Artificial Corn Drying by Selected Elevators in Indiana

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The Farmer Cooperative Service conducts research studies and service activities of assistance to farmers in connection with cooperatives engaged in marketing farm products, purchasing farm supplies, and supplying business services. The work of the Service relates to problems of management, organization, policies, financing, merchandising, quality, costs, efficiency, and membership.

The Service publishes the results of the studies; confers and advises with officials of farmers' cooperatives; and works with educational agencies, cooperatives, and others in the dissemination of information relating to cooperative principles and practices.

SUMMARY AND CONCLUSIONS

This report covers a study in Indiana of the costs, charges, and practices for artificial drying of corn at 29 country elevators and one terminal elevator in 1952. These elevators were fairly evenly distributed through the main grain producing areas of the State and included both cooperative and other types.

Only 6 of the 29 country elevators in the State did custom drying for farmers. Terminal elevators do no custom drying for farmers, although in some instances they do custom drying for country elevators. Most of the Indiana country elevators had below a 25,000 bushel capacity and lacked the storage space necessary for such drying. The remaining 23 of the 29 elevators studied dried corn for themselves.

The problem of high mositure content in corn is increasingly important. Primary reason for drying is to reduce the possibility of spoilage, but then the problem arises as to whether the farmer, the country elevator, or the terminal should do the job. This study covered only the aspects of the general problem pertaining to drying at country and terminal elevators.

If farmers have corn to sell with more than 15.5 percent moisture content and are not near an elevator that does custom drying, they must take a price discount on the wet corn. If the country elevator owns a drier, it must decide whether to dry the corn or ship it immediately to a terminal market and take a price discount for the excess mositure. If the elevator operator decides to dry the corn he must be able to operate the drier and absorb the shrinkage, if necessary, within the price discount the terminal market charges him for such moisture. Terminal markets determine this discount schedule and the country elevator has no control over it, however it is not bound by this schedule in the buying.

Country elevators do make a saving on freight when they dry corn and also have less risk of spoilage in transit. The elevator may also sell some dried corn locally or use it in feed manufacturing. In these cases the terminal market discount is less important.

If a local elevator has sufficient capacity to store shelled corn, owning a drier gives more diversification. Elevator managers estimated their driers contributed an average increase of at least 10 percent in volume of corn handled. In some cases, they must also dry to meet the local competition from other elevators with driers. However, terminals have some definite advantages in handling wet corn. They have larger storage capacity. They are able to blend wet corn of only a few points of excess moisture content with old carry-over stocks and thereby avoid artificial drying in many cases, an opportunity not available to most country elevators because of their smaller capacity and the variety in grains handled. And, of course, with larger volume, they can run a drier more economically.

This study showed volume to be one of the most important factors influencing country elevator costs of drying corn. In drying corn and shipping it on immediately to terminal markets, a country elevator -- cooperative or otherwise -- must dry an average annual volume of at least 100,000 bushels for economical operations. A volume of about 200,000 bushels is more satisfactory.

In arriving at this conclusion, the 29 country elevators were grouped according to their annual volume of corn dried. Group I consisted of 11 elevators drying an average volume of 25,000 bushels. Group II with 11 elevators dried an average of 90,000 bushels. Group III with 3 elevators dried an average of 202,000 bushels. And Group IV with 4 elevators dried an average volume of 337,000 bushels.

Costs were then determined for each group, both fixed and variable. The fixed costs included depreciation, interest, insurance and taxes. These averaged 2.1 cents a bushel for the entire 29 elevators, but ranged from .8 of a cent a bushel for Group IV to 8.4 cents for Group I with the smallest volume. Variable costs included fuel, labor, power and repairs. They averaged 1.9 cents a bushel for all the elevators, but ranged from 1.4 cents for Group IV to 4.4 cents for Group I.

The total fixed and variable costs ranged from 2.2 cents to 12.8 cents, with an overall average of 4 cents a bushel.

Fixed and variable cost for corn drying at country elevators, excluding shrinkage

Group	Number of elevators	Average annual volume dried	Average fixed cost	Average variable cost	Total cost
		Bushels		*Cents*	
I----------	11	25,000	8.4	4.4	12.8
II----------	11	90,000	2.5	2.1	4.6
III----------	3	202,000	1.3	1.8	3.1
IV----------	4	337,000	0.8	1.4	2.2
Average--		111,000	2.1	1.9	4.0

These costs did not include shrinkage, however, which averaged about 8.9 cents a bushel. This was based on drying shelled corn from 20.1 percent moisture down to 15.5 percent moisture.

Thus total costs -- fixed, variable, and shrinkage -- for drying this corn averaged 12.9 cents a bushel.

To specifically point up the problem a country elevator may be faced with, take the example of an operator who had 25,000 bushels of 20 percent moisture content corn. Price for corn with 15.5 percent moisture content was $1.50. Discount on 20 percent moisture content corn was 16 cents a bushel. Thus, the 25,000 bushels of wet corn at $1.34 a bushel would be worth $33,500. If this corn was dried to 15.5 percent moisture content the elevator would suffer a shrinkage or weight loss of

5.8 percent. The operator would then have 23,550 bushels worth $1.50 per bushel or a gross value of $35,325. This would leave a margin of $1,825 with which to dry the 25,000 bushels of wet corn. Unless he could dry the 25,000 bushels of wet corn for less than 7.3 cents a bushel he would not break even on the operation -- unless related benefits of additional volume and business brought to his elevator offset the cost of drying.

The terminal elevator studied had drying costs of 1.5 cents a bushel for fixed costs and 1 cent a bushel for variable costs -- or 2.5 cents a bushel for ownership and operating costs. A shrinkage cost of 8 cents a bushel brought total drying of this elevator to 10.5 cents a bushel. However, the moisture removed from corn dried at the terminal elevator was only 4 percentage points as compared with 4.6 percentage points removed at county elevators. This alone made drying costs lower at the terminal -- especially shrinkage which was .9 of a cent lower. The difference in total drying costs between terminal elevator and county elevators however was not all accounted for by the difference in the amount of moisture removed.

The year-to-year variation in the quantity of corn that will need drying is not easily determined since it is dependent primarily upon weather conditions. However, the increasing acceptance of the picker sheller by farmers in the commercial corn producing areas will probably have a tendency to stabilize volume. The economies of moving corn direct from the field to the elevator, either for sale or storage, are especially attractive in times of high labor and building costs if good farm storage is not already available. It is not however the volume dried in any one particular year that is important but the average volume dried over a period of several years that determines the feasibility of owning and operating a grain drier in conjunction with other elevator operations.

ARTIFICIAL CORN DRYING BY SELECTED ELEVATORS IN INDIANA

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When a farmer has corn for sale with excessive moisture, he must dry the corn on the farm or at a country elevator which does custom drying, or he must take price discounts. If the farmer elects to sell the corn without drying it, the elevator operator then has to decide whether he in turn should market the wet corn or whether he should dry it to avoid moisture discounts and risk of spoilage.

This problem is one of increasing importance. Farmers now strive to harvest their corn as early as possible to cut down field losses and to avoid extending harvesting operations into the period when the weather is likely to be more adverse. This practice results in harvesting corn with a higher moisture content than if it were harvested at a later date. Introducing and adopting late maturing varieties of corn have also added to the moisture problem. Gradual increase in the use of the picker sheller has brought on the problem of storing shelled corn of high moisture content that might otherwise be stored satisfactorily and dried naturally as ear corn.

To get information on this corn drying problem, the Farmer Cooperative Service and Purdue University studied operations on the 1952 crop in a number of elevators, cooperatives and others, in Indiana ... a State representative of the Corn Belt.

The phase of the study reported on here showed less than 10 percent of the Indiana elevators and relatively fewer farmers have grain driers. This report deals with one phase of the overall problem of grain conditioning -- the present costs, charges, and practices for artificially drying corn at country and terminal elevators. Other phases of the study on country and terminal grain conditioning practices not related to artificial drying and the practices and costs of artificial drying on farms will be covered in later reports. Most of the driers currently being used at local or country elevators came in the years 1947-50. Prior to 1946 only a small number of grain driers were in use on Indiana farms. Since then, an increasing number have been installed each year.

Note: The authors wish to express their appreciation to T. E. Hall, Chief, Grain Branch, Farmer Cooperative Service, for his help and suggestions.

A modern country elevator, constructed of concrete, with grain drier installed as near the elevator as is workable. Insurance rates on this type elevator and drier are about one-fourth of those for a wooden elevator with drier. Most country elevators in Indiana lacked storage space necessary for drying.

In order to decide whether they should dry corn artifically or whether they should take discounts for excess moisture, farmers and elevator operators must have adequate information on discounts and costs of drying corn artifically. Since the costs and returns might be different at the terminal elevator and on farms, it was decided that the costs and returns should be determined for each location.

Although this study refers only to corn drying, the same practices and principles apply to all grains. During the 1952 crop year, Indiana elevators dried only a very small amount of grains other than corn. Seven of the 29 elevators covered in the study dried some wheat. The amounts were so small that we combined wheat with corn to arrive at a weighted average for moisture content before drying.

CORN DRYING PRACTICES

LOCATION OF DRIERS

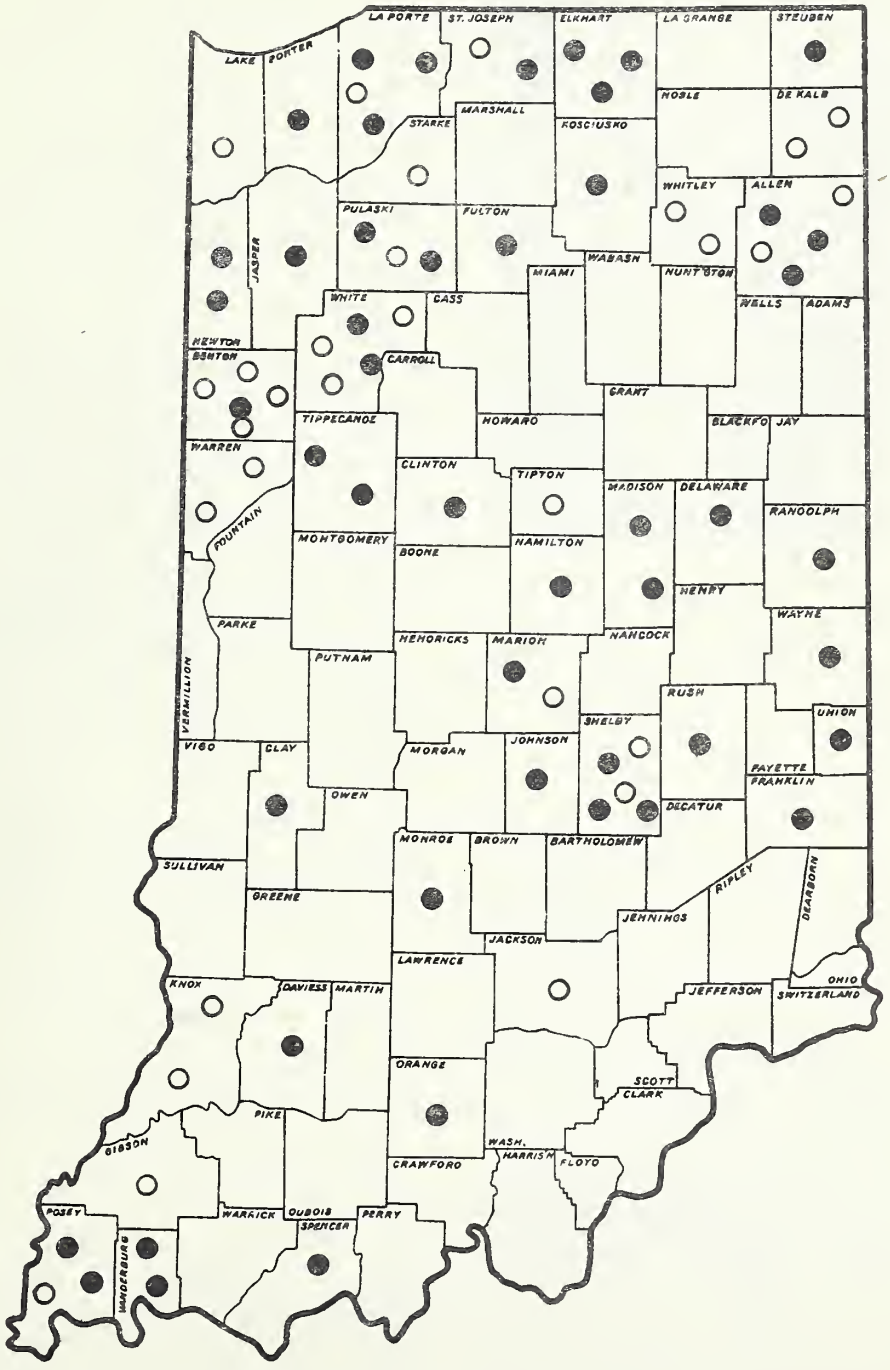
Elevators with drying equipment were fairly evenly distributed throughout the primary grain producing areas of the State. Figure 1 shows the location of country elevators with drying equipment, including those covered in this survey. According to available information, there were 76 country elevators with drying equipment throughout the State. Schedules were taken from slightly more than one-half of these elevators. Elevators that did not furnish complete information were eliminated, leaving 29 for this analysis.

MARKETING FACTORS INFLUENCING DRYING

Primary reason for drying corn is to reduce the possibility of spoilage. Shelled corn with a moisture content of more than 14 percent cannot be safely stored for any length of time unless it is turned or aerated frequently. Corn moving into commercial channels must be stored somewhere along the route to consumption. For this reason alone, moisture in corn must ultimately be reduced to a safe storage point.

FIGURE 1

LOCATION OF COUNTY ELEVATORS WITH GRAIN DRYING EQUIPMENT – INDIANA, 1952



○ ELEVATORS COVERED IN STUDY

● OTHER ELEVATORS WITH DRYING EQUIPMENT

Taking a sample from a truckload of grain for grading purposes -- determining the moisture and testing weight and general condition of the grain. A moisture content of 15.5 percent in corn is the maximum allowable without a price discount.

However, in Indiana this was probably not the reason the individual elevator operator dried corn and almost immediately shipped it on to terminal markets. His reason could have been the relationship between the cost of removing the excess moisture above 15.5 percent, and the discount the terminal would apply to his corn because of this excess moisture. This moisture in turn could cause a change in grade resulting in an additional discount. The price ratio for drying corn was not always in favor of the elevator operator. He also often dried for other reasons such as box car shortages at harvest, forcing corn to be held for several days. This corn would spoil if it were not at least partially dried. Also extremely wet corn could spoil in transit. If other elevators in the community are drying, an operator may also be forced to dry in order to draw in enough corn for him to operate efficiently.

Quality of the 1952 corn harvested in Indiana was generally good. Compared with some previous years, a relatively small proportion of the corn needed drying. The comparatively large percent of wet corn received by these elevators with drying equipment, however, did not indicate the general crop condition. For elevators without drying equipment often refused to take in corn above a certain moisture content because of the increased risk of spoilage. Farmers soon learned of this practice and hauled to elevators that had drying equipment, or harvested at lower moisture content. Being able to accept corn in any condition tended to increase the overall volume of corn handled by elevators with drying equipment.

CURRENT DRYING PRACTICES AND CHARGES

Twenty-three, or about 80 percent, of the elevators covered in this study did no custom drying. They discounted wet corn when it was received and then dried for their own account. The practice benefited the farmer only by providing an outlet that he might not otherwise have had for excessively wet corn. If terminal discount schedules were rather high the elevator with a dryer might not follow them as closely, resulting in a better price to the farmer.

Twenty percent of the elevators studied did some custom drying but showed little uniformity in their charges. Two of the elevators exchanged dry corn for wet with the farmer and charged him according to the terminal market discount schedule for the difference. Two had minimum charges of 6 and 7 cents a bushel, regardless of moisture content above 15.5 percent. The owner of the corn absorbed the shrinkage or weight loss. Of the remaining two elevators, one charged 6 cents for the first 5 percent of moisture above 15.5 percent and 1 cent for each percentage point thereafter. The other had charges of 5, 7, 9.5 and 14 cents a bushel for 18, 20, 22 and 25 percent moisture content, respectively. All charges were based on bushels of 56 pound weight without regard to moisture content. Thus farmers had little opportunity to dry their corn on a custom basis at elevators. Availability of any drying service, however, afforded them a market for corn that might otherwise have gone out of condition.

One explanation of the unwillingness of elevator operators to do custom drying for farmers was their lack of storage space at local elevators. Most Indiana country elevators were of wood cribbed construction and below 25,000 bushel capacity. They handled wheat, oats and soybeans along with corn, limiting the amount of each grain they could hold in the elevator at any one time. Most elevator operators, based upon previous experience, preferred to limit their storage almost wholly to soybeans. Storing small grains in older and relatively small elevators has not been satisfactory. However, most new country elevators now being built are 100 thousand bushel capacity or larger and constructed of concrete. In the future farmers will probably have more storage space at country elevators. And more local storage for farmer-owned grain in all probability will bring about more custom drying.

SIZE OF DRIERS

There was little variation in the size or capacity of driers installed at the elevators covered, with the exception of the two groups drying the largest volume. Twenty-two or 76 percent of the driers covered in this study had a rated capacity of 250 bushels per hour or less when reducing moisture in corn from 20.5 percent to 15.5 percent. Average output of the 22 elevators was about 175 bushels an hour.

A twin drier installation. Elevators sometimes find that their original drier is too small for their needs and then install a second one to increase capacity. If possible, elevators should try to install a drier that will be adequate for future needs. For a drier with larger capacity is more economical to own and operate than two smaller driers with the same combined capacity.

The remaining 7 driers or 24 percent of the group consisted of three 300, two 400 and two 600 bushel an hour driers. The average for all driers was about 235 bushels.

All operators were asked if their drier capacity was adequate for the average volume of corn offered for drying during 1952. Twenty answered "yes" to this question and 9, "no". The 9 answering "no" all indicated they needed about twice their present capacity.

CHARACTERISTICS OF GROUP

Elevators in this study were in general typical of the country elevators found throughout the State. Table 1 shows the distribution of the elevators, ranked according to their rated bulk capacity for individual elevators. Little or no relationship existed between size and the volume of corn dried.

Table 1. - *Selected country elevators grouped by rated bulk capacity in Indiana, 1952*

Size in bushels	Number
0-24,999	14
25,000-49,999	9
50,000-99,999	4
100,000 or more	2

The two largest elevators in the survey dried an average of only 20,000 bushels each. For this reason, it was decided to group the elevators according to the volume of corn dried. (Table 2.) This grouping also showed the percent of the corn handled that was dried.

Table 2. - *Selected country elevators with drying equipment grouped by volume of corn dried in Indiana, 1952*

Group	Volume range (1,000 bushels)	Number	Average volume dried bushels	Percent of volume dried
I	49.0 or less	11	25,000	12
II	50 - 149.9	11	90,000	55
III	150 - 249.9	3	202,000	51
IV	250 or more	4	337,000	38
Total		29	111,000	37

CORN DRYING COSTS

The costs considered in this study were only those directly applicable to the drying operations. From the standpoint of practical elevator operations, managers consider corn drying as a service operation and a method of maintaining or increasing corn volume they get to merchandise

or handle. They consider income from this increased volume more than sufficient to offset any additional administrative overhead or indirect cost involved. Therefore in decisions as to whether or not to purchase and install drying equipment these indirect costs are given little or no consideration. It is primarily the direct ownership and operating costs that are considered.

COUNTRY ELEVATORS

Types of costs. - Costs were of three main types - fixed, those incurred whether or not the equipment was used; variable - those incurred in relation to the extent equipment was used; and shrinkage, to be examined later. In discussing cost at this point, an average for all elevators is used. Later a rather detailed breakdown of the individual groups shows the variations that occur and reasons for their occurrence.

FIXED COSTS

Depreciation. - Installed price of a drier and the necessary equipment averaged $13,000. The four groups ranged from a low of $12,300 in the group drying the smallest volume of grain, about 25,000 bushels, to a high of $15,400 for the group drying the second largest volume, about 200,000 bushels. Depreciation rate in figuring this cost was 10 percent a year. More than half the elevators used this or a higher rate, although depreciation rates ranged from a low of 5 percent to a high of 20 percent. Expected life would, however, depend largely upon how much the drier was used and upon the maintenance practices followed. Thus, with a drier cost of $13,000 and a depreciation rate of 10 percent the annual cost would be $1,300. The average cost per bushel was 1.2 cents.

Interest. - An interest rate of 5 percent on the investment in the drier was considered a fair or satisfactory charge in this study. If capital was borrowed to purchase and install this equipment, this is about what the cost of the capital would be. If capital was available without borrowing, the elevator could put it to work elsewhere if not in the drier, and earn about this rate. Owners often overlook this charge, however, it is a real cost to be considered, particularly with new investments.

Actually there can be no specific answer to a fair and satisfactory rate of interest on an average basis. The financial condition of each elevator has to be considered in determining its own rate. However, the rate selected as an example here serves to point up this item of cost. The annual interest cost, 5 percent of $13,000, gives an annual cost of $650 and a per bushel cost of 0.6 cents.

Table 3. - *Average fixed costs of 29 country elevators drying an average volume of 111,000 bushels of corn in Indiana, 1952.*

Cost item	Total cost per year	Cost a bushel
Depreciation @ 10 percent---	$1,300	1.2¢
Interest on investment @ 5%-	650	0.6
Insurance - 80% coverage @ $1.74 per $100----------	181	0.2
Taxes - 28% assessment @ $2.93 per $100----------	107	0.1
Total----------	2,238	2.1

Under insurance regulations, driers such as this one installed at a wooden country elevator must be a certain number of feet away from the elevator -- depending upon its construction. Most Indiana country elevators were the wooden crib type.

Insurance. - A few of the elevators covered in this study did not insure. Insurance is a definite cost item whether an elevator assumes this risk or pays someone else to assume it. An examination of insurance policies at a number of the elevators as well as a check with an insurance company showed that the rate of insurance varied from one elevator to another, depending upon type of construction, location of drier in relation to elevator, type of safety equipment, cleanliness and many other factors. In most cases the drier was covered under the same general policy as the elevator. Because most of the elevators covered in this study were of wood construction, it was decided that a rate of $1.74 per $100 valuation with 80 percent coverage would be most typical. This would then be an annual cost of $181 and a per bushel cost of 0.2 cents. The insurance cost would be substantially lower if the elevator were of concrete or steel instead of wood cribbing with metal covering.

Taxes. - This cost varied with each county because of the different rates of taxation and method of assessment. This study used an assessment of 28 percent and a rate of $2.93 per $100 assessment. For the group this would be an annual cost of $107, or a per bushel cost of 0.1 cents.

Total fixed cost. - Table 3 summarizes these costs, giving an annual total fixed cost of $2,238 or 2.1 cents a bushel based on average volume of 111,000 bushels dried by the 29 elevators. This cost was incurred whether or not any corn was dried. The per bushel fixed cost, however, varied inversely with the volume of corn dried. This, therefore, pointed up the importance of volume in keeping the per bushel or unit cost low.

VARIABLE COST

Fuel. - Oil was the most commonly used type of fuel. Twenty-five elevators used fuel oil, compared with 2 using natural gas and 2 using bottled gas. All operators were satisfied with the type of fuel they were using, but a few of the fuel oil users thought natural gas might be cheaper in the long run because of the storage problem with fuel oil. Average fuel cost for all elevators was $978. The cost per bushel was 0.9 cents.

Labor. - Labor was the second largest item of the variable costs. The weighted average wage rate for the entire group amounted to $1.16 per hour. Based upon 665 man-hours spent per drier, total labor cost for drying amounted to $732, or a per bushel cost of 0.7 cents.

Power. - Cost information, as obtained from elevators, was inadequate because all electrical equipment and lights were usually covered by one electric meter. For this reason power cost is calculated by taking the total horsepower of the motors, of an average size drier and related equipment used in the drying operation and the average number of hours the drier was operated. Then the total number of kilowatt hours of electricity used was determined and multiplied by the price of electricity per kilowatt hour giving the total cost of power to the drying operation. The price of electricity to elevators is on a graduated scale and the larger the amount used the lower the unit price. Since the drier is considered a secondary operation to merchandising and handling, a lower unit rate is used in determining power cost for drying than would be used in determining the elevator power cost. Using this method the total power cost was $225. The cost per bushel was 0.2 cents. This per bushel cost is used for all country elevators.

Table 4. - *Average variable cost of 29 country elevators drying an average annual volume of 111,000 bushels of corn in Indiana, 1952*

Cost item	Total cost a year	Cost a bushel
Fuel	$978	0.9¢
Labor @ $1.16 an hour	771	0.7
Power	225	0.2
Repairs	102	0.1
Total	$2,076	1.9

Repairs. - This item depended upon the use of the drier and the care or preventive maintenance given during the period when it was not used extensively. A number of the managers interviewed regularly inspected the drier, to anticipate or avoid a breakdown when the drier was operating. Repairs or replacements were taken care of at that time. Repair costs varied widely between elevators -- from zero to as high as $500. However, the average total annual cost for this item was $102 or a per bushel cost of 0.1 cents. This item might be expected to increase as the average age of the driers increased.

Total variable cost. - Variable costs are summarized in Table 4, giving a total cost of 1.9 cents a bushel based upon the average volume dried by the 29 elevators covered in this study. These costs in general varied directly with the volume of corn dried. However, increased volume brought about certain economies in variable costs. These will be discussed in detail later.

TOTAL FIXED AND VARIABLE COSTS

Total costs discussed here are only the total fixed and variable costs and do not include shrinkage cost, discussed under a separate heading. Average total cost for the 29 elevators was 4 cents per bushel, based upon an average volume dried of 111,000 bushels. This 4 cents per bushel would be subject to individual variations for almost any particular elevator because of the different rates or cost of the input factors. This figure in any case indicated the expense of owning and operating a drier. To arrive at a more specific cost figure for a given volume of corn to be dried, it would be necessary to determine as nearly as possible what the rate of expense would be for each of the items under fixed and variable costs. These rates could be determined to a considerable degree of accuracy with items of fixed expense. Variable items of expense, because of their nature, could not be as easily determined.

SHRINKAGE

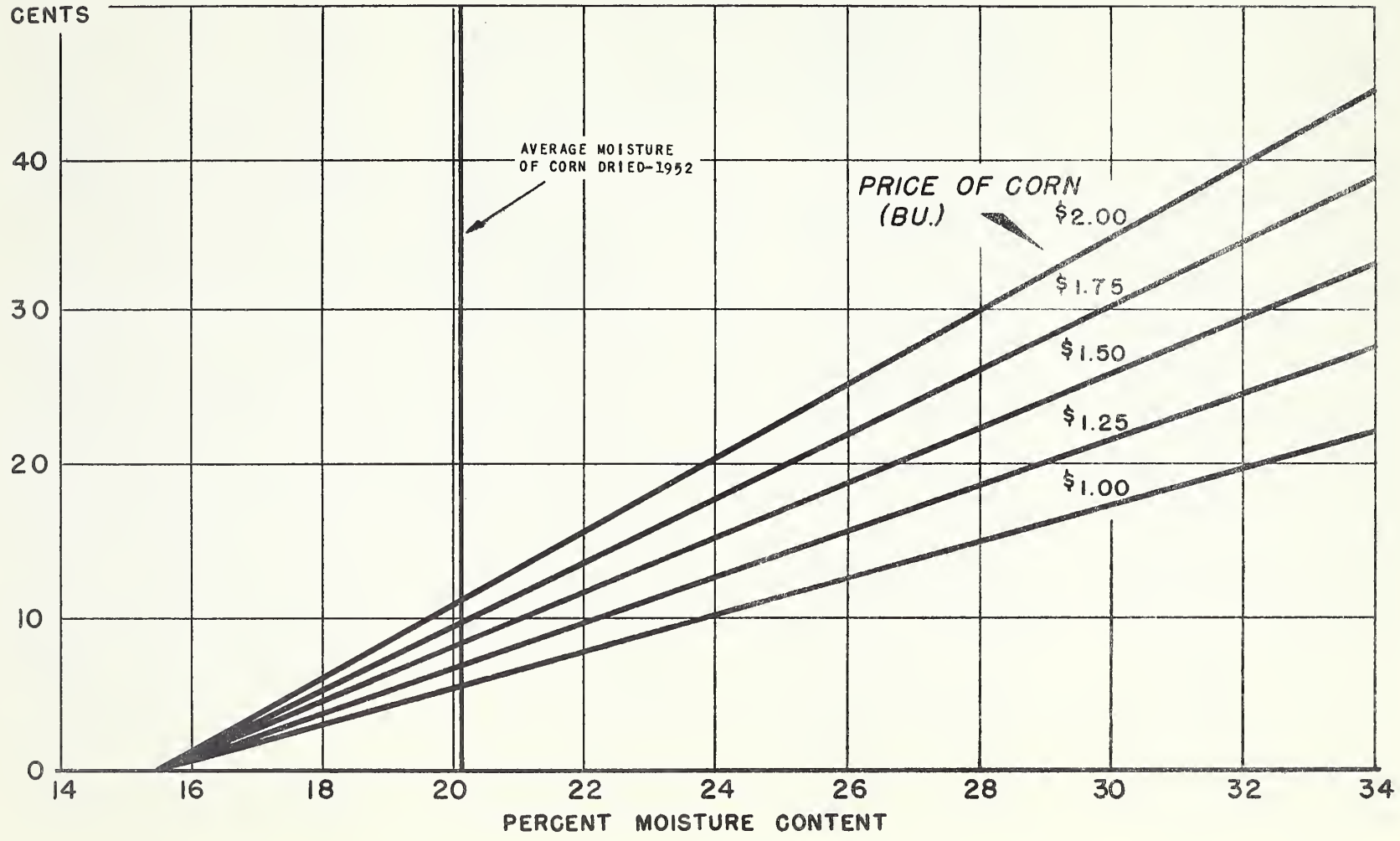
Shrinkage cost per bushel is usually greater than the cost of drying, depending, of course, upon the amount of moisture removed, the quantity dried a year and the price of the corn. The greater the amount of moisture, the greater the shrinkage cost. The shrinkage cost will vary directly with the price of corn. Therefore, the higher the price the greater the market discount will be because of an excessive amount of moisture.

Figure 2 shows shrinkage costs, taking into account the effect of price and the amount of moisture removed. This figure points up the influence of price on shrinkage cost.

Moisture content of corn dried by the elevators covered in this study averaged 20.1 percent. This corn was dried down to a moisture content of 15.5 percent, the maximum allowable without discount. Unless corn was to be stored, it was costly to dry below this point because dried corn carried no premiums to offset the weight loss and cost of additional drying. Sometimes corn was dried down to 13 or 14 percent and then blended with wetter corn, averaging 15.5 percent or as nearly that point as practical. This practice reduced the number of bushels going through the drier but the end result remained about the same.

FIGURE 2

COST OF SHRINKAGE FOR CORN DRIED FROM VARIOUS MOISTURE CONTENT TO 15.5 PERCENT AT DIFFERENT MARKET PRICES



This might not have been a wise practice if corn was to be held any length of time since the transfer of moisture from wet to dry corn was often too slow to obtain the desired result before spoilage. Improper mixing may also leave pockets of wet corn which would heat and spoil rapidly, damaging much of the surrounding corn if not the entire bin or carload.

Drying shelled corn from 20.1 percent, a reduction of 4.6 percentage points, brought about a decrease in weight of 5.9 percent. This reduction in weight was obtained by the following formula:

$$100 - \frac{79.9 \times 100}{84.5} + .5$$

Reduction in weight can also be obtained by an interpolation of Minary Table Series S, Shrinkage Cost of Drying Grain (by T. E. Minary, Jr.).

The 79.9 was the percentage of dry matter before drying and the 84.5 was the percentage of dry matter after drying. The 0.5 was the estimated percentage of invisible loss, such as dust and foreign material blown out of the corn by the large volume of air circulated. Solution of this equation gave 5.9 percent, the decrease in weight. This 5.9 percent multiplied by the price of number 2 corn ($1.50 x .059) gave a shrinkage cost of 8.9 cents a bushel.

TOTAL COST INCLUDING SHRINKAGE

Total fixed and variable costs of 4 cents a bushel plus 8.9 cents a bushel shrinkage cost equaled 12.9 cents a bushel. However, if the elevator operator had followed the terminal moisture discount schedule in effect during the fall of 1952, this shrinkage would not have been an actual cost to him. Overall discount of 16 cents a bushel to the farmer for his corn (as shown in Table 5 for 20 percent moisture content for September 1952) included shrinkage, cost of drying and a risk charge for handling the wet corn. The terminal discount may not always be large enough for the country operator to operate within, especially when corn is 2 points or less above the maximum allowable without a discount.

COST VARIATIONS BY GROUPS

Group I. - Drying an average of about 25,000 bushels annually, had a range in volume from 7,000 to 40,000 bushels. However only 3 of the 11 elevators dried less than the average. This group dried only 12 percent of the slightly more than 200,000 bushels of corn it handled, the smallest percentage of the four groups. (Table 2, page 6.)

Group I had a total drying cost of 12.8 cents a bushel. Costs in this group were especially high due to fixed charges amounting to about two-thirds of the total. Depreciation and interest were the largest of the fixed items, even though the investment in equipment was about $700 below the average for all elevators. Of the variable cost items, fuel amounted to about 50 percent, indicating that these elevators were unable to take advantage of large purchases of fuel. This group operated

driers an average of only 11 hours a day during and shortly after the harvest period, when a majority of the drying took place. The extra fuel required to get the drier heated up and into operation probably contributed to the higher fuel cost.

Table 5. - *Shelled corn moisture discount schedule per bushel, Indiana*

Moisture percent	September 1952	January 1953	May 1953
15½%----------	0	0	0
16----------	1½¢	1½¢	1½¢
16½----------	3	3	3
17----------	4½	4½	4½
17½----------	6	6	6
18----------	8	7½	7½
18½----------	10	9	9
19----------	12	10½	10½
19½----------	14	12	12
20----------	16	13½	13½
20½----------	18½	15½	15½
21----------	21	17½	17½
21½----------	23½	19½	19½
22----------	26	21½	21½
22½----------	28½	23½	23½
23----------	31	25½	25½
23½----------	34	27½	28
24----------	37	29½	30½
24½----------	40	31½	33
25----------	43	33½	35½

Over 25% - 3¢ for each ½%.

Group II. - Averaged drying about 90,000 bushels annually with a range of from 50,000 to 140,000 bushels. This group dried the highest percentage of volume handled -- 55 percent or slightly more than half of the 165,000 bushels of corn handled.

This group had a total drying cost of 4.6 cents a bushel. Fixed charges were slightly more than one-half of the total cost. Investment in facilities was only slightly above the average for all elevators, with other fixed items very near the average. Among the variable cost items, fuel costs declined rapidly as the volume of corn dried increased. Here larger bulk purchases of fuel accounted for part of the decline, along with better fuel use through longer hours of continuous operation. This group averaged operating the drier about 15 hours a day. Repairs appeared unusually low. Nine of the driers had no repair costs. Two had some repairs. One had a minimum charge of $25 for inspecting and cleaning the burner. The other drier, installed in 1947, had $100 in repairs.

Group III. - Averaged drying about 202,000 bushels with a range of 200,000 to 207,000 bushels. This is the smallest variation in volume dried by any of the groups. This group dried almost 51 percent of the volume handled.

This group had a total drying cost of 3.1 cents a bushel and averaged operating the drier 16 hours a day. Only three elevators fell into this group. Average cost for this group was heavily influenced by a single drier, the largest and most expensive of the 29 covered in this survey. Its high original cost made all of the fixed items of expense somewhat higher. Of the variable items of expense, fuel remained the same as for Group II. This high rate was accounted for partly by the single large drier which used bottled gas. Also the corn put through this drier was about 2 points higher in moisture content than the average. The two remaining driers in this group compared much more favorably with the driers in Group IV. There was however, such a sizable variation in volume between Groups III and IV that they were separated.

Table 6. - *Total per bushel cost of drying corn for 29 country elevators, grouped by average volume dried, in Indiana, 1952*

Cost item	Groups by average volume				
	I (25,000)	II (90,000)	III (202,000)	IV (337,000)	All elev. (111,000)
Fixed costs					
Depreciation @ 10%	4.9¢	1.5¢	0.7¢	0.4¢	1.2¢
Interest on investment @ 5%	2.4	0.7	0.4	0.2	0.6
Insurance - 80% @ $1.74 per $100	0.7	0.2	0.1	0.1	0.2
Taxes - 28% assessment @ $2.93 per $100	0.4	0.1	0.1	0.1	0.1
Total fixed cost	8.4	2.5	1.3	0.8	2.1
Variable costs					
Fuel	2.1	0.9	0.9	0.6	0.9
Labor @ $1.16 per hour	1.5	0.9	0.6	0.5	0.7
Power	0.2	0.2	0.2	0.2	0.2
Repairs	0.6	0.1	0.1	0.1	0.1
Total variable costs	4.4	2.1	1.8	1.4	1.9
Total costs	12.8	4.6	3.1	2.2	4.0

Group IV. - These 4 elevators were about the same from the standpoint of the various items of cost. This group averaged operating the drier 22 hours per day and dried an average volume of 337,000 bushels. The range was from 270,000 to 429,000.

The cost of drying was 2.2 cents a bushel, considerably below the average, for all groups. On an individual basis little or no decrease

in cost per bushel occurred after about 300,000 bushels. As a group, the total cost was at its lowest point. Total fixed costs were below the average for all elevators and slightly above those in Group I. Per bushel fuel costs were at their lowest point.

DISCOUNTS AND OTHER FACTORS

It paid elevators to dry corn whenever their cost of drying and loss from shrinkage was less than the current terminal market discount on wet corn. Elevators also derived other indirect benefits from drying corn, such as savings on freight. In a 100,000 pound capacity car, about 1,800 bushels of wet corn could be shipped. If this corn were dried down from the 20.1 percent to 15.5 percent moisture content, its weight would reduce about 6,000 lbs. If the freight charge were 20 cents per hundredweight to the terminal market, freight charges alone would be cut $12 a car. If corn was not dried, freight would have to be paid on this excess water in the corn.

Drying also greatly reduced the possibility for spoilage in transit. If high moisture corn was delayed in transit or in unloading at the terminal market, the chances of spoilage were much greater. An elevator with drying equipment would in all probability attract a larger volume of corn since it could take high moisture corn. This increased volume was important not only in reducing drying cost but also in bringing more traffic to elevators. This traffic is important where sidelines are handled along with the corn drying.

WHEN DID IT NOT PAY TO DRY CORN

It did not pay elevators to dry corn when their discount to the farmer and other indirect benefits were less than the cost of drying. Elevators in Group I had fixed and variable costs of 12.8 cents per bushel. If a shrinkage cost of 8.9 cents a bushel was added, the total cost would be 21.7 cents a bushel. The discount to the farmer for wet corn would have to be increased to about this amount to make it practical to dry corn of 20 percent moisture content.

However, under discount schedules in effect during the fall of 1952, corn would need a moisture content of about 21.5 percent before it would be economical for an elevator with 25,000 bushel volume to

Unloading corn at a typical wooden cribbed country elevator. Elevator managers estimated their driers contributed an average increase of at least 10 percent in volume of corn handled.

dry. It did not pay to dry when sufficient amount of dry corn was available to blend with wet corn to make an average moisture content requiring no discount. This factor was not very important at country elevators in Indiana because of their small capacity. It was important, however, at terminal and sub-terminal locations where considerable corn was stored, especially where there was a carry-over from the previous year. This particular point played an important role and was usually reflected in the discount rates. Discount rates were always the highest in the fall during harvest but tended to ease up considerably in the spring and summer when more dry corn was available for blending purposes.

IMPORTANCE OF VOLUME

Volume was one of the most important factors influencing costs. Fixed costs per bushel of course continued to decline as volume increased. Variable costs declined to an optimum level and thereafter remained at that level or began to increase as volume expanded. As a group, the per bushel variable cost did not increase. However, when adjustments were made for certain differences in input factors in Groups III and IV, this increase in variable cost occurred and began at about the 200,000 bushel level indicating that this was a satisfactory volume for the drying equipment most generally found at elevators covered in this survey.

Where volume was substantially below the average, the fixed cost amounted to more than 50 percent of the total cost. In Group II where about 90,000 bushels were dried, or approximately 20,000 bushels less than the average for all elevators, the fixed costs were about 1/2 cent higher whereas variable costs were only 1/5 of a cent higher than the average for all elevators. When the proportion of fixed cost became more than 50 percent of the total cost, volume was below a satisfactory level.

Low volume did not indicate inefficient operation. Usually the corn crop had sufficiently matured and dried out in the vield so that only a very small proportion needed artificial drying. In years when this is the case, market discounts may be such that it is not economical for the country elevator to dry corn. Terminal elevators, which determine the discount, usually have sufficient carry-over stocks that are adequately dry to blend with corn of only a few excess percentage points of moisture, eliminating the actual cost of drying. Thus, terminal moisture discounts will reflect more of the weight loss and less of an actual drying charge.

TERMINAL ELEVATOR

Terminal elevators did not furnish sufficiently complete information to arrive at meaningful averages. However, one elevator gave enough information for an analysis with the exception of two items, labor and power. These two items were calculated: labor an average of those terminals

reporting; and power in the same manner as country elevators except a lower unit rate was used. Then an analysis of this single elevator drying cost was made.

This elevator dried about 30 percent of the volume of corn handled during the year covered. This percentage was considerably less than for any of the country groups, except Group I which dried only 12 percent of its volume. This in itself is an indication of the opportunities available to terminal operators to blend new crop with old crop corn, thereby avoiding the cost of operating a drier. Moisture content of corn dried averaged about 18 percent compared with slightly more than 20 percent at country points. This difference was due largely to natural drying in handling and shipping between the time corn was received at country points and arrived at the terminal. Country points may have also blended some corn, especially the larger elevators.

TYPES OF COST

Fixed Costs

Table 6 shows terminal fixed costs. They were not discussed individually unless their rates differed from country elevator rates.

Depreciation. - Life expectancy was longer for the 1,000 bushel capacity drier at this elevator because of its more permanent type housing than smaller driers at country points. Therefore this drier was depreciated over a longer period of time. A depreciation rate of 6 2/3 percent was relatively common at terminals and was used in calculating this example.

Interest. - Interest on investment accrued at the same rate as on country point areas - 5 percent.

Insurance. - This insurance rate of $0.381 per $100 was less than one-fourth the country elevator rate, primarily because of the type of construction. Terminals were concrete while a vast majority of country elevators in Indiana were wood, greatly increasing their fire hazard. Fire protection at terminal locations in most cases was also much better. For these primary reasons, their rate was $0.381 compared with $1.74 per $100 valuation for country elevators. Valuation was based on 80 percent of original cost, the same as at country locations.

Taxes. - Tax assessment of 28 percent and rate of $2.93 per $100 valuation were the same as for country elevators.

These costs, based upon a volume of 710,000 bushels, totaled $10,228, or a fixed cost of 1.5 cents a bushel.

Table 7. - *Terminal elevator corn drying cost in Indiana, 1952*

Cost item	Total cost	Per bushel costs[1]
Fixed costs		
Depreciation @ 6-2/3 percent	$5,328	0.7¢
Interest on investment @ 5 percent	4,000	0.6
Insurance - 80 percent @ $0.381 per $100	244	0.1
Taxes - 28 percent assessment @ $2.93 per $100	656	0.1
Total fixed costs	10,228	1.5
Variable costs[1]		
Fuel	3,150	0.4
Labor @ $1.75 per hour	2,485	0.4
Power	795	0.1
Repairs	800	0.1
Total variable costs	7,230	1.0
Total costs	17,458	2.5

[1]Based on volume of 710,000 bushels.

Variable Costs

Table 7 also shows variable costs. This bore little or no resemblance to similar costs at country elevators. Fuel charge was the actual cost to the terminal elevator for drying 710,000 bushels of corn from an average of about 18 percent moisture content down to about 14 percent. This was a reduction of 4 percentage points compared with a reduction of 4.6 percentage points at country elevators. Labor rate was an average of the three elevators covered adjusted for overtime normally worked during the harvest rush period. Power cost for the drying operation, as with country elevators, could not be separated from other power cost. Therefore the same method of determining this item was used here as was used for country elevators. However, because of the overall greater volume of electricity used by terminal elevators a lower kilowatt hour rate was used. Repairs were those actually made but were fairly well in line with the average for all country elevators for this item. Thus, total variable costs based on the above information were 1 cent a bushel.

TOTAL COSTS

Total costs to this terminal elevator for drying 710,000 bushels of corn was 2.5 cents a bushel. This cost, of course would vary among elevators because of the difference in input factors. However, where individual items could be compared with like items in other terminal elevators, there was very little variation. For this reason -- with the possible exception of power -- 2.5 cents a bushel was considered a sufficiently reliable figure.

Amount of corn dried was relatively small compared with most previous years because of the exceptionally good condition of the crop at harvest. In years when the crop condition was not so good there would be a further reduction in the fixed cost items on a per bushel basis since their total remains the same regardless of volume dried.

SHRINKAGE

Shrinkage cost was calculated with the same formula used for country elevators. Terminal elevators usually expected to store corn for at least a short period before moving it on into trade channels. Therefore, in most cases they dried corn from 18 percent down to 14 percent moisture content to help maintain quality. This was a reduction in moisture content of 4 percentage points. By using the formula on page 12 we calculated a decrease in weight of 5.2 percent in the drying process. This decrease in weight times the price gave the cost of shrinkage (.052 x $1.55), or 8 cents a bushel. The $1.55 price for a bushel of corn at the terminal was 5 cents a bushel more than the price at country elevators, allowing country elevator a 5 cents a bushel handling margin. This margin, of course, would vary greatly between country elevators, depending primarily upon local competition. In any circumstances, the cost of shrinkage would vary directly with the price of the corn.

TOTAL COST INCLUDING SHRINKAGE

Fixed and variable costs of 2.5 cents a bushel plus the 8 cents a bushel shrinkage cost gave a total cost of 10.5 cents a bushel. The elevator however, discounted the corn 8 cents a bushel, in line with the discount schedule in effect during the fall of 1952. Thus, drying corn down to 14 percent cost 2.5 cents a bushel more than the discount of 8 cents. The terminal usually made up this difference from premiums it received on corn sold below 15.5 percent moisture. These may be outright premiums, or come from raising the corn to Number 1 grade, with a maximum moisture content of 14 percent.

COUNTRY VERSUS TERMINAL ELEVATORS

Should the country or terminal elevator dry the corn? Answer to this question will depend almost wholly upon the local circumstances and the amount of corn any given country elevator expects to dry.

Unless a country elevator could dry an average annual volume of about 100,000 bushels of corn, the fixed cost alone was about as much as both fixed and variable costs at the terminal. However, certain local conditions, such as storage, feed grinding, milling and increasing local volume marketed made it attractive for the country elevator to have a drier. These conditions provided a diversification that might not otherwise be available. In these cases the operator might be able to merchandise corn to a much better advantage locally than by shipping to terminals. This practice would avoid the transportation cost to the terminal, an important factor under present conditions.

The operator who just dried corn and shipped it on to terminal markets had to operate within the discount schedule set at terminal markets over which he had no control. If terminals did not get enough wet corn or if they had large dry carry-over stocks for blending they were likely to set their discount much lower, or at least to a point where they would draw enough wet corn to operate their drier efficiently. For instance, a country elevator might be confronted with a considerable volume of local wet corn that needed drying when the terminal discount schedule for various reasons might be relatively low. The country elevator then would probably take a loss on any grain it dried because it could not discount the farmer enough to absorb the actual drying and shrinkage cost. In cases like this, it would be to the advantage of the country elevator to ship the wet corn instead of drying it.

The competitive situation should not be overlooked where volume is concerned. In response to the question, "Does your drier enable you to receive corn you otherwise would not because of its condition?" Twenty-three of the 29 operators answered "yes". These 23 operators were then asked about how many bushels of this type corn they received. Nineteen of the 23 responded with estimates. Average of these estimates was about 41,000 bushels. This average was heavily influenced by the estimates of 2 elevators of 150,000 and 250,000 bushels. When these two elevators were eliminated, the average of the remaining 19 was about 22,000 bushels. Thus, average volume of corn handled increased about 10 percent. In years when corn was not as dry as in 1952, this increase would probably be even larger.

Insufficient data over a period of years prevented a further evaluation of drier influence in increasing volume. It was, however, significant that about 80 percent of the operators covered in this survey felt that the drier had been an important factor in increasing the total volume of corn they handled. And of course, volume is one of the most important factors affecting the efficiency of elevator operations.