total investment in land. Interest expense was charged each plant whether or not the firm had any interest bearing debts. Tax expense included only county and city property taxes and varied considerably among plants. However, no attempt was made to standardize the rates because of the complexity of tax assessment values and tax rates. Insurance expenses, on the other hand, was computed for all plants even though some carried little or no insurance. This expense item was based on insurance costs on 80 percent of the original cost of the buildings and equipment at the rate for the individual plant.

Building costs for approximately one-half of the storage space available in the plant was allocated to receiving and one-half to shipping. The processing and miscellaneous functions each received a building cost allocation based on the space used.

There was some objection to allocating utilities and other miscellaneous expenses on the basis of original investment in the equipment used in the three primary functions. However, any other approach did not appear to be practical and such an allocation was used. Actually there is justification for this allocation in that, generally, as the investment in equipment increased the amount of electricity (the major utilities item) required to operate the machinery increased. Equipment repair and maintenance costs were charged directly to the primary function involved.

Allocation of Labor Costs: As noted above certain of the labor costs were considered as overhead. However, no attempt was made to allocate this overhead labor between the primary functions. Instead, overhead labor costs and miscellaneous labor expenses were combined and added to the costs individually computed to obtain the total cost of processing. All unskilled labor was charged at the rate of 75 cents per hour. Two of the plants paid 90 cents per hour for one skilled laborer. In other instances, the pay was not above the 75 cent per hour used in computing the labor costs. The annual labor expense was not taken directly from the plants' books because of the practical impossibility of separating the labor expense for the supplementary enterprises. Instead, the time required to perform a given function was obtained and labor cost per hour was applied to compute the labor expense per hour of machine operating time.

Determination of Hours of Machine Operating Time: Data obtained on the quantity of seed cleaned during 1952 were related to the operators' estimate of the average quantity of each kind of seed cleaned per hour to determine the number of hours the machine was actually in operation.

Estimates on the average quantity of seed cleaned per hour were obtained from all but one plant. In this plant the operator felt that he was not well enough acquainted with the plant operation to make a valid estimate. Therefore, the average for three other plants having the same size screen and air machines was used.

Some Characteristics Of The Plants Studies

Date of Construction and Location: Three of the plants studies were located in the Delta, two in the Black Belt, two in the Clay Hills, and two in the Coastal Plains. Dates of construction ranged from 1940 to 1952, but most of them were constructed during the period of 1948 through 1951. In the group of plants having facilities for handling bulk seed, one was built in 1940, one in 1945, and one in 1951. Two of the plants in Group II were constructed in 1948 and one in 1949, with one adding additional storage facilities in 1949 and one making additions in 1952. For the group of small plants, one was built in 1943, and two

in 1949, with one making additions in 1952.

Capital Investment: There was a relatively wide range in the capital investment in buildings and equipment within each group of plants and between groups. The averages for each group are shown in Table 1. The group of plants having facilities for receiving seed in bulk (Group I) had a total capital investment about two and one-half times as great as Group II. However, based on the estimate of the total costs chargeable to seed processing, Group I was only about one and three-fourths as great as Group II.

The total outlay of capital is an important item, since it is highly probably that the facilities would be necessary to handle the seed processed by the plant during peak seasons. However, the fact that the owners were able to utilize the facilities for other enterprises during periods when the seed processing equipment was not in use must also be taken into consideration. The owners undoubtably saw this possibility when planning the plant and were influenced considerably in their decisions relative to the size of the facility to build. It will be noted that the average floor space chargeable to seed processing by Group I and II was approximately equal, reflecting the space requirements for machines of approximately the same size and about the same floor space for storage.

The most significant difference in the capital investment for Groups I and II was in the cost of receiving equipment. Group I had an average total capital investment in this item of $12,075; whereas Group II averaged only $929. The average investment in receiving equipment chargeable directly to seed processing was $8,371 and $674 for Group I and II, respectively.

Facilities for receiving seed in bulk included truck or wagon scales, truck hoists and dumping pits, elevators for lifting seed, and some type of conveyor system. All plants in Group I had truck scales 40 feet or more in length; two had truck hoists and dumping pits; and one had an outside pit into which seed were shoveled through grain doors or over the side of the truck. Each conveying system was different. One plant lifted seed and let them flow by gravity into storage bins or into the holding bin over the cleaner. Seed could be transferred from bins near the main elevator to those most distant from the main elevator by letting them flow by gravity into another elevator where they were lifted and permitted to flow into any of the bins which could not be reached from the main elevator. One plant transferred seed from the dumping pit by a screw conveyor system either into storage bins or into the holding bins above the cleaning machine. The other plant lifted seed from the dumping pit onto a belt conveyor and in turn, into storage bins or to the holding bin over the cleaner.

Differences in investment in processing machinery reflect, for the most part, differences in the cost of holding bins for different plants and a bagging bin in one plant. In addition, costs of installing machines were somewhat higher for plants in Group I than in Group II. Plants in Group II had holding bins over the machines but they were relatively small and generally of cheaper construction than those in Group I.

Investment in shipping equipment made up a relatively small share of the total. Group I was higher since a proportion of the total cost of the conveyor system of one plant and of the cost of a motor lift in another plant was charged to shipping. On the other hand, for Group II about the only equipment included was the platform scale for weighing the cleaned, bagged seed and a proportional share of the cost of bag trucks and other similar equipment.

Investment in miscellaneous equipment included both office and laboratory equipment, and was considerably higher for plants in Group I than in Group II.

Table 1. Average capital investment in buildings and equipment by three groups of seed processing plants in Mississippi.

Item	Actual cash outlay when plants were constructed and equipped			Estimated cost if plant had been constructed and equipped in 1952.[1]		
	Group I	Group II	Group III	Group I	Group II	Group III
(a) Average total capital investment in all buildings and equipment used in seed processing.						
Buildings and land	$25,750	$11,292	$2,892	$33,586	$12,882	$3,499
Receiving equipment	12,075	929	18	15,252	950	24
Processing equipment	10,301	7,169	1,970	15,536	8,189	2,587
Shipping equipment	1,139	68	70	1,659	84	87
Miscellaneous equipment	1,005	305	------	1,625	343	------
Total:	$50,270	$19,763	$4,950	$67,658	$22,448	$6,197
Square feet of floor space in buildings	9,536	4,699	2,560	9,536	4,699	2,560
(b) Average capital investment chargeable to the seed processing operation.						
Buildings and land	$14,403	$11,292	$2,892	$19,635	$12,882	$3,499
Receiving equipment	8,371	674	18	9,612	686	24
Screen and air machine[2]	7,456	5,036	1,737	11,633	5,826	2,347
Shipping equipment	481	68	70	656	84	87
Miscellaneous equipment	605	305	------	958	343	------
Subtotal:	$31,316	$17,375	$4,717	$42,494	$19,821	$5,957
Other processing equipment	2,845	2,133	233	3,902	2,363	240
Total:	$34,161	$19,508	$4,950	$46,396	$22,184	$6,197
Square feet of floor space in buildings charged to seed processing	4,607	4,699	2,560	4,607	4,699	2,560

[1] Costs for 1952 based on indexes of building costs and of farm machinery costs. See text page 5 and Tables 1 and 2 of the Appendix.

[2] Includes the costs of installation and of (1) feeding and bagging elevators, (2) holding bins over the machines and (3) sacking bins (when these facilities were owned by the plant).

Most of the differences in this item was due to the amount of laboratory equipment used by the respective plants. For example, all plants in Group I had moisture testers, whereas, none in Group II owned this item. Other items accounted for the remainder of the differences.

Total capital investment in buildings and equipment for plants in Group III was relatively low. The plants were housed in adequate, low-cost buildings of sufficient size to accomodate only one screen and air machine. One plant added a dodder mill in 1951, but it was not to any appreciable extent during either 1951 or 1952.

Labor Required to Perform Various Functions Within the Plant: Labor required to perform different tasks within the plant varied greatly among the plants studied. Some variation was due to differences in the amount of labor-saving equipment in the plant, some to the arrangements of machinery, and some to variations in the efficiency of labor. From the standpoint of maximum usefulness of the findings in this study, the latter differences entered as a limiting factor. For example, one plant was conspicuous in the inefficient use of labor. Although the amount of labor-saving equipment in the plant should have made possible substantial savings, labor was used so inefficiently that actually more was required to perform some of the functions in the plant than in plants without labor-saving devices.

There was the alternative of not using the data for the plant with such inefficient labor but such action would have defeated, to an extent, the purpose of the study. Instead, the data were retained and are included in the averages which follow. However, attention is directed in the text to the time saved with the maximum labor efficiency which was observed in the plants. This attention gives the needed emphasis to the importance of the efficiency of labor on the cost of processing.

For the purpose of comparison between Groups I and II, the labor required to perform the major functions within the plant was classified as receiving, processing, and shipping.

Receiving labor included that required to get seed from the farm truck to the machine, but did not include labor required to dump seed into the feed elevator of the screen and air machine. For example, for seed received in bulk by plants having bulk handling facilities and transferred to bulk storage, the labor time actually required to get the seed dumped into the pit and transferred to the storage bin was counted. Then, later, when these seed were transferred to the machine, labor time was computed again. This labor time was translated into pounds of product handled per man minute of labor expended. The pounds of products handled per man minute was divided into the weighted average quantity of seed cleaned per hour by the plants to obtain the man minutes of receiving time per hour of machine operating time. Since all of the seed received by the plant were not transferred to plant storage but were cleaned as they were received, man minutes required for receiving per hour of machine operation were broken down to show the time required to receive under each condition. The same procedure was followed for all of the plants.

Processing labor included that required to dump seed into the feed elevator, the labor used to bag off, weigh, and sew the bags, and that required in the general supervision of the machine operation. The labor required in processing per hour of machine-operating time was based on timed observations.

Shipping labor as the term is used in this study, included all labor required to stack the seed from the platform scales onto the bag truck or motor lift pallet, to move into the warehouse and stack, and to move from the warehouse to the farm truck. It was assumed that there would always be one man from the farm truck to assist in stacking the

Table 2. Average number of man minutes required per hour of machine operating time at specific functions, two groups of seed processing plants in Mississippi.[1]

Function	Using weighted average quantity cleaned by the plants during 1952		Using same quantity for each group	
	Group I	Group II	Group I	Group II
Receiving:				
When seed are transferred directly to machine:				
Bulk	13.4	-----	12.0	-----
Bagged	(23.4)[2]	23.8[3]	(21.2)[2]	30.0[3]
When seed are transferred to storage and later to the machine:				
Bulk	(18.9)[2]	-----	(17.1)[2]	-----
Bagged	(46.2)[2]	(44.8)[2]	(42.2)[2]	(52.7)[2]
Processing:	121.0	162.0	121.0	162.0
Shipping:				
Bagged seed loaded direct from machine to farm truck	(12.1)[2]	(14.2)[2]	(11.0)[2]	(15.5)[2]
Bagged seed stocked in warehouse, then loaded on truck	23.6	35.2	21.5	38.5
Total	158.0	221.0	154.5	230.5
Weighted average quantity of seed cleaned per hour (pounds)	2,182	1,831	2,000	2,000

[1]Does not include any time spent for clean-up and change-over between lots of seed.

[2]Numbers in parenthesis are not included in the totals.

[3]Includes time data for a relatively small amount of seed received in bulk and dumped at the machines.

seed on the truck and his labor was not included in the time computations. Labor required for shipping was translated into the requirements per hour of machine operation by the same procedure as for receiving.

Apparently the greatest reduction in labor required per hour of machine operating time for Group I over Group II was in the labor required to transfer seed to the cleaning machine from bulk storage in Group I plants as compared with bagged storage in Group II plants, Table 2. There was a wide variation in the amount of labor required to perform this function by the plants within Group I, but there was relatively little difference among the plants within Group II. The differences among plants within Group I were due primarily to two factors—very inefficient labor in one plant and self-cleaning versus flat-bottom storage bins in the other two plants. The time data indicated that with efficient use of labor and with self-cleaning storage bins the labor time required to transfer seed from storage to the cleaner could be reduced by at least 50 percent. The most important factor was labor efficiency in the one plant previously mentioned.

The labor required to transfer seed from bagged storage to the cleaner was about the same for Group I as for Group II but was not very important for Group I from the standpoint of the total cleaning time, because a relatively small proportion of their receipts was in bags.

The difference in the processing labor required per hour of machine operating time between the two groups was due to several factors. These factors included (1) the labor required to dump bagged seeds into the feed hopper, (2) the labor required to sew the bags of cleaned seed, and (3) the larger holding bins and bagging bins in Group I permitted more freedom of movement, i. e., sometimes made it possible for one man to perform two tasks instead of only one.

The labor required to sew the bags of cleaned seed varied considerably among plants. Generally speaking the use of a good sewing machine, hanging above the platform scale and counter balanced, should replace one laborer when cleaning such seeds as roughpeas or oats. The machine is also an important item in saving time with seed which are cleaned at a slower rate, especially when, as a result, the man who would be employed with hand sewing can perform other routine tasks. However, here again the problem of inefficient labor entered into the time data. One plant with a small sewing machine actually spent more time sewing than some of the plants using all hand sewing. Ordinarily the man who bagged off could also weigh and sew the bags (for most commodities) when sewing with a machine, whereas, when the bags were hand sewed, one man bagged off and weighed and another sewed the filled bags. The man who did the hand sewing could generally be able to keep up with the seed which ran relatively fast, and would have time for other tasks when sewing seed which ran slowly. For the plant in question, however, even with the sewing machine the two men tending the machine often did not keep up, and had to be helped.

Larger holding bins over the machines and the use of a large bagging bin by one plant in Group I permitted much more flexibility in the use of the labor force. For example, with a large holding bin and a relatively large bagging bin one man could dump bagged seed and in most cases assist in bagging off cleaned seed; and, for seed which cleaned slowly, could perform both operations. On the other hand, without the holding bins, it was necessary to keep one man for each job. Holding bins were essential for plants with facilities for receiving seed in bulk.

In terms of the total time spent on processing, two plants in Group I used about one and one-half man hours of labor per hour of machine operating time, but one used almost three hours. This difference was due, for the most part, to the problem of inefficient labor in one plant: Two of the plants in Group II used about two man hours of labor per hour of machine time and one used almost four hours. For the plants in this group the difference was due to several factors. Among them were: (1) The plant using almost four hours used one man to dump bagged seed or scoop bulk seed into the feed hopper, one man to bag off, one man to sew, and the owner spent almost full time supervising or doing odd tasks around the machines. It should be noted here, however, that with his arrangement of machines, the same labor force could clean, scarify, and reclean seed (which required scarification) without any apparent decrease in the volume of seed cleaned. In this respect the plant was more efficient than any of the observed plants, if these other operations were carried on with the cleaning operation. These data do not reflect this over-all increase in plant efficiency since the study was made to determine the cost of operating the "primary" machine in the plant. (2) One plant in Group II, using about two hours of labor per hour of machine operation on the processing function, had this relatively low rate of labor use primarily because the seed were received in bulk and fed into the feed elevator of the machine by the use of an auger. The time for the one man employed in this operation was charged

to receiving. If the seed had been dumped from bagged storage another laborer would have been required. (3) The third plant in this group cleaned seed at a relatively slow rate throughout the period the time data were taken. Therefore, one man bagged and sewed without difficulty and one man dumped the bagged seed into the feed elevator and performed other tasks around the machine. The use of the average for three plants in Group II seems to give a representative figure for each plant when consideration was given to the factors which could not be measured during the period the time data were taken.

The shorter time required for the shipping function by the plants in Group I was primarily the result of the use by one plant of a motor lift for stacking in the warehouse and for loading out. The rate for stacking in the warehouse per man minute of labor expended was about four times as great when the motor lift was used and for loading on the farmer's truck it was about one-third to one-half greater. (This computation assumed that two men from the plant would always be required for loading out when using the motor lift. One would serve as the motor lift operator and the other would help stack from the pallet onto the farm truck.)

Clean-up Time: From the standpoint of the labor actually required to operate a seed-cleaning plant, that required for clean-up between different lots of seed was the most important limiting factor in this study. The labor required to clean-up varied more between plants than for any other operation. For example, the only clean-up done by some of the plants was to pull the screens, brush them off, let the machine run for two or three minutes with the screens out, sweep up around the machine, move the screenings for the whole lot into the warehouse (or set outside the plant) and replace the screens. On the other hand, one plant was extremely meticulous in cleaning up, particularly following a lot of seed which was known to contain any noxious weeds. The screens were pulled and the machines operated for a few minutes. After this, all the machine was cleaned with a portable electric blower, and every seed was cleaned from the screens. The blower was used to clean from behind each elevator cup on both the feed elevator and the bagging elevator, and care was taken to clean up well around the machine. The plant owner estimated that he used an average of twelve man hours to clean-up between lots of seed.

There was, in addition to the wide variation in labor requirement among plants, a wide variation among different lots of seed which were cleaned by the individual plants. Most of the operators pointed out, and it was observed to an extent, that between lots of the same kind of seed there was ordinarily only a limited amount of clean-up needed, but for different kinds of seed more labor was required. Even in the latter case the order in which the seed were cleaned affected the time for clean-up, that is, (for example) whether oats were following clover or clover was being followed by oats.

With this background one can readily see the practical impossibility of determining the average clean-up labor required per hour of machine operating time. However, failure to compute the time does not indicate a failure to recognize the importance of this operation on the total cost of processing. On the other hand, an operator should be able to get some idea of this cost for his individual plant by estimating the average labor required to clean-up and the number of hours required to clean an average lot of seed. By doing this he can divide the variable labor cost for the average clean-up period by the number of hours he expects to run before changing over again and add this to the other costs as computed in this study and obtain an estimate of the

total costs of processing for each hour of machine operating time.

Average Number of Hours of Machine Operation: The plants in Group I averaged 1,507 hours of machine-operating time during 1952 and cleaned a weighted average of 2,182 pounds of seed per hour of machine-operating time. The quantity of seed cleaned by the plants varied considerably but averaged about 2.8 million pounds during 1952.

The plants in Group II averaged only 698 hours of machine-operating time and cleaned a weighted average of 1,831 pounds of seed per hour. The plants in this group averaged only slightly over 1.1 million pounds of seed cleaned during 1952, but this relatively low average was due in part to the fact that one plant cleaned only about 200 thousand pounds during the year. However, of this 200 thousand pounds, a high proportion was small seeded legumes and other small seeds which cleaned at a slow rate and the hours of machine operation for this plant compared more favorably with the average for the group.

Generally speaking, the rate at which the different kinds of seed were cleaned by plants with same size machines did not vary significantly. Therefore, the difference in the average quantity of seed cleaned per hour is explained, for the most part, by the difference in the relative quantities of seed cleaned by the plants which cleaned at a slow rate and those which cleaned at a more rapid rate. A simple example will illustrate this point. Let us assume that Plants A and B each cleaned two million pounds of seed. Plant A cleaned 500 thousand pounds of seed that cleaned at an average rate of 500 pounds per hour and 1,500 thousand pounds that cleaned at an average rate of 3,000 pounds per hour. The weighted average for this plant would be 1,333 pounds per hour. On the other hand, let us assume that the proportion was one million pounds of each type of seed cleaned by Plant B. The weighted average for Plant B would be 857 pounds per hour.

The number of hours of machine operation for the plants indicated that there was considerable idle time for the machines even when operating at or near capacity. As noted above, the time required for clean-up between lots of seed was a very important factor in this respect, but other factors also accounted for some of this idle machine time. Probably the most important one, other than clean-up, for most of the plants was time that the machine was stopped while the labor force was working on the supplementary enterprise. Although this time was not chargeable to the seed processing operation there was, nevertheless, the fact that the machine was idle. The plant operators often shut down to receive and ship seed, which accounts for some of the idle machine time.

Cost of Plant Operation

Annual Investment Costs: The annual investment costs[4] for the plants studied are shown in Tables 3 and 4. The data in Table 2 show a separate item for buildings and land, whereas, in Table 4 these costs have been allocated to the three primary functions.

The differences in the investment costs reflect to a large extent the same to the capital investment. The greatest difference in the two groups was in the investment cost of receiving equipment. Group I had a total investment cost of $2,091 while Group II had a cost of $397 for this item, Table 4. The amount of the receiving costs chargeable to seed processing was also considerably higher for Group I than for Group II, even though a much greater proportion of the total for Group I was allocated to other enterprises. The average annual investment costs for the screen and air

[4] Investment costs as used in this study refer to the proportion of fixed cost attributable to capital investment. Fixed costs not included in investment cost consist primarily of salaried employees including management.

Table 3. Average annual investment costs for three groups of seed processing plants in Mississippi.

Item	Costs based on prices prevailing when the plants were constructed and equipped.			Estimated costs if plants had been constructed and equipped in 1952.[1]		
	Group I	Group II	Group III	Group I	Group II	Group III
(a) Average total annual fixed costs for all buildings and equipment used in seed processing.						
Buildings and land	$2,023	$ 855	$220	$2,609	$ 956	$269
Receiving equipment	1,166	83	1	1,637	85	1
Processing equipment	1,192	804	238	1,773	904	306
Shipping equipment	152	7	4	221	9	7
Miscellaneous equipment	117	35	----	185	39	----
Total	$4,650	$1,784	$465	$6,425	$1,993	$583
(b) Average annual fixed cost chargeable to the seed processing operation.						
Buildings and land	$1,051	$ 855	$220	$1,433	$ 955	$269
Receiving equipment	512	60	1	610	61	1
Screen and air machines[2]	829	561	213	1,285	639	280
Shipping equipment	58	7	6	81	9	8
Miscellaneous equipment	71	35	----	111	39	----
Subtotal:	$2,521	$1,518	$440	$3,520	$1,704	$558
Other processing equipment	363	243	25	488	265	26
Total	$2,884	$1,761	$465	$4,008	$1,969	$584

[1] Costs for 1952 based on indexes of building costs and of farm machinery costs. See page 5 and Tables 1 and 2 of the Appendix.

[2] Includes the fixed costs of (1) feeding and sacking elevators, (2) holding bins over the machines, and (3) sacking bins (when these facilities are owned by the plant).

Table 4. Average annual investment costs by type of operation for three groups of seed processing plants in Mississippi.

Item	Costs based on prices prevailing when the plants were constructed and equipped.			Estimated costs if plants had been constructed and equipped in 1952.[1]		
	Group I	Group II	Group III	Group I	Group II	Group III
(a) Average total annual fixed costs for all buildings and equipment used in seed processing.						
Receiving	$2,091	$ 397	$ 56	$2,800	$ 433	$ 70
Processing	1,480	991	277	2,230	1,111	354
Shipping	962	357	131	1,201	405	159
Miscellaneous	117	40	-----	186	45	-----
Total:	$4,650	$1,785	$464	$6,427	$1,994	$583
(b) Average annual fixed cost chargeable to the seed processing operation.						
Receiving	$ 959	$ 374	$56	$1,203	$ 408	$ 70
Screen and air machines[2]	1,018	689	250	1,582	782	327
Shipping	426	357	131	539	405	159
Miscellaneous	71	49	-----	111	45	-----
Subtotal:	$2,474	$1,460	$437	$3,435	$1,640	$556
Other processing equipment	410	301	27	647	329	27
Total:	$2,884	$1,761	$464	$4,082	$1,969	$583

[1] Costs for 1952 based on indexes of building costs and of farm machinery costs. See page 5 and Tables 1 and 2 of the Appendix.

[2] Includes the fixed costs of (1) feeding and sacking elevators, (2) holding bins over the machines, and (3) sacking bins (when these facilities are owned by the plant).

machines were $329 more for Group I than for Group II. This difference was due for the most part to differences in cost of installation and of supplementary equipment such as holding bins and elevators.

The effect of the general price level on the cost of operation can be seen by comparing the annual investment costs based on prices prevailing at the time the plant was constructed and equipped, with the estimated annual investment costs if the plant had been constructed and equipped in 1952, Table 4. For example, the total investment cost for Group I increased from $4,650 to $6,425, or an over-all increase of about 38 percent. The total investment costs for Group II increased from $1,785 to $1,994 or an over-all increase of about 12 percent.

Overhead Labor Cost

Attention has been directed to the fact that many of the operators kept at least one laborer as a nucleus for his seasonal labor force. Four plants actually kept two laborers on a year-round basis, but each of the operators pointed out that they were able to do this only because their services could be utilized by the supplementary enterprise. Therefore, the overhead labor cost included only the wages of one laborer.

The annual overhead labor cost was based on the assumption that during the rush season the laborer would work 60 hours per week, but during seasons when only a relatively small quantity of seed was being cleaned he would work only 40 hours per week. The number of months which the plants were operated at capacity varied among the plants but an average of five months at capacity was used as the basis for computing this cost item. The minimum wage was considered most satisfactory for use even though two of the plants paid the most experienced men 90 cents per hour, and some did not pay the minimum. During the rush season, therefore, the weekly wage would be $52.50 (75 cents for 40 hours and $1.125 for 20 hours) and during the remaining weeks the wage would be $30.00 or an annual wage of $2,055.

The salary for the foreman, or plant superintendent and/or the owner, is also an overhead labor cost. However, this item was omitted from the computation because of the practical impossibility of assigning a value to the time which the various men spent with seed cleaning. It was felt that, since there was such a wide variation here, it would be better to compute the cost of processing exclusive of this cost and let the individual plant operator make charges for this particular item of expense. The time spent by the plant owner or superintendent varied from casual supervision to a very active participation in the work within the plant. The time which these men worked was included in determining the time spent performing the various operations in the plants, but the labor cost was computed at the rate for unskilled labor. There was only one plant in which this method of computation made any material difference, and when considered in terms of an average this effect was minimized.

Miscellaneous Costs

The miscellaneous costs shown in Table 5 include only the expenses incurred during 1952 which were considered chargeable to the seed-cleaning or processing operation. Most of the difference in the total miscellaneous costs for Group I and Group II was the result of higher maintenance and repair costs and the cost of insurance on inventory for Group I. One of the plants in Group II carried insurance on inventory for the farmers who requested it but it was not considered a direct cost to the plant since the cost of the insurance was included in the cleaning charges. If a farmer did not desire to have his seed insured while they were being held in plant storage he signed a statement to that effect.

Summary of Fixed and Miscellaneous Costs

The difference in the total costs (except variable labor) of operating the "primary" machine for Group I was about 45 percent higher than for Group II, Table 6. It should be noted that the investment cost here included only the proportion of the total which was chargeable to the seed cleaning operation, and also, that this same basis was used for computing the miscellaneous costs.

The estimated total costs (except variable labor) if the plant had been constructed and equipped in 1952 is also summarized in Table 5. Based on this estimate the costs for Group I were almost 60 percent greater than Group II. The comparison of the estimates and the actual average costs gives an indication of the effect of the general level of prices prevailing when the facility was constructed and equipped.

Cost Per Hour of Machine Operation

It was pointed out previously that the costs have been computed with the view to determining the cost per hour of operation for only the screen and the air machine. The fixed costs for all other processing equipment, including a building cost allocation are shown in Table 4. However, no allocation was attempted for the receiving equipment, shipping equipment, or miscellaneous costs. The costs per hour of operation for the screen and the air machine included the total costs of these items which were considered chargeable to the seed-processing operation.

The labor cost for one man was included in the cost item of overhead labor. Therefore, the variable labor costs have been computed on the basis of the man minutes required per hour of macine-operating time, minus 60 minutes. For plants in Group I, variable labor

Table 5. Average annual miscellaneous costs for the seed processing enterprise, three groups of seed processing plants, 1952.

Item	Group I	Group II	Group III
Utilities	$ 653	$558	$ 87
Maintenance and repairs	791	162	75
Insurance of inventory	206	-----	-----
Other miscellaneous expense	200	177	-----
Total	$1,850	$897	$162

Table 6. Summary of costs (except variable labor) chargeable to the seed processing enterprise,[1] three groups of seed processing plants.

Cost Item	Costs based on prices prevailing at the time the building was constructed and equipped.			Estimated if plant had been constructed and equipped in 1952.[2]		
	Group I	Group II	Group III	Group I	Group II	Group III
Investment costs	$2,474	$1,460	$465	$3,435	$1,641	$583
Overhead labor	2,055[3]	2,055[3]	-----	2,055[3]	2,055[3]	-----
Miscellaneous	1,850	987	162	1,850	897	162
Total	$6,379	$4,412	$627	$7,340	$4,593	$745

[1]Only the screen and air machine included in processing equipment.

[2]Estimates of costs for 1952 based on indexes of construction costs and of farm machinery.

[3]Does not include any charge for the time spent on the seed processing operation by the foreman and/or owner.

requirements per hour of machine-operating time amounted to 98 minutes for seed received in bulk and transferred directly to the machine, Table 6. The plants in Group II required 161 minutes, above the overhead labor, for each hour of machine-operating time. If the same volume (2,000 pounds) were cleaned per hour by each group, the variable labor would have been 94 and 170 minutes, respectively, for Group I and Group II. The labor required for the various functions when seed are all received and stored is also shown in Table 2. Attention should be given to the fact that the time computed here does not include an allowance for time required for clean-up and change-over or for any idle time by the labor force. Also of importance is the fact that the overhead labor does not include an allowance for the owner and/or foreman. Reasons for omitting these items have been pointed out on page 16.

Tables 7 and 8 show costs for the different groups of plants when operating at various levels of capacity ranging from 250 to 2,000 hours of machine operation per year. The effect of the number of hours of operation on the average total fixed costs per hour for the screen and the air machine in each of the three groups is illustrated in Table 7. This table reveals several things which are important. Among these points are: (1) When a plant has high fixed costs, such as those in Group I, it is imperative that it operate at a relatively high capacity in order to reduce the cost per hour of operation; (2) The plants in Group III cannot afford to install other labor-saving equipment unless the volume handled can be increased substantially, and (3) The level of prices prevailing at the time the plants were constructed and equipped will materially affect the cost of operation. For example, based on prices prevailing at the time the plants were constructed and equipped, the fixed cost for Group I, operating at an annual capacity of 700 hours, was estimated at $3.53 per hour of machine operating time; however, the estimated cost, if the plants had been constructed and equipped in 1952, was $4.91 per hour—a difference of $1.38 per hour of operation.

The labor costs (excluding a charge for the owner and/or foreman) are included in the costs shown in Table 8 for Group I and II. The most important point to note from this table is that each group has the most economical balance between labor and fixed costs at their present level of operation. Based on prices prevailing at the time the plants were constructed and equipped when operating 700 hours per year, Group II has a cost of $8.58 per hour and Group I has a cost of $8.91 per hour. On the other hand, at an annual rate of 1,500 hours, the plants in Group I had a cost of $5.46 per hour and Group II had a cost of $5.89 per hour. Although plants in Group I had considerably lower costs per hour of operation at their present level of operation ($5.46 per hour for 1,500 hours) than plants in Group II ($8.58 for 700 hours) these data emphasize the fact that unless the plants in Group II could increase the volume of seed cleaned it would not be economical for them to put in additional labor-saving equipment.

The estimates given in Table 8 (b) indicate that if the plants had all been constructed in 1952, those in Group II would have had lower costs at even 1,500 hours of annual machine operation. At the 700 hour level the cost for Group II was substantially lower, $8.83 as compared with $10.29 for Group I, and at the 1,500 hour level the comparable figures were $6.01 for Group II and $6.10 for Group I.

For those persons who want more information on costs, Tables 4 and 5 are included in the Appendix. Table 4 shows what the total investment cost per hour of operation would have been if the plant operators had not been able to offset

Table 7. Average investment costs per hour of machine operation for the screen and air machine when operating at different levels of capacity, three groups of seed processing plants in Mississippi.[1]

Group and cost item	Average investment costs	Cost per hour when operating at an annual capacity of 250 hours[2]	500 hours[3]	700 hours	1,000 hours	1,500 hours[4]	2,000 hours
(a) Based on prices prevailing when the plants were constructed and equipped.							
Group I:							
Receiving	$ 959	$3.84	$1.92	$1.37	$ .96	$ .64	$ .48
Processing	1,018	4.07	5.04	1.45	1.02	.68	.51
Shipping	426	1.70	.85	.61	.43	.28	.22
Miscellaneous	71	.28	.14	.10	.07	.05	.04
Total:	$2,474	$9.89	$4.95	$3.53	$2.47	$1.65	$1.25
Group II:							
Receiving	$ 374	$1.49	$ .74	$ .53	$ .37	$ .25	$ .18
Processing	689	2.74	1.37	.98	.69	.46	.34
Shipping	357	1.43	.72	.51	.36	.24	.18
Miscellaneous	40	.16	.08	.06	.04	.03	.02
Total:	$1,460	$5.82	$2.91	$2.08	$1.46	$ .98	$ .72
Group III:							
Receiving	$ 56	$ .22	$ .11	$ .08	$ .06	$ .04	$ .03
Processing	250	1.00	.50	.36	.25	.17	.12
Shipping	131	.52	.26	.19	.13	.09	.06
Total:	$ 437	$1.74	$ .87	$ .63	$ .44	$ .30	$ .21
(b) Estimated if plants had been constructed and equipped in 1952.[5]							
Group I:							
Receiving	$1,203	$ 4.81	$2.40	$1.72	$1.20	$ .80	$ .60
Processing	1,582	6.33	3.16	2.26	1.58	1.05	.79
Shipping	539	2.16	1.08	.77	.54	.36	.27
Miscellaneous	111	.44	.22	.16	.11	.07	.06
Total:	$3,435	$13.74	$6.86	$4.91	$3.43	$2.28	$1.72
Group II:							
Receiving	$ 408	$ 1.63	$ .82	$ .58	$ .41	$ .27	$ .20
Processing	782	3.13	1.56	1.12	.78	.52	.39
Shipping	405	1.62	.81	.58	.40	.27	.20
Miscellaneous	45	.18	.09	.06	.04	.03	.02
Total:	$1,640	$ 6.56	$3.28	$2.34	$1.63	$1.09	$ .81
Group III:							
Receiving	$ 70	$ .28	$ .14	$ .10	$ .07	$ .05	$ .04
Processing	327	1.31	.66	.47	.33	.22	.16
Shipping	159	.64	.32	.23	.16	.11	.08
Total:	$ 556	$ 2.23	$1.12	$ .80	$ .56	$ .38	$ .28

[1] The total receiving, shipping and miscellaneous costs "chargeable to seed processing" are included here, but only the fixed costs for the screen and air machine are included under processing. See text page 13.

[2] Approximate average number of hours actually operated by the plants in Group III.

[3] Approximate average number of hours actually operated by the plants in Group II.

[4] Approximate average number of hours actually operated by the plants in Group I.

[5] Estimates based on indexes of construction costs and farm machinery costs. See text page 5 and Appendix Tables 1 and 2.

Table 8. Total cost per hour of machine operating time for the screen and air machine, two groups of seed processing plants in Mississippi when operating at different levels of capacity.[1]

Group and cost item	cost of item Average total	Costs per hour when operating at an annual capacity of 500 hours	700 hours[2]	1,000 hours	1,500 hours[3]	hours 2,000
(a) Fixed costs based an prices prevailing at the time when the plants were constructed and equipped.						
Group I:						
Investment costs	$2,474	$ 4.95	$ 3.53	$2.47	$1.65	$1.25
Overhead labor	2,055[4]	4.11	2.94	2.06	1.37	1.03
Misc. costs	1.850[5]	1.23	1.23	1.23	1.23	1.23
Subtotal:	$6.379	$10.29	$ 7.70	$5.76	$4.25	$3.51
Variable labor @ 75¢ per hour[6]		1.21	1.21	1.21	1.21	1.21
Total:		$11.50	$ 8.91	$6.97	$5.46	$4.72
Group II:						
Investment costs	$1,460	$ 2.92	$ 2.09	$1.46	$ .97	$ .73
Overhead labor	2,055[4]	4.11	2.94	2.06	1.37	1.03
Misc. costs	897[5]	1.28	1.28	1.28	1.28	1.28
Subtotal:	$4,412	$ 8.31	$ 6.31	$4.80	$3.62	$3.04
Variable labor @ 75¢ per hour[6]		2.27	2.27	2.27	2.27	2.27
Total:	$ 10	$10.58	$ 8.58	$7.07	$5.89	$5.31
(b) Estimated fixed costs if plant had been constructed and equipped in 1952.[5]						
Group I:						
Investment costs	$3,435	$ 6.87	$ 4.91	$3.44	$2.29	$1.72
Overhead labor	2,055[4]	4.11	2.84	2.06	1.37	1.03
Misc. costs	1,850[5]	1.23	1.23	1.23	1.23	1.23
Subtotal:	$7,340	$12.21	$ 9.08	$6.73	$4.89	$3.98
Variable labor @ 75¢ per hour[6]		1.21	1.21	1.21	1.21	1.21
Total:		$13.42	$10.29	$7.94	$6.10	$5.19
Group II:						
Investment costs	$1,641	$ 3.28	$ 2.34	$1.64	$1.09	$ .82
Overhead labor	2,055[4]	4.11	2.94	2.06	1.37	1.03
Misc. costs	897[5]	1.28	1.28	1.28	1.28	1.28
Subtotal:	$4,593	$ 8.67	$ 6.56	$4.98	$3.74	$3.13
Variable labor @ 75¢ per hour[6]		2.27	2.27	2.27	2.27	2.27
Total:		$10.94	$ 8.83	$7.25	$6.01	$5.40

[1]The total receiving, shipping and miscellaneous costs "chargeable to seed processing" are included here, but only the fixed costs for the screen and air machine are included under processing. See text page 13.

[2]Approximate average number of hours actually operated by the plants in Group III.

[3]Approximate average number of hours actually operated by the plants in Group II.

[4]Approximate average number of hours actually operated by the plants in Group I.

[5]Estimates based on indexes of construction costs and farm machinery costs. See text page 5 and Appendix Tables 1 and 2.

[6]Variable labor 97.1 man minutes per hour of machine operating time for the plants in Group I and 181.9 man minutes per hour of machine operating time for the plants in Group II.

part of their investment costs by having supplementary enterprises. They were able to use part of the seed-processing facilities in these supplementary enterprises during seasons when they were not being used to process seed. Table 5 contains a cost schedule similar to the one in Table 7, but all of the labor is assumed to be variable. In studying the table, the assumptions on which the data are based should be noted. These assumptions are given in Footnote 3 of the Appendix Table 5. For plants without an overhead labor cost, Appendix Table 5 may be most useful as a guide. However, as in the other computation, there was no allowance for clean-up and change-over time or for the owner and/or the foreman.

Adjustment Which Would Provide More Efficient Operations

The preceding data have emphasized the relationship of the volume of seed cleaned to the cost per hour of machine operation. However, the time data taken during the course of this study provide a basis for pointing out other ways of increasing efficiency without increasing the volume of seed handled. In addition, there are areas where changes will bring increased efficiency as the volume of seed handled is increased.

Several fundamental facts affecting processing cost should be pointed out. They are probably obvious to those already operating seed-processing plants, but they may be less obvious to those considering the construction of a plant. The first of these is that each time a lot of seed is handled, the cost of processing is increased. Therefore, every effort should be made to hold to a minimum the number of times a lot is handled during the cleaning process. Another important consideration is that the most economical method of transferring seed from one point to another is by gravity flow. (Assuming, of course, that any economy thus gained is not offset by other higher costs, such as, excessive capital investment in relation to the volume of seed to be handled.) Still another point is that the elevation of the loading platform will materially affect the labor required for loading and unloading bagged products. Finally, but not necessarily least important, the time required to clean up between lots of seed should be considered before installing any additional equipment which is designed to reduce labor time in one area of the plant, while increasing the labor required for clean-up.

Since no time data were taken for the small plants in Group III, no specific recommendations can be made for increasing efficiency within this group. However, it is doubtful that they could economically add any substantial amount of labor-saving equipment with their present volume of operation. If these plant operators increase the volume of seed handled, then the same general methods of increasing efficiency would apply as those given for the plants in Groups I and II.

The plants similar to those studied in Groups I and II which do not have a truck hoist and dumping pit should consider this method of receiving for bulk seeds. Observations indicated that, with the average efficiency of labor employed, the volume of seed received per man minute of labor could be increased at least three times. One operator without a dumping pit was only one-half as efficient as those having a dumping pit; however, two operators with some facilities for handling bulk seed, but who did not have dumping pits were only about one-fourth as efficient. Part of this inefficiency was due to inefficient labor, but it could not all be attributed to this factor. The installation of the dumping pit should not be considered, however, if the volume of seed cleaned is not large enough so that the economics in labor will more than offset the additional fixed cost of the receiving equipment. In most cases the addition of a dumping pit would require that an

elevator also be installed or alterations made on the one currently in use.

The most economical handling of bulk seeds requires that adequate storage facilities be provided and that these facilities be accessible to both the receiving and the processing equipment. There are many obstacles in the way of making specific recommendations for providing these facilities. As noted earlier in the report, each of the plants with facilities for handling bulk seed had a different method of transferring the seed to storage. Time data taken were not conclusive enough to determine exactly which method of transfer was most efficient but two observations require consideration. First, the gravity-flow method is undoubtedly more economical if the seed can be lifted high enough to flow freely into the storage bins, and second, the equipment should be relatively easy to clean.

There seems to be little doubt that, in most cases, it would be economical in the long run to provide storage bins with self-cleaning bottoms. The labor used to maintain the flow of grain and to clean out the flat bottom bin increased significantly the total labor required. Time data were not taken over a long enough period to give concrete information on labor required, but in attempting to add storage space by the use of flat bottom bins the operator should consider at least two factors. Probably the most important one is the estimated length of time which would be required to clean the bins during one season (using an average turnover based on actual or anticipated volume of seed to be cleaned) multiplied by the number of years which the facilities will be used. Another important factor is the size of the average lot of seed received. In many instances, the plants in Group I did not use all of the space in a storage bin because of the relatively small lots of seed being received. This factor indicates that the additional storage space afforded by flat bottom bins may not be as important as may seem to many operators.

A number of suggestions were offered by plant managers. Two of these suggestions seem worthy of mention although neither was in actual use. One of these was the use of a movable bottom with sloping sides which could be moved along a track above the transfer belt or auger and through which the flow of seed could be regulated. Another suggestion was the use of portable bins which would hold the average small lot of seed and which could be handled by the use of a motor (fork) lift.

For the plants with sufficient volume a motor lift should be considered for receiving bagged seed and for transferring bagged seed to storage and from storage to the farm truck. From the standpoint of the labor required the one plant using a motor lift stacked the seed in the warehouse about four times as fast as the other plants in both Group I and Group II. The other plants stacked the seed in storage at about the same rate, averaging less than 100 pounds per man minute of labor. The plant using the motor lift averaged about 400 pounds of seed per man minute. The savings were not as significant when transferring from storage to the farm truck since the driver usually waited for a pallet to be unloaded before returning for another load. Even then there was a considerable reduction in labor, particularly over the plant loading from ground level. In this instance the motor lift was almost three times as efficient as hand labor. Each of the four plants with "truck bed level" loading ramps loaded out about 150 pounds per man minute of labor, whereas the plant with the motor lift averaged almost 225 pounds. This compared with about 85 pounds for the plant with a ground level plant floor and without a motor lift.

A number of factors should be considered in arranging the machines within the plant. Apparently one of the most

important factors in this respect is to provide for the continuous flow of seed through all of the machines used in the cleaning process. For example, if a series of machines are to be used for processing a specified lot of seed, the equipment should be so arranged that continuous flow can be accomplished without having to bag or transfer the seed to bulk storage and be brought back to the other machines at a later date. In providing arrangement for continuous flow of seed through the machines, two plants in the sample provided an interesting contrast. One of the plants, which used a two-screen machine as a scalper could scalp, scarify, clean over a four-screen machine, and transfer to a spiral or length separator without handling the seed after they were dumped into the feed elevator pit. Each of these machines could be by-passed and the seed bagged at any point along the cleaning process. At the other extreme, one plant had the screen and air machine which was used to clean most of the legume seed at one end of the plant building and the gravity table which was used to reclean much of the clover seed located at the opposite end of the building. The clover had to be bagged off and moved to the gravity table which increased the labor requirement significantly.

A holding bin above the screen machine and a large bagging bin provided for much more flexibility in the use of plant labor. Without these bins it was often necessary to keep one man dumping seed from bags into the machine and one man bagging. At least one-third to one-half of the laborer's time could be devoted to other tasks if the seed could be dumped and bagged more rapidly. This was particularly true with seed that cleaned at a relatively slow rate.

An electric bag sewing machine mounted above the bagging area will generally replace one man when cleaning seed that flow freely, such as oats and roughpeas. It was often impossible for one person to hand sew as fast as the seed were bagged. On the other hand, where the sewing machine was used efficiently on person could bag off and sew without any apparent difficulty.

APPENDIX

Table 1. Index numbers of prices paid by farmers for farm machinery, 1930-52.[1]

Year	Index 1910-14 = 100	Year	Index 1910-14 = 100
1930	152	1942	164
1931	150	1943	170
1932	142	1944	174
1933	138	1945	176
1934	144	1946	182
1935	148	1947	206
1936	150	1948	240
1937	153	1949	270
1938	158	1950	276
1939	155	1951	299
1940	153	1952	309
1941	155		

[1]Source: Bureau of Agricultural Economics, **Agricultural Prices,** October 27, 1950, page 41, for the years 1930 through 1949. Data for 1950 through 1952 are simple averages of the quarterly indexes taken from the respective issues of the same publication.

Table 2. Index numbers of commercial and factory building construction costs, 1930-52.[1]

Year	Index 1947-49 = 100	Year	Index 1947-49 = 100
1930	51.4	1942	60.8
1931	47.6	1943	63.2
1932	41.0	1944	67.5
1933	42.0	1945	71.6
1934	45.8	1946	78.1
1935	45.1	1947	91.7
1936	46.5	1948	103.6
1937	51.9	1949	104.8
1938	53.8	1950	109.5
1939	54.3	1951	117.9
1940	55.2	1952	121.9
1941	57.9		

[1]Source: E. H. Boeckh and Associates, Reported by National Production Authority, United States Department of Commerce, Washington, D. C., in Construction and Building Materials, Statistical Supplement, May, 1952, Page 34.

Table 3. Schedule of depreciation rates used in this study

	Percent
I. Buildings	
A. All buildings except wood construction	3
B. Wood construction	4
II. Equipment	
A. Scales	
1. Truck or wagon	3
2. Platform	4
B. Processing	6.7
C. Elevators	
1. Bucket	5
2. Chain	10
D. Conveyors	
1. Belt	6.7
2. Screw	10
E. Other	
1. Bag trucks	6.7
2. Bag sewing machines	6.7
3. Laboratory equipment	6.7
4. Stencil cutting machine	5
5. Truck hoist and dumping pit (combine)	5
6. Other miscellaneous	6.7
7. Motor lift and pallets	10

Table 4. Average investment costs per hour of operation for the major functions within the plant, when operating at different levels of capacity, three groups of seed processing plants in Mississippi.[1]

Group and cost item	Average investment costs	Cost per hour when operating at an annual capacity of: 250 hours[2]	500 hours	700 hours[3]	1,000 hours	1,500 hours[4]	2,000 hours
(a) Based on prices prevailing when the plants were constructed and equipped.							
Group I:							
Receiving	$2,091	$ 8.36	$ 4.18	$2.99	$2.09	$1.39	$1.05
Processing	1,480	5.92	2.96	2.11	1.48	.99	.74
Shipping	962	3.85	1.92	1.37	.96	.64	.48
Miscellaneous	117	.47	.24	.17	.12	.08	.06
Total:	$4,650	$18.16	$ 9.30	$6.64	$4.65	$3.10	$2.33
Group II:							
Receiving	397	1.59	.80	.57	.40	.27	.20
Processing	991	3.96	1.98	1.42	.99	.66	.50
Shipping	357	1.43	.72	.51	.36	.24	.18
Miscellaneous	40	.16	.08	.06	.04	.03	.18
Total:	1,785	7.14	3.58	2.56	1.79	1.20	.90
Group III:							
Receiving	56	.22	.11	.08	.06	.04	.03
Processing	277	1.11	.56	.40	.28	.19	.14
Shipping	131	.52	.26	.19	.13	.09	.07
Total:	464	1.85	.93	.67	.47	.32	.24
(b) Estimated if the plants had been constructed and equipped in 1952.[5]							
Group I:							
Receiving	$2,800	$11.20	$ 5.60	$4.00	$2.80	$1.87	$1.40
Processing	2,230	8.92	4.46	3.19	2.23	1.49	1.12
Shipping	1,201	4.80	2.40	1.72	1.20	.80	.60
Miscellaneous	186	.75	.38	.27	.19	.12	.09
Total:	$6,427	$25.67	$12.84	$9.18	$6.42	$4.28	$3.21
Group II:							
Receiving	433	1.73	.86	.62	.43	.29	.22
Processing	1,111	4.44	2.22	1.59	1.11	.74	.56
Shipping	405	1.62	.81	.58	.40	.27	.20
Miscellaneous	45	.18	.09	.06	.04	.03	.02
Total:	1,994	7.97	3.98	2.85	1.98	1.33	1.00
Group III:							
Receiving	70	.28	.14	.10	.07	.05	.04
Processing	354	1.42	.71	.51	.35	.24	.18
Shipping	159	.64	.32	.23	.16	.11	.08
Total:	583	2.34	1.17	.84	.58	.40	.30

[1]Note: These data are shown primarily, for emphasis on what the overall investment cost per hour of plant operation would be if the operators of the seed processing plants did not have supplementary enterprises to help offset these investment costs. It should be noted that the cost per hour of machine operation for the screen and air machine shown in the following tables, allocate certain of these investment costs to other enterprises and also that the investment cost for processing equipment other than the screen and air machine are omitted. For definition of investment cost see footnote 4 page 13.

[2]Approximate average number of hours actually operated by the plants in Group III.

[3]Approximate average number of hours actually operated by the plants in Group II.

[4]Approximate average number of hours actually operated by the plants in Group I.

[5]Estimates based on indexes of construction costs and farm machinery costs. (See text page 5 and Appendix Tables 1 and 2.)

Table 5. A comparison of the investment[1] costs and labor costs per hour of machine operation for two groups of seed processing plants in Mississippi when operating at different levels of capacity.

Groups and function	500 hours			700 hours[2]			1,000 hours			1,500 hours[3]			2,000 hours		
	Investment costs	Labor costs[3]	Total	Investment costs	Labor costs[3]	Total	Investment costs	Labor costs[3]	Total	Investment costs	Labor costs[3]	Total	Investment costs	Labor costs[3]	Total
(a) Fixed costs based on prices prevailing when the buildings were constructed and equipped.															
Group I:															
Receiving	1.92	.18	2.10	1.37	.18	1.55	.96	.18	1.14	.64	.18	.82	.48	.18	.66
Processing	2.04	1.51	3.55	1.45	1.51	2.96	1.02	1.51	2.53	.68	1.51	2.19	.51	1.51	2.02
Shipping	.85	.27	1.12	.61	.27	.88	.43	.27	.70	.28	.27	.55	.22	.27	.49
Total:	4.81	1.96	6.77	3.43	1.96	5.39	2.41	1.96	4.37	1.60	1.96	3.56	1.21	1.96	3.17
Group II:															
Receiving	.74	.52	1.26	.53	.52	1.05	.37	.52	.89	.25	.52	.77	.18	.52	.70
Processing	1.37	2.02	3.39	.98	2.02	3.00	.69	2.02	2.71	.46	2.02	2.48	.34	2.02	2.36
Shipping	.72	.48	1.20	.51	.48	.99	.36	.48	.84	.24	.48	.72	.18	.48	.66
Total:	2.83	3.02	5.85	2.02	3.02	5.04	1.42	3.02	4.44	.95	3.02	3.97	.70	3.02	3.72
(b) Investment costs estimated for the cost of buildings constructed and equipped in 1952.															
Group I:															
Receiving	2.40	.18	2.58	1.72	.18	1.90	1.20	.18	1.38	.80	.18	.98	.60	.18	.78
Processing	3.16	1.51	4.67	2.26	1.51	3.77	1.58	1.51	3.09	1.05	1.51	2.56	.79	1.51	2.30
Shipping	1.08	.27	1.35	.77	.27	1.04	.54	.27	.81	.36	.27	.63	.27	.27	.54
Total:	6.64	1.96	8.60	4.75	1.96	6.68	3.32	1.96	5.25	2.21	1.96	4.17	1.66	1.96	3.62
Group II:															
Receiving	.82	.52	1.34	.58	.52	1.10	.41	.52	.93	.27	.52	.79	.20	.52	.72
Processing	1.56	2.02	3.58	1.12	2.02	3.14	.78	2.02	2.80	.52	2.02	2.54	.39	2.02	2.41
Shipping	.81	.48	1.29	.58	.48	1.06	.40	.48	.88	.27	.48	.75	.20	.48	.68
Total:	3.19	3.02	6.21	2.28	3.02	5.30	1.59	3.02	4.61	1.06	3.02	4.08	.79	3.02	3.81

[1] For definition of investment costs see footnote 4 page 13

[2] Approximate average number of hours actually operated by the plants in group II.

[3] Approximate average number of hours actually operated by the plants in Group I.

[4] The labor costs shown here are based on the following assumptions: (1) The plants in each group cleaned a weighted average quantity of 2,000 pounds of seed per hour. (2) All the labor costs were variable and labor was paid 75 cents per hour. (3) One half of the seed received was transferred directly to the machine and one half was placed in storage and later transferred to the machine. For Group I all the storage was bulk storage with the average receiving time being 14.6 man minutes per hour of machines operating time. For Group II all the storage was bagged storage with the average receiving time being 41.4 man minutes per hour of machine operating time. (4) Processing time was 121 and 162 man minutes per hour of machine operating time for Group I and II, respectively. (5) Shipping time was 21.5 and 38.5 man minutes per hour of machines operating time for Group I and II, respectively.