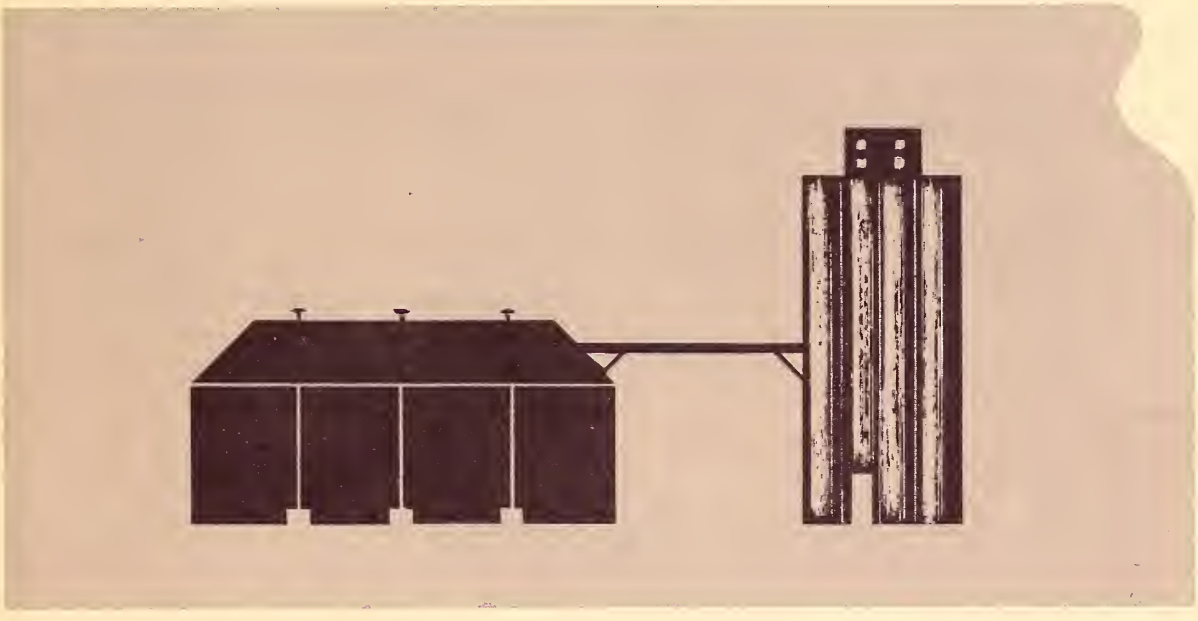
Economics of

FLAT GRAIN STORAGE FACILITIES *in Kansas*



FARMER COOPERATIVE SERVICE • U.S. DEPARTMENT OF AGRICULTURE IN COOPERATION WITH
KANSAS AGRICULTURAL EXPERIMENT STATION • MARKETING RESEARCH REPORT NO.685

FARMER COOPERATIVE SERVICE
U.S. DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C. 20250

Joseph G. Knapp, Administrator

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 such 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.

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This is a joint study by Kansas State University and Farmer Cooperative Service. Thus, in addition to being listed as USDA Marketing Research Report 685, the Dept. of Agricultural Economics, Kansas Agricultural Experiment Station, Manhattan, lists it as their contribution No. 389.

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Contents

Highlights

Grain was not stored in flat buildings in Kansas on a large scale until technological developments made such storage possible for long periods without much loss in quality.

Flat-storage facilities underwent a period of expansion from 1945 to 1960. The greatest development was in the 1950's when flat steel facilities were used to meet additional storage needs of Kansas grain producers. They were generally constructed at lower cost per bushel than concrete facilities. Kansas commercial grain-storage capacity grew from 174 million bushels in 1950 to about 836 million bushels in 1962.

The model approach was used to analyze costs of storing grain in flat warehouses. Models ranged in size from 50,000 to 250,000 bushels in multiples of 50,000 bushels. Each model was operated in conjunction with an existing 300,000-bushel concrete upright facility which aids in emptying and filling the horizontal building.

The following tabulation shows the difference in the cost of storing grain at 100 percent capacity and at only half capacity:

Model capacity	Annual cost per bushel	
	100 percent filled	50 percent filled
Bushels	Cents	Cents
50,000	9.3	14.4
100,000	8.7	13.3
150,000	8.2	12.5
200,000	7.9	11.9
250,000	7.7	11.6

Annual cost of maintaining empty facilites varied from 4.1 (for smallest unit) to 2.9 cents per bushel of space.

Costs are not reduced proportionally as percent of storage capacity is reduced. That is, if storage of grain is reduced by 50 percent, total costs of storage are reduced not by 50 percent but only by 22 to 25 percent.

When utilization of a unit is only 50 percent of capacity, the cost per bushel of storing grain is greatly increased. Under such conditions, the per-bushel cost increased at least 50 percent for each of the models studied.

Research data and management contacts indicate the following advantages and disadvantages of flat facilities:

Advantages:

1. Lower investment cost per bushel of storage space.

2. Can be constructed in a short time.

3. More alternative uses than upright facilities.

Disadvantages:

1. Difficult and costly to move grain in and out of storage.

2. Not as economical for merchandising grain as upright facilities.

3. Lower moisture content of grain necessary in flat than in upright storage.

Results of this study will provide information to those planning new storage and to those desiring cost estimates of flat-storage facilities. These cost data should apply generally to flat-storage facilities throughout the Midwest. Former grain-storage studies have dealt with the concrete upright and the round metal storage bins without giving specifically the costs of flat storage.

Economics of Flat Grain Storage Facilities In Kansas

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Large-scale use was not made of flat facilities for grain storage in Kansas until maintenance of grain quality in this type of facility had proved successful.

Development and improvement of grain aeration systems and use of automatic grain-temperature recording systems provided the means of maintaining stored-grain quality in flat facilities. In elevators already operating upright storage facilities, increased carry-over stocks permitted selection of more suitable stocks for storage in flat facilities.

Flat or horizontal storage is any storage the height of which is less than the diameter or width. Upright storage, on the other hand, is any storage with height greater than the diameter or width. Other terms synonymous with upright are bin, tank, silo, or vertical storage.

Our study showed a variety of sizes of flat facilities in use. Most additions of flat rectangular steel buildings at country points range in capacity from 50,000 to 250,000 bushels. However, installations include round steel bins of 9,000- and 12,000-bushel capacity and larger, steel buildings of quonset-type construction, rectangular steel buildings other than of quonset-type construction, and other miscellaneous types of facilities.

Because of the rapid expansion and the increase in importance of flat storage in recent years, Farmer Cooperative Service and Kansas State University made this study to provide information to those planning new storage and to those desiring cost estimates of flat-storage facilities. The cost data in this report should apply generally to flat-storage facilities throughout the Midwest. Allowance was made for recent increases in building costs to arrive at the estimated cost figures.

The purpose of this report is (1) to indicate the role and development of flat-type facilities in meeting the needs of Kansas producers for grain-storage space, and (2) to analyze the costs of storing in flat facilities.

An earlier USDA study analyzed costs of storing wheat in off-farm concrete elevators and on-farm round steel storage bins in Kansas. (1) A similar study on costs of storing corn was made in Iowa during the same period. (2) The present study differs from the earlier Kansas study in the type of storage structure analyzed and in the method of analyzing the assembled data.

Note: Appreciation is expressed to the management of the elevators who provided major information for this study, and to Francis P. Yager, Grain Branch, Farmer Cooperative Service, for work in the early phases of this study, and for helpful suggestions.

Much of the grain storage constructed at country elevators in recent years is of this type. The conveyor seen near right of the flat storage roof is attached to a concrete elevator.

Method and Scope of Study

Much of the data in this report was supplied by cooperatives and other grain elevator operators in Kansas. Information was also obtained from elevator financial reports, the Kansas State Grain Inspection Department, Kansas tax rate schedules, and personal interviews with 12 selected elevators throughout Kansas from 1958 to 1962.

Our cost data and analyses were limited to the flat facility of rectangular steel design. Although the round or circular bin is classified as flat storage, it was not included in the cost portion of this report. The quonset-type building, however, was included.

Since wheat was the major grain stored in flat facilities in Kansas, all management practices and operating costs reported here necessarily pertain to those in handling wheat. The most common practice was to place dry, year-old high-quality wheat from upright facilities in the flat-storage units whenever possible.

We used a model approach in analyzing building and operating costs of selected sizes of flat-storage units. Storage capacities of model sizes used in this report were 50,000, 100,000, 150,000, 200,000, and 250,000 bushels.

The model design was a rectangular steel building, quonset or other type, attached to the concrete upright structure. This enables filling and emptying the flat-storage facility with a minimum of hand labor.

The various size models ranging from 50,000 to 250,000 bushels were all of the same general design and construction. Estimated acquisition costs of the model buildings, including equipment, were $18,000; $32,000; $44,000; $55,000; and $68,000, respectively. Acquisition cost per bushel of capacity for other types of facilities vary from the above costs for flat-storage facilities. (See appendix, table 10.)

Each facility had a temperature-detection system, an aeration system, and permanent mechanical grain-moving equipment. This equipment was of the size and design to

Another common type of facility added by Kansas elevators during the rapid storage expansion period was the round metal bin. These bins are not attached to the upright facilities and must be filled and emptied with portable equipment.

adequately serve the requirements of warehousemen in aerating, fumigating, filling, and emptying these storage units. Some hand labor, however, was necessary to empty this type of building.

Temperature cables made it possible to detect temperature changes and to allow for corrective action. The aeration system was used to cool the grain and to apply fumigants to control insect infestation.

It was assumed that each model was operated in conjunction with an existing 300,000-bushel upright elevator facility capable of handling twice its own capacity and twice that of any added flat storage. This would be without any major changes in upright facilities or personnel.

For purposes of allocation of joint costs between the flat facility and other parts of the business, in all cases the upright facility was assumed to have a combined annual storage and merchandising volume of 600,000 bushels. With the addition of a flat facility, the entire rated capacity was used for storage and an increase in annual grain-merchandising volume of one-half the capacity of the flat building was assumed. Length of storage period in the flat building was 2 years.

Each elevator was assumed to have annual sideline sales of $30,000. Sideline activities include, primarily, sale of farm supplies such as feed, seed, fertilizer, oil, grease, salt, lumber, and similar items.

The term "model" as used in this report does not mean an ideal operation or an average situation. Rather, it designates a relatively efficient operation that is representative of the cost and type of construction of a slightly better-than-average elevator in Kansas.

Grain-Storage Facilities in Kansas

In 1945, at the start of the expansion period, about one-half of total commercial elevator space was at country points and one-half at terminal elevators and wholesale processing plants. Division of space between country and terminal points remained roughly the same throughout the expansion period (1945-60).

Kansas, with slightly more than 845 million bushels in January 1963, had the second largest storage capacity of all States; Texas, with 920 million bushels had the largest capacity. These two States, with a combined total of approximately 1,760 million bushels, had nearly a third of the total off-farm storage capacity of the United States.

Importance of Flat Storage

Storage expansion at country points in Kansas from 1945-60 was mainly through construction of concrete elevators and flat facilities. Space in concrete elevators increased by approximately 173 million bushels and in flat facilities by approximately 112 million bushels. However, from 1955 to 1960, flat facilities expanded more than upright. More than 75 percent of the 1945-60 expansion in flat facilities occurred from 1955 to 1960 (table 1).

More storage space was necessary to handle adequately increasing stocks of grain during the 1950's (appendix, table 11). Greater use of flat storage and its role in Kansas storage expansion were apparent.

Reduction in stocks of grain owned by the Commodity Credit Corporation has eliminated need for further general expansion of commercial elevator space in Kansas and other areas of the United States at this time. It

Most country elevators have expanded their storage capacity in recent years. These rectangular, flat, metal buildings (above) show the major form new expansion took.

Table 1.--Kansas commercial grain-storage capacity at country points, by type of facility, for selected years

Type of facility	1945		1950		1955		1960	
	Capacity	Percentage of total	Capacity	Percentage of total	Capacity	Percentage of total	Capacity	Percentage of total
	1,000 bushels	Percent	1,000 bushels	Percent	1,000 bushels	Percent	1,000 bushels	Percent
Upright:								
Reinforced concrete.....	11,190	25	56,360	57	101,340	57	184,360	51
Wood elevator with attached upright storage.....	32,850	73	36,870	37	48,150	27	64,440	18
Flat.....	760	2	5,700	6	27,280	16	113,120	31
Total.....	44,800	100	98,930	100	176,770	100	361,920	100

Source: Kansas State University, Manhattan, Kans., Survey of Horizontal Commercial Storage Facilities in Kansas, 1959.

also appears that storage available in flat facilities in 1962 may be adequate for present needs, with no further increase indicated.

Flat buildings have limited usefulness for wheat-merchandising operations when mixing and blending of stocks for maximum return is desired. However, technological developments in conditioning and maintaining the quality of grain and in methods of early detection of quality deterioration have made these buildings suitable for long-term storage of properly conditioned wheat and other grains.

Extra effort required to move grain into and out of flat buildings makes them more suited to long-term than short-term storage. Managers indicated that storage periods of 2 or more years are definitely more advantageous than shorter periods, if the wheat remains in satisfactory condition.

Flat-Storage Costs

Costs of horizontal grain storage are important to all warehousemen utilizing these facilities. Storage has been one of the major sources of elevator income in the past decade. Grain merchandising and sideline activities are other significant income sources.

Fixed Costs

Costs of flat storage are separated into fixed, direct variable, and indirect variable costs.

Fixed costs are those which vary little or not at all, regardless of volume handled or even if operations cease.

Depreciation

For purposes of this analysis, buildings and equipment were depreciated on a straight-line basis over a period of 20 years, or at an annual rate of 5 percent (table 2). The resulting depreciation costs ranged from $900 for the 50,000-bushel unit to $3,400 for the 250,000-bushel unit.

Table 2.--Annual depreciation at rate of 5 percent on model flat grain-storage facilities, by capacity, Kansas, 1962

Model capacity	Estimated building cost[1]	Annual depreciation
Bushels	Dollars	Dollars
50,000	18,000	900
100,000	32,000	1,600
150,000	44,000	2,200
200,000	55,000	2,750
250,000	68,000	3,400

[1]Cost of aeration, temperature detection, and grain handling equipment is included, but not any of the facilities in the concrete upright portion.

Interest

A rate of 5 percent per year was chosen to estimate annual interest costs. Interest figured on the original cost reflects the relatively higher outlay when a building is new. Using half the original cost, interest charges for the models ranged from $450 for the smallest to $1,700 for the largest. Interest expense or interest outlay declines gradually as the loan balance declines.

The term "interest" here includes that cost associated with any borrowed capital as well as that cost or return on equity. Average interest was calculated by multiplying one-half the cost of the facility by the interest rate. Thus the annual interest charge used in this analysis was one-half the cost of each facility multiplied by an interest rate of 5 percent (table 3).

Taxes

The general property tax was figured at a rate of 63.44 mills per dollar valuation for all model sizes.

In 1950, the average property tax levy per dollar of valuation in Kansas was 35.12 mills. This average levy on property has increased steadily each year. In 1960, the average mill rate was 63.44 per dollar of valuation, which was the rate used in this analysis.

Using an estimated appraisal of 7 cents a bushel times the building capacity gave an assessed value. This amount, multiplied by the mill rate, provided an approximation of the general property tax.[1] These tax amounts were $222, $444, $666, $888 and $1,110 respectively for the 50,000-, 100,000-, 150,000-, 200,000-, and 250,000-bushel capacity units.

Railroad Lease

Most elevators leased from a railroad property that could be used to serve the upright or flat facility, or both. Although the rate of the railroad-lease charge was unchanged for several years, it recently increased slightly for elevators leasing railroad siding. A per-bushel capacity charge of 1 cent per 100 bushels was attributed as a flat-storage cost, resulting in a charge of

[1] Appraised valuation for tax purposes of 7 cents per bushel was chosen in accordance with an assessment sheet of Clay County, Kansas, 1960.

Table 3.--Annual interest at 5 percent on model flat grain-storage facilities, by capacity, Kansas, 1962

Model capacity	One-half estimated building cost[1]	Annual interest
Bushels	Dollars	Dollars
50,000	9,000	450
100,000	16,000	800
150,000	22,000	1,100
200,000	27,500	1,375
250,000	34,000	1,700

[1] Cost of aeration, temperature detection, and grain handling equipment is included, but not any of the facilities in the concrete-upright portion.

from $5 for a 50,000-bushel unit to $25 for a 250,000-bushel unit.

Warehouse Bond

The majority of Kansas elevators are bonded and licensed under Kansas rather than Federal warehouse law. (3) Therefore, we calculated the warehouse bond according to Kansas law (appendix, page 22). The bond cost was calculated at the rates in the following tabulation:

Bond amount	Bond rate per $1,000
First $10,000	$5.00
Next 15,000	2.50
Above 25,000	1.25

All elevator buildings were covered under one bond and all capacities, both upright and flat structures, were totaled into an aggregate capacity under such bond. That is, the bond cost of a 300,000-bushel upright facility was $97.81 and any flat-capacity bond cost added to this was nominal.

The bond cost for flat facilities at the lowest rate of $1.25 per $1,000 resulted in the following additional costs for the five models:

Facility type	Capacity size	Amount of bond	Cost of bond
	Bushels	Dollars	Dollars
Flat steel.....	50,000	875	1.09
Flat steel.....	100,000	1,750	2.19
Flat steel.....	150,000	2,625	3.28
Flat steel.....	200,000	3,500	4.38
Flat steel.....	250,000	4,375	5.47

Warehouse License

In Kansas, a warehouse license is necessary to operate an approved public warehouse for storing grain (appendix, page 23).

The license fee was computed for this analysis as that extra cost above the cost of a license for the 300,000-bushel elevator assumed to exist before the flat facility was built. On this basis, the additional fee was $25 for the 50,000-bushel flat facility; $50 for the 100,000-bushel capacity; and $75, $100, and $125 respectively for the 150,000-, 200,000-, and 250,000-bushel units. All license fees were based on those figures applying to local public warehouses since this information referred to the local country elevators. (3)

Insurance

Businesses require insurance to protect their assets effectively. Associations either buy insurance from an outside firm or provide self-insurance. Very few elevators are of such magnitude and diversity that they can provide self-insurance; consequently, most country elevators purchase their insurance.

Two types of insurance are discussed in this section: (1) building insurance, and (2) crime and liability insurance.

Building.--The rate used to calculate annual fire and windstorm insurance costs was $0.16 per $100 of valuation. This figure is based on cost data obtained in 1960. However, there were wide differences in rates among the elevators, depending upon location, hazards, and kind of building.

The amount of building insurance coverage also varied according to the amount desired by the owners. In many cases, however, coverage was at least 80 percent of the insurable value of the building, which was adequate for full coverage under an 80 percent co-insurance clause.

While insurance policies of some elevators might stipulate an 80 or 90 percent co-insurance clause, the actual amount of coverage

carried might, (and frequently did), exceed these percentages. A liberal estimate of 90 percent was used in calculating this cost (table 4).

This insurance cost may vary in future years depending upon replacement cost, depreciated value, added equipment, losses sustained, or any other change affecting the value or rate.

Under our assumptions, building insurance costs ranged from $26 for the 50,000-bushel unit to $98 for the 250,000-bushel unit.

Crime and Liability.--Since adequate crime and liability insurance is almost a "must" for the operation of any elevator regardless of volume handled, this type of insurance was considered a fixed cost.

Included in liability insurance for the entire elevator were: $100,000/$300,000 for bodily injury; property damage coverage of $25,000; and $10,000, medical payment coverage.

A comprehensive crime policy included: (1) $10,000 on manager and $5,000 on all other employees for employee bond; (2) $500 without and within for burglary or robbery; and (3) $5,000 coverage for forgery, check alteration, or other pecuniary irregularities. Total cost of comprehensive crime and liability insurance for the upright facility plus an attached flat building was estimated at $828 annually.

Allocation of this insurance cost was based on the rated capacity of the facilities involved. This cost ranged from $118 to $376, as indicated in table 5.

Direct Variable Costs

Specific managerial decisions and volume handled affect costs of such operations as fumigation, aeration, insurance on stocks of grain, shrinkage and quality deterioration on grain in storage, and labor necessary in filling and emptying the flat building. These were classified as variable costs.

In elevators observed, labor varied greatly depending upon how the building was equipped; that is, whether it was attached to an upright facility to fill only, attached to fill and empty by permanent conveying equipment, or whether it was completely unattached. No case was found in which flat storage was attached to an upright facility to empty only by permanent conveyors.

Table 4.--Building insurance coverage and cost, at rate of $0.16 per $100 valuation, on flat-storage models, by size, Kansas, 1962

Model capacity	Building cost	Minimum coverage for 90 percent co-insurance	Building insurance cost
Bushels	Dollars	Dollars	Dollars
50,000	18,000	16,200	26
100,000	32,000	28,800	46
150,000	44,000	39,600	63
200,000	55,000	49,500	79
250,000	68,000	61,200	98

Table 5.--Allocation of crime and liability insurance to the flat facilities, by size, Kansas, 1962

Facility type		=	Capacity total	Proportion of flat to total	x	Total insurance cost	=	Insurance cost allocated to flat facility
Upright	1,000 bushels Flat		1,000 bushels			Dollars		Dollars
300	50		350	1/7		828		118
300	100		400	1/4		828		207
300	150		450	1/3		828		276
300	200		500	2/5		828		332
300	250		550	5/11		828		376

Fumigation

The kinds, costs, and methods of application of fumigants were not uniform. Managers indicated, in some cases, that grain was fumigated when it was put into flat storage and at other times when it was necessary to preserve the grain quality. In some instances, inspection of stored grain for insects and application of fumigants was done under contract by an outside firm. In others, managers indicated they applied fumigants upon recommendation of professional grain inspectors.

Outside firms were responsible in some cases for monthly grain inspections and for furnishing the skilled workers necessary to apply fumigant supplied by the elevator. The elevator was charged a monthly fee per bushel for these services. This arrangement may be an indication of a greater degree of specialization gradually appearing in this phase of the grain warehousing industry.

Based on actual data, the cost of obtaining and applying a fumigant was at a rate of $0.0067 (or slightly more than one-half cent) a bushel. These costs appeared to be adequate for this operation as shown in the following tabulation.

Estimated annual fumigation cost at 0.0067 cents a bushel at 100 percent occupancy of flat-storage facility, Kansas, 1962

Model capacity	Fumigation cost
Bushels	Dollars
50,000	335
100,000	670
150,000	1,005
200,000	1,340
250,000	1,675

Some fumigants were applied with the aeration equipment. Three fumigation methods tested in Kansas for effective control of insects in stored grain were: gravity penetration of gas, a single-pass fumigation, and a closed recirculation method. All were recognized internationally. (4)

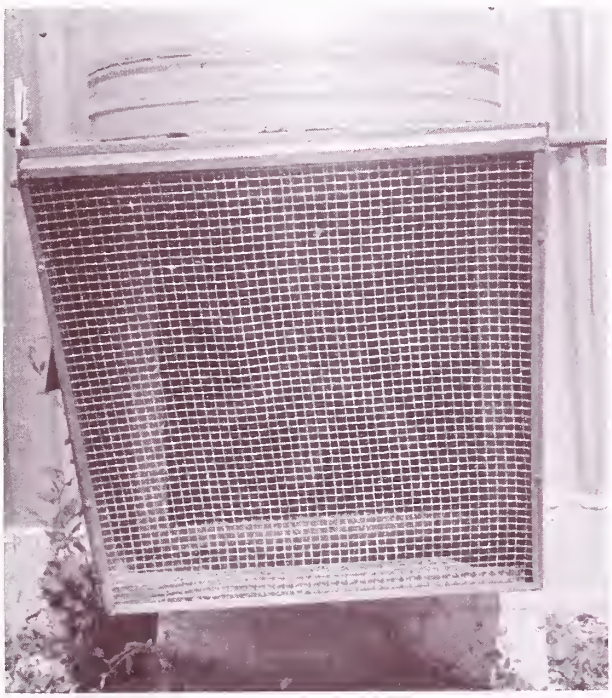
Flat-storage operators used various fumigants, insecticides, and grain protectants for periodic surface treatment of grain. The

treatments helped control insects and reduce the number of complete fumigations required.

Aeration

The aeration system assumed necessary on the basis of data available was a permanently installed automatic system powered by either two 5-horsepower motors or three 3-horsepower motors for the 250,000 bushel model. Aeration systems for lower capacity models required correspondingly lower horsepower aeration systems. Electric power cost for circulating air figured at one-fifteenth cubic feet of air per minute per bushel amounted to 0.155 cents a bushel. This resulted in costs of $78, $155, $233, $310, and $388 respectively for the five sizes of model units. (5)

Repairing, performing maintenance duties, and operating the aeration system are part of the regular duties of the elevator operator. Any inspection or decisions attributed to the management function were included in regular management salary.



This "close-up" of an aeration duct indicates the relative size of the duct through which grain is aerated.

In addition to its principal function of reducing and equalizing temperatures throughout the grain mass, the aeration system was of special value in applying fumigants, permitting grain to be stored with a moisture content slightly above safe storage level, holding wet grain for brief periods, and removing odors. However, grain with high moisture content or wet grain was usually held in upright rather than in flat storage. Some shrinkage of moisture in the grain itself took place when grain was aerated. (Shrinkage and quality-deterioration factors, are accounted for in a later section.)

Grain Insurance

Grain insurance costs varied because of rates charged and monthly volumes. Insurance firms calculated annual premium adjustments on grain stock reports of elevators. Thus, the insured reported regularly on inventory stocks and the company adjusted its coverage. A portion of the premium was paid at the beginning of the insuring period. Annual adjustments were made for balances due on actual computed coverages.

The rate we used per $100 valuation for each model unit was 10 cents. With wheat valued at $2 a bushel, coverage necessary for each storage unit amounted to twice the capacity when completely filled. Consequently, these costs amounted to $100, $200, $300, $400, and $500 from the smallest (50,000-bushel) to the largest (250,000-bushel) size.

These costs may be conservative for situations with greater hazards and inadequate protective equipment.

Shrinkage and Quality Deterioration

Shrinkage and quality deterioration of grain are known to exist, but are not easily

determined at frequent intervals during storage. Often the actual physical shrinkage is not known until the entire quantity of grain has been removed from the building or structure.

In some cases, a shrinkage figure is calculated using the book inventory times a shrinkage figure of one-half of 1 percent to 1 percent of the grain handled and stored. Shrinkage and quality-deterioration costs vary significantly, depending upon the specific condition and kind of grain. Some elevators make no allowance for shrinkage in their normal accounting procedures.

Elevator personnel account for shrinkage and quality losses of grain in various ways. An earlier study reports the following:

"In most elevator operating statements, shrinkage influences net operating results but is not shown as a cost item. Actually its influence is in fewer units sold and in lower gross margins by the amount of the shrinkage. Sometimes an elevator audit will have a commodity statement schedule which shows shrinkage, but even then it is not shown in the operating statement as a separate cost item. . . . Loss of quality on commodities sold as compared to purchase is, like shrinkage, an influence that lowers gross margins in practically all elevator operating statements. However, loss of quality is less apparent in those statements than other losses because it is practically never shown in a supporting schedule to the operating statement." (6)

A study of shrinkage and grade of wheat in Kansas country elevators suggests annual shrinkage approximating one-fourth of 1 percent. (7)

Elevator managers reported quality deterioration, in addition to shrinkage, in small amounts of grain in flat buildings. The irregular occurrence of such losses provides an illusive basis for estimating an annual loss. However, it appeared to us that these losses were of about the same magnitude as shrinkage in quantity in storage. On this basis, an estimate of one-half of 1 percent of the value of grain stored was arrived at as a combined estimate of annual cost of shrinkage and quality deterioration.

Total annual shrinkage and quality-deterioration cost for the 50,000-bushel unit with grain priced at $2 per bushel was $500. The other units, being in multiples of 50,000 bushels, had shrinkage and quality-deterioration costs of $1,000, $1,500, $2,000 and $2,500, respectively.

Indirect Variable Costs

Direct variable costs discussed thus far apply specifically to operation of the flat building and to storage of grain therein.

Two other important costs are shared with other elevator operations. The portion of these costs attributable to the flat building, however, is not too clearly distinguishable. The two costs are: (1) personnel costs, i.e., those of providing management and labor, and (2) use costs, i.e., those associated with the use of existing facilities to receive grain for storage in the flat facility, and in moving grain through the concrete elevator for filling or emptying the flat building.

Personnel Costs

Management practices for flat-storage differed extensively from those employed in upright-storage facilities. Mixing, blending, turning, and drying require engineering and physical design of such nature that they cannot be done as economically in flat buildings as in upright.

Management decisions on aeration, fumigation, and on equipment used in filling and emptying can affect the size of savings. Because grain-handling practices in flat storage differed from those in upright storage to which managers were accustomed, the exercise of

These three ducts are a part of the aeration system. Their purpose is to maintain the quality of the grain stored in this Kansas flat-storage facility.

managerial judgment vitally affected the success of flat-storage operations.

In addition to management, labor is required for filling and emptying a flat storage facility; checking condition of stocks; operating and maintaining the aeration system; applying grain fumigants and protectants, and otherwise maintaining the condition of stored grain. Bookkeeping is necessary for maintaining stock records and for accounting for costs attributable to the flat facilities. In our analysis, personnel expenses were allocated between facilities on the basis of the amounts of grain stored and handled by each facility.

When the flat facility was filled to capacity, four people were employed by the elevator. Personnel salaries amounted to $17,600.

Personnel expenses also included: (1) workmen's compensation calculated at $1.60 per $100 of payroll; (2) social security tax at 3 1/8 percent of the first $4,800 of earnings for each employee; and (3) unemployment insurance calculated at 3.1 percent of the first $3,000 of earnings for each employee (appendix, page 23).

Personnel expenses allocated to grain functions were divided between upright and flat facilities on a bushel-volume basis. Total volume of grain storage and grain merchandising combined was 675,000, 750,000, 825,000, 900,000, and 975,000 bushels, respectively, for models including the upright facility and each of the 5 flat buildings. The percentage of total personnel expense allocated to flat storage varied from 7.4 percent for the 50,000-bushel facility to 25.6 percent for the 250,000-bushel facility.

Of total personnel costs, allocations to flat storage ranged from $1,385 for the 50,000-bushel unit to $4,792 for the 250,000-bushel unit. On this basis, per-bushel cost varied from about 2 to 3 cents a bushel (table 6).

Table 6.--Total annual personnel expenses and allocation to the flat facility, by model size, Kansas, 1962

Model capacity	Total personnel cost[1]	Allocation to flat storage		Per-bushel cost
		Proportion	Amount	
Bushels	Dollars	Percent	Dollars	Cents
50,000	18,717	7.4	1,385	2.77
100,000	18,717	13.3	2,489	2.49
150,000	18,717	18.2	3,406	2.27
200,000	18,717	22.2	4,155	2.08
250,000	18,717	25.6	4,792	1.92

[1] Includes salaries, workmen's compensation, social security, and unemployment compensation.

Use Cost

The term "use cost" here refers to the cost for the use of upright facilities which are attributable to the flat-storage function. These costs involve office supplies, bookkeeping, scales, heat, light, communications and similar items. Also, included are costs of elevating grain in the 300,000-bushel headhouse and conveying grain to and from the flat storage unit in connection with filling and emptying the flat storage unit.

Based on cost data obtained from Kansas elevators, cost of these services to the flat-storage activity was estimated at 1 cent per bushel stored. Total cost to flat facilities occupied at capacity were $500, $1,000, $1,500, $2,000, and $2,500, respectively, for the five size units.

Total and Per-Bushel Costs

Variable costs discussed in the previous section were based on an assumption of 100 percent occupancy of the flat-storage facility. However, these facilities are not always filled to capacity.

In this section, we shall discuss total fixed and variable costs at 100 percent and at 50 percent occupancy.

100 Percent Occupancy

The sum of fixed and variable costs for a facility 100 percent filled is shown in table 7. Data in this table assume a 2-year occupancy period.

These data indicate that the per-bushel costs are reduced as the size of the storage unit increases. Thus, the per-bushel cost of a 50,000-bushel unit is 9.3 cents and continues to decline as the unit size increases, until the cost of 7.7 cents per bushel for a 250,000-bushel unit is reached. Also, the larger the unit, the smaller the rate of decrease in the unit cost of storing grain. Annual cost per bushel, if facilities were emptied and refilled each year, would be increased by one-half the cost of emptying and filling the flat building.

This concrete and flat building illustrates the way different types of storage structures are utilized in combination to satisfy the storage needs at many cooperative elevators.

50 Percent Occupancy

When volume stored in a given facility is reduced, cost will be reduced but not in the same proportion as the reduction in volume. Fixed cost does not change.

Some variable costs, however, change proportionally with changes in volume. Costs of fumigation; costs of fire and windstorm insurance protection on stocks; and costs of shrinkage and quality deterioration vary proportionally with reduction in volume. Costs of operating the aeration system is also assumed to vary proportionally with volume stored in a given facility since the resistance to airflow of most grain increases almost directly in proportion to the grain depth. (5)

Table 7.--Operating costs of various-size flat-storage facilities, at 100 percent occupancy, Kansas, 1962

Model capacity	Fixed costs		Variable costs		All costs	
	Total	Per bushel	Total	Per bushel	Total	Per bushel
Bushels	Dollars	Cents	Dollars	Cents	Dollars	Cents
50,000	1,747	3.5	2,898	5.8	4,645	9.3
100,000	3,159	3.2	5,514	5.5	8,673	8.7
150,000	4,398	2.9	7,944	5.3	12,342	8.2
200,000	5,548	2.8	10,205	5.1	15,753	7.9
250,000	6,839	2.7	12,355	5.0	19,194	7.7

Personnel expenses are not reduced as rapidly as the volume of grain. Some of the labor involved in filling and emptying the flat building is avoided when the building is not filled to capacity. Management responsibility for maintaining quality is not reduced when volume is reduced. Total management and labor effort is reduced by an estimated 20 percent when volume stored is reduced by 50 percent. Management and labor costs allocated to the flat facility vary accordingly.

Such management and labor costs can be considered to vary, however, only if alternatives exist within the firm for use of the manpower not needed to operate flat storage or if the total labor supply or labor cost can be adjusted. If neither of these conditions exists, it may not be possible to adjust costs as much as indicated here.

Many of the costs involved in use costs are variable. On a bushel basis, 50-percent reduction in use cost is assumed with a 50-percent reduction in volume stored.

Total costs, however, are reduced by only 22 to 25 percent when the volume of grain stored is reduced by 50 percent (table 8). Cost per bushel of grain stored when the storage unit is utilized at less than its capacity increases from 11.6 to 14.4 cents per bushel. As the size of the storage unit becomes smaller, the rate of the increase in the per-bushel storage cost becomes larger. The degree of utilization, therefore, is very important in considering the per-bushel cost of storing grain.

As storage volumes are reduced, increased emphasis of merchandising grain and farm supplies may become more desirable.

Empty Facilities

Fixed costs continue even when the flat facility is unoccupied. In addition, elevator employees must spend time performing custodial tasks, maintaining records, and paying current outlay fixed costs. The addition to fixed costs of an annual charge of $300 to cover these activities results in costs per bushel of space of 4.1, 3.5, 3.1, 2.9, and 2.9 cents, respectively, for the five model facilities (appendix, table 14). Costs remaining when the flat facility was empty ranged from 37 to 44 percent of storage costs at 100 percent occupancy.

Annual total dollar cost of storing grain in a 250,000-bushel unit was $19,194. This storage cost was reduced to $14,455--or by

Table 8.--Operating costs of various model size flat-storage facilites per bushel stored at 50 percent occupancy, Kansas, 1962

Model capacity	Fixed costs		Variable costs		All costs	
	Total	Per bushel	Total	Per bushel	Total	Per bushel
Bushels	Dollars	Cents	Dollars	Cents	Dollars	Cents
50,000	1,747	7.0	1,865	7.4	3,612	14.4
100,000	3,159	6.3	3,504	7.0	6,663	13.3
150,000	4,398	5.9	4,995	6.6	9,393	12.5
200,000	5,548	5.5	6,349	6.4	11,897	11.9
250,000	6,839	5.5	7,616	6.1	14,455	11.6

$4,739--when this size unit was filled to only one-half its capacity. The fixed cost remaining on a 250,000-bushel unit was $7,139 when no grain was stored (table 9).

Reductions in the costs per bushel of grain stored decreased as the size of the model became larger and as the degree of utilization became greater.

Table 9.--Total dollar cost and cost per bushel of capacity in flat-storage models, Kansas, 1962

Model capacity	Filled to capacity		50 percent utilized		Empty	
Bushels	Dollars	Cents	Dollars	Cents	Dollars	Cents
50,000	4,645	9.3	3,612	7.2	2,047	4.1
100,000	8,673	8.7	6,663	6.7	3,459	3.5
150,000	12,342	8.2	9,393	6.3	4,698	3.1
200,000	15,753	7.9	11,897	5.9	5,848	2.9
250,000	19,194	7.7	14,455	5.8	7,139	2.9

Advantages and Disadvantages of Flat Facilities

The principal advantage of flat facilities compared with upright was the lower investment cost per bushel of storage space. This was particularly significant in expanding facilities to store Government-owned stocks. Intentions to halt increases in stocks and to reduce carryover stocks during much of the expansion period may have encouraged elevators more inclined to invest in facilities requiring low initial investment.

A second advantage of flat facilities was the relatively short period needed for their construction. Flat facilities could be built after the size of the growing crop could be determined with comparative accuracy and be ready for occupancy at harvest time. The obvious advantage to storage operators was the assurance that the facility would be occupied and earning income immediately after construction.

A supplementary advantage to the producer was reduced difficulty in making deliveries to the elevator at harvest time, particularly in years of large crops.

Flat facilities offer a third advantage in the possibility of alternative use of the building if it were not needed for grain storage. Suggested possibilities were use as a feed or fertilizer warehouse, a feed milling facility, or a seed cleaning plant.

These advantages were suggested by elevator managers as some primary reasons for their choice of flat facilities. A number of managers indicated comparative cost of the various types of facilities was of major importance in their decisions.

The principal disadvantage of flat facilities was the difficulty and the expense of moving grain into, out of, and within the facility.

Filling and emptying rates for flat buildings at various locations ranged from 1,000 to 3,000 bushels an hour. Filling and emptying usually required 2 or 3 men. This is in contrast to country elevators of modern concrete construction which handle 4,000 to 6,000 bushels an hour with grain flowing

from hoppered-bottom bins and easy simultaneous access to grain flows from more than one bin for blending and mixing.

Difficulties in moving grain within flat facilities make them less practical as merchandising facilities which is a second disadvantage. This is particularly true for wheat, where mixing and blending various qualities of grain contribute to operate margins.

Since movement of grain for mixing and blending is less practical and more costly in flat facilities, turning or rebinning grain is not a satisfactory means of conditioning it for storage or for equalizing temperature and moisture conditions within the grain mass. Use of a grain aeration system is the principal method of maintaining quality in storage stocks in flat houses.

A lower and more uniform moisture content of grain, generally necessary for satisfactory storage in flat houses, is a third disadvantage of flat-storage facilities. A few managers place wheat in flat houses directly from the fields at harvesttime, but extreme caution and judgment should be used in this storage practice.

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Appendix

Table 10. --Construction cost per bushel of storage space in various types of storage facilities in Kansas, 1955-60

Bushel capacity	Type of facility		
	Concrete elevator	Concrete storage annex	Flat steel buildings
	Dollars		
50,000	--	--	0.35
100,000	1.00	0.52	0.33
150,000	0.75	0.49	0.31
200,000	0.68	0.48	0.29
300,000	0.61	0.46	0.27
500,000	0.56	0.44	0.24

Source: Kansas State University, Department of Agricultural Economics, survey and supplemental data, 1959.

Table 11. --Capacity of off-farm commercial grain-storage facilities in Kansas, January 1, selected years

Year	Storage capacity	Year	Storage capacity
	1,000 bushels		1,000 bushels
1948	142,006	1956	403,221
1950	174,113	1958	473,696
1952	210,292	1960	741,078
1954	268,617	1962	836,600

Source: Farm Facts, Kansas State Board of Agriculture, Topeka, Kans., selected years.
Stocks of Grain in All Positions, Statistical Reporting Service, U. S. Dept. Agr.

Table 12. --Annual estimated costs of storing grain in flat-storage units at 100 percent occupancy for various model sizes, by cost item, Kansas, 1962

Costs	Capacity size in bushels				
	50,000	100,000	150,000	200,000	250,000
	Dollars				
Fixed costs:					
Depreciation	900	1,600	2,200	2,750	3,400
Interest	450	800	1,100	1,375	1,700
Taxes	222	444	666	888	1,110
Railroad lease	5	10	15	20	25
Warehouse bond	1	2	3	4	5
Warehouse license	25	50	75	100	125
Insurance, elevator and equipment	26	46	63	79	98
Insurance, crime and liability	118	207	276	332	376
Total fixed cost	1,747	3,159	4,398	5,548	6,839
Variable costs:					
Direct:					
Fumigation	335	670	1,005	1,340	1,675
Aeration	78	155	233	310	388
Insurance (grain)	100	200	300	400	500
Shrinkage and deterioration	500	1,000	1,500	2,000	2,500
Indirect					
Personnel	1,385	2,489	3,406	4,155	4,792
Use cost	500	1,000	1,500	2,000	2,500
Total variable cost	2,898	5,514	7,944	10,205	12,355
Total cost	4,645	8,673	12,342	15,753	19,194
Cost per bushel of capacity (cents)	9.3	8.7	8.2	7.9	7.7
Cost per bushel stored (cents)	9.3	8.7	8.2	7.9	7.7

Table 13. --Annual estimated costs of storing grain in flat-storage units at 50 percent occupancy for various model sizes, by cost item, Kansas, 1962

Costs	Capacity size in bushels				
	50, 000	100, 000	150, 000	200, 000	250, 000
	Dollars				
Fixed costs:					
Depreciation	900	1, 600	2, 200	2, 750	3, 400
Interest	450	800	1, 100	1, 375	1, 700
Taxes	222	444	666	888	1, 110
Railroad lease	5	10	15	20	25
Warehouse bond	1	2	3	4	5
Warehouse license	25	50	75	100	125
Insurance, elevator and equipment	26	46	63	79	98
Insurance, crime and liability	118	207	276	332	376
Total fixed cost	1, 747	3, 159	4, 398	5, 548	6, 839
Variable costs:					
Direct:					
Fumigation	168	335	503	670	838
Aeration	39	78	117	155	194
Insurance (grain)	50	100	150	200	250
Shrinkage and deterioration	250	500	750	1, 000	1, 250
Indirect:					
Personnel	1, 108	1, 991	2, 725	3, 324	3, 834
Use cost	250	500	750	1, 000	1, 250
Total variable cost	1, 865	3, 504	4, 995	6, 349	7, 616
Total cost	3, 612	6, 663	9, 393	11, 897	14, 455
Cost per bushel of capacity (cents)	7. 2	6. 7	6. 3	5. 9	5. 8
Cost per bushel stored (cents)	14. 4	13. 3	12. 5	11. 9	11. 6

Table 14. --Annual estimated cost of flat-storage units by size and by cost item, when no grain is stored, Kansas, 1962

Cost	Capacity size in 1,000 bushels				
	50	100	150	200	250
	Dollars				
Fixed costs:					
Depreciation	900	1,600	2,200	2,750	3,400
Interest	450	800	1,100	1,375	1,700
Taxes	222	444	666	888	1,110
Rail lease	5	10	15	20	25
Warehouse bond	1	2	3	4	5
Warehouse license	25	50	75	100	125
Insurance, elevator and equipment	26	46	63	79	98
Insurance, crime and liability	118	207	276	332	376
Personnel	300	300	300	300	300
Total fixed cost	2,047	3,459	4,698	5,848	7,139
Variable costs:					
Cost per bushel of capacity (cents)	4.1	3.5	3.1	2.9	2.9

Warehouse Bond

Calculation of the warehouse bond was based on an average wheat price of $2 a bushel, minus 25 cents, multiplied by the appropriate percentage outlined in the "Kansas Public Warehouse Law, Rules and Regulations" quoted subsequently. For Kansas elevators licensed under the State warehousing law, the bond is computed by:

"Capacity of the warehouse times the closing cash grain price per bushel of No. 2 hard ordinary wheat in Kansas City the first Monday in April of each year, less twenty-five cents (25¢) a bushel times fifteen percent (15%) up to a sum of $200,000, and above $200,000 add the amount obtained by multiplying said cash grain price per bushel less 25 cents times one percent (1%) times capacity in excess of that capacity used to compute the first $200,000 of the amount of the bond: Provided, that in no event shall said bond be for an amount less than ten thousand dollars ($10,000). Said bond shall be in favor of the State of Kansas for the benefit of all persons interested, or to their legal representatives, attorneys, or assigns, conditioned for the faithful performance of all his duties as such public warehouseman. In case any person shall make application for licenses for two (2) or more separate public warehouses in this State, he may give a single bond covering all such applications, and the amount of such bond shall be the total amounts which would be required for the several applications if separate bonds were given. Provided, however, that in computing the amount of such single bond the warehouseman may add together the capacity of all warehouses to be covered thereby and use such aggregate capacity for the purpose of computing said bond." (3)

Warehouse License

"Any person desiring to engage in business as a public warehouseman in this State (Kansas) shall, before the transaction of any such business, present to the director of the State grain inspection department on a form designated by him, a written application for a license for each separate warehouse (or in case the applicant owns more than one warehouse at one rail point, then all of such warehouses may be incorporated in one application) at which he desires to do such business and the individual name and address of each person interested as principal in the business (and in case the business is operated or to be operated by a corporation, setting forth the name of the president and secretary) and further setting forth a complete certified financial statement of recent date on a blank furnished by said director, and such further information as the director may require, and designate whether a local public warehouse license or a terminal public warehouse license is desired." (3)

Personnel Costs

The following tabulation is an example of the cost of unemployment compensation for certain personnel:

Personnel	Annual salary	Maximum amount of salary necessary	Rate used	Cost of compensation
Manager	$7,200	$3,000	3.1%	$93.00
Assistant manager	4,200	3,000	3.1	93.00
Full-time help	3,600	3,000	3.1	93.00
Bookkeeper	2,600	2,600	3.1	80.60
All personnel	$17,600	$11,600	3.1%	$359.60

The applicable social security rate is 3-1/8 (3.125) percent times each employee's salary up to the maximum of $4,800. The following example indicates the social security costs for four employees:

Personnel	Annual salary	Salary portion necessary	Rate used	Cost of social security
Manager	$7,200	$4,800	3.125%	$150.00
Assistant manager	4,200	4,200	3.125	131.25
Full-time help	3,600	3,600	3.125	112.50
Bookkeeper	2,600	2,600	3.125	81.25
All personnel	$17,600	$15,200	3.125%	$475.00

Workmen's compensation calculated at $1.60 per $100 of payroll amounted to $282 with a total payroll of $17,600 for these four employees.

List of Publications Available

What Influences Off-Farm Grain Sales in Missouri? FCS Gen. Rpt. 91, Francis P. Yager.

Wheat Storage, a Study of Conditioning and Quality Maintenance Practices and Costs at Kansas Local Elevators, Bul. 399, L. Orlo Sorenson and Stanley K. Thurston. Agr. Expt. Sta., Manhattan, Kans.

Country Elevators, Cost-Volume Relations in the Spring Wheat Belt, by Francis P. Yager. FCS Serv. Rpt. 63.

Cost-Volume Relationships for New Country Elevators in the Corn Belt by Stanley K. Thurston and R. J. Mutti. FCS Serv. Rpt. 32.

Economics of Grain Drying at Kansas Local Elevators, by J. C. Eiland and L. Orlo Sorenson, Mktg. Res. Rpt. 449.

New Local Elevators, Cost-Volume Relations in the Hard Winter Wheat Belt by Thomas E. Hall, W. K. Davis, and H. L. Hall, FCS Serv. Rpt. 12.

A copy of each of these publications may be obtained upon request, while the supply is available from:

Farmer Cooperative Service
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