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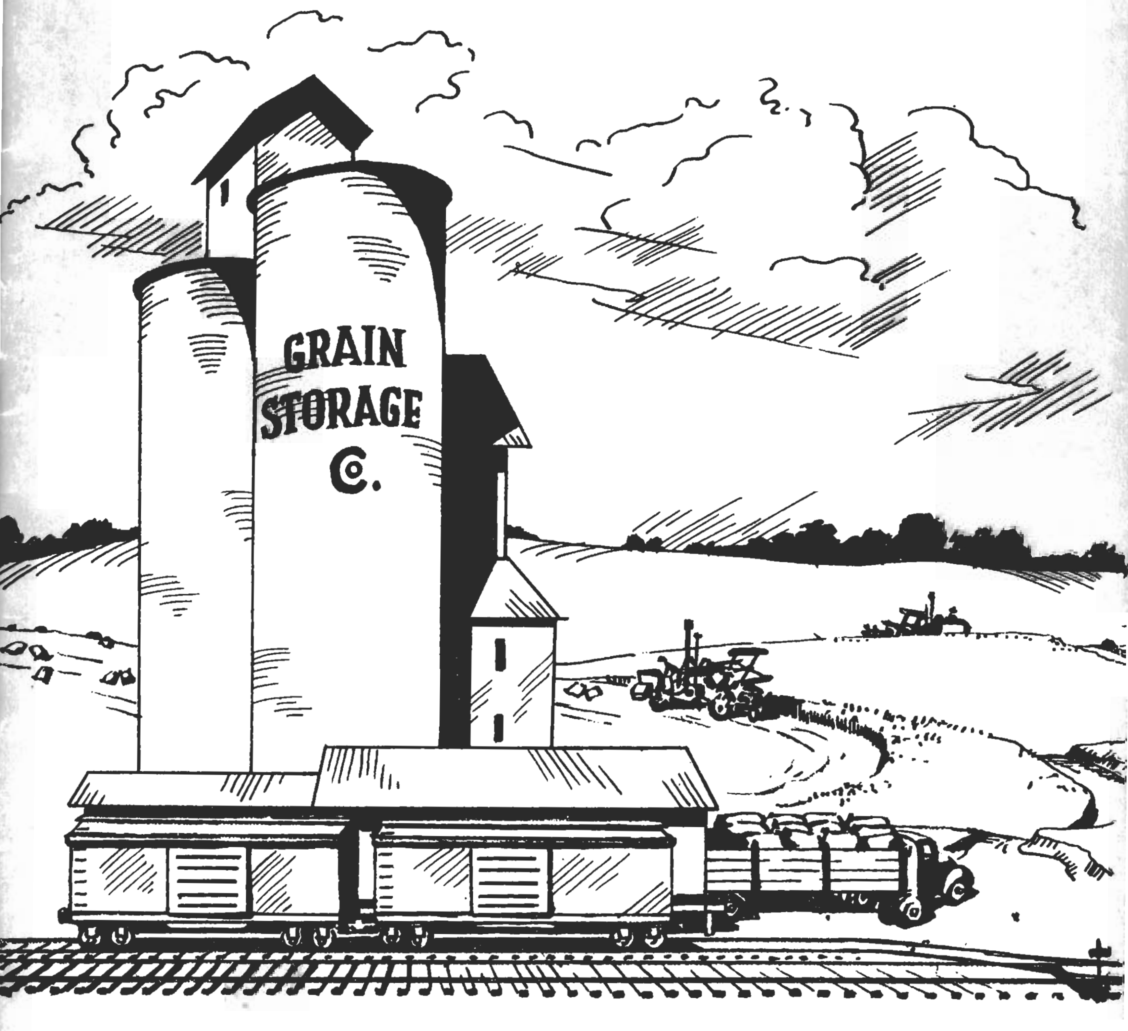
Planning

GRAIN ELEVATORS FOR THE SOUTHEAST



BULLETIN OF THE UNIVERSITY OF GEORGIA
ATHENS, GEORGIA

ACKNOWLEDGMENTS

Grateful appreciation for the splendid cooperation, information, and interest of those listed below is hereby acknowledged. To these and many others we are deeply indebted.

Commercial Companies, Contractors, and Engineers: Corn States Hybrid Service, Des Moines, Iowa; Faleide Engineering Company, Chicago, Illinois; S. F. Johnston & Sons, Roanoke, Virginia; H. G. Onstad, Burlington, Wisconsin; J. E. Reeser & Son, Maroa, Illinois; Sprout, Waldron & Company, Muncy, Pennsylvania; The Hess Company, Cicero, Illinois.

Individuals: Wayne H. Freeman, Coastal Plain Exp. Station, Tifton, Georgia; Leo E. Holman, BPISAE, USDA; W. M. Hurst, BPISAE, USDA; Frank P. King, University of Georgia; G. D. Kite, Virginia Polytechnic Institute; L. F. Stice, University of Illinois; Charles Turner, University of Georgia; S. H. Usry, N. C. State College; Fred Webb, Elizabeth City, N. C.; H. D. White, University of Georgia; G. B. Wood, Purdue University.

BULLETIN OF THE UNIVERSITY OF GEORGIA

Volume LI, No. 7d June, 1951

Entered at the Post Office at Athens, Georgia, as Second Class Matter, May 27, 1946, under Act of Congress of August 24, 1912. Issued Monthly by the University except July and August.

SERIAL NO. 1019

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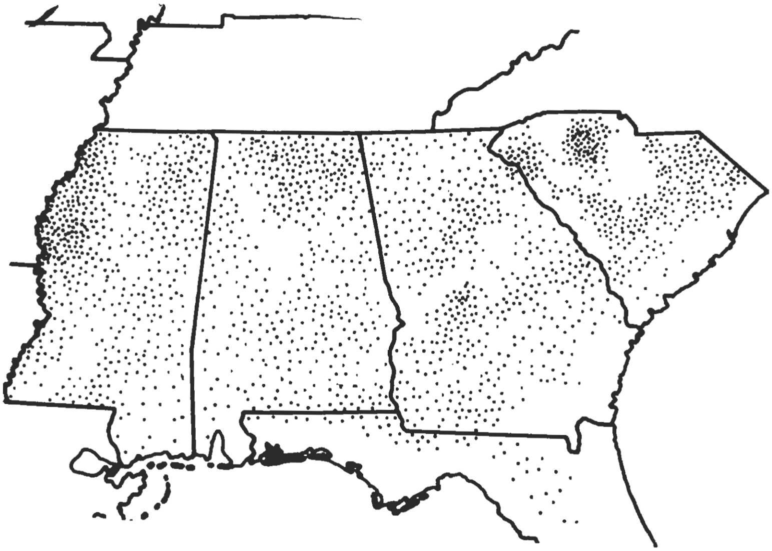

FIGURE 1. *Map showing distribution of grain and soybeans in the Southeastern states, 1948 Census.*

TABLE 1 — Grain Production in the Southeast

	CORN		WHEAT	
	1937-46 Average 1000 bu.	1948 Estimate 1000 bu.	1937-46 Average 1000 bu.	1948 Estimate 1000 bu.
Alabama	44,175	58,824	163	170
Florida	7.515	6,910		
Georgia	45,281	49,182	2,102	2,984
Mississippi	44,468	53,544	222	308
S. Carolina	24,839	28,360	2,735	3,444

	SOYBEANS		OATS		BARLEY	
	1937-46 Average 1000 bu.	1948 Estimate 1000 bu.	1937-46 Average 1000 bu.	1948 Estimate 1000 bu.	1937-46 Average 1000 bu.	1948 Estimate 1000 bu.
Alabama	200	969	4,199	5,750	67	38
Florida			355	399		
Georgia	75	112	12,331	13,728	139	100
Mississippi	885	2,394	8,678	10,989	68	50
S. Carolina	84	220	14,505	12,144	377	473

Planning Grain Storage Elevators

By

W. M. Bruce, W. E. Garner, J. W. Simons, and L. L. Smith

The towering grain elevators like fingers pointing skyward are familiar landmarks to those who travel Midwestern and Great Plains States. These structures have been largely responsible for the United States' being called the "breadbasket" of the world. They have served as surge bins between the farmer and the processor and helped in the orderly marketing of our grain. Low prices during the early 30's, the importance of food in fighting World War II, and support prices have focused attention on country-point grain elevators for storage as well as for marketing.

Grain production in the Southeast has increased during recent years as shown in Table 1, and there is need for country-point grain handling and storage facilities here. Farmers are producing more grain than can be stored on the farm without excessive losses from weather damage, rodents, and insects.

A Georgia survey shows that on-farm and off-farm storage structures are inadequate for handling grain crops and for preserving quality.[1] Less than half the farm storage capacity provided protection from weather and only 3½ percent was reported rodent proof. Off-farm storage structures including grain elevators, warehouses for sacked grain, flour mills, corn mills, and feed mills were, in general, poorly equipped to handle grain for the public. There are however, several modern grain elevators in Georgia and some of the mills are well equipped to store and handle grain for their own use.

This report is based in part on work conducted cooperatively under the Research and Marketing Act of 1946 by the Agricultural Engineering Division, College Experiment Station, College of Agriculture, University of Georgia, and the Bureau of Plant Industry, Soils and Agricultural Engineering, USDA.

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[1] "Survey of Grain Storage Facilities in Georgia in 1949," The Georgia USDA Council and the Grain Branch, Production and Marketing Administration, Athens, Georgia, May 1950.

The increase in livestock in the Southeast emphasizes that the trend toward grain may be accelerated. Increased yields brought about by the better farming practices and hybrid seeds have increased production.

It is proving less and less profitable to ship grain grown in the Southeast outside the area for processing and storage to be bought back as needed. Factors affecting this margin will be magnified as the price of grain decreases. The solution to this problem is to store and process more grain in the area where it is produced. The distribution of grain and soybeans grown in the Southeast by states is shown in Figure 1.

Central or country-point grain storage and processing facilities appear desirable for farmers in the Southeast because of climate, insect

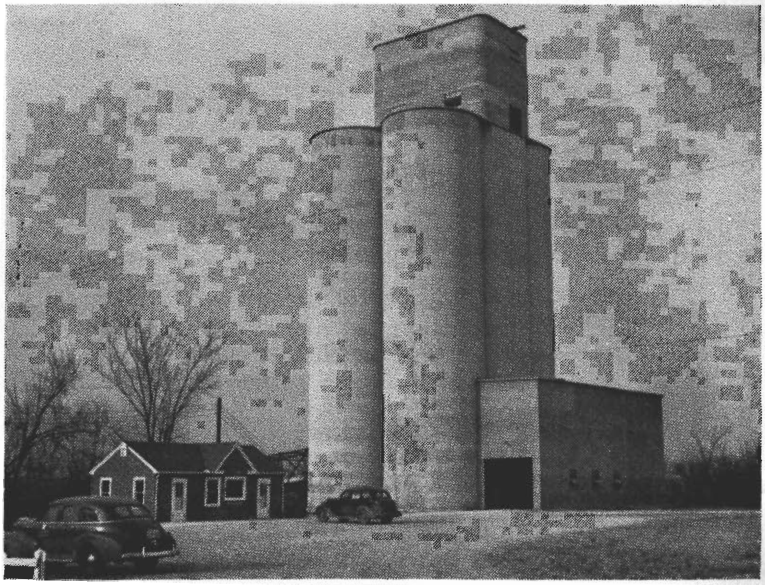

FIGURE 2. *A modern Midwest elevator of 190,000 bushel capacity. This illustration is similar to Plant 2 shown under Plant Design and Layout.*

pests and farm practices. The necessity of harvesting corn early in order to combat unfavorable climatic conditions prevailing in the Southeast is one of the main reasons for providing drying facilities. Due to high humidity, corn allowed to stay in the field to dry seldom reaches a moisture content low enough for safe bulk storage in buildings tight enough for effective fumigation. Shelled corn in bulk storage with moisture content above 14 percent must be shifted frequently. Shifting grain in storage is an expensive operation without the hidden loss that seems to occur every time a bin is changed.

Corn dried in the field is found to be severely infested with rice weevils or Angoumois grain moths. During the last few years, this infestation has destroyed an appreciable percentage of corn remaining in the field until mid-November or later. This could well represent the difference between profit and loss to the average producer. Besides this loss, the danger exists of the processor losing still more if adequate steps, such as fumigation to control this hazard, are not followed. Eradication can best be effected in a tight storage equipped with adequate drying facilities.

The combine has shortened the harvest season and marketing periods for small grains. These conditions produce a flooded market for a short period, and the farmer is forced to sell on a weakened market due to lack of storage. Adequate elevator storage would solve this problem, at least in part.

This engineering study is based on data collected on grain storage in five Southeastern states, and in Illinois and Indiana. The latter two states were chosen because of their long experience in grain storage, and also because information on corn storage could be learned best in these Corn Belt States. The study covered grain elevators of the conventional type but did not include the storage and handling of grain in the quonset type of structure.

More than 40 plants were visited and data were secured on 27. These plants were selected on the basis of their adequacy for Southeastern storage conditions. For the most part, the plants selected had been built or re-equipped in the last 10 years. It was found that although each plant had certain good features, none incorporated all the elements of design and plan considered as best in efficiency of operation and construction.

SOME ECONOMIC FACTORS AFFECTING THE BUSINESS

While this report deals principally with structures and equipment for handling and storing grain, a few economic factors will be mentioned. Individuals or groups contemplating construction and operation of grain elevators, should realize that a grain elevator is a business, and not merely a place to receive and store grain. Several state institutions such as Kansas State College, Manhattan, Kansas; Purdue University, Lafayette, Indiana; and the University of Illinois, Urbana, Illinois, have issued publications dealing with the economic phases of grain elevator operation. The Farm Credit Administration, the Bureau of Agricultural Economics, and the Production and Marketing Administration of the U. S. Department of Agriculture, Washington, D. C., also have published reports on grain storage, handling and marketing.

Grain prices change depending in part upon number and price of feed animals, amount of grain in storage, weather conditions, foreign production, and government storage policies. These elements tend to make grain handling a speculative operation. Some of these were instrumental in the organization of grain exchanges. Grain prices and bids are posted on these exchanges, and serve as guides in grain transactions throughout the world.

An adequate volume of business must be maintained to make a reasonable return on the plant investment. According to a study of grain elevators in Illinois, those that consistently made the most profit during the period 1935-39, handled 300,000 or more bushels of grain per year, and sold merchandise to the extent of 10 to 30 percent of their total sales.[2]

FINANCING AND PLANT INVESTMENT

Those who anticipate going into the grain handling and storage business should investigate the possibility of low-cost, long-term methods of financing construction and equipment. By this means, capital is reserved for operating expenses and grain purchase. The greatest need for this extra capital is felt during peak harvesting periods.

Many plants visited had been in operation for 30 years or more. They had probably changed ownership at least three times. Thus, it was almost impossible to get reliable estimates on the cost of old elevators. Therefore, cost of construction in 1949 is considered here. It is well to bear in mind that the principal cost items in present-day construction of an elevator are labor, steel, cement, aggregate, and lumber. These items are at an all-time high and there are no indications of an imminent decline in price.

New elevators seem to follow certain trends. Structures of reinforced concrete are common. For concrete elevators with capacities of around 75,000 bushels, $1.25 per bushel of storage capacity is considered minimum cost in grain production areas. This figure will be larger for smaller elevators, depending upon the geographic location and capacity. Elevators with a capacity greater than 75,000 bushels will cost less per bushel to construct than smaller ones. Equipment necessary to elevate, clean, and weigh grain is included in this estimate,

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[2]Norton, L. J., *Business Policies of Country Grain Elevators*, University of Illinois, Agr. Exp. Station, Bulletin 477, p. 29 1941.

as is the installation of a 300 to 400 bushel per hour, self-contained, prefabricated drier.

In smaller installations steel construction costs less than concrete. This type is gaining considerable recognition from a cost basis. They are shipped unassembled and can be erected by unskilled labor. These features are discussed in detail under Storage Bins.

Operating capital needed depends upon how fast the grain turnover is effected and the price per bushel. Persons who have had experience plan to buy and sell grain the same day. By so doing, the operator runs little risk of the price going down with grain on hand.

If this rule is followed, capital necessary for operating expenses can be limited to not more than what the elevator would receive in one day. However, other factors, such as lack of transportation, often prohibit the operator from shipping out as fast as he receives. In this case, he is forced to hold the grain and either sell future contracts to cover his holdings or run the risk of loss through market fluctuations.

LOCATION

Location of the grain storage plant is of prime importance. The wrong location can easily cost hundreds of dollars extra each year of operation.

The lot should be well drained, not subject to flooding, and should provide ample parking and loading space. Plants were visited in Illinois and Indiana which had been destroyed by fire as many as four times on the same location. These fire hazards are being eliminated in the grain growing sections by using more fire-resistive construction materials and exercising good fire-preventive measures.

Utilities are important. Many elevators use electric motors with 100 hp rated loads requiring 3 phase service. A heavy demand is evident during peak load periods. Since drying is of importance in present day operation, a cheap source of heat, such as natural gas, has advantages. A good water supply lowers insurance rates.

Transportation is the life blood of the industry, and access to railroads and trucks is important. Often elevators are located with access to more than one railroad to take advantage of competitive freight rates. Securing ''milling in transit'' rates, which are offered by some railroads as an inducement to ship via their lines, can have advantages.

Because of high freight rates in the South, the plant will have to rely on truck transportation for much of its hauling. Often citrus

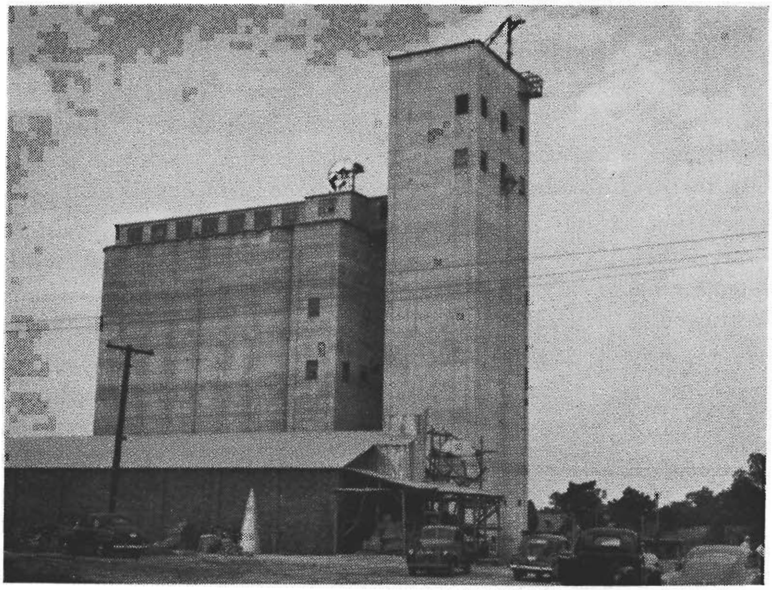

FIGURE 3. *A Western-type grain elevator in Georgia. A bin-type drier used primarily for lupine seed drying is shown in the foreground.*

fruits and fresh vegetables are hauled north and the elevator operators find it profitable to take advantage of low rates offered on the return trip. The design of much of the new equipment on the market today is predicated on increased truck transportation.

The radius of operations will be much greater in the South than in the main grain-producing states. Improved transportation and the more varied types of services offered make the grain elevator a center of operation for a radius of 100 miles or more. One elevator in Laurinburg, North Carolina, receives corn from the Elizabeth City, N. C. territory in sizeable lots by truck and rail. The distance between these two points is more than 200 miles.

Future expansion is another important consideration. Since anyone starting in business without previous experience is at a disadvantage and often without sufficient capital to build a large plant, it is the general practice to start out in a smaller way, making allowances for future expansion, storage space, and extra services to be added as customers demand and income from the business warrants. This was brought out clearly in a study of some 27 elevators in Virginia, North Carolina, Indiana, and Illinois. Twenty-five of the 27 intend to add storage space or services, or both, as soon as possible.

A construction firm, specializing in building granary storages in Illinois, stated that their crews had done approximately 70 percent of the plant expansion of country-type elevators in Illinois over the 10 years before 1948-49. Due perhaps to the government storage program, the demand has since increased to such an extent that they can do hardly 25 percent of the work, and in December 1949, they were booked solid through November 1950.

Space for expansion must be taken into consideration. Figure 5 shows a plan which lends itself very nicely to expansion. This elevator has a capacity of 56,000 bushels and was constructed for $64,000. There is space for a drier that has not yet been installed, and the price does not include the $12,000 or more necessary for the drier. A storage building of this capacity was once considered large for country elevators in Illinois. Today almost the reverse is true. It is now considered to be the minimum essential structure to house the storage capacity and equipment needed in this region.

There has been a reduction in the number of small elevators in the midwest. Due to competition and improved handling, the smaller, less efficient elevators, which have depended entirely upon grain handling for income, have sold out or discontinued their business in

FIGURE 4. *A well located flour mill and feed mill in Laurinburg, N. C., which buys farmers' grain from a radius of more than 100 miles.*

favor of the larger combination processing, handling, and storage elevators. In Illinois, this reduction has amounted to over 25 percent

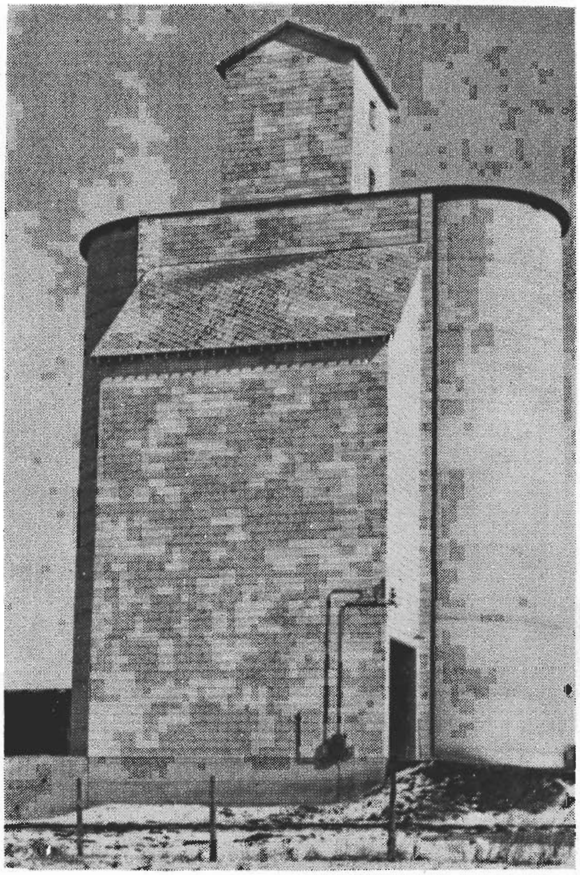

FIGURE 5. *A Midwest elevator of* 56,000 *bushel capacity used for receiving and shipping grain.*

in the past 10 years, according to L. F. Stice, grain marketing specialist at the University of Illinois.

PLANT DESIGN AND LAYOUT

The present tendency is for grain storage and grain processing or milling to be in separate buildings. This development has brought changes in construction plans, with emphasis now on storage. The main factors contributing to the plant design of today are economical handling and flexibility of machinery, enabling the operator to blend and dry grains, while holding cost of construction to a minimum.

Sketches to illustrate certain points of interest to a prospective builder are shown on the following pages. These plans represent some of the more recently built storage facilities.

Plant No. 1

Plant No. 1 (Figure 6) is a combination of reinforced concrete bins and a wood crib workhouse. Its capacity exceeds 90,000 bushels and it was estimated at one dollar per bushel of storage capacity, primarily due to the labor needed and because it was built in an area where local labor rates were low. This figure has been exceeded by 25 percent, however, and it is still incomplete. This plant contains essentials for good grain elevating and storage and is located on a railroad.

Probably the main adverse criticisms of this plant are that it has no truck scales and no unloading truck-dump. All the grain received in this plant must be in bags. In Eastern North Carolina, where this plant is located, it is the custom for farmers to bring their grain to the elevator in bags, so the building was designed accordingly. Another criticism is that over half the cost of construction is in the

FIGURE. 6. *An elevator showing a combination of concrete storage bins and wood cribbed bins contained in the rectangular building at the front. Building at rear houses drier furnace and fan. A portion of the drier can be seen just behind the bins.*

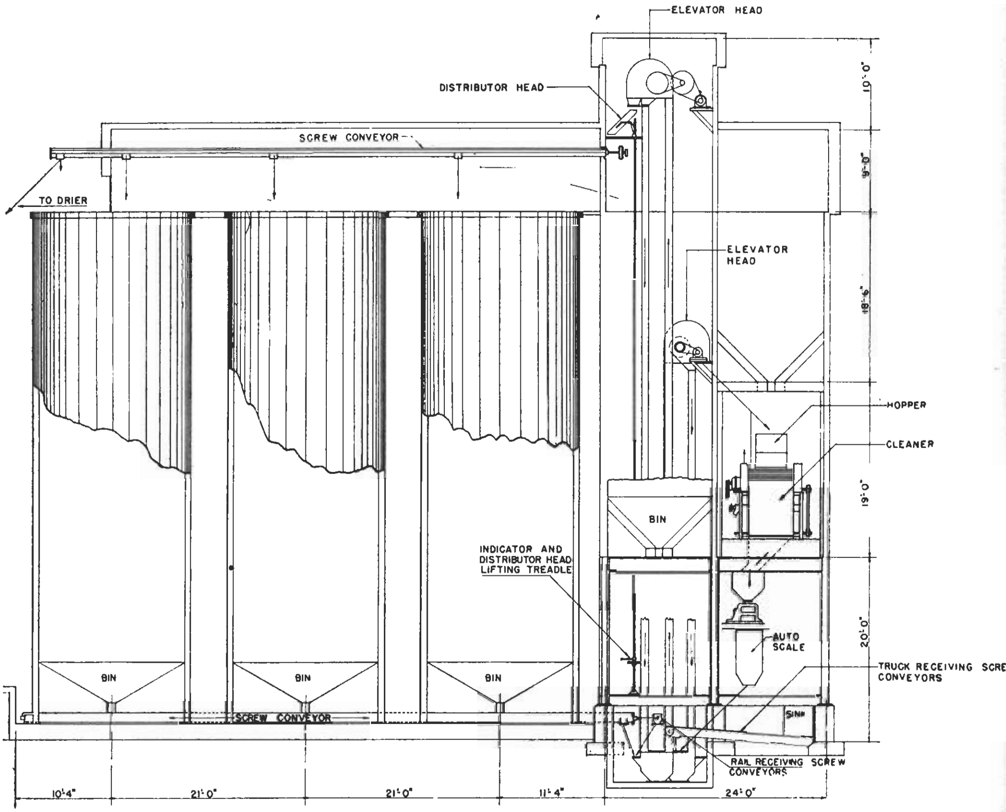

FIG 7 SCHEMATIC ELEVATION OF THE ELEVATOR SHOWN IN FIG 6

FIGURE 7. *Schematic elevation of eleavtor shown in Figue.* 6.

workhouse where only a small proportion of the total storage capacity is located. This is expensive because the normal cost of construction of rectangular type wood cribbed bins is very high and the increased cost of insurance on wood construction will be realized in the years to come.

The elevating machinery is entirely adequate. The two elevator legs extending from the basement floor to the headhouse are used for receiving grain and transferring it from one bin to another. A short elevator running from the basement to the third floor feeds the cleaner from which grain is delivered into an auotmatic scale by gravity. The capacity of the equipment is adequate to take care of receiving the grain and is limited only by the rather cumbersome receiving arrangement.

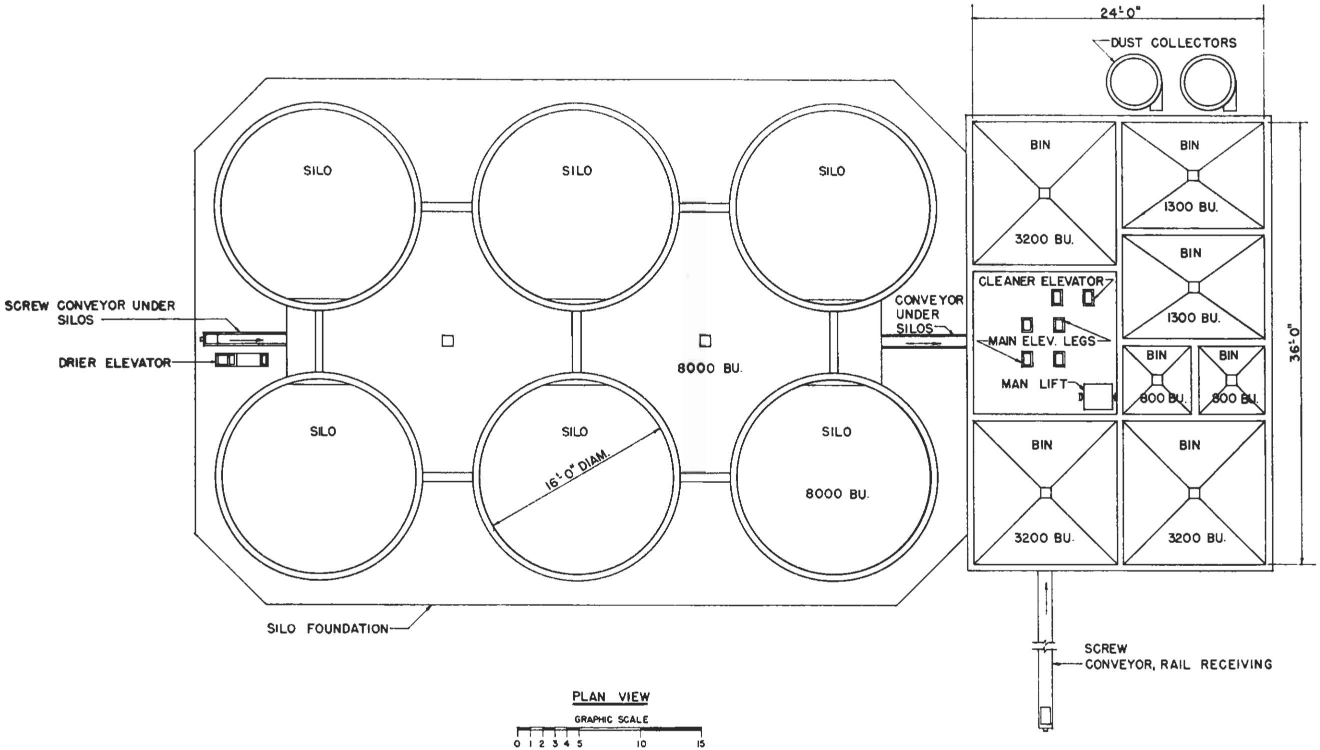

FIG. 8. SCHEMATIC PLAN OF ELEVATOR SHOWN IN FIG. 6.

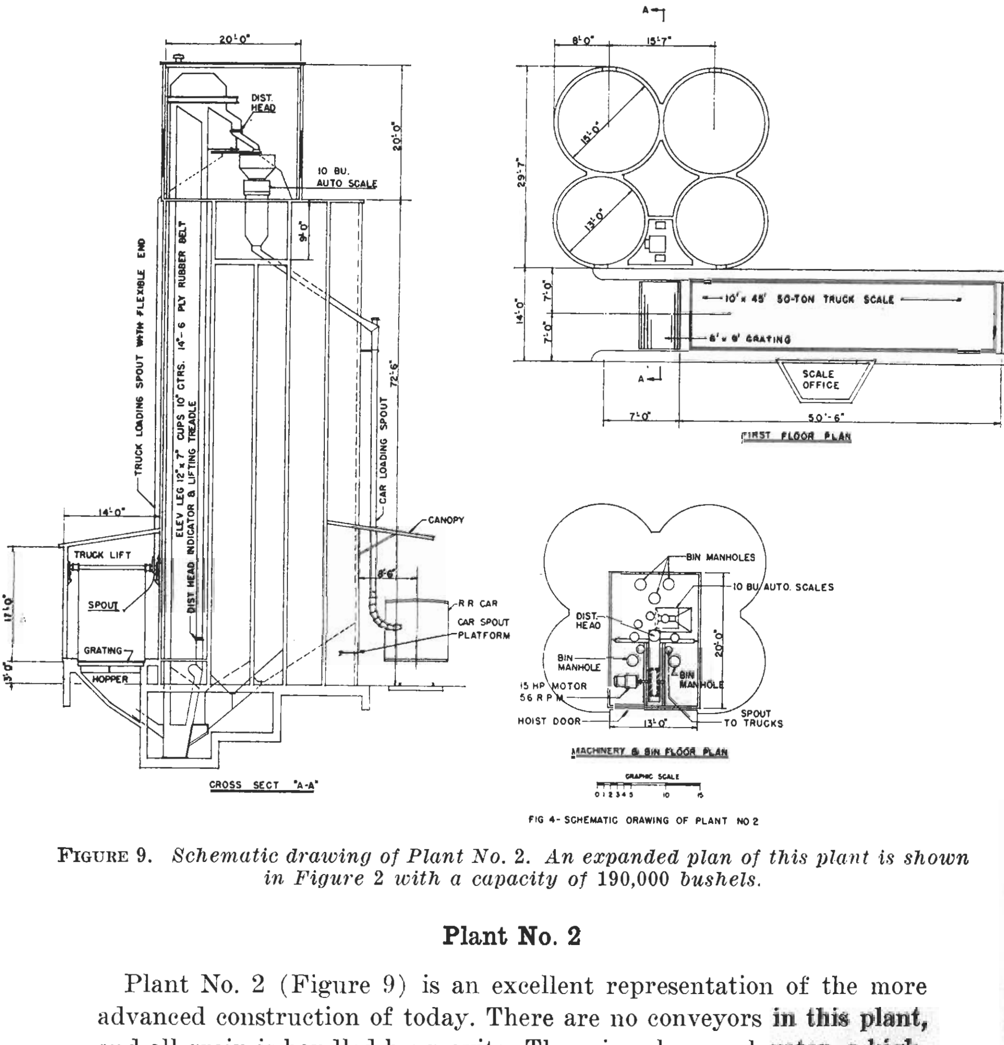

FIGURE 9. *Schematic drawing of Plant No. 2. An expanded plan of this plant is shown in Figure 2 with a capacity of 190,000 bushels.*

Plant No. 2

Plant No. 2 (Figure 9) is an excellent representation of the more advanced construction of today. There are no conveyors in this plant, and all grain is handled by gravity. There is only one elevator, a high-speed 5,000-bushel-per-hour capacity leg. This plant is typical of the midwest in that it takes care of the receiving and shipping only. It has a capacity of 35,000 bushels bin storage, but has no drier.

With three changes, this plan could well serve the needs of small country elevators in the Southeast. Additions could be taken care of in the original design. As previously stated, no attempt should be made to handle grain in the Southeast without adequate drying facilities. A cleaner should be located preferably just under the elevator head, and thus the headhouse would need to extend approximately 30 feet above the top of the tanks instead of 20 feet as shown in the plan. For best results, two elevators should be located in the work-house. This would make the plan very flexible and storage capacities could be increased to meet the demands of the operator by increasing the size or adding additional bins. The elevator shown in Figure 2, page 5, is of this general layout with enlarged storage capacity which has been obtained by increasing the diameter and the height of the bins.

Plant No. 3

Plant No. 3 (Figure 10) was constructed of reinforced concrete in 1947. At the time of construction very little was known about grain handling in the South, and this was one of the first attempts in Georgia to establish this kind of business. All conveying is done with high speed belts. This type conveyor is more expensive in first cost,

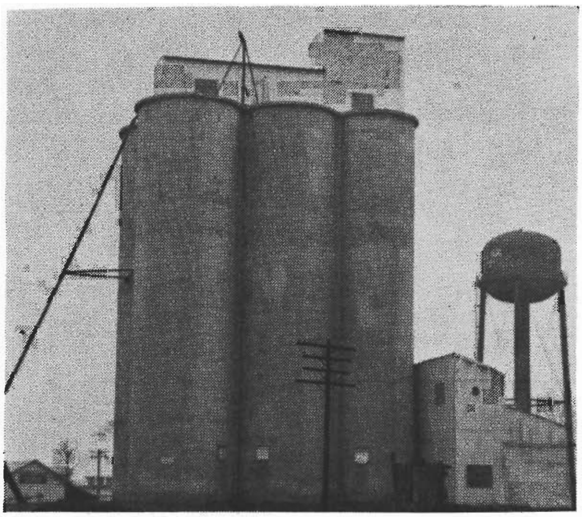

FIGURE 10. *This recently constructed Georgia elevator is well located and constructed. Additional storage can be added as the demand necessitates.*

but long life and the small amount of up-keep necessary make it an advantageous installation. No cleaner or scalper was planned, and there is no drier. The operator plans to install both a drier and a cleaner and to increase storage capacity 50 percent in the near future.

Plant No. 4

Grain handling facilities need to be flexible in that receiving, shipping and drying operations have to be carried on simultaneously. Since the Southeast is heavily infested with insects, storages must be

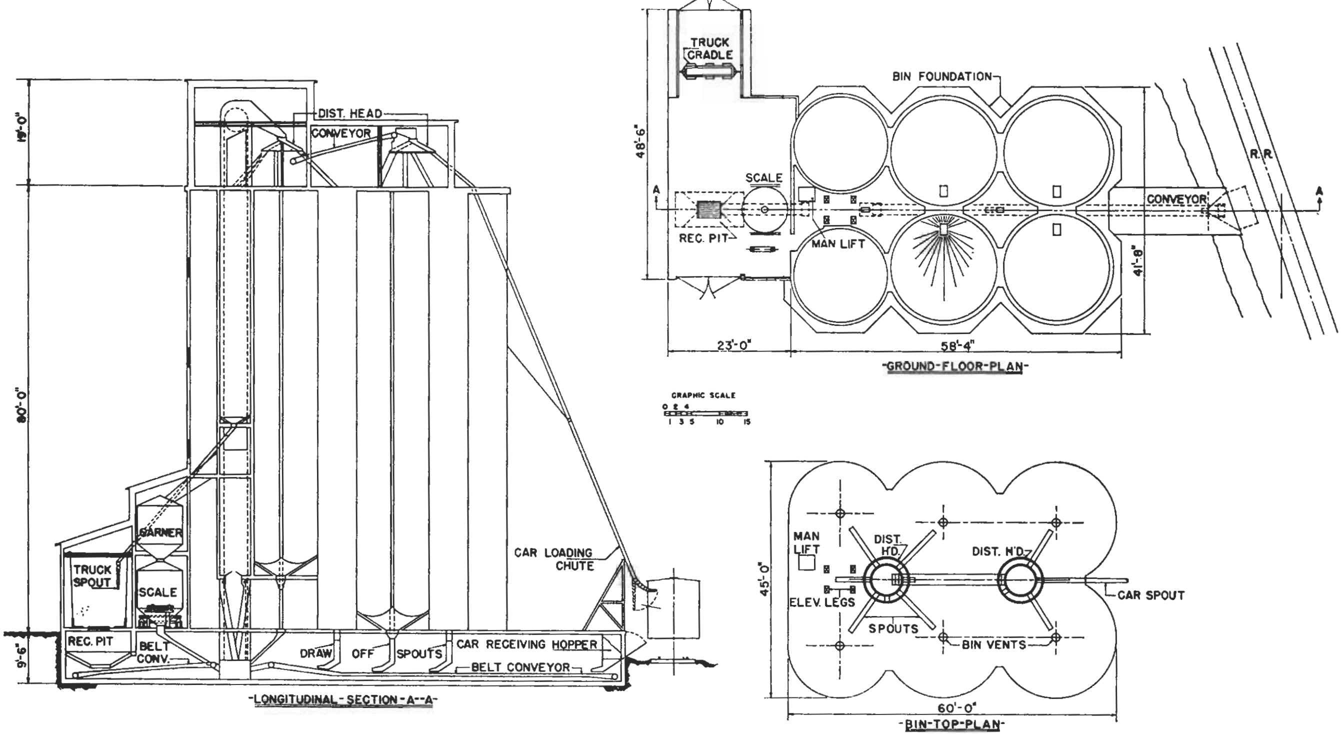

FIG. 11-SCHEMATIC DRAWING OF PLANT NO. 3 PICTURED IN FIGURE 10.

tight, and harboring places for insects cannot be tolerated. This virtually eliminates the use of wood and other porous materials. Cost is also a very important item, and since the use of grain elevators is new in the Southeast, very little data are available for the size plant needed for any location.

For this reason it was thought best to plan for a minimum storage so located that additional bins can be placed to meet the needs. It is believed that these requirements are met in the suggested plant No. 4. (Figure 12.)

Grain brought into this plant first moves over the truck scales, which are 50 feet long and 10 feet wide. A scale of this length will accommodate large trucks and semi-trailers and should have a 50-ton capacity. The weighing mechanism, located inside the office building where it is convenient to the operator, should be a semi-automatic recording device that will make a permanent record of both the loaded and unloaded weight on one ticket. The weight of the grain is then figured by subtracting one from the other.

Sometimes a sample of the grain is taken at this point with a sampling probe. More often, however, the sample is obtained by the elevator operator during unloading and brought back to the office for grading. This is done so that any defective grain which shows up is given due consideration.

Besides grading and weighing equipment, bookkeeping records and routine office supplies are maintained at this location. Often an intercommunication system is established between this point and other important locations throughout the plant. The office building need not be large. A 20 foot by 30 foot structure is considered adequate working space and will give room for clerical and managerial office duties.

The truck moves from the scale to the unloading shed where the grain is removed by means of lifting the front end of the truck with a hoist and allowing the grain to spill out into a hopper located in the floor. This hopper is usually covered by a steel grate which aids in screening out the large foreign matter and also permits passage over the opening by traffic. The grain is conveyed from the truck dump, which has a capacity of 300 bushels or more, into the elevator boot by a drag conveyor. The elevator moves it to the headhouse where it is distributed to its proper location.

All grain not dry enough to store or not clean should be passed over the cleaner. From the cleaner, the grain can be moved into the holding bins or into the wet grain bin to be passed through the drier. The automatic weighing scales are located so that grain can be passed

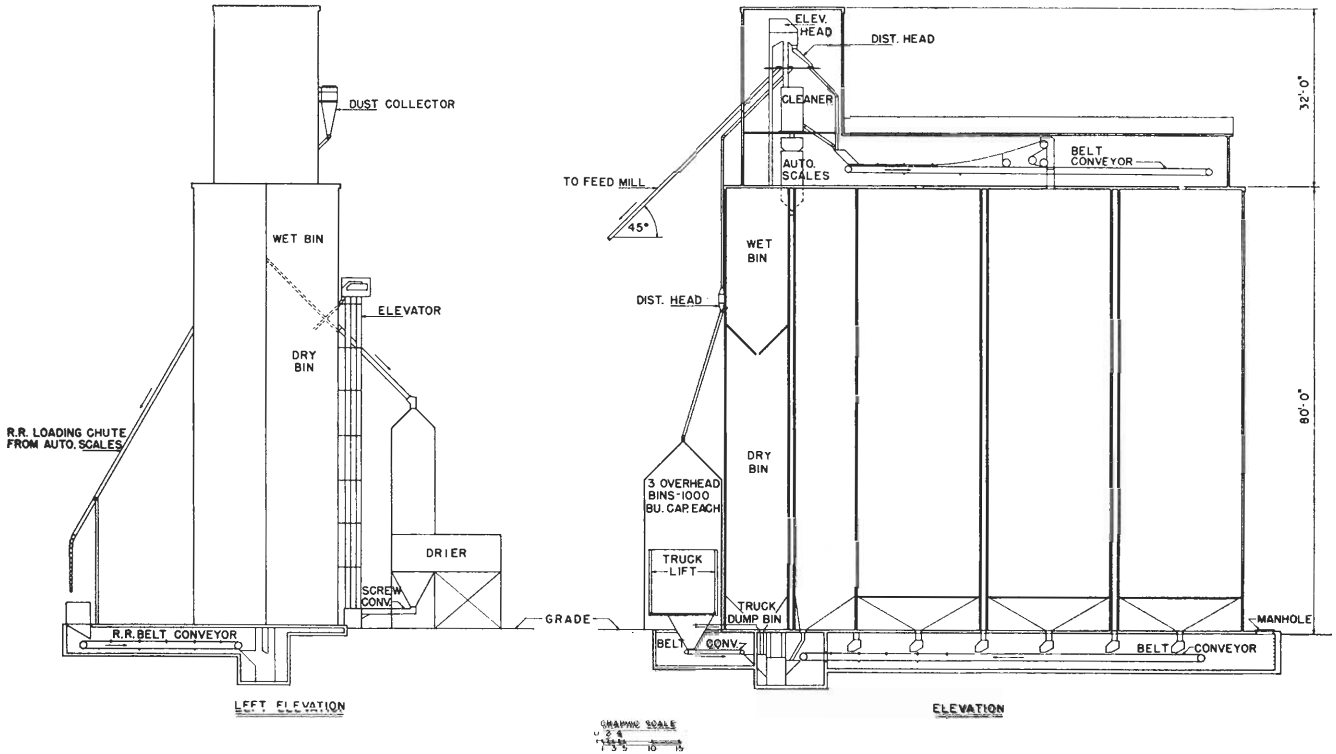

FIGURE 12. *Schematic elevation of proposed plan described in Plant 4.*

over the cleaner and through the scales before shipping. Grain being received or shifted need not be reweighed and thus the automatic scale can be bypassed.

Grain delivered into the wet grain bin is fed by gravity into the drier. Controls activate an alarm system to warn the operator when this bin is either nearly full or nearly empty. This allows the operator to tend the drier with maximum efficiency. An outside elevator of small capacity re-elevates the dried grain conveyed to it from the bottom of the drier by a screw conveyor, and places it in a dry grain bin located under the wet bin. The grain can be removed from this bin, re-elevated to the headhouse, and conveyed to its proper location in the system.

There are no steps leading from the main floor to the headhouse in this plant. A small combination passenger and limited freight man-lift is provided. A ladder is constructed adjacent to the guide supports of the lift for emergency use.

The plan affords three methods by which grain can be removed from the system. It can be drawn out of any bin and conveyed to the main elevator legs, directed from there through the automatic scales for weighing and into the car loading chute which will feed the grain by gravity into a freight car parked on the siding. The grain can be fed directly into a truck from alongside any of the holding bins through an unloading chute without the necessity of being elevated. In this case the grain would be weighed at the regular truck platform scales. Another method of loading out grain is to elevate it in the main system, allow it to pass into one of the three bins in the unloading shed, and from there by gravity to a truck in the driveway.

The elevator can also be used as a storage for a feed mill processing plant. If this plant is located close enough, grain can be elevated to the headhouse and allowed to flow by gravity to the processing plant. The processing plant should be close enough so that the feeder pipe will have not less than a 45-degree angle with the ground to allow the grain to move by gravity. An easy rule to follow is to assume that the grain will flow 1 foot in a horizontal direction for each foot of height.

A railroad dump conveniently located for unloading grain shipped in by railroad car is connected with the elevator by means of a belt conveyor. This dump and conveyor may vary according to individual plant requirements.

The overall plant is extremely flexible. The cylindrical storage tanks may be constructed of any of the conventional building ma-

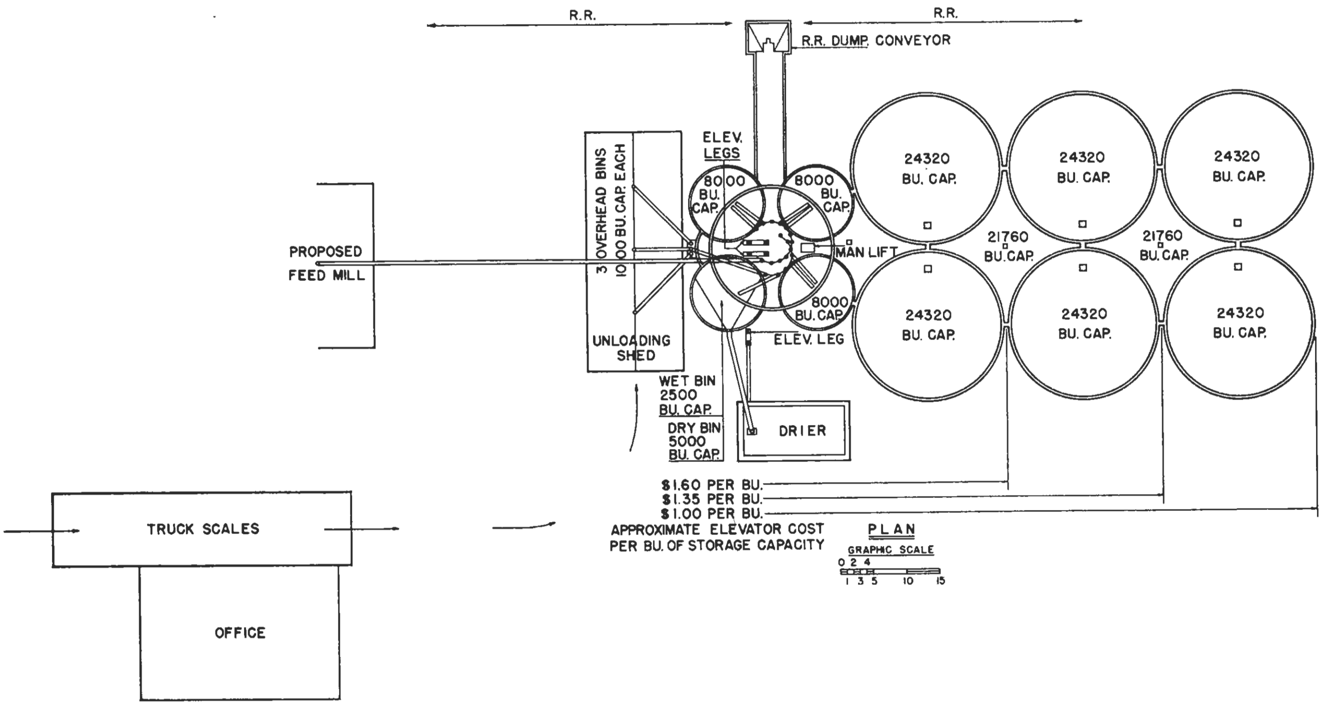

FIG. 13-PLAN OF PLANT 4
SHOWING COSTS OF THE PROGRESSIVE SIZED UNITS

terials if proper precautions are taken in line with good practice for the material used.

The workhouse plan would be altered somewhat in case monolithic reinforced concrete construction is used. More flexibility can be obtained with more bins of varying sizes in the workhouse. This is especially true if more than one kind of grain is to be handled at the same season. In the case of slip-form construction, it is much more practical and economical to tie the bins together using common walls. Intersticed bins of varying sizes can be best employed by using concrete slip form methods of construction as illustrated in Plants 2 and 3.

The building can have only the four small tanks, headhouse, and unloading shed and have a reasonably complete unit. Two, four, or six large holding tanks can be added in pairs if the need arises. Often these holding bins are built with flat bottoms rather than hopper bottoms. This is more economical, providing more storage space at cheaper cost per bushel, but it is not advisable if frequent moving of the grain is anticipated.

One manufacturer gave approximate figures on the construction of the complete layout. These figures are based on 1949 prices using lightweight staves which are considered slightly cheaper than reinforced concrete construction. The sketch (Figure 13) on page 22 shows what is included in the breakdown of the several units. The workhouse, unloading shed and two storage tanks totaling approximately 90,000 bushels capacity, are quoted at approximately $1.60 per bushel storage capacity. The 160,000 storage capacity system which includes two additional bins and an intersticed bin can be built for approximately $1.35 per bushel. This elevator with two more bins and another intersticed bin would have a capacity of 230,000 bushels and cost approximately $1.00 per bushel.

ELEVATOR EQUIPMENT

The prospective elevator owner has a wide choice of equipment from which to select. His choice will depend upon the types and kinds of grain to be processed and the speed of handling desired. All installations whether electrical, mechanical or heating should be in accordance with national, state, and local regulations for fire and safety. Since there are wide variations here it is advisable to obtain an experienced grain engineer and let him design the elevator to do the specified job.

The equipment found in an elevator is included in the following paragraphs. In most cases, some of this equipment will be superfluous, but to acquaint the reader with the available equipment and its functions, it is included.

Elevator Legs: It is from this equipment that the elevator derives its name. The elevator is composed of two pulleys, one located in the "boot," usually in the basement, and the other in the "head," which is usually located in the top-most part of the structure. A belt, to which cups are fastened, dips up the grain in the boot and carries

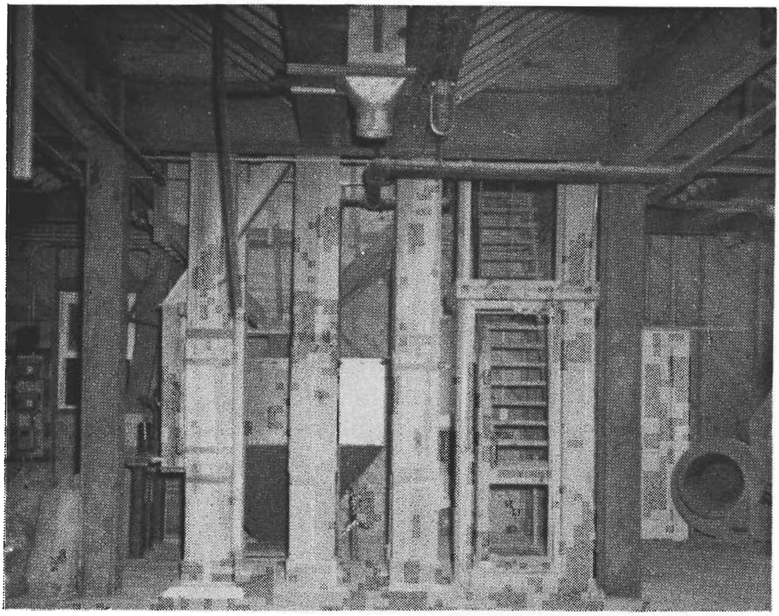

FIGURE 14. *Three sets of elevator legs are shown in this picture. A hand-operated one man lift can be seen in front of the steps. At the far right is a part of a car grain blower. A hopper scale is located just back of the elevator legs. An overhead sprinkler system can also be seen.*

it to the top, where it is distributed by gravity to the bins or to the processing equipment. This belt is enclosed in a box-like structure made of either steel or wood. An electric motor is usually located at the top and drives the mechanism from the head pulley. The speed at which the elevator can be run is dependent upon the design of the head. Speed of belt, size of buckets and spacing of buckets on the belt determine the capacity, usually expressed in bushels per hour.

Elevators with capacities of from 200 to 5,000 or more bushels per hour are available. Their prices are dependent upon the height to which grain must be elevated and on the materials of construction.

Conveyors: While elevators are used to lift grain from one level to another vertically, conveyors are used to transport it in a horizontal plane, or up or down very slight inclines. Several kinds are used, depending upon the type of job, speed, and accuracy of operation required.

The most common means of horizontal conveyance is the screw conveyor. This equipment is low in cost and upkeep. Capacities depend upon the size, speed, and length. An allowance of $10 per foot for cost of a screw conveyor should suffice in the ordinary country elevator.

In large elevators, particularly terminal elevators, belt conveyors are used. The belt conveyor is a much more costly installation and less free of dust than the screw conveyor since it is not generally enclosed. The capacity is much greater and cost of up-keep is reported to be very small.

Drag conveyors are usually used in the bottom of truck and railroad dumps to move the grain from the dumps to the elevator boots. They are relatively inexpensive and consist of steel plates fastened to the links of an endless chain operated by a small geared motor. Shaker conveyors are replacing these drag conveyors in some of the more modern elevators and have proved successful due to the increased volume afforded. These conveyors were priced at around $200 in 1949.

Cleaners: Cleaners are usually placed in the workhouse just under the elevator head level. Grain elevated from the dumps can be carried over the cleaner and be directed from there into the bins by gravity, eliminating the cost of re-elevating. Much care should be taken to obtain a cleaner geared to the capacity of the elevator leg. If corn is to be shelled and shucks and cobs run over the cleaner, a 20 percent additional capacity is allowed over the elevator leg capacity.

The cost of cleaners varies according to capacity and manufacturer. Cleaners with capacities of from 500 to 5,000 bushels per hour were priced from $500 to $2,500, respectively in 1950.

Corn Shellers: Shellers are common elevator equipment, although in some sections they are disliked by operators because of the dust created, the necessity for cob disposal, and the need for special elevator buckets for elevating. They are generally located in the basement and are attached to a special truck dump by a shaker conveyor that feeds the sheller. From the sheller the corn cobs and shucks are fed into the elevator boot and carried up to the headhouse by an ele-

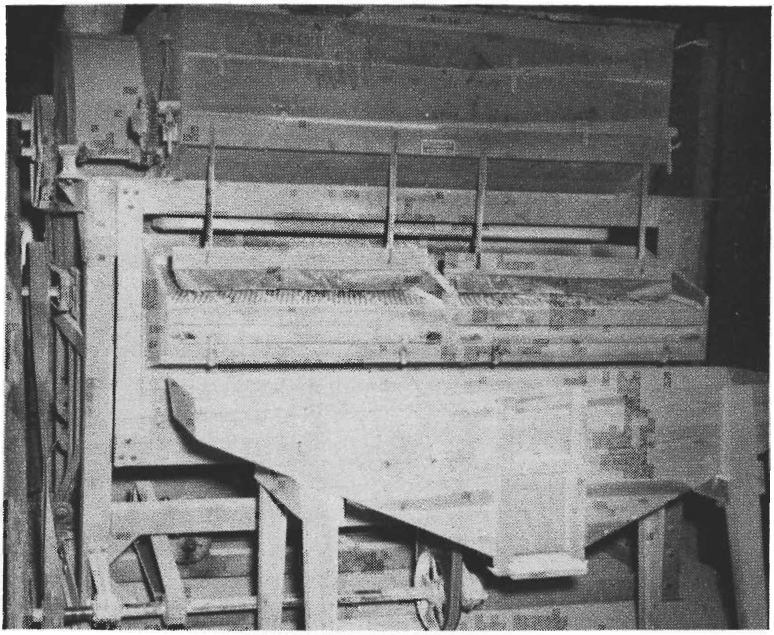

FIGURE 15. *An elevator cleaner located in the cupola or headhouse.*

vator with a bucket especially designed for this purpose. Some operators prefer the corn sheller and cleaner in a separate building. Customarily corn is left in the shuck in the Southeast until delivery to the buyer or used on the farm. This necessitates a different type sheller from that usually found in the Midwest.

Elevator shellers have fairly high power demands. The cost of the sheller usually includes the motor. Prices ran up to $1,000 in 1950.

Hammer Mills: The use of hammer mills in grain elevators is confined to those plants that mix feed. They are usually located in the basement and have auxiliary blowers separately attached to elevate feed to a cyclone mixer on a higher floor level. The degree of fineness can be regulated to suit feed specifications. Power requirements are high, sometimes running up to 100 hp or more. Prices range between $1,000 and $4,000 for hammer mills having high capacities.

Scales: Weighing devices are necessities in the elevator business and need expert attention frequently. They should be in good condition at all times. Installations with capacities of 100,000 pounds and platforms not less than 50 feet long and 10 feet wide are the present order of the day in truck scales. This has been made necessary with the transportation of grain by large trucks. Scales of this size with automatic recording devices cost $5,000 or more. They are not usually covered and are located away from the elevator but adjacent to the office where they can be read from inside the building. Often a bookkeeper or secretary in the office is assigned the duty of operating the scales. No effort should be spared to see that the customer has utmost confidence in all elevator weighing devices.

Another type of scale used in most elevators is the automatic dumping scale. This is usually located below the level of the cleaner which extracts foreign materials. Clean grain then passes into a surge tank which supplies this scale. The scale can be bought in several sizes. The capacity in pounds corresponds to the test weight of a specified number of bushels of grain. The scale fills and dumps automatically, recording each operation. The grain is then delivered to its assigned bin. (This type scale together with the cleaner is often located in the headhouse above the level of the bins so that the grain is conveyed away by gravity.) A six-bushel automatic scale cost approximately $1,250 in 1950.

Still another type scale used in elevators, especially those with feed-milling equipment, is the hopper scale. The capacity is usually

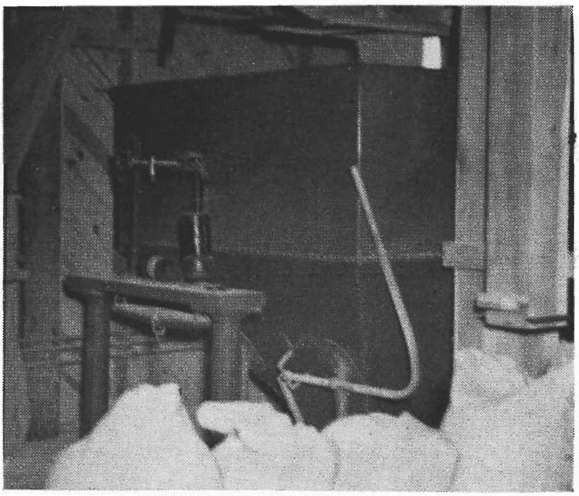

FIGURE 16. *A hopper scale common in most batch feeding mixing plants.*

one or two tons for small establishments and any specified number of pounds less than its capacity can be measured. This is useful in mixing different quantities of various ingredients for feeds. These scales are usually located so that workhouse or feed mill bins empty the ingredients into them by gravity. The hopper scale feeds the mixture out by gravity into an elevator boot or else the mixture is carried to the mixer by a cyclone feed collector.

Dust Collectors: Dust is a serious problem around all elevators, especially those where cleaning and grinding of seed and grain is done. Dust causes discomfort and inefficient working conditions, besides being a distinct fire hazard.

The common method of alleviating the dust problem is to separate the dust from the air discharged from cleaners and similar equipment. The dust-laden air is blown into a collector. The inverted cone shaped design causes the heavy particles to be dropped into a bin and the air is released through a vent in the top. One or more of these devices is used in almost every well-designed elevator.

FIGURE 17. *The structure on the extreme left is a cob burner which is fed from the cleaner located in the cupola. A dust collector can be seen on the side of the cupola. On the roof of the front shed which is the feed mill can be seen a cyclone which receives ground feed from the grinder located in the basement.*

Since the cost involves only the metal, which can be of light gauge, and the labor to fabricate it, there is no great expense. Ample intake and exhaust ducts should be taken into consideration and a dust bin which can be readily emptied and cleaned out is necessary. The cost will vary, but $100 should be ample for materials and construction.

Fire Control Devices: As in all structures, fire control is an important safety measure. Proper designing with fire-resistant materials, controlling dust, and prohibiting of smoking on the premises are not enough to eliminate this ever-present hazard.

Fire extinguishers should be placed at convenient locations and they need to be properly charged and in working order at all times.

Overhead sprinkling systems are used in many elevators where some milling is done. Insurance cost can be greatly decreased if a few ordinary preventive measures are followed.

Magnetic Separators: Scrap iron is a considerable source of worry to elevator workers. Screens and gratings fail to perform a perfect job of separating it out, and thus damage to machinery often results. In some cases, fires have been traced to foreign metal which was carried into a piece of machinery.

To eliminate this hazard, magnetic separators are used. They may be attached to a chute or the metal in the grain may be separated while passing over a belt. The cost is not high and this precautionary measure is well worth the time and expense of installation.

Distribution Heads: With a central elevating system and from six to 20 possible places for grain to be delivered, such as to cleaner, bins, drier, and railroad siding, the need for a distributing system is obvious. If it is operated from the working floor, it saves many steps and much confusion as compared with the old method that necessitated climbing to the turn-head each time a change was necessary.

Operation of this essential piece of equipment is simple. The cost is moderate. One hundred dollars should buy the complete mechanism.

Car Loaders: When elevator design has not allowed for loading out railroad cars by gravity it is necessary to install a car loader. This equipment consists of a high-speed fan blower usually operated by a 10 hp. electric motor. The grain is introduced into the exhaust air and does not come in contact with the fan blades. A spout which divides the grain, allowing the car to be filled from both ends, is standard equipment. Depending upon capacity, a car can be loaded in approximately two hours. The cost of this equipment, not including the motor, was about $250.00 in 1950.

Man Lifts: The term "man-lift" is used to describe the various types of rapid inter-floor transportation units for workers in the elevator. There are three main types in use and the choice will depend upon the service desired.

The counter-balanced, hand-operated, one-man platform unit is intended for use where vertical travel heights are small and use is limited to one or two different workers. Installation space is small and the cost is approximately $250.00.

The electric motor operated, cage type, one or two man elevators are intended for vertical travel up to 200 feet. A small amount of freight may be transported within the capacity limits allowed. Operating cost is small as the motor operates only while the elevator is in use. The price of this elevator is $2,000 up.

The belt-type employee's elevator provides the quickest service and will carry the maximum amount of inter-floor traffic. There is no waiting at any floor for either up or down transportation. The motor is usually operated continuously when there is much inter-floor traffic. Operation costs run approximately $1 per day. The cost of this type elevator, including the motor starts at around $4,000. Height in excess of 50 feet increases the initial costs.

Car Unloaders: When there is no suitable way to lift a carrier and allow the grain to be spilled out, a car unloader is often used. This device is also used to empty storage bins built with flat bottoms to give added capacity. In working the machine the operator draws backward on a scoop attached by a rope to a motor-driven winch. When he stops, the machine automatically starts winding in the rope, being so set that when the scoop reaches the preadjusted length of travel the driving clutch is released. This allows him to pull the scoop back and start the action over again.

The single action car unloader is rated at moving 2,000 cubic feet per hour. The cost was approximatley $700 in 1950, which included a 5 hp electric motor.

Truck Lifts: Overhead truck lifts are used almost exclusively for receiving grain from farm-type trucks. The front wheels of the truck are driven on the platform which is raised by motor-driven hoist. For dumping large trucks and semi-trailers too heavy for this hoist, large, motor-operated platform dumps that accommodate the entire truck length are used. This lift is often installed in conjunction with a scale of suitable capacity.

Lifts of the winch type for smaller farm trucks that raise only the front end of the truck range in price from $1,200 to $2,000.

Bagging Equipment: There are many pieces of equipment to facilitate bagging grain and feeds. Sewing machines are used to close most feed bags. These can be bought in a variety of models, sizes and mountings. For quick, efficient bag closing, wire is often used. Wire ties can be purchased, and a spring twister enables the operator to perform the task with dexterity. Sewing machines cost $400 up. Wire ties require no expensive equipment. A twister and 100 ties cost less than $10.

Grain Testing Equipment: The science of testing grain has been simplified in recent years until today almost anyone can learn to do an acceptable job in a short time. The main tests run are to determine moisture content, dockage or foreign matter present, and test weight per bushel.

Moisture content is obtained by instruments that rely on one of two general principles. The most common is the electronic method that measures moisture content by electrical resistance or impedance. This is a quick and reasonably accurate method of determination. The instruments' costs are high, most of them selling for approximately $400

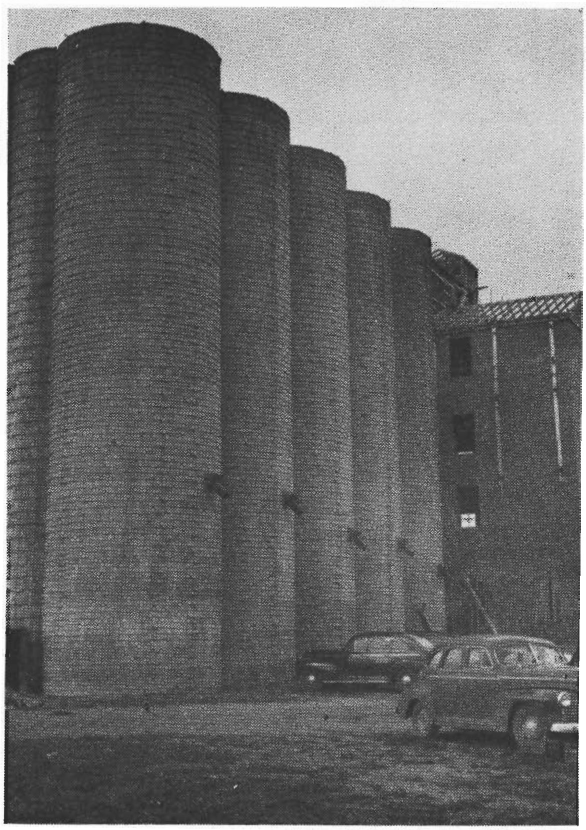

FIGURE 18. *Truck loading spouts may be seen on the sides of the concrete stave grain bin.*

The oil bath type is considered more accurate and costs less than $100. However, the time consumed in making a test is considerably longer and operators object to this.

Dockage tests are important in small grain. This test determines the amount of foreign matter in the sample. It is performed by a small hand-operated cleaner and the percentages of the samples are applied to the load.

Test weights are performed by weighing a sample of seed in a small, standard measuring device which records the test weight on the scale beam.

These tests are important and the operator should acquaint his patrons with the processes and thus obtain their cooperation and confidence.

Truck Loading Chutes: Truck loading chutes are small doors in the sides of storage bins. They are usually of metal and care should be used to see that they are water tight. They are generally not more than 15 feet from the ground level and are convenient to trucks for loading. This device saves time and expense by eliminating the need for elevating grain for loading.

Grain Temperature Detector Systems: When grain is to be stored in large bins for considerable time, it is advisable to install a temperature detector system. Cables or pipes with thermocouples placed at 5 or 6 foot intervals are suspended from the top of the bin through the middle of the grain. The thermocouples usually are connected to a panel placed at a convenient central location in the elevator.

Readings taken daily and recorded on a chart reveal unwarranted changes in grain temperature. Since grain spoilage is usually accompanied by an increase in temperature, much turning of the grain for inspection can be eliminated.

STORAGE BINS

The storage necessary for a country-type elevator is a debatable question. The grain grown in a certain area is a poor criterion for selecting elevator capacity since it is not known how much of this grain will be handled. Where elevators have been built in new territory, usually there has been an increase in grain production and more elevator space was profitable.

Storage bins and the workhouse with which they are connected make up what is commonly called a grain elevator. Until recent years the bins were made in the workhouse. This wooden structure was generally rectangular in plan and usually extended from one floor level below the ground to 75 to 100 feet above the ground. Rectangular bins were partitioned off within the building. Cleaning, weighing, and elevating equipment was usually located between bins. Today there is a tendency to do away with wooden construction. A shed to cover the grain dumps and an office building are the only wooden structures used, and often these are of fire-resistant materials. There are two very good reasons for new planning to develop in this manner. Fire insurance is cheaper, and cost of construction is less.

With improved construction methods, cylindrical storage can now be built much cheaper than rectangular storage on a per bushel basis. Concrete and steel lend themselves to this type of construction and are considered excellent materials for grain storage. The labor cost of erection is minimized by the use of these materials. Bins of

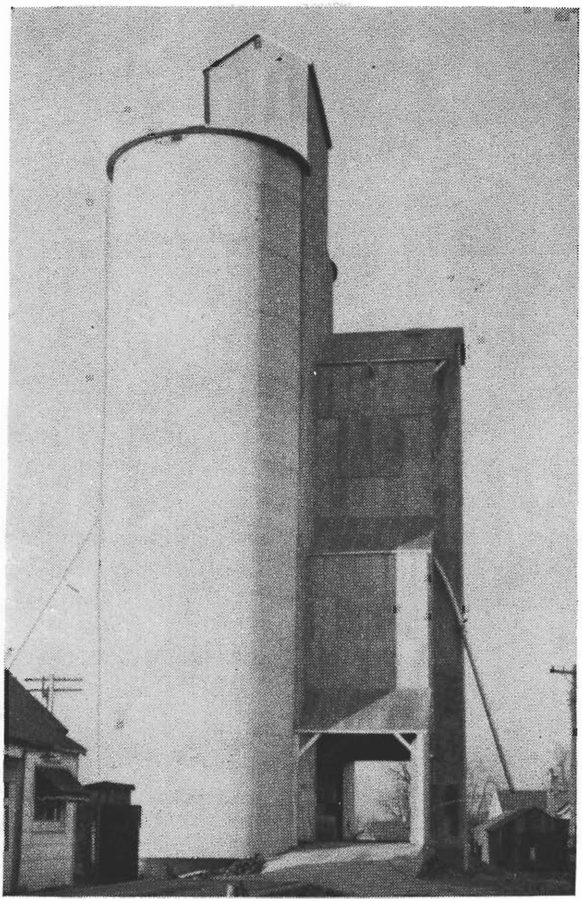

FIGURE 19. *The concrete bins of this elevator are still in excellent condition although they have gone through two fires.*

concrete and steel can be expected to render good service over many years. There are concrete bins still in use after 70 years, some of which have survived one or two fires that destroyed adjacent wood frame buildings.

Most of the older grain storage facilities are made of wood. The bins are of crib construction. The price of lumber, which favored

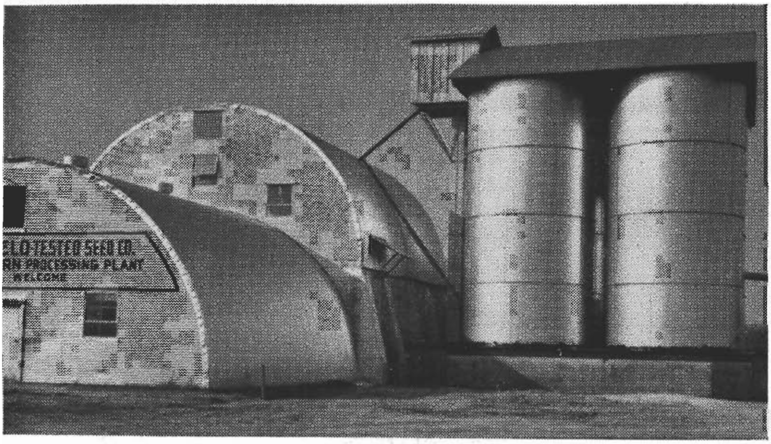

FIGURE 20. *These steel bins are used to store hybrid seed corn in North Carolina.*

this type of construction in past years, has advanced to a point where the reverse is now true. Wood is excellent grain storage material as far as grain conditioning is concerned; however, chances of insect damage are probably higher in wood than in any other of the better-known building materials.

The excessive time required to erect cribbed bins is an adverse factor in the choice of wood. Although common labor can be used, the labor cost is not reduced because of the time required.

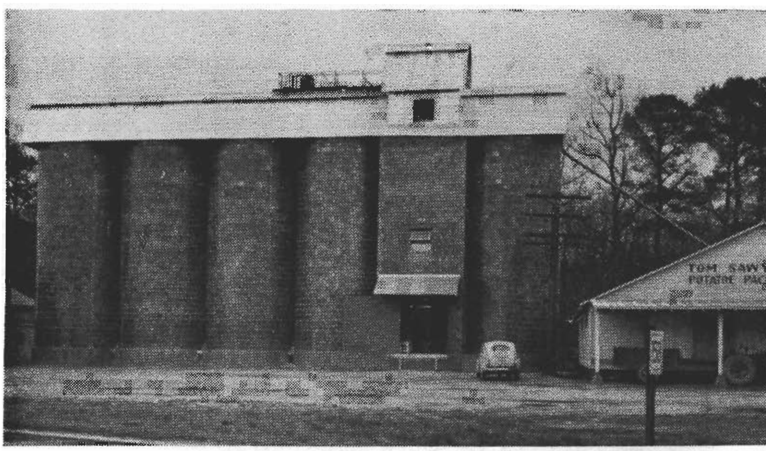

FIGURE 21. *A glazed tile elevator of recent construction built in connection with a general merchandise and farming business in Eastern North Carolina.*

Bins made of hollow tile and reinforced with steel are well liked. The cost of the tile and steel is high and skilled labor is required for construction. Work progresses slowly in comparison to steel and reinforced concrete. Tile construction has fire-resistant qualities and if water-proofed mortar joints are used it is satisfactory for grain conditioning and storage buildings. The lasting qualities of tile construction should be equal to reinforced concrete.

Steel bins have not been used extensively until recent years. Their initial cost is less for storage capacities up to about 40,000 bushels. They can be erected cheaply since common labor can be used and the rate of construction is faster than any other type on a man-hour basis.

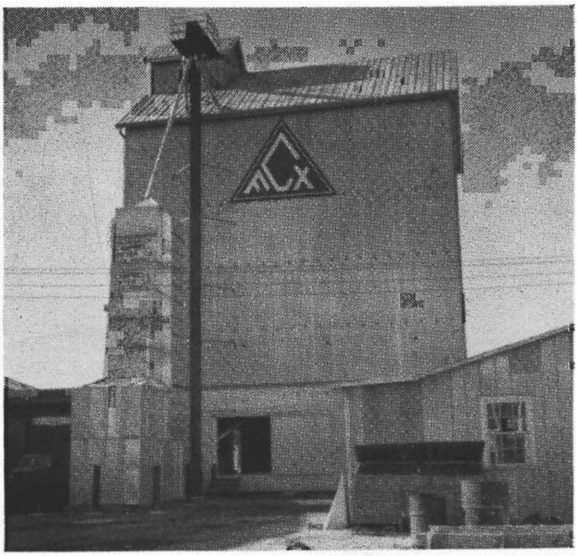

FIGURE 22. *A self-contained, column-type drier of 300-bushel-per-hour capacity is shown in the foreground. A dual leg elevator can be seen which feeds drier and returns dried grain to the bin.*

Care must be taken to secure the joints so that there will be no seepage of water. Claims of excessive spoilage due to condensation have not been substantiated in plants visited. Figure 20 shows steel bins used for hybrid seed corn. This type of construction is also used for private and government storage in many places in the Midwest.

There are several manufacturers making concrete staves for storage construction. Staves are laid much the same as tile. A waterproofing compound is fitted in the joints and the structure is encircled with steel tie rods. Failures observed in this type of structure were due to leakage and lack of proper reinforcement. Cost of construction is not considered high, but maintenance costs must be taken into consideration.

In any type of grain bin construction the highest proportionate costs are in the foundation and roof. If you propose to build a structure 90 feet high, 2/3 of the cost is in the first 45 feet of height.

Before deciding on a location soil tests should be conducted to see if bins will be supported without danger. Often pilings must be driven to support the weight of bins loaded with grain. The site may be unsuitable. This condition should have weight in the choice between sites. Services such as these are furnished by engineers experienced in heavy construction.

DRIERS

Facilities for drying grain have become an essential part of an up-to-date elevator, since modern methods of harvesting often result in high-moisture-content grain which must be conditioned properly

Figure 23. *The box-like structure in the foreground is a self-contained, column-type drier with a capacity of more than 1000 bushels per hour. This plant is a good example of adequate planning for future expansion. The bins in the foreground to which the drier is connected were installed first. The remaining bins shown at left of picture have been added.*

to maintain high quality. Harvesting small grain or corn as soon as it is mature is an advantage to both the farmer and the elevator operator, as lower quality and losses due to weather and insects are largely avoided. Accordingly, the elevator operator must be equipped

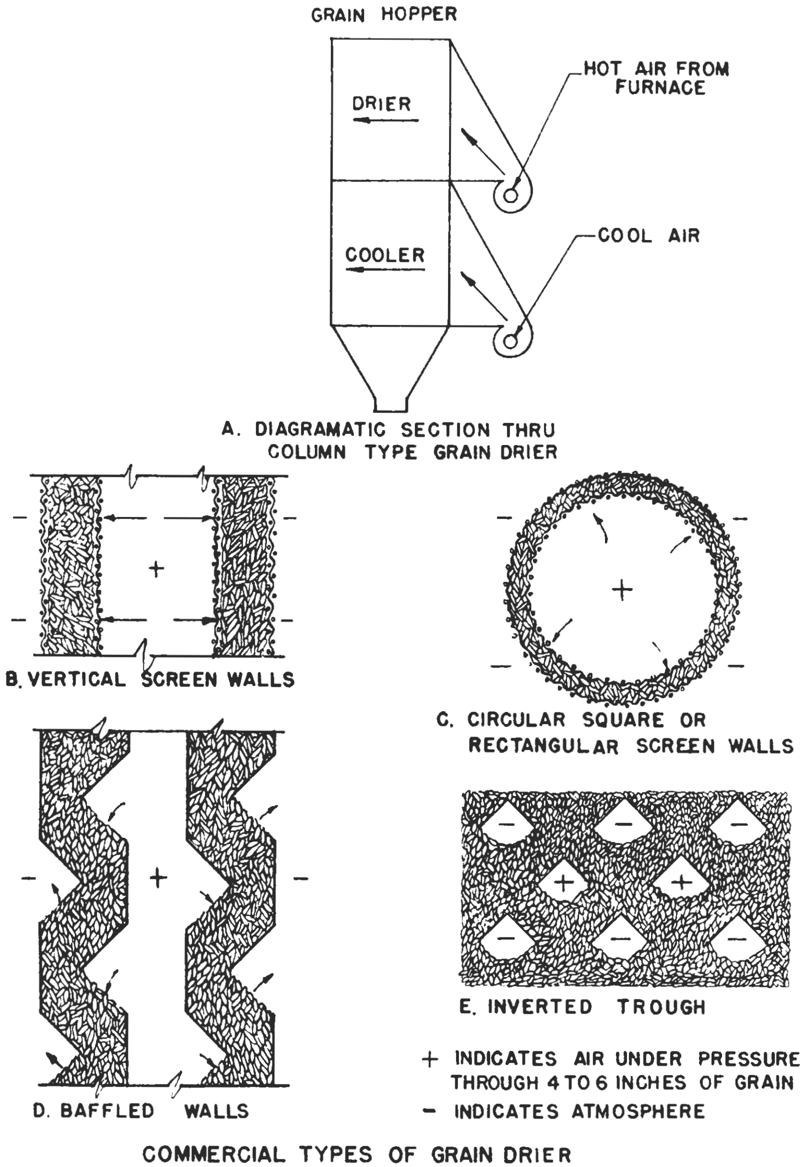

FIGURE 24. *Schematic illustrations of different types of column driers.*

to receive wet grain and handle it with minimum loss over a long period.

Types of Driers, Construction and Operation: There are three general types of grain driers in commercial use: (1) bin type, (2) belt conveyor type, and (3) column type. The bin type is used by many seed producers. It is not generally recommended, however, for use in elevators, because it requires a large floor area for large-volume drying and does not lend itself as well as some other types to mechanized handling. The belt conveyor type is relatively new and is not as widely used as the column type. Some operators report that high temperatures must be used with the belt type drier in order to get large volume drying.

The vertical column type is by far the most common drier in grain elevators. There are four designs now in use, as shown in Figure 24. These machines usually have drying and cooling sections as illustrated in Figure 24-A. In one design two or more pairs of thin columns made of heavy wire screen supported by steel members, are erected vertically with a plenum chamber between the columns. This chamber between each pair of grain columns is air tight so that when heated air is blown into the chamber, it must pass out through the screened columns containing grain. Another design provides two vertical steel cylinders, one inside the other. These cylinders are perforated so that heated air blown into the inner cylinder will pass through the perforations and through the grain held or moving downward between the two cylinders. This general type also may be square or rectangular rather than circular. In the third design one or more pairs of rectangular vertical columns are constructed with an air chamber between them. The grain moves slowly downward over a series of slanted shelves, the drying air passing through the grain as it flows from the shelf above to the one below. In the fourth design a square or rectangular vertical column is provided with a series of inverted V-shape baffles across the column. The grain moves downward over these baffles, which are open at the bottom. Air is forced into half of the baffles from whence it passes either upward or downward through the grain and enters the baffles above or below to be discharged outside.

All of the column types are provided with a large hopper at the top to hold grain for several hours operation or a small hopper to which an elevator provides a constant supply. By whichever method, the columns must be kept full at all times during operation. A signal control is desirable to warn the operator when the hopper is about full; otherwise an overflow should be provided so grain will be spouted back to the storage bin.

In all these designs mechanical arrangements are provided at the bottom of the columns so that grain can be held in the columns as long as desired or can be fed at varied rates to a conveyor or elevator for return to a dry bin.

The heater and fan for the column units are sometimes housed in a separate building. This increases the cost of drying facilities and the trend is to provide complete units of all-metal construction containing seed chamber, fan heater, and necessary controls. The unit is enclosed for weather protection and can be erected as far from the elevator as may be required by state insurance regulations.

Heated air is essential to dry large quantities of grain rapidly, particularly in areas having high humidity. Butane or propane gas and fuel oil are the most widely used fuels, although natural gas is used where available. By far the majority of driers use direct heat; that is, the products of combustion are released into the drying air stream. Greater efficiency in the use of fuel is thus obtained.

Controls are provided to shut off the heater and fan if flame, ignition, or power failure occurs. In addition, most commercial driers are equipped with modulating burner controls so that the drying air temperature can be maintained at a constant level.

Drying Temperatures and Drier Capacities: According to W. V. Hukill, "Obviously, if the grain is to be used for seed, drying temperatures should be limited to not more than 110°F. Corn to be used for wet milling should probably not be exposed to temperatures higher than about 130°F. There is some evidence that temperatures in the neighborhood of 200°F have an injurious effect on corn to be used as feed, but this point is not well established."[3]

With grain driers of a given type and size, rate of drying is influenced chiefly by kind and moisture content of the grain, amount of heat supplied, and temperature of the drying air, assuming that the amount of air supplied is constant. The rate of drying different grains varies, as small grains dry faster than shelled corn. This will also affect drier capacity. In describing a drier it is not enough to state that the capacity is 300 bushels per hour. The buyer must know the capacities for different grains at various moisture content and drying air temperatures. Wet grain dries faster than fairly dry grain in the initial stages of drying so that the rate of moisture removal is not the same. However, at a drying air temperature of 110°F, a rough rule of thumb method is to figure a reduction in moisture content of one percent per hour; at 130°F, 1¼ percent per

[3]Hukill, W. V., "Types and Performances of Farm Grain Driers," *Journal American Society of Agricultural Engineers*, p. 54, February, 1948.

hour; and at 150°F, $2\frac{1}{4}$ percent per hour. This assumes that approximately equal volumes of air are supplied at the various temperatures. Thus, if a drying temperature of 130°F is used and the drier is set to discharge 1,200 bushels per hour, the grain will be reduced about $1\frac{1}{2}$ percent in moisture content. For a reduction in moisture content of six percent, such a drier must be set to discharge about 300 bushels per hour.

Initial Cost: Initial costs of driers vary considerably depending upon type, whether completely prefabricated, and whether suitable labor is available locally for erecting. Probably $12,000 is a minimum installed cost for the prefabricated column type, having a capacity of 300 bushels per hour with an average reduction in moisture content of six percent. This price would not include cost of elevating equipment which might be needed for operation of the drier.

Some concerns now offer a complete service which includes installation and checking of the drier under actual operating conditions by a competent engineer or foreman. Advantages of this type of service are that the owner knows in advance the cost for a complete installation, and satisfactory operation is assured under terms of the contract.

Cost of Operation: Fuel for supplying heat, electricity for operating motors and controls, maintenance of the equipment, interest on the investment, amortization of cost, and insurance premiums are the main items of expense in figuring cost of operation. If the drier is completely mechanized, labor cost for operating it should be low. Only a fraction of one man's time should be needed and generally the elevator operator can operate the drier along with other elevator duties.

Little corn was found to be dried at elevators on a custom basis. A deduction in price amounting to three cents per bushel was usually made for each percent of moisture above that for the based grade price. This deduction took care of the loss in weight as well as drying costs and provided a margin of profit.

On the basis of 1949 grain drying prices, the actual cost of drying was obtained from one plant operator. The costs were for over 200,000 bushels of corn of varying moisture contents:

17½% to 15%	5c per bushel	25% to 15%	11½c per bushel
20% to 15%	8½c per bushel	30% to 15%	14c per bushel

These costs include a calculated average cost of $3\frac{1}{2}$ cents per bushel for labor, elevating, and cleaning. An additional $3\frac{1}{2}$ cents should be added if the grain is to be received and shipped in bags as is common in some sections visited.

The cost of drying corn and soybeans was found to be about the same for like moisture contents. Oats, which weigh less per bushel, can be dried cheaper than any other grain on a per bushel basis. Other grains ranged between corn and oats, depending upon weight per bushel. In the final analysis, cost of drying any grain depends largely upon the amount of water to be evaporated.

ALLIED BUSINESS

Allied business, or "sidelines" are important factors contributing to the success of any elevator enterprise. Today the term "sidelines" hardly describes these important adjuncts. Efficient use of labor demands a year-round business be conducted. People who sell grain spend their money to buy gas, coal, home and farm supplies. The mere presence of this merchandise at a traffic center such as this will insure sales. Proof of this is shown in any publication on grain elevator financial status. A minimum of 40 percent of the yearly operating cost must be defrayed by so called sidelines sales of elevators handling a yearly average of less than 200,000 bushels of grain.

Feed Grinding: Seventy four percent of the plants visited operated feed grinding facilities. Customers brought in their own grain and supplemented it with other ingredients available at the elevator.

Feed grinding machines have the highest power requirements of any of the more common operations around an elevator. Fifty, 75, and even 100 horsepower motors are not uncommon for this operation. Prices of the grinders and motors range from $2,000 to $4,000.

Rates for grinding varied considerably depending on fineness of grinding and other factors. Common charges were 10 and 15 cents per 100 pounds.

Feed Mixing: The plants with grinders had mixers. Feeds were often mixed to the customer's specifications using his own grain. Recommended ingredient formulas were provided by many states.

Most firms carried an established, complete line of commercial feeds. They also produced their own brand name feeds consisting of specified amounts of the various grains with the correct commercial concentrates added to produce a balanced ration.

Power demands for mixing were small. Most of the mills could feed grain and the desired concentrates by gravity into a batch scale hopper, usually of one-ton capacity. The mixture was then fed through a mixer and bagged or dumped in bulk on the farmer's conveyance.[4]

One and two-ton mixers were most common. Their costs ranged from $500 to $1,000.

When the farmer's grain was used, the mixing charge was generally five cents per 100 pounds plus price of the concentrates. This operation is simple and can be handled by one man if bagging is not desired. Often two mixers are used to save time and afford smoother labor operation.

Seed Cleaning: Seed cleaning was done by 11 percent of the firms and was concentrated in sections on the eastern seaboard. Crimson

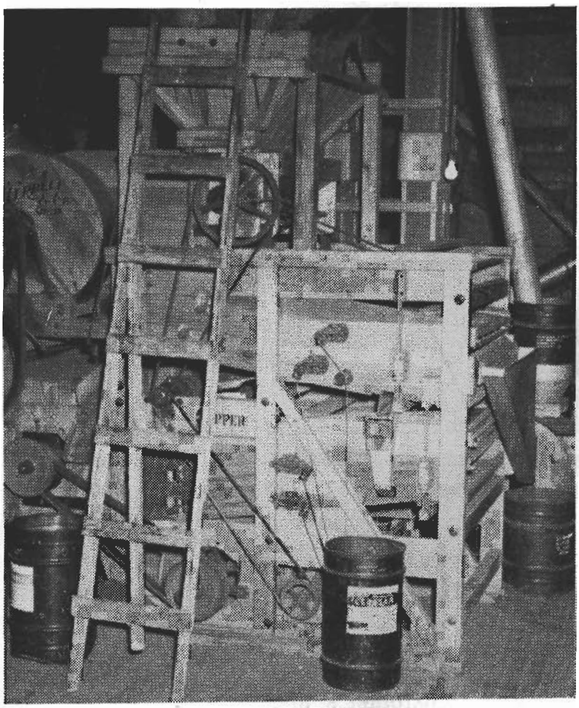

FIGURE 25. *One of the cleaners used to clean lespedeza, crimson clover and other small seeds.*

clover, lespedeza, soybeans, blue lupine, and small grains made up the bulk of the seeds cleaned. This is a specialized business and considerable knowledge of seed and machinery is necessary for success. In most cases grain storage was established as a sideline. Labor requirements during peak seasons are quite heavy.

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[4]Hurst, W. M., "Farmers' Cooperative Feed Mills," *Farm Credit Administration Report, Miscellaneous Report 125*, October 1948. Processed, p. 41.

A prime factor in obtaining pure seed is periodic cleaning of elevator boots and other foreign material collection places in machinery and equipment. Design to facilitate this cleaning is usually included in all manufactured handling equipment.

Machinery used in this operation consists of seed cleaners, hullers, scarifiers, elevators, graders, seed treaters, and bag closers. With the exception of bag closers, none of this machinery is duplicated in any other elevator operation, so a separate building for this operation is necessary.

The plant generally buys seed direct from the combine and processes it. Germination tests are run under state supervision and the seed is stored until the planting season. The end product is sold through dealers over wide territories. Reputation built and maintained insures volume of business and good income.

This is a specialized business, and will not be discussed in detail here.

Corn Shelling: There were corn shellers in many elevators studied, because corn made up a large percentage of the grain produced. To some extent this condition will exist in the Southeast.

Elevator operators differed in opinion as to whether corn should be shelled at the elevator or on the farm. If shelled at the elevator, cob disposal becomes a problem. Some cobs can be ground and used

FIGURE 26. *Shellers of this kind travel from farm to farm to do custom shelling.*

for poultry house litter or for fuel in residences. Although they furnish intense heat, they burn quickly and last only a short time. Other alternatives are to dispose of cobs in burners or haul them to a dump. Cob burners are fire hazards and expensive to construct. Much labor and trucking expense are consumed if they are dumped.

Experiments with a shelling attachment on large mechanical pickers have proved satisfactory and desirable where the corn has high moisture content at harvest. Kernels are damaged less when shelling is done immediately after picking. The cobs do not accumulate, but are scattered back on the field. This equipment should be generally available within the next year or two.

Elevator shellers with capacities ranging from 250 bushels to 2,000 bushels per hour are available at $300 to $700. Portable husker-shellers are priced at about $350 for 150 bushels per hour capacity.

Trucking: Many elevators operate trucks. Small trucks are used to pick up grain and deliver feed to and from farms. Larger trucks deliver grain to nearby mills and terminals and bring in feed and feed concentrates. Present day demand for hauling affords steady employment for trucks and drivers during off peak seasons. Sixty-three percent of the elevators visited operated trucks, and the remainder relied on farmers and trucking companies for this hauling.

Lumber, Building Materials, and Hardware: Twenty nine percent of the elevators handled lumber and building materials. According to a Farm Credit Administration Report[5] covering the period 1929-38, this sideline for farmers' cooperative elevators during the period 1929-38, inclusive, was the third most lucrative from the standpoint of income and volume handled. During the 10-year period average gross income was 15.42 cents per dollar of sideline sales.

Farm Machinery: Most cooperative elevators sell some machinery or are associated with concerns that handle machinery. Only five elevators sold farm machinery at their business. One of these was owned by an individual, and the other four were cooperative enterprises. A farm machinery line is generally considered as a business in itself because of the repair and service aspects.

Petroleum Products: Few elevators owned by individuals sold petroleum products to any extent. The opposite was true of cooperative enterprises, because in the sections surveyed there are cooperative refineries.

Petroleum products sold included greases, tractor, truck, and automobile oils, sprays, and fuel oils. In addition, complete filling station service was offered at many cooperative elevators.

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[5]"Business Stability of Iowa Farmers' Elevators," Farm Credit Administration Bulletin 44, p. 60.

Coal: For many years coal has ranked high in total dollar sales throughout the West and Midwest. No elevators visited in the East handled coal. The elevators visited in Indiana and Illinois realized little, if anything, from the sale of coal, probably because of the presence of natural deposits of petroleum products in most of the sections. In other states in the Midwest, such as Kansas and the Dakotas, coal sales make up a large percentage of the ''sideline'' business.

Grain Processing: Grain processing is used here to mean Soybean oil extraction plants, corn meal, and flour mills. These are major enterprises in themselves and in most cases grain storage was constructed as an addition to insure convenience and accessibility to a source of raw material.

General Merchandise: This business also was usually established before elevator construction. Owners, in most cases, were interested in extensive farming operations. This circumstance is quite common throughout the South. The addition of grain elevators was another step in successful expansion of large farming enterprises.

MANAGEMENT

As in any business enterprise of importance, managerial ability can be gained only through experience, continuous study, and observation. The manager of a grain elevator and the allied enterprise must keep in mind that his business is service and merchandising, not speculation.

Every elevator must have some person who can understudy the manager in the mechanical aspects. There are many operations problems to be taken care of by a person experienced and trained in this line. He must know the power supply hook-up, where switch boxes, starter boxes, and motors are located, how to replace fuses, how to clean motors, and where to look for trouble. He must inspect each night to see that doors and windows are locked. The main power switch must be thrown off each night. This man should know how to blend grain and direct the flow of grain through the distributors. He should know how to repair and replace spouts, automatic scales, belts, and pulleys; where and when to grease moving parts; and how to keep the plant clean from basement to cupola.

LABOR

Labor requirements vary with handling methods, efficiency of equipment, and services performed. No estimate of labor requirements can be made without reference to a specific plan.

In some cases a bookkeeper, whose jobs are to weigh in grain, test samples, pay off accounts, and keep the records; and an outside man, whose duties are to inspect grain, obtain samples, and operate the elevator and drier, have been successful in operating an elevator having a capacity of 250,000 bushels.

Present day planning and construction of an elevator that will allow an operator to be located at a central vantage point and operate the controls has lessened the labor requirements considerably. Planning with these factors in mind can do much toward contributing to success.

As facilities are added labor requirements will naturally increase. Often labor can be switched to relieve heavy work loads from season to season or even for periods during each day.

According to one authority,[6] "The largest item of expense of a cooperative elevator is the amount paid in salaries and wages. So, it is highly important that employees be fully utilized. A rough measure of how well their time is being used is given by determining how much business volume is handled for each dollar paid in salaries and wages. There is a wide spread among elevators in this regard. In eastern Kansas, for example, the "low" elevator had only $19.34 of sales for each dollar paid in salaries as against $101.86 for the "high" association.

"The wide difference between elevators as indicated, is not due entirely to differences in efficiency in using employees' time, but the latter is no doubt an important factor. It ordinarily requires more labor as well as other expense to handle a dollar of sideline sales than a dollar of grain sales. The elevator which engages in such service activities as feed grinding or trucking adds to its expenses by such activities without their being reflected in business volume as indicated by dollar sales. It is well to keep in mind these shortcomings of sales per dollar paid in salaries and wages as a measure of efficiency in utilizing labor."

"Cooperative elevators with a business volume of $50 or more for each dollar paid in salaries and wages are usually in position to hold unit costs down where they can meet competition and safeguard the capital structure. Associations with business volume below that figure need to check operations to determine if the outlay for labor is bringing enough return. This return may be in the form of income from such sources as feed grinding or commissions not reflected

[6]Hedges, Harold, FCA "Operations of Cooperative Grain Elevators in Kansas and Oklahoma," *Farm Credit Administration Bulletin No. 30.*

in sales, or from sidelines (petroleum products for example) on which handling margins are relatively large."

INSECT CONTROL

It is important to keep in mind that grain insects are a serious hazard and cause heavy damage yearly to grain in the Southeast. Many types attack grain in the field and are never checked from that time. An opinion most often expressed in favor of storage fa-

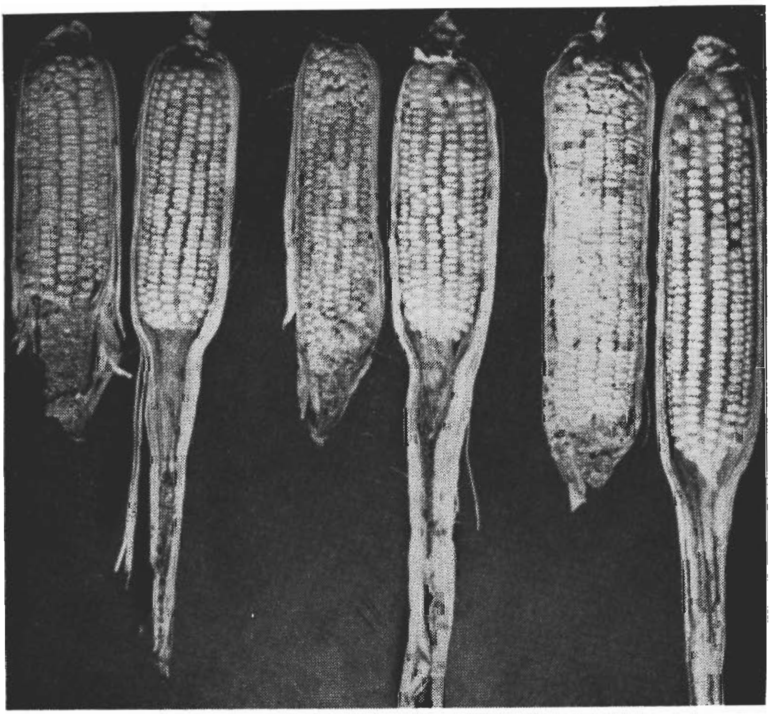

FIGURE 27. *An illustration of insect damage to hybrid strain of corn due to short shucks.*

cilities was that grain should be harvested early, hauled to the elevator, dried, and stored in a tight bin where proper fumigation[7] could destroy these pests.

The soft strains seem to be the most susceptible to insect infestation. Many of these strains have inadequate ear coverage due to short shucks. Corn breeders are improving this quality by breed-

[7]"Control of Insect Pests of Grain in Elevator Storages." *Farmers Bulletin No. 1880, USDA.*

ing for longer ear coverage. Figure 27 shows progress that has been made.

The end of the exposed ear, however, is not the only point of entrance for insects. Late harvested corn will reveal shucks with holes drilled through them indicating that the insects enter in that manner. Estimates have been made that corn left in the field 30 to 60 days after maturing sustains 10 to 25 percent loss during an autumn season common to this section. Increased fertilization and improved cultural practices to increase per acre yields are of little avail if insects are allowed to take an increased toll. Storing field-run corn in the ear or shelled, without first reducing moisture and then using fumigants is impractical and wasteful.

Rodents: Although rodents are of concern to farmers who store grain on the farm, little rodent damage is experienced by elevator operators. Poison and cleaning up of breeding and nesting places have reduced such losses to a minimum.

Services of exterminating companies who specialize in rodent control are available. The nominal fee charged is considered a good investment by elevator operators in exchange for rat-free premises. Frequent inspections are made and the elevator owner is urged to communicate with the company immediately upon suspecting an outbreak.

INSURANCE

Insurance costs, labor and interest on investment constitute the chief expenditures in grain elevator operation. Utmost care should be taken to see that the most favorable rates are obtained by taking advantage of zoning and fireproof construction.

Not all Southeastern states have adequate rating schedules for grain elevators. Those that do not are in the process of revising and establishing rates. Rates vary between states for similar types of storage. The lowest rate found was $0.18 per hundred and the highest rate on a much less fire-resistant structure, was in excess of $2. Many operators indicated cost of insurance was so high that they could not afford adequate coverage.

A Virginia operator who constructed new fireproof grain storage bins and discontinued use of storage space in his mill of frame construction, asserted that the difference in insurance cost alone would amortize his investment over a period of 20 years.

SUMMARY

1. A recent Georgia survey shows that on-farm and off-farm storage structures are inadequate for handling grain crops and preserving quality.

2. According to a study of grain elevators in Illinois, those that consistently made the most profit handled 300,000 bushels or more grain per year and sold merchandise to the extent of 10 to 30 percent of their total sales.

3. For reinforced concrete elevators of around 75,000 bushels, $1.25 per bushel of storage capacity is considered minimum cost.

4. Land drainage, soil types, utilities, transportation, and future expansion are important items to consider in locating an elevator.

5. A study of old and new plants showed that some modifications in elevator design in use in other areas would be necessary to meet conditions in the Southeast.

6. There is a wide variation in equipment and design and it is advisable to obtain the services of an experienced grain engineer and let him design the elevator to do the specified job.

7. The more common present day storage bin building materials are reinforced concrete, steel, wood, concrete staves, and tile. They rank in importance about in the order named.

8. Grain driers are an absolute necessity in the Southeast. Two designs, vertical and bin type, are used and the choice between the two depends upon the job to be accomplished.

9. Allied businesses are important to obtain an even spread of labor throughout the year. They can be as extensive as the need in the community warrants.

10. Although the opportunity for speculation is present, the manager of a grain elevator must always keep in mind that his business is service and merchandising.

11. Present day planning and construction of an elevator has alleviated the necessity of a heavy labor load even in the peak harvesting season and is contributing much to the success of the enterprise.

12. Design to obtain insect and rodent proof storage cannot be over emphasized.

13. Insurance costs constitute one of the main expenditures in the operation of an elevator. Proper planning can minimize this cost in some cases as much as 80 or 90 percent.

RECOMMENDATIONS OR SUGGESTIONS

Because of the newness of this industry in the Southeast and the complexity of operation as compared with other regions, these suggestions are made in the hope that they will be helpful to prospective grain elevator owners and operators.

1. Services of an experienced grain engineer for proposals and advice can be obtained for a nominal fee and he should be consulted before formulation of definite plans.

2. Proposals should be compared on a basis of services to be installed and the flexibility of the plant in receiving, turning, drying, and shipping out of grain and cost of maintenance and labor rather than relying on the cost per bushel of grain storage.

3. Consultations with persons experienced in the economics of the enterprise to obtain information on operations, marketing peculiarities, and location with respect to regional need are important considerations not to be overlooked.

4. Since site, railroad siding construction , installation of utilities, and capital needed for operation are not figured in the contractors bid, allowances for these should be made in the amount of capital needed.

5. Bids for construction should be let under the supervision of the planning engineers for the completed job, including machinery. Thus responsibility for fulfilling the contract is left in the hands of one person. Contractors usually get a discount on machinery, but under competitive bid system this would be reflected in a lower total bid.

6. In the South consideration should be given to constructing the elevator during the winter months. Often northern contractors are looking for business during that period and the difference will be reflected in the availability of reliable contractors and the decreased amount of the bid.

7. Often the consideration of experienced management is improperly emphasized. Almost anyone can be taught the mechanical operation of a present day grain elevator. The complexity of the operation is in the bookkeeping methods and contacting farmers to obtain their business. Often an experienced operator imported from some other section knows little about anything except mechanical operation of the elevator.

8. Specific rules should be adopted by the management on the method of hold farmers' grain in storage for use or sale. Storage

charges will have to be made. If money is borrowed on the farmers' grain in storage the situation can become very complicated often resulting in loss of money for the elevator. Many elevator operators refuse to take this type of business altogether.