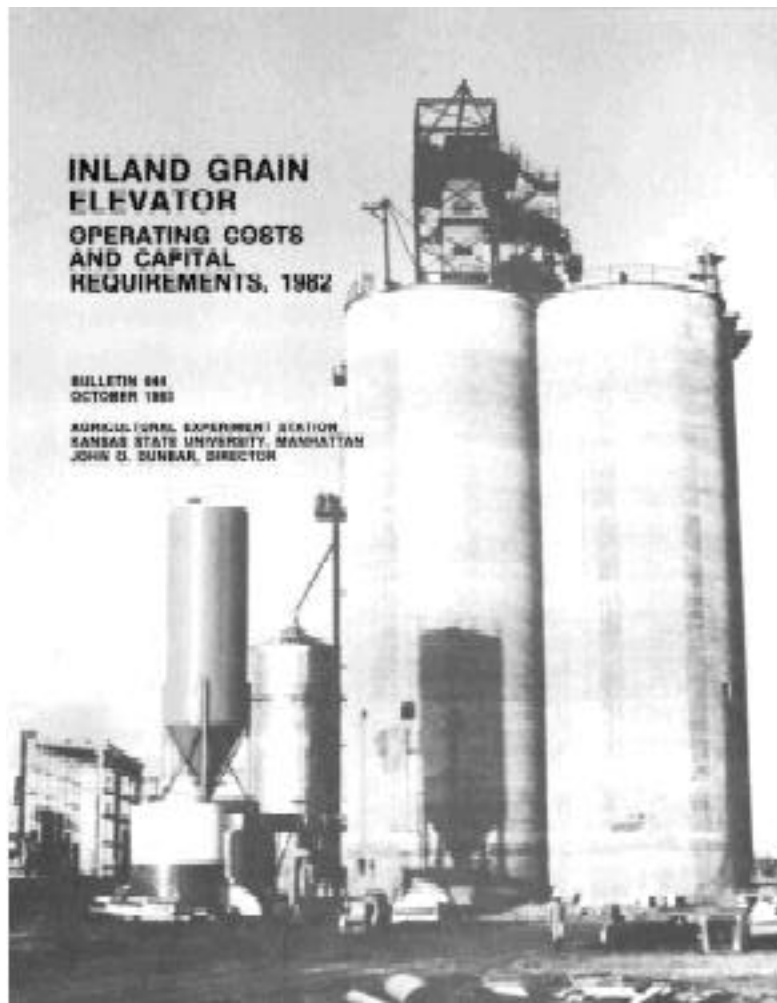


Inland Grain Elevator

Operating Costs
and Capital
Requirements, 1982

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INLAND GRAIN ELEVATOR OPERATING COSTS AND CAPITAL REQUIREMENTS, 1982

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SUMMARY

Capital investment and annual operating costs are estimated for four sizes (25-, 50-, 75-, and 100-car loadout) of corn-soybean, wheat-sorghum, and wheat-barley model grain elevators and three sizes (25-, 50-, and 75-car loadout) of soybean elevators.

Capital investment estimates for the corn-soybean model elevators range from about \$2.0 million for a 25-car loadout model to about \$5.5 million for a 100-car loadout model. Estimated investment requirements span a range from about \$1.9 million to \$4.8 million for the wheat-barley models and a range from about \$2.1 million to \$5.3 million for wheat-sorghum models.

Annual operating costs are estimated for each of the 15 model elevators at three levels of annual throughput, 20, 35, and 50 trainloads. Total estimated fixed costs exceed 60 percent of estimated total annual operating costs in all cases and exceed 70 percent for certain soybean models. As annual throughput increases from 20 to 50 trains per year, total estimated costs per bushel decrease: 57 to 58 percent for soybean model elevators; 58 to 60 percent for corn-soybean and wheat-barley models; and 60 to 61 percent for wheat-sorghum models.

Estimated per unit costs tend to decline sharply as shipping capacity increases from 25- to 50-car loadout. Total annual costs per bushel decline approximately 34, 37, 39, and 38 percent, respectively, for the corn-soybean, wheat-sorghum, wheat-barley, and soybean model elevators as size of elevators increases from 25-car loadout to 100-car loadout (75-car loadout for soybean models), and when 35 trains per year are shipped. Estimated total annual costs per bushel are lowest for model soybean elevators, ranging from 5.9 cents per bushel for the 75-car loadout elevator at maximum throughput, to 22.5 cents per bushel for the 25-car loadout elevator at minimum throughput. Per bushel cost estimates are highest for wheat-sorghum models, ranging from 7.35 cents per bushel for a 100-car loadout elevator at maximum throughput, to 29.41 cents per bushel for the 25-car loadout elevator at minimum throughput.

Appendices include estimated investment and operating costs for dust control systems and grain drying systems of the model elevators.

INTRODUCTION

This report estimates construction and operating costs of inland grain elevators built in 1982 in four grain-growing areas of the United States. The model elevators, on which the costs are based, incorporate current building and equipment design.

Restructuring in the U.S. grain marketing-transportation system began in 1972-73 when the United States experienced a sudden large increase in export demand for grain. This restructuring, which affects the number, size, and location of elevators, will be accelerated by changes in rail rate determination and consolidation in the rail industry that promote single-line volume rates, multi-car and unit-train rates. It has been predicted that elevators that do not adapt to unit-train technology will "suffer accordingly."

The restructuring that is expected to occur in the U.S. grain elevator industry prompted this study of capital requirements and operating costs for fifteen model unit-train loadout elevators. Such information will assist management and decision makers in the grain industry, as they plan and map strategies for the remainder of this century. The information also will be useful to government policy makers, as they analyze the impact of government policies and regulations on the grain production-marketing-transportation complex.

¹Remarks made by Thomas N. Walsh, Burlington Northern Railroad, at the annual Crop Quality Council meeting, Minneapolis, November 1982.

METHODOLOGY

The economic-engineering approach is used to develop models of unit-train loadout elevators for four grain growing areas of the United States: corn-soybean; wheat-sorghum; wheat-barley; and soybeans. Models are developed for four sizes of corn-soybean, wheat-sorghum, and wheat-barley elevators and three sizes of soybean elevators. The general geographical areas are: corn-soybean models—Ohio, Indiana, Illinois, Iowa, and Minnesota; wheat-sorghum models—Texas, Oklahoma, Missouri, Kansas, and Nebraska; wheat-barley models—North Dakota, Montana, Idaho, and Washington; and soybean models—Arkansas, Louisiana, Tennessee, and Mississippi. The economic-engineering method analyzes costs of production processes or marketing services by examining resource requirements. Per unit product costs are developed by applying costs to the resources used in the production process or marketing service.

One advantage of the economic-engineering method is that estimates of costs can be provided in instances where historical operating records of actual operations are non-existent. In addition, this method of detailed analysis provides for easy updating of cost estimates when resource prices change. A disadvantage of the method is that it does not lend itself to standard tests of statistical reliability.

This cost analysis of grain elevators includes costs of structures, equipment, and operation. The effects of elevator location, availability of grain, grain acquisition, and grain marketing alternatives on operating costs were not considered. Thus, a firm contemplating building an elevator should address these costs in any feasibility study.

The models were designed to meet current building practice and environmental and safety regulations. Model specifications were based on recommendations from grain elevator engineers of grain companies, equipment manufacturers, design and construction firms, and the government; industry, government, and university economists; and grain elevator operating superintendents. The final models represent workable combinations of specifications from the sources consulted. Prices in effect in the fall of 1982 were used to determine costs.

BASIC GRAIN ELEVATOR OPERATIONS

The model elevators developed for this study were designed to serve as assembly points to load grain for shipment in unit trains. Drying capacity was included only for infrequent off-grade grain. Long-term grain storage was not considered to be an activity of the elevator(s). Grain merchandising strategies for the model elevators would require considerations of scheduling grain receipts, advanced purchasing arrangements, prior storage, and pricing methods, among other things.

The basic product flow for the model elevators may be described briefly as: receiving; cleaning and distribution; drying, if required; storage; and shipping. In addition, necessary maintenance and office functions are included.

Receiving

The model elevators receive grain by truck. Upon arrival, trucks are weighed on a platform scale, and the loads are sampled with a mechanical probe sampler. The sample is evaluated while the truck proceeds to the hydraulic truck dumper.

Grain is conveyed from the receiving pit to a bucket elevator installed in the open, outside the storage bins.

Cleaning and Distribution

From the head of the bucket elevator the grain flows over a gravity cleaner to remove pieces of stalk, stones, and other foreign material. The grain then may move by gravity or conveyor to bin distribution, drying, or directly to loadout.

Storage

Storage bins are included in the models to accumulate grain for loading unit trains. Storage is provided to load 25, 50, 75, or 100 hopper cars, depending upon the specific model. Aeration, fumigation, and temperature monitoring systems are incorporated for grain quality maintenance.

Shipping

Grain exits from bin bottoms and moves by gravity or conveyor to the shipping leg(s) (bucket elevator(s)). The grain then flows from the elevator head(s) to a surge bin ahead of the shipping scale. After weighing, the grain is sampled with a diverter mechanical sampler before entering the rail car. Corn-soybean models are equipped with a scalper that precedes the scaling surge bin. The scalper removes stalk or cob material that is disallowed in some markets to control certain insects. The shipping system of the model elevators includes a pit and reclaim conveyor in the rail loadout system so that, in the event a car is loaded with off-grade grain, it may be unloaded and properly handled to meet shipping specifications. This system is not intended to be used as a rail receiving unit.

MODEL SPECIFICATIONS

The model elevators of this study are assumed to be one part of an operation that merchandises production inputs and supplies, as well as grain. Plan views and flow diagrams shown in Figures 1-15 illustrate the general layout and design of the model grain elevators. Tables 1-3 delineate more specifically the structures, equipment, land, and improvements of each model. Table 4 sets out the storage capacity, annual throughput, and throughput ratio of each model operated at various levels.

The product flow, throughputs, and general elevator specifications are consistent with recommendations of construction and operating engineers. The elevators were designed with no headhouses or over-bin galleries, for increased safety and to minimize costs of any future expansion. Adequate land was included for future expansion.

25 CAR LOADOUT CORN-SOYBEAN FACILITY

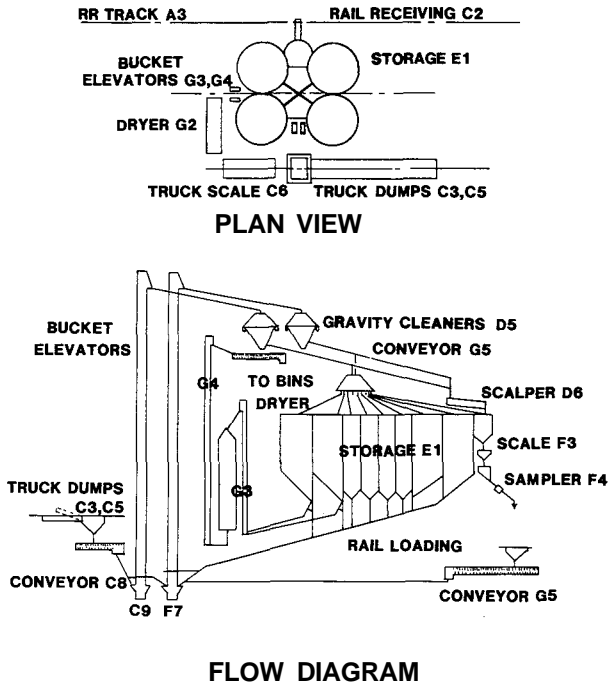


Figure 1. Flow diagram and plan view of 25-car loadout corn-soybean facility. For key codes to Figs. 1-4, refer to Table 1.

50 CAR LOADOUT CORN-SOYBEAN FACILITY

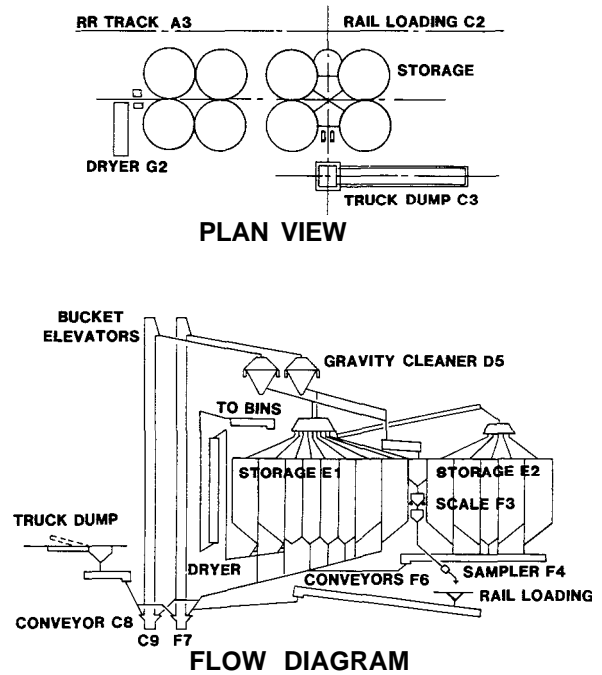


Figure 2. Flow diagram and plan view of 50-car loadout corn-soybean facility.

75 CAR LOADOUT CORN-SOYBEAN FACILITY

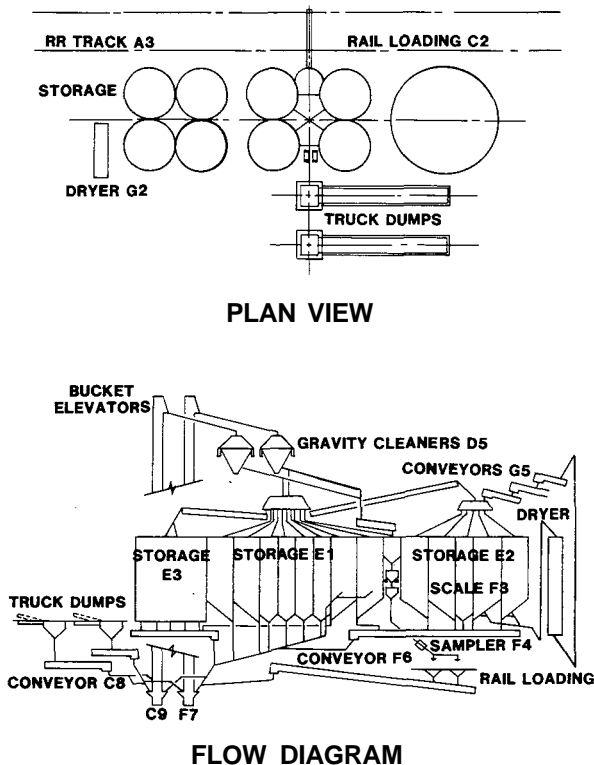


Figure 3. Flow diagram and plan view of 75-car loadout corn-soybean facility.

100 CAR LOADOUT CORN-SOYBEAN FACILITY

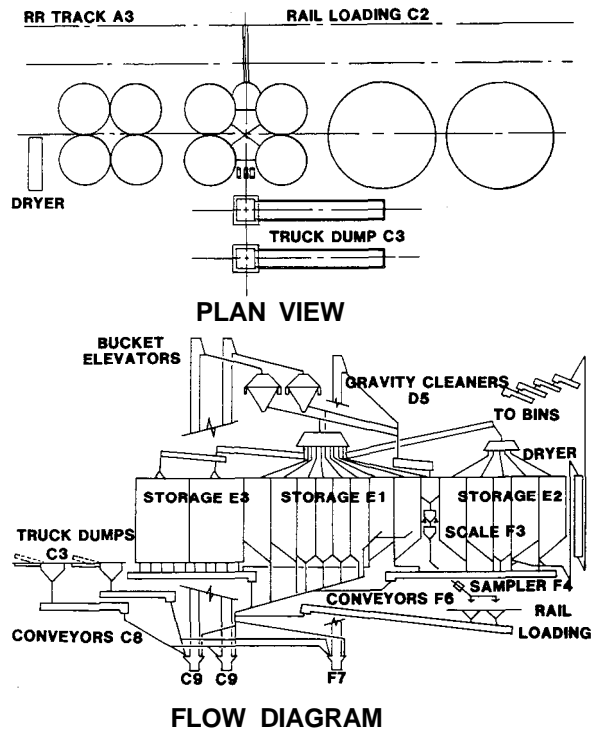


Figure 4. Flow diagram and plan view of 100-car loadout corn-soybean facility.

25 CAR LOADOUT WHEAT-SORGHUM FACILITY

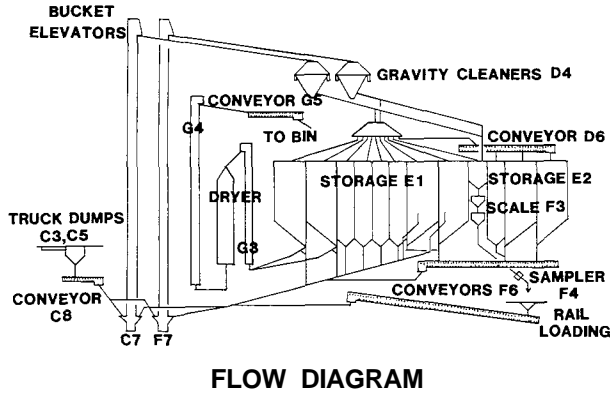
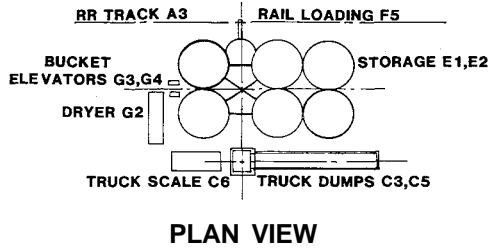


Figure 5 Flow diagram and plan view of 25-car loadout wheat-sorghum facility. For key codes to Figs. 5-12, refer to Table 2.

50 CAR LOADOUT WHEAT-SORGHUM FACILITY

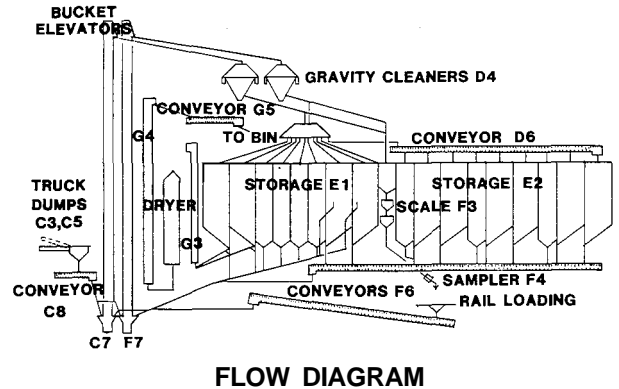
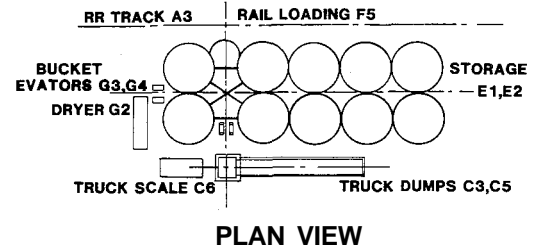


Figure 6. Flow diagram and plan view of 50-car loadout wheat-sorghum facility.

75 CAR LOADOUT WHEAT-SORGHUM FACILITY

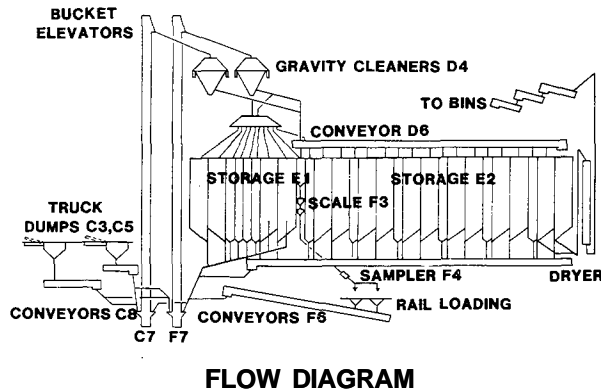
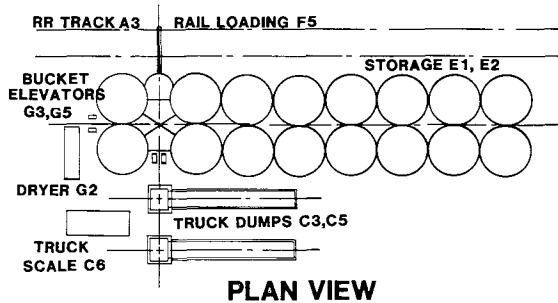


Figure 7. Flow diagram and plan view of 75-car loadout wheat-sorghum facility.

100 CAR LOADOUT WHEAT-SORGHUM FACILITY

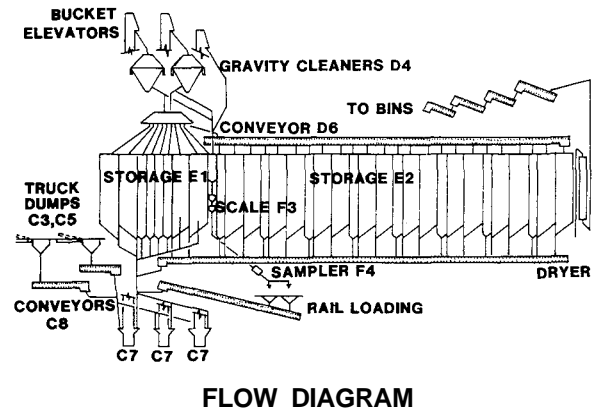
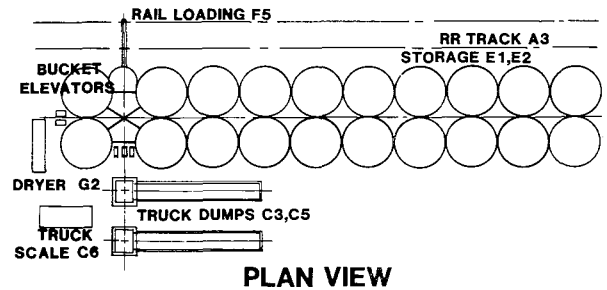


Figure 8. Flow diagram and plan view of 100-car loadout wheat-sorghum facility.

25 CAR LOADOUT WHEAT-BARLEY FACILITY

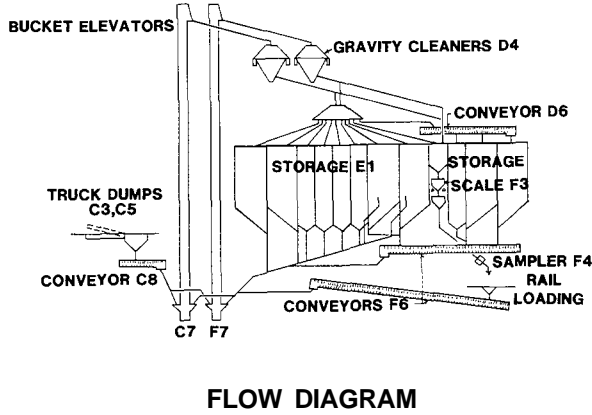
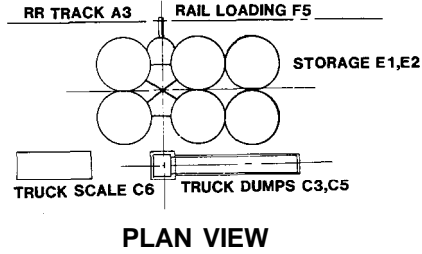


Figure 9. Flow diagram and plan view of 25-car loadout wheat-barley facility.

50 CAR LOADOUT WHEAT-BARLEY FACILITY

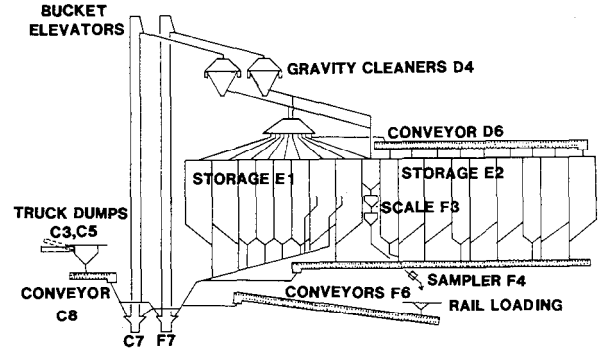
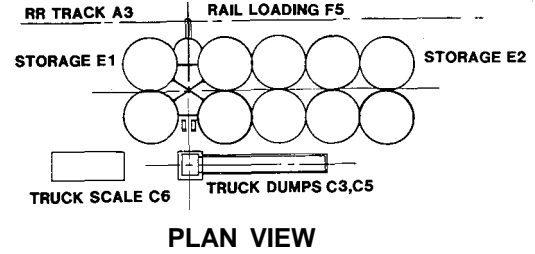


Figure 10. Flow diagram and plan view of 50-car loadout wheat-barley facility.

75 CAR LOADOUT WHEAT-BARLEY FACILITY

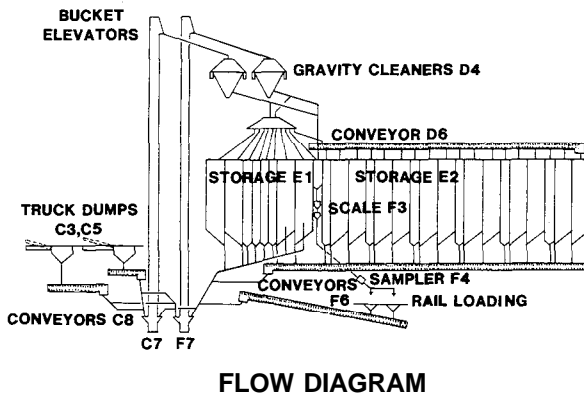
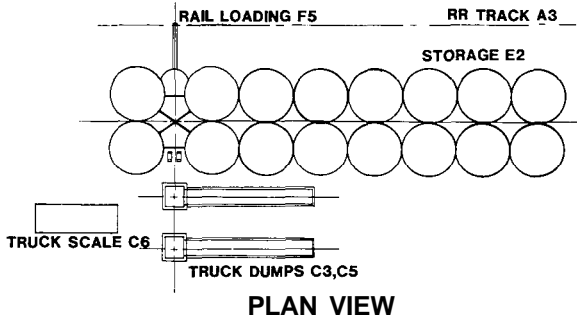


Figure 11. Flow diagram and plan view of 75-car loadout wheat-barley facility.

100 CAR LOADOUT WHEAT-BARLEY FACILITY

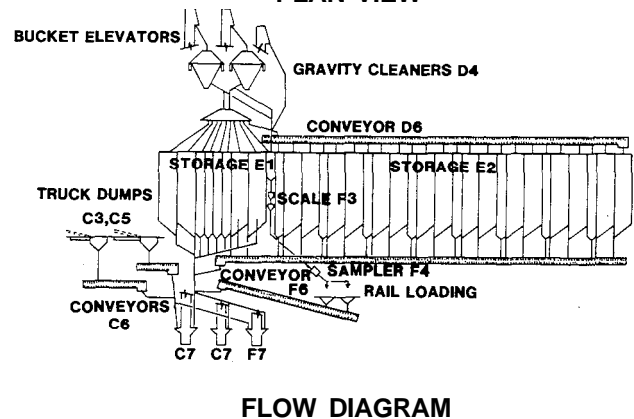
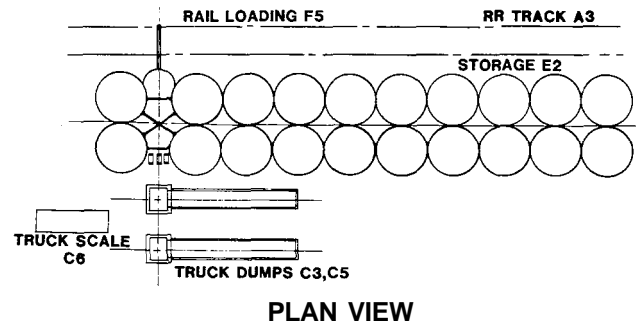


Figure 12. Flow diagram and plan view of 100-car loadout wheat-barley facility.

25 CAR LOADOUT SOYBEAN FACILITY

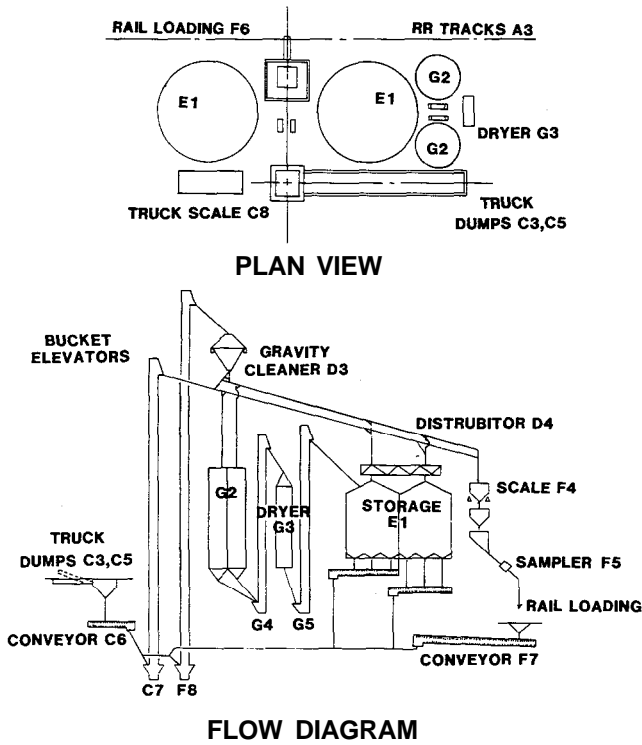


Figure 13. Flow diagram and plan view of 25-car loadout soybean facility. For key codes to Figs. 13-15, refer to Table 3.

50 CAR LOADOUT SOYBEAN FACILITY

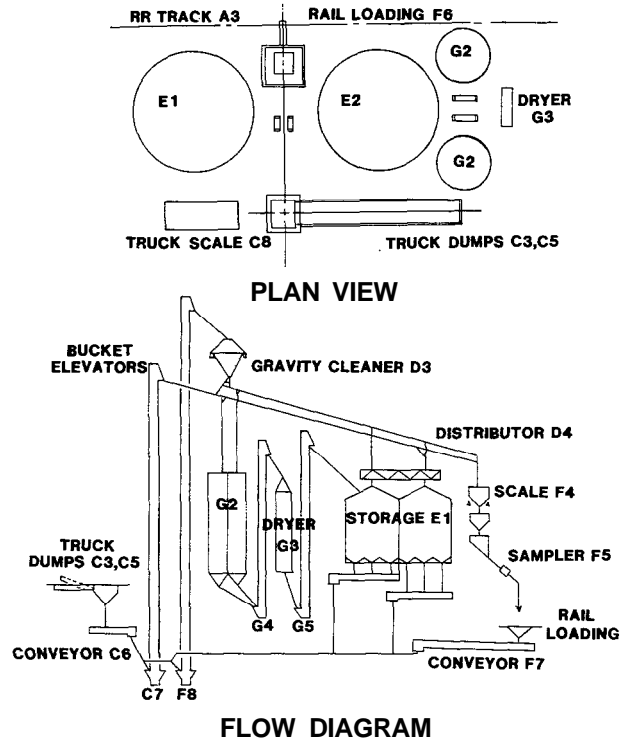


Figure 14. Flow diagram and plan view of 50-car loadout soybean facility.

75 CAR LOADOUT SOYBEAN FACILITY

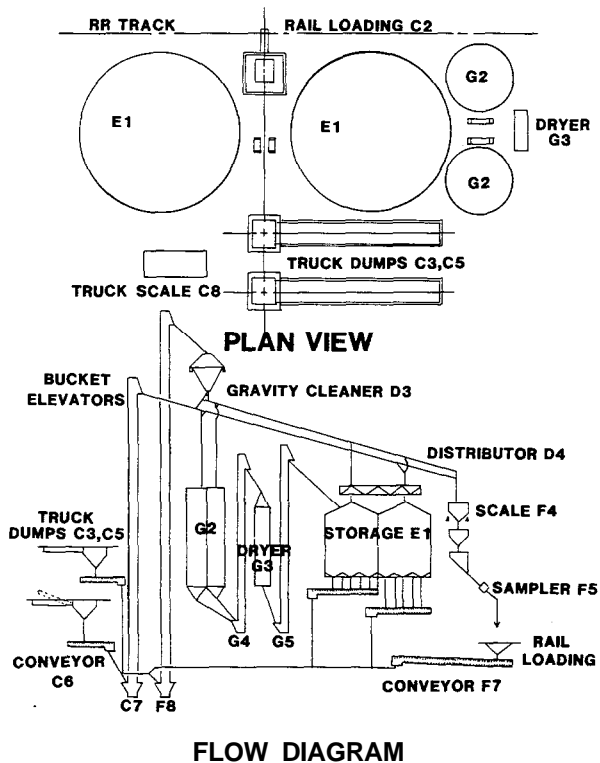


Figure 15. Flow diagram and plan view of 75-car loadout soybean facility.

Table 1. General specifications for four model corn-soybean elevators.

Item	Loadout Capacity			
	25-car	50-car	75-car	100-car
A. Land and Improvements:				
1. Land (acres)	13	16	19	23
2. Rail switches (no.)	1	3	7	9
3. Rail trackage (ft.)	2,850	4,950	8,150	9,840
4. Utility connections	—	—	—	—
5. Fencing (ft.)	4,400	4,860	5,320	5,800
6. Roads and parking (sq. ft.)	21,600	26,400	31,200	36,000
B. Plant Operations:				
<i>Structures</i>				
1. Office building (sq. ft.)	576	720	864	864
2. Shop and electrical switch building (sq. ft.)	200	304	448	720
<i>Equipment</i>				
3. Switch engine (no.)	1	1	2	2
(loaded car capacity)	6	12	6	6
4. Grain test equipment	—	—	—	—
5. Office equipment	—	—	—	—
C. Receiving:				
<i>Structures</i>				
1. Truck pit (no.)	1	1	2	2
2. Rail pit (no.)	1	1	1	1
3. Truck dumper pit (no.)	1	1	2	2
4. Truck drive enclosure (no.)	1	1	2	2
<i>Equipment</i>				
5. Truck dumper (no. @ 10' × 70')	1	1	2	2
6. Truck scale (no. @ 10' × 70')	1	1	1	1
7. Sampler probe (no.)	1	1	1	1
8. Conveyor (no.) (bu./hr. capacity)	10,000	15,000	20,000	20,000
9. Leg (no.) (bu./hr. capacity)	10,000	15,000	20,000	20,000
10. Dust control system (cfm)	10,000	10,000	20,000	20,000
D. Cleaning and Distribution:				
<i>Structures</i>				
1. Main support tower	—	—	—	—
2. Annex support tower	N/A	—	—	—
3. Large tank support tower	N/A	—	—	—
4. Conveyor bridge (no.)	N/A	1	2	3
<i>Equipment</i>				
5. Gravity cleaner (no.) (bu./hr. capacity)	10,000	15,000	20,000	20,000
6. Scalper (no.) (bu./hr. capacity)	20,000	30,000	40,000	40,000
7. Distributor (no. and size)	1, 10-way N/A	1, 10-way 1, 6-way	1, 12-way 1, 6-way	1, 12-way 1, 6-way
E. Storage:				
<i>Structures</i>				
1. Main storage bins (bu. cap.)	262,500	262,500	262,500	262,500
2. Annex (bu. cap.)	N/A	262,500	262,500	262,500
3. Large tank (bu. capacity)	N/A	N/A	262,500	525,000
4. Dust bin (cu. ft.)	1,000	1,000	1,000	1,000
<i>Equipment</i>				
5. Aeration (bu. @ cfm, 1/10) (bushel @ cfm, 1/6.7)	120,000	360,000	622,000	885,000
6. Temperature system	—	—	—	—
7. Fumigation system	—	—	—	—
8. Man lift (no.)	1	1	1	1

Continued...

Table 1. Continued

Item	Loadout Capacity			
	25-car	50-car	75-car	100-car
F. Shipping:				
<i>Structures</i>				
1. Scale support	—	—	—	—
2. Sampler and scale rooms (sq. ft.)	144	144	144	144
<i>Equipment</i>				
3. Shipping scale (bu./hr. cap.)	20,000	30,000	40,000	40,000
4. Sampler (no. and in.)	1-18	1-22	1-24	1-24
5. Loadout spout (no. and in.)	1-18	1-22	1-24	1-24
6. Reclaim conveyors (no.)	1	1	1	1
(bu./hr. capacity)	10,000	10,000	10,000	10,000
(no.)	N/A	1	2	3
(bu./hr. capacity)	—	15,000	20,000	20,000
7. Leg ^a (no.)	1	1	1	1
(bu./hr. capacity)	10,000	15,000	20,000	40,000
8. Gates (no.)	10	15	20	30
9. Dust control system (cfm)	8,000	9,000	10,000	10,000
G. Drying:				
<i>Structures</i>				
1. Foundations	—	—	—	—
<i>Equipment</i>				
2. Dryer (bu./hr. capacity)	2,000	3,000	4,000	5,000
3. Wet leg (bu./hr. capacity)	3,000	3,000	4,000	5,000
4. Dry leg (bu./hr. capacity)	3,000	3,000	4,000	5,000
5. Dry grain conveyor (no.)	1	2	3	4
(bu./hr. capacity)	2,000	3,000	4,000	5,000

— = One complement of the item.

N/A = Not applicable.

^aReceiving legs for the 25-, 50-, and 75-car loadout elevators are also used for shipping.

Table 2. General specifications for four model wheat-sorghum and wheat-barley elevators.

Item	Loadout Capacity			
	25-car	50-car	75-car	100-car
A. Land and Improvements:				
1. Land (acres)	13	16	19	23
2. Rail switches (no.)	1	3	7	9
3. Rail trackage (ft.)	2,850	4,950	8,150	9,840
4. Utility connections	—	—	—	—
5. Fencing (ft.)	4,400	4,860	5,320	5,800
6. Roads and parking (sq. ft.)	21,600	26,400	31,200	36,000
B. Plant Operations:				
<i>Structures</i>				
1. Office building (sq. ft.)	576	720	864	864
2. Shop and electrical switch building (sq. ft.)	200	304	448	720
<i>Equipment</i>				
3. Switch engine (no.)	1	1	2	2
(loaded car capacity)	6	12	6	6
4. Grain test equipment	—	—	—	—
5. Office equipment	—	—	—	—
C. Receiving:				
<i>Structures</i>				
1. Truck pit (no.)	1	1	2	2
2. Rail pit (no.)	1	1	1	1
3. Truck dumper pit (no.)	1	1	2	2
4. Truck drive enclosure (no.)	1	1	2	2
<i>Equipment</i>				
5. Truck dumper (no. @ 10' × 70')	1	1	2	2
6. Truck scale (no. @ 10' × 70')	1	1	1	1
7. Leg (no.)	1	1	1	2
(bu./hr. capacity)	10,000	15,000	20,000	20,000
8. Conveyor (no.)	1	1	2	2
(bu./hr. capacity)	10,000	15,000	20,000	20,000
9. Sampler probe (no.)	1	1	1	1
10. Dust control system (cfm)	10,000	10,000	20,000	20,000

Table 2. Continued

Item	Loadout Capacity			
	25-car	50-car	75-car	100-car
D. Cleaning and Distribution:				
<i>Structures</i>				
1. Main support tower	—	—	—	—
2. Annex support tower	N/A	—	—	—
3. Conveyor bridge (no.)	N/A	—	—	—
<i>Equipment</i>				
4. Gravity cleaner (no.)	2	2	2	2
(bu./hr. capacity)	10,000	15,000	20,000	20,000
5. Distributor (no. and size)	1, 10-way	1, 10-way	1, 12-way	1, 12-way
6. Conveyor (no.)	1	1	1	1
(bu./hr. capacity)	10,000	15,000	20,000	20,000
7. Dust control system (cfm)	3,000	4,000	5,000	6,000
E. Storage:				
<i>Structures</i>				
1. Main storage bins (bu. cap.)	230,000	230,000	230,000	230,000
2. Annex (bu. capacity)	120,000	470,000	820,000	1,170,000
3. Dust bin (cu. ft.)	1,000	1,000	1,000	1,000
<i>Equipment</i>				
4. Aeration (bu. @ cfm, 1/10)	230,000	480,000	800,000	1,080,000
(bushel @ cfm, 1/6.7)	120,000	120,000	120,000	120,000
5. Temperature system	—	—	—	—
6. Fumigation system	—	—	—	—
7. Man lift (no.)	1	1	1	1
F. Shipping:				
<i>Structures</i>				
1. Scale support	—	—	—	—
2. Sampler and scale rooms (sq. ft.)	144	144	144	144
<i>Equipment</i>				
3. Shipping scale (bu./hr. cap.)	20,000	30,000	40,000	40,000
4. Sampler (no. and in.)	1-18	1-22	1-24	1-24
5. Loadout spout (no. and in.)	1-18	1-22	1-24	1-24
6. Reclaim conveyors (no.)	1	1	1	1
(bu./hr. capacity)	10,000	10,000	10,000	10,000
(no.)	1	1	1	1
(bu./hr. capacity)	10,000	15,000	20,000	40,000
7. Leg ^a (no.)	1	1	1	1
(bu./hr. capacity)	10,000	15,000	20,000	40,000
8. Gates (no.)	14	20	26	32
9. Dust control system (cfm)	8,000	9,000	10,000	10,000
G. Drying:^b				
<i>Structures</i>				
1. Foundations	—	—	—	—
<i>Equipment</i>				
2. Dryer (bu./hr. capacity)	2,000	3,000	4,000	5,000
3. Wet leg (bu./hr. capacity)	3,000	3,000	4,000	5,000
4. Dry leg (bu./hr. capacity)	3,000	3,000	4,000	4,000
5. Dry grain conveyor (no.)	1	1	1	1
(bu./hr. capacity)	2,000	3,000	4,000	5,000

— = One complement of the item.

N/A = Not applicable.

^aReceiving legs for the 25-, 50-, and 75-car loadout elevators are also used for shipping.

^bThe drying system is not included in the wheat-barley elevators.

Table 3. General specifications for three model soybean elevators.

Item	25-car	50-car	75-car
A. Land and Improvements:			
1. Land (acres)	13	16	19
2. Rail switches (no.)	1	3	7
3. Rail trackage (ft.)	2,850	4,950	8,150
4. Utility connections	—	—	—
5. Fencing (ft.)	4,400	4,860	5,320
6. Roads and parking (sq. ft.)	21,600	26,400	31,200

Continued...

Table 3. Continued

Item	Loadout Capacity		
	25-car	50-car	75-car
B. Plant Operations:			
<i>Structures</i>			
1. Office building (sq. ft.)	576	720	768
2. Shop and electrical switch building (sq. ft.)	200	304	448
<i>Equipment</i>			
3. Switch engine (no.)	1	1	2
(loaded car capacity)	6	12	6
4. Grain test equipment	—	—	—
5. Office equipment	—	—	—
C. Receiving:			
<i>Structures</i>			
1. Truck pit (no.)	1	1	2
2. Rail pit (no.)	1	1	2
3. Truck dumper pit (no.)	1	1	2
4. Truck drive enclosure (no.)	1	1	2
<i>Equipment</i>			
5. Truck dumper (no. @ 10' × 70')	1	1	2
6. Conveyor (no.) (bu./hr. capacity)	10,000	15,000	20,000
7. Leg (no.) (bu./hr. capacity)	10,000	15,000	20,000
8. Truck scale (no. @10' × 70')	1	1	1
9. Sampler probe (no.)	1	1	1
10. Dust control (cfm)	10,000	10,000	20,000
D. Cleaning and Distribution:			
<i>Structures</i>			
1. Leg and support tower	—	—	—
2. Cleaner support tower	—	—	—
<i>Equipment</i>			
3. Gravity cleaner (no.) (bu./hr. capacity)	10,000	15,000	20,000
4. Two-way valves (no.)	4	4	4
5. Dust control system (cfm)	3,000	3,000	4,000
E. Storage:			
<i>Structures</i>			
1. Main storage bins (bu. cap.)	131,250	262,500	393,750
2. Fines storage (bu. capacity)	800	800	800
3. Dust bin (cu. ft.)	1,000	1,000	1,000
<i>Equipment</i>			
4. Aeration (bu. @ cfm, 1/10)	131,250	262,500	393,750
5. Temperature system	—	—	—
6. Fumigation system	—	—	—
7. Man lift (no.)	1	1	1
F. Shipping:			
<i>Structures</i>			
1. Surge bins (bu. capacity)	600	800	1,000
2. Scale support	—	—	—
3. Sampler and scale room (sq. ft.)	144	144	144
<i>Equipment</i>			
4. Shipping scale (bu./hr. cap.)	20,000	30,000	40,000
5. Sampler (no. and in.)	1-18	1-22	1-24
6. Loadout spout (no. and in.)	1-18	1-22	1-24
7. Reclaim conveyor (no.) (bu./hr. capacity)	10,000	10,000	10,000
(no.)	N/A	2	2
(bu./hr. capacity)	—	15,000	20,000
8. Shipping leg (no.) (bu./hr. capacity)	20,000	30,000	40,000
9. Gates (no.)	6	6	10
10. Dust control system (cfm)	8,000	9,000	10,000

Table 3. Continued

Item	Loadout Capacity		
	25-car	50-car	75-car
G. Drying:			
<i>Structures</i>			
1. Foundations	—	—	—
2. Drying bins (bu. capacity)	20,000	25,000	35,000
<i>Equipment</i>			
3. Dryer (bu./hr. capacity)	2,000	3,000	4,000
4. Wet leg (bu./hr. capacity)	3,000	3,000	4,000
5. Dry leg (bu./hr. capacity)	3,000	3,000	4,000
6. Dry grain conveyor (no.) (bu./hr. capacity)	1 2,000	2 3,000	2 4,000

— = One complement of the item.
N/A = Not applicable.

Table 4. Storage capacity, annual throughput, and ratio of annual throughput to storage capacity for model grain elevators at various loadout rates and levels of output.

Storage Capacity Annual Throughput and Ratio	Loadout Capacity in Cars			
	25	50	75	100
	— Bushels —			
Storage Capacity:				
Corn-soybean elevators	262,500	525,000	787,500	1,050,000
Wheat-sorghum and wheat-barley elevators	350,000	700,000	1,050,000	1,400,000
Soybean elevators	131,250	262,500	393,750	N/A
Annual Throughput:				
All elevators:				
20 trains/yr.	1,750,000	3,500,000	5,250,000	7,000,000
35 trains/yr.	3,062,500	6,125,000	9,187,500	12,250,000
50 trains/yr.	4,375,000	8,750,000	13,125,000	17,500,000
Ratio of Annual Throughput to Storage Capacity:				
	— Throughput ratios —			
Corn-soybean elevators:				
20 trains/yr.	6.67	6.67	6.67	6.67
35 trains/yr.	11.67	11.67	11.67	11.67
50 trains/yr.	16.67	16.67	16.67	16.67
Wheat-sorghum and wheat-barley elevators				
20 trains/yr.	5.00	5.00	5.00	5.00
35 trains/yr.	8.75	8.75	8.75	8.75
50 trains/yr.	12.50	12.50	12.50	12.50
Soybean elevators:				
20 trains/yr.	13.33	13.33	13.33	N/A
35 trains/yr.	23.33	23.33	23.33	N/A
50 trains/yr.	33.33	33.33	33.33	N/A

N/A = Not applicable.

Operating Capacities

Elevator Legs

The basic identifier used to describe the model elevators was the number of cars loaded at one loading; 25, 50, 75, or 100. Design of the elevator is such that a 12-hour loading time restraint can be met under normal operating conditions.

Designed receiving leg capacity of the model elevators ranges from 10,000 bushels per hour (BPH) for 25-car loadout elevators to 40,000 BPH for 100-car loadout elevators. Receiving capacity can be doubled on the 25- and 50-car loadout facility by adding one receiving pit and associated equipment to utilize the shipping legs as dual-purpose legs.

Designed shipping capacity of the model elevators ranges from 20,000 BPH for the 25-car loadout elevators to 40,000 BPH for the 100-car loadout elevators. The shipping systems of the 25-, 50-, and 75-car loadout elevators accomplish shipping capacities by use of a shipping leg and the receiving leg in a dual purpose role. The 100-car elevators are designed with two 20,000 BPH receiving legs and one 40,000 BPH shipping leg, facilitating simultaneous receiving and shipping at 40,000 BPH, whereas the smaller elevators can only accomplish simultaneous operations equivalent to the designed receiving leg capacity.

Cleaning and Distribution

Cleaning and distribution capacities are designed to equal the designed shipping capacity.

Drying

Drying capacity was included for corn-soybean, wheat-sorghum, and soybean models to handle occasional shipments that may be high in moisture and need drying to prevent deterioration of quality. Thus, drying capacity for different elevator sizes is not a ratio of elevator throughput. Drying was not considered to be a major service function of the model elevators. Dryer capacities are: 2,000; 3,000; 4,000; and 5,000 BPH, respectively, for the 25-, 50-, 75-, and 100-car loadout elevators.

Storage

The designed storage capacity requirements account for the number of grains handled, crop yield, production density, the area served (based on density of production and yield), the working hours per year, and a maximum of one train per week loadout. Storage capacity is equivalent to 1.5-, 3-, and 4-unit trains, respectively, for soybean, corn-soybean, and wheat-sorghum or wheat-barley model elevators. Harvest time surges for storage capacity are assumed to be handled by existing on-farm and country elevator capacity. Storage capacities of the model elevators are given in Table 4.

Equipment

Equipment for the basic operations of the model elevators is listed in Tables 1-3. The kind, type, size, and number of equipment items required for each model elevator were based on elevators recently completed by construction engineers.

The unspecified categories of grain testing equipment and office equipment in Tables 1-3 include necessary items regularly found in grain elevator operations. Switch engines are specified according to number of cars handled and track layout.

Connected horsepower of electric motors for operations of the various model elevators is listed in Table 5.

Structures

Structures listed in Tables 1-3 include receiving pits, receiving and shipping enclosures, equipment supports, buildings for office, shop, and grain samples, electrical switches, grain storage bins, and dust bins.

Grain Storage

Grain storage bins for the model elevators are both concrete and steel, depending upon the grain and the size of the elevator. The soybean model elevators of states bordering the Mississippi River in the South have steel tanks for storage exclusively, consistent with current practice.

The wheat-sorghum and wheat-barley model elevators have concrete storage bins exclusively. Smaller bins are needed for these grains to segregate them for more diverse quality characteristics relative to corn and soybeans. Consequently, the use of concrete bins and interstices provides more flexibility in grain segregation.

The core storage unit of the corn-soybean elevators of the Midwest consists of four concrete silos with interstices, as represented by the 25-car loadout elevator. The 50-car loadout elevator storage consists of the core storage, plus an annex of four concrete silos plus an interstice. The increased storage capacity of the 75-car loadout elevator over the 50-car elevator is provided by the addition of one steel tank. The 100-car model elevator has two steel tanks (Table 1).

Other Facilities

Dust storage for all model elevators is provided by an elevated steel tank. Drying bins for wheat-sorghum and corn-soybean model elevators are the two end concrete bins nearest the dryer (Figures 1-8). Two steel tanks serve as drying bins for the soybean model elevators (Figures 13-15). Buildings for offices, shop, grain samples, and electrical switches are of all steel construction.

Land and Improvements

Land and improvements for the model elevators include rail trackage and switches, utility hookups for electricity, gas, water, and sewer, fencing of the premises, and pavement of roadways and parking areas.

Site Sizes

Site sizes for the model elevators were set at 13, 16, 19, and 23 acres, respectively, for the 25-, 50-, 75-, and 100-car loadout models. Sites for the model elevators require access to a viable rail line and a paved highway adequate for semi-trailer trucks.

Table 5. Connected horsepower of motors for operations of 15 model grain elevators.

Elevator and Operation	Elevator Size— Cars/Train			
	25	50	75	100
	— Connected horsepower —			
Corn-Soybean:				
Receiving	240	324	549	799
Storage	103	183	283	383
Shipping	308	468	622	586
Drying	133	204	298	395
Wheat-Sorghum and Wheat-Barley:^a				
Receiving	250	332	575	812
Storage	143	223	323	423
Shipping	308	460	627	599
Drying	133	204	298	395
Soybeans:				
Receiving	210	258	418	N/A
Storage	48	88	128	N/A
Shipping	249	367	438	N/A
Drying	133	204	298	N/A

^aWheat-barley model elevators do not include dryers.
N/A = Not applicable.

Improvements

Rail trackage and switches for the model elevators are dependent upon the number of cars loaded at one loading and the track configuration. Track configurations of the model elevators optimize car maneuverability with consideration given to possible future expansion. Trackage and number of switches for each model elevator are listed in Tables 1-3.

Pavement area for roads and parking and fencing footage were estimated by construction engineers from records of recently constructed elevators.

COSTS

Costs used in this study are based on prices prevailing in the fall, 1982. This section discusses capital requirements for construction and fixed and variable operating costs of the model elevators.

Capital Requirements

Tables 6-9 present estimated capital investment requirements for model corn-soybean, wheat-sorghum, and wheat-barley, and soybean elevators, respectively. Subtotals are presented by operation for structures and equipment. Investments for land and improvements are presented by item. Investment requirements specifically for dust control and grain drying operations in the model elevators are analyzed in Appendices A and B, respectively.

Structures

Structures include storage bins; buildings for offices, shop, electrical switching equipment, and grain samples; enclosures for truck receiving and rail shipping; grain handling and equipment pits; structural supports for equipment; and foundations for dryers.

The proportion of total investment for structures ranges from about 32 percent for the 25-car corn-soybean model elevator to over 42 percent for the 50-car wheat-barley model. Generally, investment percentages for structures are lowest for the all steel con-

struction of the soybean model elevators, and highest for the all concrete wheat-barley model elevators. The cost for storage bins is, as expected, the largest element of the investment for structures (Tables 6-9).

Equipment

The equipment investments presented in Tables 6-9 include delivery and installation costs (including electrical). The range of equipment investment as a percentage of total investment is from 44 to 49 percent for the wheat-barley model elevators, which do not include a drying operation, to 48-53 percent for the corn-soybean models. Equipment investment generally declines percentagewise as the size of the model elevator increases. Combined receiving and shipping equipment investment comprises by far the largest proportion of equipment investment. Receiving equipment is the largest single item for all model sizes except the 50-car model, where shipping equipment investment exceeds receiving equipment investment due to a combination of factors related to equipment capacity requirements and costs for that particular model.

Land and Improvements

Land. Cost estimates of land for the model grain elevators are \$4,200, \$3,000, \$1,700, and \$1,300 per acre, respectively, for the corn-soybean, soybean, wheat-barley, and wheat-sorghum growing areas. The site was assumed to be in a rural area, level, to have adequate subsoil load-carrying capacity, and access to a viable railroad and a highway capable of handling heavy semi-trailer trucks.

Except for utility connections, land was the smallest investment item for the model elevators (Tables 6-9). The pattern of land investment as a percentage of total investment for the various grain-growing areas follows the same pattern as land cost per acre and declines with elevator size—highest in the corn-soybean growing area, ranging from 2.8 to 1.8 percent, and lowest in the wheat-sorghum growing area, ranging from .81 to .55 percent.

Table 6. Estimated capital investment requirements for four model corn-soybean elevators, 1982.

Item	25-car Loadout			50-car Loadout			75-car Loadout			100-car Loadout		
	Structures	Equipment	Total	Structures	Equipment	Total	Structures	Equipment	Total	Structures	Equipment	Total
— Dollars —												
Land and Improvements:												
Land			54,600			67,200			79,800			96,600
Rail trackage and switches			154,400			283,500			491,500			600,000
Utilities			18,000			20,500			23,000			32,000
Fencing, roads and parking			76,800			86,200			95,600			105,000
Subtotal			303,900			457,400			689,900			833,600
Plant Operations	32,000	68,000	100,000	41,520	98,000	139,520	52,380	128,000	180,380	58,380	129,000	187,380
Receiving	80,000	320,500	400,500	80,000	351,500	431,500	182,000	581,000	763,000	182,000	721,000	903,000
Cleaning and Distribution	35,000	150,500	185,500	55,500	232,000	287,500	70,000	394,000	464,000	89,500	458,000	547,500
Storage	454,300	78,400	532,700	848,100	118,200	966,300	1,241,900	154,200	1,396,100	1,635,700	186,000	1,821,700
Shipping	17,800	267,000	284,800	19,800	378,500	398,300	23,800	518,000	541,800	27,800	676,000	703,800
Drying	5,000	159,000	164,000	7,000	243,500	250,500	10,000	368,000	378,000	12,000	457,000	469,000
Total	624,100	1,043,400	1,971,400	1,051,920	1,421,700	2,931,020	1,580,080	2,143,200	4,413,180	2,005,380	2,627,000	5,465,980

Table 7. Estimated capital investment requirements for four model wheat-sorghum elevators, 1982.

Item	25-car Loadout			50-car Loadout			75-car Loadout			100-car Loadout		
	Structures	Equipment	Total	Structures	Equipment	Total	Structures	Equipment	Total	Structures	Equipment	Total
— Dollars —												
Land and Improvements:												
Land			16,900			20,600			24,700			29,900
Rail trackage and switches			154,500			283,500			491,500			600,000
Utilities			18,000			23,500			24,000			32,000
Fencing, roads and parking			76,800			86,200			95,600			105,000
Subtotal			266,200			414,000			635,800			766,900
Plant Operations	32,000	68,000	100,000	41,520	98,000	139,520	52,380	128,000	180,380	58,380	129,000	187,380
Receiving	80,000	320,500	400,500	80,000	351,500	431,500	182,000	581,000	763,000	182,000	721,000	903,000
Cleaning and Distribution	35,000	135,500	170,500	59,000	195,000	254,000	71,000	354,000	425,000	84,000	416,000	500,000
Storage	568,000	94,800	662,800	988,000	133,000	1,121,000	1,320,500	177,400	1,497,900	1,548,000	211,600	1,759,600
Shipping	17,800	308,000	325,800	19,800	410,500	430,300	23,800	566,000	589,800	23,800	694,000	717,800
Drying	5,000	159,000	164,000	7,000	243,500	250,500	10,000	368,000	378,000	12,000	457,000	469,000
Total	737,800	1,085,800	2,089,800	1,195,320	1,431,500	3,040,820	1,659,680	2,174,400	4,469,880	1,908,180	2,628,600	5,303,680

Table 8. Estimated capital investment requirements for four model wheat-barley elevators, 1982.

Item	25-car Loadout			50-car Loadout			75-car Loadout			100-car Loadout		
	Structures	Equipment	Total	Structures	Equipment	Total	Structures	Equipment	Total	Structures	Equipment	Total
-- Dollars --												
Land and Improvements:												
Land			22,100			27,200			32,300			39,100
Rail trackage and switches			154,500			283,500			491,500			600,000
Utilities			18,000			23,500			24,000			32,000
Fencing, roads and parking			76,800			86,200			95,600			105,000
Subtotal			271,400			420,400			643,400			776,100
Plant Operations	32,000	68,000	100,000	41,520	98,000	139,520	52,380	128,000	180,380	58,380	129,000	187,380
Receiving	80,000	320,500	400,500	80,000	351,500	431,500	182,000	581,000	763,000	182,000	721,000	903,000
Cleaning and Distribution	35,000	135,500	170,500	59,000	195,000	254,000	71,000	354,000	425,000	84,000	416,000	500,000
Storage	568,000	94,800	662,800	988,000	133,000	1,121,000	1,320,500	177,400	1,497,900	1,548,000	211,600	1,759,600
Shipping	17,800	308,000	325,800	19,800	410,500	430,300	23,800	566,000	589,800	23,800	694,000	717,800
Total	732,800	938,800	1,931,000	1,188,320	1,188,000	2,796,720	1,649,680	1,806,400	4,099,480	1,896,180	2,171,600	4,843,880

Table 9. Estimated capital investment requirements for three model soybean elevators, 1982.

Item	25-car Loadout			50-car Loadout			75-car Loadout		
	Structures	Equipment	Total	Structures	Equipment	Total	Structures	Equipment	Total
-- Dollars --									
Land and Improvements:									
Land			39,000			48,000			57,000
Rail trackage and switches			154,500			283,500			491,500
Utilities			18,000			18,000			21,000
Fencing, roads and parking			76,800			86,200			95,400
Subtotal			288,300			435,700			664,900
Plant Operations	34,000	68,000	102,000	41,600	98,000	139,600	52,320	128,000	180,320
Receiving	80,000	295,500	375,500	90,000	325,500	415,500	188,000	565,000	753,000
Cleaning and Distribution	82,000	58,500	140,500	98,000	72,500	170,500	119,000	100,000	219,000
Storage	266,600	63,000	329,600	450,600	81,500	532,100	621,600	100,300	721,900
Shipping	43,000	284,000	327,000	46,000	351,500	397,500	52,000	433,000	485,000
Drying	85,000	159,000	244,000	119,500	243,500	363,000	132,500	368,000	500,500
Total	590,600	928,000	1,806,900	845,700	1,172,500	2,453,900	1,165,420	1,694,300	3,524,000

Rail trackage and switches. Cost of rail siding was estimated at \$50 per linear foot of used track plus \$12,000 per switch. Extraordinary grading and ballast requirements were not considered, since a level plant site was assumed. Estimated cost of a rail siding varies from about 51 percent to 78 percent of the investment in land and improvements, depending on the elevator size and the grain-growing area. Investments are presented in Tables 6-9 for the trackage and switches listed in Tables 1-3.

Utility hookups. The investment for utility hookups varies with elevator size, mainly due to requirements of electrical hookup equipment. Total utility connection investments range from \$18,000 for the 25-car model elevators to \$32,000 for the 100-car models (Tables 6-9).

Fencing, Roads, and Parking. Fencing costs for the model elevators are estimated at \$15 per linear foot and costs for pavement of roads and parking are estimated at 50 cents per square foot (Tables 6-9).

Total Estimated Investment for Model Grain Elevators

Total estimated investment is lowest for the soybean model elevators because they specialize in one grain and thus have less storage capacity. Consequently, investment costs also are less for receiving, cleaning and distribution, and shipping equipment.

Estimated investment costs are highest for the 25-, 50-, and 75-car wheat-sorghum elevators. Costs for these models vary from \$56,000 to \$118,400 more than for corn-soybean models with comparable shipping capacity. This is due to several cost differences, the biggest being in the shipping systems (Tables 6 and 7). For the 100-car loadout models, a combination of cost differences resulted in higher estimated investment costs for the corn-soybean model. The estimated investment costs for the wheat-barley models are lower than the wheat-sorghum models, mainly because the former do not have drying systems.

A comparison of estimated investment costs of smallest and largest models for the various grain growing areas reveals that the 100-car loadout models require 2.77, 2.54, and 2.51 times the investment of the 25-car loadout corn-soybean, wheat-sorghum, and wheat-barley models, respectively (Tables 6-8). The 75-car loadout soybean model requires 1.95 times the estimated investment of the 25-car soybean model (Table 9).

Operating Costs

Operating costs are estimated for each of the model elevators at three levels of annual throughput. Costs are categorized as either fixed or variable (Tables 10-13). Operating costs for dust control and grain drying operations are analyzed individually in Appendices A and B, respectively.

Fixed Costs

Fixed costs include depreciation, interest on investment, insurance, taxes, and administrative expenses. Costs arising from investment (or ownership) constitute the major portion of fixed costs.

Depreciation. Depreciation is the single largest annual cost for the model grain elevators. Depreciable assets (total investment minus land investment) were depreciated over 15 years, using the straight-line method to estimate depreciation costs.

Interest on investment. Interest on investment is the second largest annual cost for the model grain elevators. Interest on investment was estimated at 12 percent of half the non-land investment (total initial investment minus land investment) plus 12 percent of the land investment.

Insurance. Insurance on structures and installed equipment was estimated at 17.72 cents per \$100 of initial investment. This rate was based on average costs of 90 percent coinsurance on facilities and replacement costs for equipment under fire and extended coverage.

Taxes. Taxes on land, structures, and equipment installed were estimated at \$1 per \$100 investment. Variations in tax rates by location were not considered in this study.

Administrative. Administrative expenses for the model elevators are for management, secretarial, and bookkeeping services, charged to the grain elevator operations of the firm.

Suggested management charges consistent with industry scales, and included in Tables 10-13, are \$25,000, \$31,250, \$37,500, and \$50,000, respectively for the 25-, 50-, 75-, and 100-car loadout, model elevators.

Secretarial and bookkeeping service charges suggested by industry management vary by grain-growing area and with the size of the model elevator. Estimated charges for these services by grain-growing area and for increasing elevator size are: corn-soybean area-\$4,150, \$5,650, \$6,500, and \$8,671; wheat-sorghum area-\$4,000, \$5,350, \$6,100, and \$8,200; wheat-barley area-\$4,200, \$5,750, \$6,500, and \$8,800; and the soybean area-\$3,700, \$5,100, and \$5,750.

Total fixed costs. Total estimated fixed costs for the model elevators exceed 60 percent of estimated total annual operating costs in all cases and exceed 70 percent for certain soybean models. Wheat-sorghum model elevators as a group have the lowest percentage fixed costs of total annual operating costs, while the soybean model elevators have the highest percentage.

Table 10. Estimated annual costs for four model corn-soybean elevators at three operating levels, 1982.

Cost Item	25-car Loadout			50-car Loadout			75-car Loadout			100-car Loadout		
	Trains Per Year			Trains Per Year			Trains Per Year			Trains Per Year		
	20	35	50	20	35	50	20	35	50	20	35	50
— Dollars —												
Fixed Costs:												
Depreciation	127,786	127,786	127,786	190,921	190,921	190,921	288,892	288,892	288,892	357,959	357,959	357,959
Interest	121,560	121,560	121,560	179,893	179,893	179,893	269,579	269,579	269,579	333,755	333,755	333,755
Insurance	2,955	2,955	2,955	4,383	4,383	4,383	6,598	6,598	6,598	9,515	9,515	9,515
Taxes	19,714	19,714	19,714	29,310	29,310	29,310	44,132	44,132	44,132	54,660	54,660	54,660
Administrative	29,150	29,150	29,150	36,900	36,900	36,900	44,000	44,000	44,000	58,700	58,700	58,700
Total fixed costs	301,165	301,165	301,165	441,407	441,407	441,407	653,201	653,201	653,201	814,589	814,589	814,589
Variable Costs:												
Wages and salaries	17,784	31,121	44,459	24,625	43,093	61,562	20,373	35,653	50,932	28,311	49,545	70,778
Electricity	15,518	11,276	10,503	27,934	20,601	19,513	40,653	27,313	23,686	56,848	40,082	36,498
Fuel	45,018	45,164	45,309	67,581	67,840	68,098	90,231	90,668	91,105	112,837	113,420	114,000
Maintenance and repairs	57,504	57,504	57,504	85,915	85,915	85,915	130,001	130,001	130,001	161,081	161,081	161,081
Insurance on inventory	1,305	1,305	1,305	2,610	2,610	2,610	3,915	3,915	3,915	5,220	5,220	5,220
Inspection and sampling	2,625	4,595	6,562	3,500	6,125	8,750	3,938	6,891	9,844	5,250	9,188	13,125
Interest on working capital	13,928	8,362	6,203	27,522	16,324	11,935	41,018	24,086	17,371	54,656	32,098	23,164
Other	16,731	17,255	17,781	21,237	22,287	23,337	25,744	27,319	28,894	30,250	32,350	34,450
Total variable costs	170,413	176,583	189,626	260,924	264,795	281,720	355,873	345,846	355,748	454,453	442,983	458,316
Total Costs	471,578	477,748	490,791	702,331	706,202	723,127	1,009,074	999,047	1,008,949	1,269,042	1,257,572	1,272,905
— Cents —												
Cost Per Bushel	26.95	15.60	11.22	20.07	11.53	8.26	19.22	10.87	7.69	18.13	10.27	7.27

Table 11. Estimated annual costs for four model wheat-sorghum elevators at three operating levels, 1982.

Cost Item	25-car Loadout			50-car Loadout			75-car Loadout			100-car Loadout		
	Trains Per Year			Trains Per Year			Trains Per Year			Trains Per Year		
	20	35	50	20	35	50	20	35	50	20	35	50
— Dollars —												
Fixed Costs:												
Depreciation	138,193	138,193	138,193	201,335	201,335	201,335	296,345	296,345	296,345	351,585	351,585	351,585
Interest	126,402	126,402	126,402	183,697	183,697	183,697	269,675	269,675	269,675	320,015	320,015	320,015
Insurance	3,231	3,231	3,231	4,655	4,655	4,655	6,793	6,793	6,793	8,039	8,039	8,039
Taxes	20,898	20,898	20,898	30,408	30,408	30,408	44,699	44,699	44,699	53,037	53,037	53,037
Administrative	29,000	29,000	29,000	36,600	36,600	36,600	43,600	43,600	43,600	58,200	58,200	58,200
Total fixed costs	317,724	317,724	317,724	456,695	456,695	456,695	661,112	661,112	661,112	790,876	790,876	790,876
Variable Costs:												
Wages and salaries	17,055	29,846	42,637	23,612	41,322	59,031	19,500	34,125	48,750	27,096	47,418	67,740
Electricity	20,120	13,102	11,014	32,633	22,409	19,934	45,713	29,517	24,590	62,179	42,525	37,661
Fuel	45,018	45,164	45,309	67,581	67,840	68,098	90,231	90,668	91,105	112,837	113,420	114,000
Maintenance and repairs	62,187	62,187	62,187	90,601	90,601	90,601	133,355	133,355	133,355	158,213	158,213	158,213
Insurance on inventory	2,139	2,139	2,139	4,279	4,279	4,279	6,418	6,418	6,418	8,558	8,558	8,558
Inspection and sampling	2,625	4,595	6,562	3,500	6,125	8,750	3,938	6,891	9,844	5,250	9,188	13,125
Interest on working capital	29,628	17,291	12,457	58,885	34,172	24,448	88,050	50,862	36,157	117,353	67,795	48,221
Other	18,131	19,705	21,281	24,037	27,187	30,337	29,944	34,669	39,394	35,850	42,150	48,450
Total variable costs	196,903	194,030	203,586	305,128	293,935	305,478	417,149	386,505	389,613	527,336	489,267	495,958
Total Costs	514,627	511,754	521,310	761,823	750,630	762,173	1,078,261	1,047,617	1,050,725	1,318,212	1,280,143	1,286,744
— Cents —												
Cost Per Bushel	29.41	16.71	11.91	21.77	12.26	8.71	20.54	11.40	8.01	18.83	10.45	7.35

Table 12. Estimated annual costs for four model wheat-barley elevators at three operating levels, 1982.

Cost Item	25-car Loadout			50-car Loadout			75-car Loadout			100-car Loadout		
	Trains Per Year			Trains Per Year			Trains Per Year			Trains Per Year		
	20	35	50	20	35	50	20	35	50	20	35	50
-- Dollars --												
Fixed Costs:												
Depreciation	127,260	127,260	127,260	184,635	184,635	184,635	271,145	271,145	271,145	320,313	320,313	320,313
Interest	117,126	117,126	117,126	169,435	169,435	169,435	247,906	247,906	247,906	292,974	292,974	292,974
Insurance	2,941	2,941	2,941	4,211	4,211	4,211	6,124	6,124	6,124	7,208	7,208	7,208
Taxes	19,310	19,310	19,310	27,967	27,967	27,967	40,995	40,995	40,995	48,439	48,439	48,439
Administrative	29,200	29,200	29,200	37,000	37,000	37,000	44,000	44,000	44,000	58,800	58,800	58,800
Total fixed costs	295,837	295,837	295,837	423,248	423,248	423,248	610,170	610,170	610,170	727,735	727,735	727,735
Variable Costs:												
Wages and salaries	24,251	42,439	60,627	33,592	58,786	83,979	27,930	48,877	69,824	38,821	67,937	97,053
Electricity	11,092	6,903	5,656	18,072	11,969	10,491	25,231	15,562	12,621	34,392	22,658	19,754
Fuel	194	304	485	345	604	862	583	1,020	1,457	777	1,360	1,940
Maintenance and repairs	57,267	57,267	57,267	83,086	83,086	83,086	122,015	122,015	122,015	144,141	144,141	144,141
Insurance on inventory	1,797	1,797	1,797	3,594	3,594	3,594	5,391	5,391	5,391	7,188	7,188	7,188
Inspection and sampling	2,625	4,595	6,562	3,500	6,125	8,750	3,938	6,891	9,844	5,250	9,188	13,125
Interest on working capital	24,581	14,301	10,314	48,987	28,345	20,278	73,258	42,137	29,875	97,698	56,225	39,896
Other	18,131	19,705	21,281	24,037	27,187	30,337	29,944	34,669	39,394	35,850	42,150	48,450
Total variable costs	139,938	147,348	163,989	215,213	219,696	241,377	288,290	276,562	290,421	364,117	350,847	371,547
Total Costs	435,775	443,185	459,826	638,461	642,944	664,625	898,460	886,732	900,591	1,091,852	1,078,582	1,099,282
-- Cents --												
Cost Per Bushel	24.90	14.47	10.51	18.24	10.50	7.60	17.11	9.65	6.86	15.60	8.80	6.28

Table 13. Estimated annual costs for three model soybean elevators at three operating levels, 1982.

Cost Item	25-car Loadout			50-car Loadout			75-car Loadout		
	Trains Per Year			Trains Per Year			Trains Per Year		
	20	35	50	20	35	50	20	35	50
-- Dollars --									
Fixed Costs:									
Depreciation	117,860	117,860	117,860	160,393	160,393	160,393	231,175	231,175	231,175
Interest	110,754	110,754	110,754	150,114	150,114	150,114	214,897	214,897	214,897
Insurance	2,691	2,691	2,691	4,263	4,263	4,263	5,067	5,067	5,067
Taxes	18,069	18,069	18,069	24,539	24,539	24,539	35,246	35,246	35,246
Administrative	28,700	28,700	28,700	36,350	36,350	36,350	43,250	43,250	43,250
Total fixed costs	278,074	278,074	278,074	375,659	375,659	375,659	529,635	529,635	529,635
Variable Costs:									
Wages and salaries	14,387	25,178	35,968	19,914	34,849	49,784	16,374	28,654	40,935
Electricity	5,795	7,972	10,150	10,065	13,897	17,730	12,936	17,116	21,295
Fuel	16,019	16,165	16,310	24,082	24,341	24,599	32,232	32,669	33,106
Maintenance and repairs	53,037	53,037	53,037	72,177	72,177	72,177	103,819	103,819	103,819
Insurance on inventory	1,241	1,241	1,241	2,482	2,482	2,482	3,723	3,723	3,723
Inspection and sampling	2,625	4,595	6,562	3,500	6,125	8,750	3,938	6,891	9,844
Interest on working capital	6,612	3,941	3,084	13,057	7,648	5,868	19,405	11,186	8,410
Other	16,031	16,031	16,031	19,837	19,837	19,837	23,644	23,644	23,644
Total variable costs	115,747	128,160	142,383	165,114	181,356	201,227	216,071	227,702	244,776
Total Costs	393,821	406,234	420,457	540,773	557,015	576,886	745,705	757,337	774,411
-- Cents --									
Cost Per Bushel	22.50	13.26	9.61	15.45	9.09	6.59	14.20	8.24	5.90

Table 14. Job description, number of staff, and wage rates for model grain elevators, 1982.^a

Job Description	No.	Model Facility			
		Corn-Soybean	Wheat-Sorghum	Wheat-Barley	Soybean
		–Dollars/hours–			
Superintendent	1	9.30	9.00	12.10	7.80
Scaleman-Probe Operator	1	7.94	7.68	10.85	6.55
Equipment Operator	1	7.06	6.71	9.85	5.56
Grain Foreman	1	7.94	7.68	10.85	6.55
Locomotive Operator	1	7.06	6.71	9.85	5.56
Scaleman and Controls Operator	1	7.50	7.10	10.35	5.80
Car Cleaner, Sealer, and Locomotive Operator	1	7.06	6.71	9.85	5.56
Total	7	N/A	N/A	N/A	N/A

N/A = Not applicable.

^aWage rates include 20 percent for employee benefits.

Variable costs

Variable costs estimated for the model grain elevators include wages and salaries, electricity, fuel, maintenance and repairs, insurance on inventory, inspection and sampling fees, interest on working capital, and other costs. Annual costs for specified variable costs are presented in Tables 10-13 for each model elevator at three levels of yearly operation.

Wages and Salaries. Employee requirements and wage rates (including 20 percent fringe benefits) furnished by grain industry management are presented in Table 14 for each of the grain growing areas. Wages are charged according to industry management estimates of the percentage of workers' time spent in grain elevator activities relative to total operations, which include merchandising agricultural inputs and supplies. Equipment and jobs are similar for all model elevators, thus crew size is fixed. Labor cost per bushel declines as elevator throughput increases and as equipment capacity increases in the larger model elevators. Management, bookkeeping, and secretarial services are included under Administrative Costs.

Electricity. Electricity cost estimates are based on the average equipment running times specified by elevator operators and engineers. Rates used to estimate electricity costs were 6.6 cents, 6.7 cents, 4.0 cents, and 6.2 cents per kilowatt hour, respectively, for the corn-soybean, wheat-sorghum, wheat-barley, and soybean growing areas.²

Electricity costs decline for the model elevators as output increases because aeration equipment was assumed to be used more for shipping 20 trains per year than for 35 or 50 trains per year. Estimated aeration equipment running time percentages were 20, 10, and 0, respectively, for 20, 35, and 50 trains per year.

²Electricity rates reported in *Agricultural Prices* (U.S. Department of Agriculture), October 1982, for the states in each grain-growing area were weighted by estimated 1982 crop production for the appropriate grains to obtain weighted average electricity rates.

Fuel. Fuel costs are for liquified petroleum gas for drying and diesel fuel for operating the rail car mover(s). Fuel needed for drying was estimated with the assumptions that: dryers would operate 288 hours per year; moisture content of the grain dried would be reduced 6 percentage points for corn and sorghum and 2 percentage points for soybeans; and wheat and barley would not be dried. Liquified petroleum gas cost was estimated at 72.9 cents per gallon.

Manufacturers' records were used to estimate diesel fuel requirements for the rail car movers. Gallon requirements per hour were 1.5 and 2.0, respectively, for the small and large engines specified for the model elevators (Tables 1-3). Diesel fuel cost was estimated at \$1.11 per gallon.

Maintenance and Repairs. Annual costs for maintenance and repairs include costs of replacing equipment parts that fail, plus outside services hired to make repairs. The estimated maintenance and repairs costs for the model plants were computed at 3 percent of total investment minus land investment, as recommended by elevator maintenance engineers. This method of computation likely overstates maintenance and repairs for low levels of operation and may understate costs for high levels of operation, since it is an average and does not account for running time (use), specifically. Detailed data that specify the contribution of individual factors, such as use, to maintenance and repairs costs were not available to further refine the average used in this study.

Insurance on inventory. Annual costs for inventory insurance were computed at the rate of 16.2 cents per \$100 inventory value. Inventory value was computed using storage capacity times estimated grain price. Estimated grain prices used were \$3.05, \$3.75, \$3.15, and \$5.80, respectively, for the corn-soybean, wheat-sorghum, wheat-barley, and soybean model elevators.

Inspection and sampling fees. The hourly contact services rate for regular work hours of \$21.80 charged by the Federal Grain Inspection Service was used to estimate inspection and sampling costs. The time allowed for sampling and inspection was estimated by

dividing bushels shipped by three-fourths of the designed shipping capacity.

Interest on working capital. Working capital needs for the model elevators were considered to be the sum of costs for one month's wages, electricity, and fuel and the value of the average inventory held at 100 percent occupancy. Average inventory held is assumed to vary inversely with the number of trains the model elevator ships each year. Consequently, model elevators operated at maximum annual throughput experience lower costs for interest on working inventory, because of cash flow acceleration. Interest on investment may be overstated, since maximum average inventory is assumed. In addition, purchasing under various arrangements that reduce cash obligations and sales procedures involving cash advancements were not considered. The prices used to compute the value of the inventory for interest charges were the same as those listed in the section, Insurance on Inventory. An interest rate of 11 percent was used.

Other costs. Other costs include fumigation, bonding, legal and audit fees, license fees, and costs for marketing information, telephone, postage, dues, subscriptions, donations, and advertising. Estimates used for fumigation costs were 0.04 cent per bushel throughput for corn-soybean model elevators, and 0.12 cent per bushel for wheat-sorghum and wheat-barley elevators. No fumigation costs were included for soybean model elevators, since stored-product insect problems in soybeans are nil. Estimates of the various other costs were provided by industry sources.

ECONOMIC RELATIONSHIPS

The foregoing data allow analyses of certain economic relationships. Cost relationships among the three annual operating levels and among regions, as well as economies of size, are evaluated for the model grain elevators in this section.

Varying Annual Throughput of Model Elevators

Since total fixed costs remain the same regardless of the annual throughput, the lowest per bushel fixed costs occur at the highest throughput, 50 trains per year (Tables 15-18).

As annual throughput increases from 20 trains to 50 trains, total estimated costs per bushel decrease. The decrease, which increases with size, is 57 to 58 percent for soybean model elevators, 58 to 60 percent for corn-soybean and wheat-barley models, and 60 to 61 percent for wheat-sorghum models.

The cost decreases associated with increased annual throughput in this study are substantial but costs incurred for grain merchandising operations to assure the quantity, quality, and timely arrival of grain receipts for unit-train loadout are not included. Activities such as price enhancement to cover storage costs in other facilities, pre-purchase of grain, and special pricing arrangements would likely negate some of the economies of increased output.

Economies of Size

Estimated total costs per bushel decline approximately 34, 37, 39 and 38 percent, respectively, for the corn-soybean, wheat-sorghum, wheat-barley, and soybean model elevators, as size of elevator increases from 25-car loadout to 100-car loadout (75 cars in the case of soybean models), when 35 trains per year are shipped.

Data from Tables 15-18 were used to develop Figures 16-19, which show the relationship between annual throughput and average operating costs for the model grain elevators of this study.

Cost Variations Among Model Grain Elevators

Estimated total costs per bushel also may be compared for the model elevators according to the grain(s) handled by examining Tables 15-18 (Figure 20). For any given size or operating level applicable to soybean model elevators, total costs per bushel are lowest relative to models for the other grain-growing areas. This phenomenon is due partially to the lower fixed costs associated with storage capacity of models for the soybean growing area, which have storage for only one commodity. Variable costs that contribute to the overall lowest costs for soybean model elevators are wages and other costs associated with inventory.

Estimated costs per bushel are higher for wheat-sorghum models than for corn-soybean or wheat-barley models. Estimated costs for corn-sorghum models are lower mainly because of lower fixed costs associated with a lower investment and lower variable costs associated with value of inventory.

Wheat-barley model elevator estimated costs are lower than those for wheat-sorghum and corn-soybean models mainly because of the absence of costs associated with drying operations. However, wheat-barley model elevators have noticeably lower electricity costs, in any event, because of the lower electrical rates in that particular grain-growing area.

Table 15. Estimated per unit costs for four model corn-soybean elevators at three operating levels, 1982.*

Cost Item	25-car Loadout			50-car Loadout			75-car Loadout			100-car Loadout		
	Trains Per Year			Trains Per Year			Trains Per Year			Trains Per Year		
	20	35	50	20	35	50	20	35	50	20	35	50
-Cents per bushel -												
Fixed Costs:												
Depreciation	7.30	4.17	2.92	5.45	3.12	2.18	5.50	3.14	2.20	5.11	2.92	2.05
Interest	6.95	3.97	2.78	5.14	2.94	2.06	5.13	2.93	2.05	4.77	2.72	1.91
Insurance	.17	.10	.07	.13	.07	.05	.13	.07	.05	.14	.08	.05
Taxes	1.13	.64	.45	.84	.48	.33	.84	.48	.34	.78	.45	.31
Administrative	<u>1.66</u>	<u>.95</u>	<u>.67</u>	<u>1.05</u>	<u>.60</u>	<u>.42</u>	<u>.84</u>	<u>.48</u>	<u>.34</u>	<u>.84</u>	<u>.48</u>	<u>.34</u>
Total fixed costs	17.21	9.83	6.88	12.61	7.21	5.04	12.44	7.11	4.98	11.64	6.65	4.65
Variable Costs:												
Wages and salaries	1.02	1.02	1.02	.70	.70	.70	.39	.39	.39	.40	.40	.40
Electricity	.89	.37	.24	.80	.34	.22	.77	.30	.18	.81	.33	.21
Fuel	2.57	1.47	1.04	1.93	1.11	.78	1.72	.99	.69	1.61	.93	.65
Maintenance and repairs	3.29	1.88	1.31	2.45	1.40	.98	2.48	1.41	.99	2.30	1.31	.92
Insurance on inventory	.07	.04	.03	.07	.04	.03	.07	.04	.03	.07	.04	.03
Inspection and sampling	.15	.15	.15	.10	.10	.10	.08	.08	.08	.08	.08	.08
Interest on working capital	.80	.27	.14	.79	.27	.14	.78	.26	.13	.78	.26	.13
Other	<u>.96</u>	<u>.56</u>	<u>.41</u>	<u>.61</u>	<u>.36</u>	<u>.27</u>	<u>.49</u>	<u>.30</u>	<u>.22</u>	<u>.43</u>	<u>.26</u>	<u>.20</u>
Total variable costs	9.74	5.77	4.33	7.46	4.32	3.22	6.78	3.76	2.71	6.49	3.62	2.62
Total Costs	26.95	15.60	11.22	20.07	11.53	8.26	19.22	10.87	7.69	18.13	10.27	7.27

*Items may not sum due to rounding.

Table 16. Estimated per unit costs for four model wheat-sorghum elevators at three operating levels, 1982.*

Cost Item	25-car Loadout			50-car Loadout			75-car Loadout			100-car Loadout		
	Trains Per Year			Trains Per Year			Trains Per Year			Trains Per Year		
	20	35	50	20	35	50	20	35	50	20	35	50
-Cents per bushel-												
Fixed Costs:												
Depreciation	7.90	4.51	3.16	5.75	3.29	2.30	5.64	3.23	2.26	5.02	2.87	2.01
Interest	7.22	4.13	2.89	5.25	3.00	2.10	5.14	2.93	2.06	4.57	2.61	1.83
Insurance	.18	.11	.07	.13	.07	.05	.13	.07	.05	.12	.07	.05
Taxes	1.19	.68	.48	.87	.50	.35	.85	.49	.34	.76	.43	.30
Administrative	<u>1.66</u>	<u>.95</u>	<u>.66</u>	<u>1.05</u>	<u>.60</u>	<u>.42</u>	<u>.83</u>	<u>.47</u>	<u>.33</u>	<u>.83</u>	<u>.48</u>	<u>.33</u>
Total fixed costs	18.16	10.37	7.26	13.05	7.46	5.22	12.59	7.19	5.04	11.30	6.46	4.52
Variable Costs:												
Wages and salaries	.97	.97	.97	.67	.67	.67	.37	.37	.37	.39	.39	.39
Electricity	1.15	.43	.25	.93	.37	.23	.87	.32	.19	.89	.35	.22
Fuel	2.57	1.47	1.04	1.93	1.11	.78	1.72	.99	.69	1.61	.93	.65
Maintenance and repairs	3.55	2.03	1.42	2.59	1.48	1.03	2.54	1.45	1.02	2.26	1.29	.90
Insurance on inventory	.12	.07	.05	.12	.07	.05	.12	.07	.05	.12	.07	.05
Inspection and sampling	.15	.15	.15	.10	.10	.10	.08	.08	.08	.07	.07	.07
Interest on working capital	1.69	.56	.28	1.68	.56	.28	1.68	.55	.28	1.68	.55	.28
Other	<u>1.04</u>	<u>.64</u>	<u>.49</u>	<u>.69</u>	<u>.44</u>	<u>.35</u>	<u>.57</u>	<u>.38</u>	<u>.30</u>	<u>.51</u>	<u>.34</u>	<u>.27</u>
Total variable costs	11.25	6.34	4.65	8.72	4.80	3.49	7.95	4.21	2.97	7.53	3.99	2.83
Total Costs	29.41	16.71	11.81	21.77	12.26	8.71	20.54	11.40	8.01	18.83	10.45	7.35

*Items may not sum due to rounding.

Table 17. Estimated per unit costs for four model wheat-barley elevators at three operating levels, 1982.*

Cost Item	25-car Loadout			50-car Loadout			75-car Loadout			100-car Loadout		
	Trains Per Year			Trains Per Year			Trains Per Year			Trains Per Year		
	20	35	50	20	35	50	20	35	50	20	35	50
-Cents per bushel-												
Fixed Costs:												
Depreciation	7.27	4.16	2.91	5.28	3.01	2.11	5.16	2.95	2.07	4.58	2.61	1.83
Interest	6.69	3.82	2.68	4.84	2.77	1.94	4.72	2.70	1.89	4.19	2.39	1.67
Insurance	.17	.10	.07	.12	.07	.05	.12	.07	.05	.10	.06	.04
Taxes	1.10	.63	.44	.80	.46	.32	.78	.45	.31	.69	.40	.28
Administrative	<u>1.67</u>	<u>.95</u>	<u>.67</u>	<u>1.06</u>	<u>.60</u>	<u>.42</u>	<u>.84</u>	<u>.48</u>	<u>.34</u>	<u>.84</u>	<u>.48</u>	<u>.34</u>
Total fixed costs	16.90	9.66	6.76	12.09	6.91	4.84	11.62	6.64	4.65	10.40	5.94	4.16
Variable Costs:												
Wages and salaries	1.39	1.39	1.39	.96	.96	.96	.53	.53	.53	.55	.55	.55
Electricity	.63	.23	.13	.52	.20	.12	.48	.17	.10	.49	.18	.11
Fuel	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01
Maintenance and repairs	3.27	1.87	1.31	2.37	1.36	.95	2.32	1.33	.93	2.06	1.18	.82
Insurance on inventory	.10	.06	.04	.10	.06	.04	.10	.06	.04	.10	.06	.04
Inspection and sampling	.15	.15	.15	.10	.10	.10	.08	.08	.08	.08	.08	.08
Interest on working capital	1.40	.47	.24	1.40	.46	.23	1.39	.46	.23	1.40	.46	.23
Other	<u>1.04</u>	<u>.64</u>	<u>.49</u>	<u>.69</u>	<u>.44</u>	<u>.35</u>	<u>.57</u>	<u>.38</u>	<u>.30</u>	<u>.51</u>	<u>.34</u>	<u>.28</u>
Total variable costs	8.00	4.81	3.75	6.15	3.59	2.76	5.49	3.01	2.21	5.20	2.86	2.12
Total Costs	24.90	14.47	10.51	18.24	10.50	7.60	17.11	9.65	6.86	15.60	8.80	6.28

*Items may not sum due to rounding

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Table 18. Estimated per unit costs for three model soybean elevators at three operating levels, 1982*.

Cost Item	25-car Loadout			50-car Loadout			75-car Loadout		
	Trains Per Year			Trains Per Year			Trains Per Year		
	20	35	50	20	35	50	20	35	50
-Cents per bushel-									
Fixed Costs:									
Depreciation	6.73	3.85	2.69	4.58	2.62	1.83	4.40	2.52	1.76
Interest	6.33	3.62	2.53	4.29	2.45	1.72	4.09	2.33	1.64
Insurance	.15	.08	.06	.12	.07	.05	.10	.06	.04
Taxes	1.03	.59	.41	.70	.40	.28	.67	.38	.27
Administrative	<u>1.64</u>	<u>.94</u>	<u>.66</u>	<u>1.03</u>	<u>.59</u>	<u>.42</u>	<u>.82</u>	<u>.47</u>	<u>.33</u>
Total fixed costs	15.89	9.08	6.36	10.73	6.13	4.29	10.09	5.76	4.04
Variable Costs:									
Wages and salaries	.82	.82	.82	.57	.57	.57	.31	.31	.31
Electricity	.33	.26	.23	.29	.23	.20	.25	.19	.16
Fuel	.92	.53	.37	.69	.40	.28	.61	.36	.25
Maintenance and repairs	3.03	1.73	1.21	2.06	1.18	.82	1.98	1.13	.79
Insurance on inventory	.07	.04	.03	.07	.04	.03	.07	.04	.03
Inspection and sampling	.15	.15	.15	.10	.10	.10	.08	.08	.08
Interest on working capital	.38	.13	.07	.37	.13	.07	.37	.13	.07
Other	<u>.92</u>	<u>.52</u>	<u>.37</u>	<u>.57</u>	<u>.32</u>	<u>.23</u>	<u>.45</u>	<u>.26</u>	<u>.18</u>
Total variable costs	6.61	4.18	3.25	4.72	2.96	2.30	4.12	2.48	1.86
Total costs	22.50	13.26	9.61	15.45	9.09	6.59	14.20	8.23	5.90

*Items may not sum due to rounding.

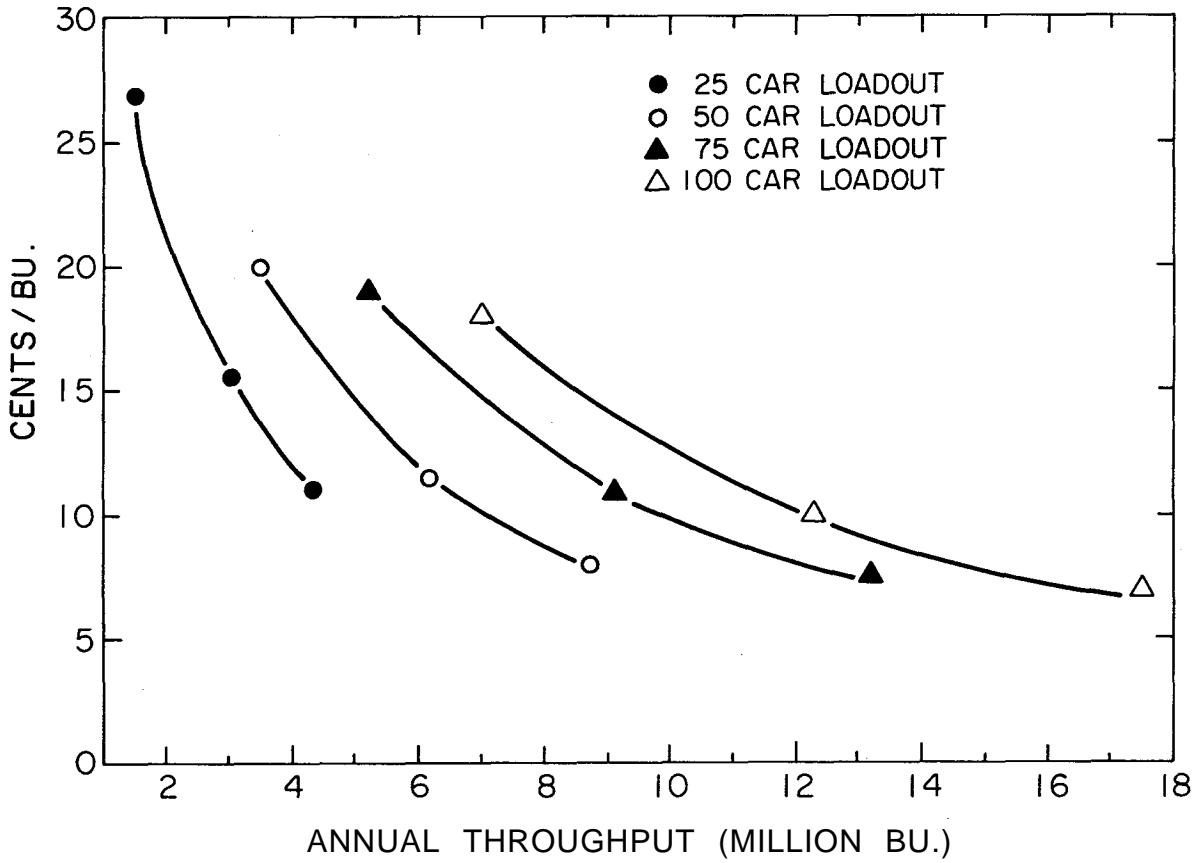


Figure 16. Cost curves for four model corn-soybean elevators.

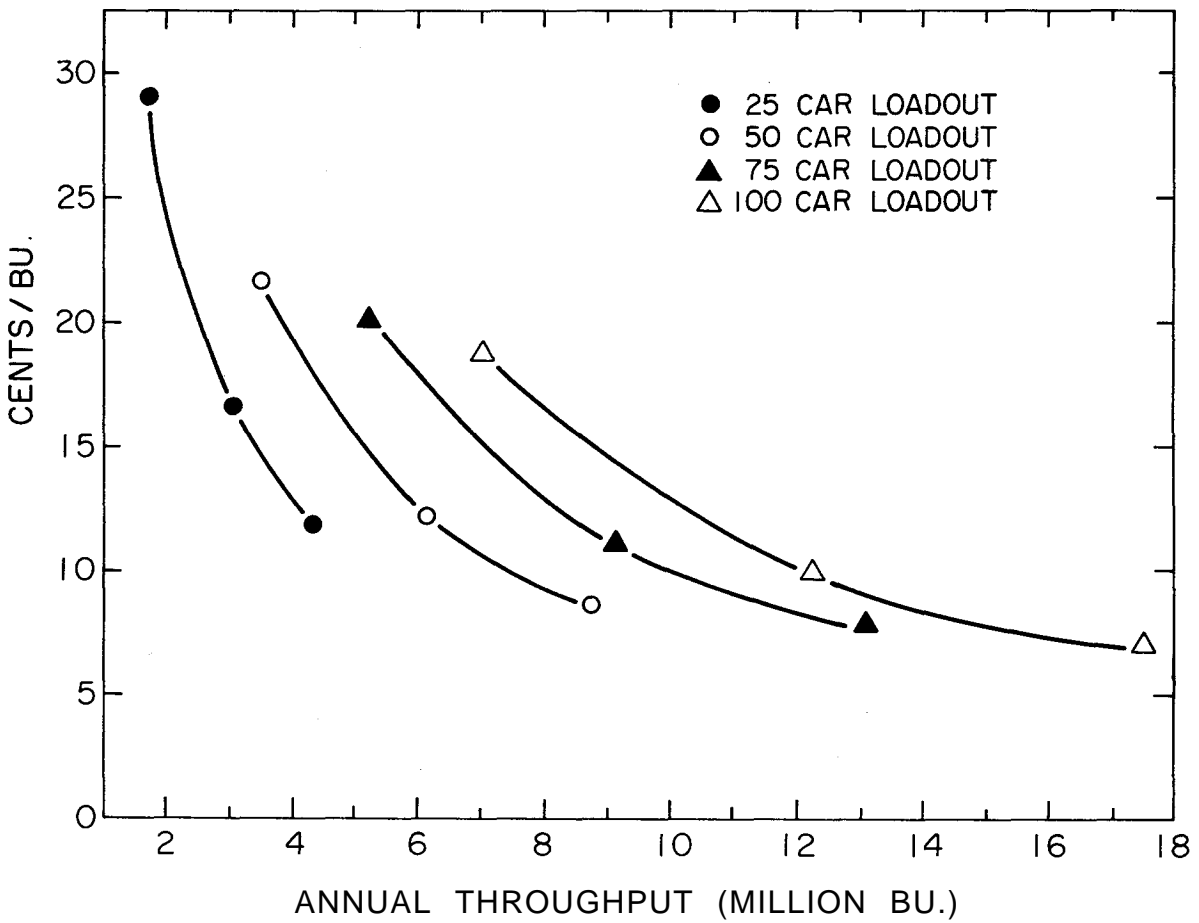


Figure 17. Cost curves for four model wheat-sorghum elevators.

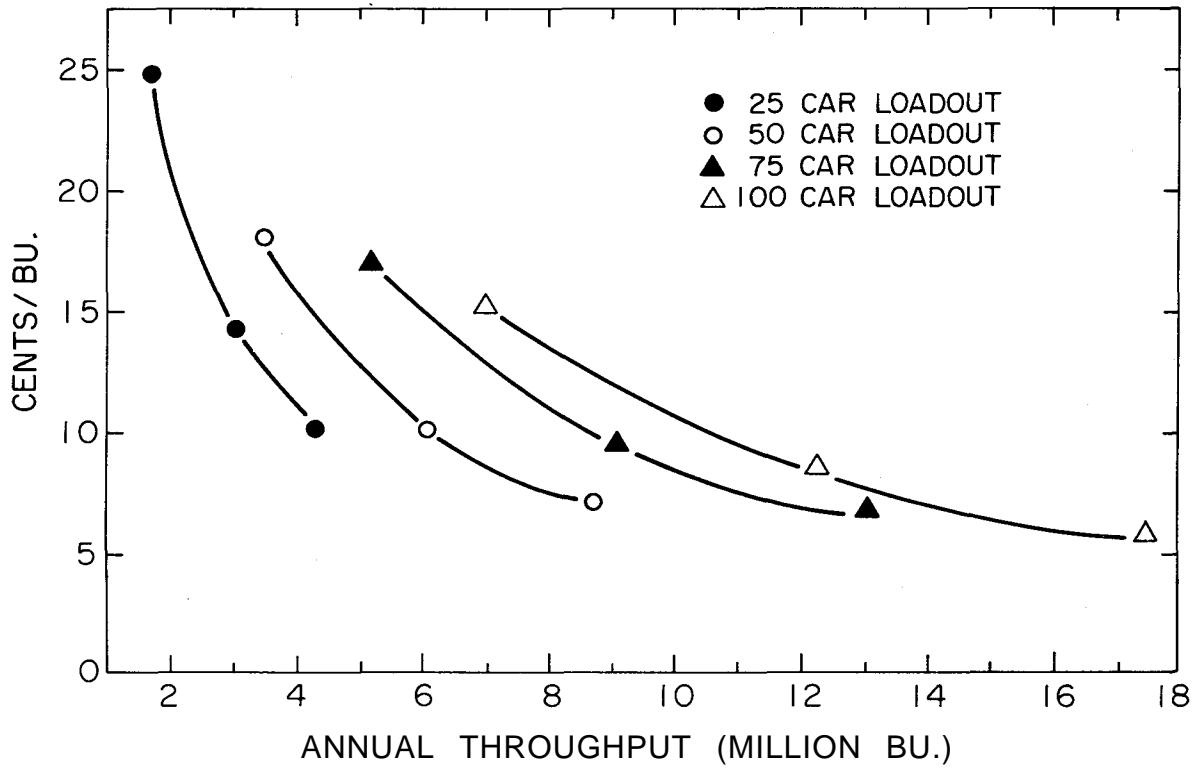


Figure 18. Cost curves for four model wheat-barley elevators

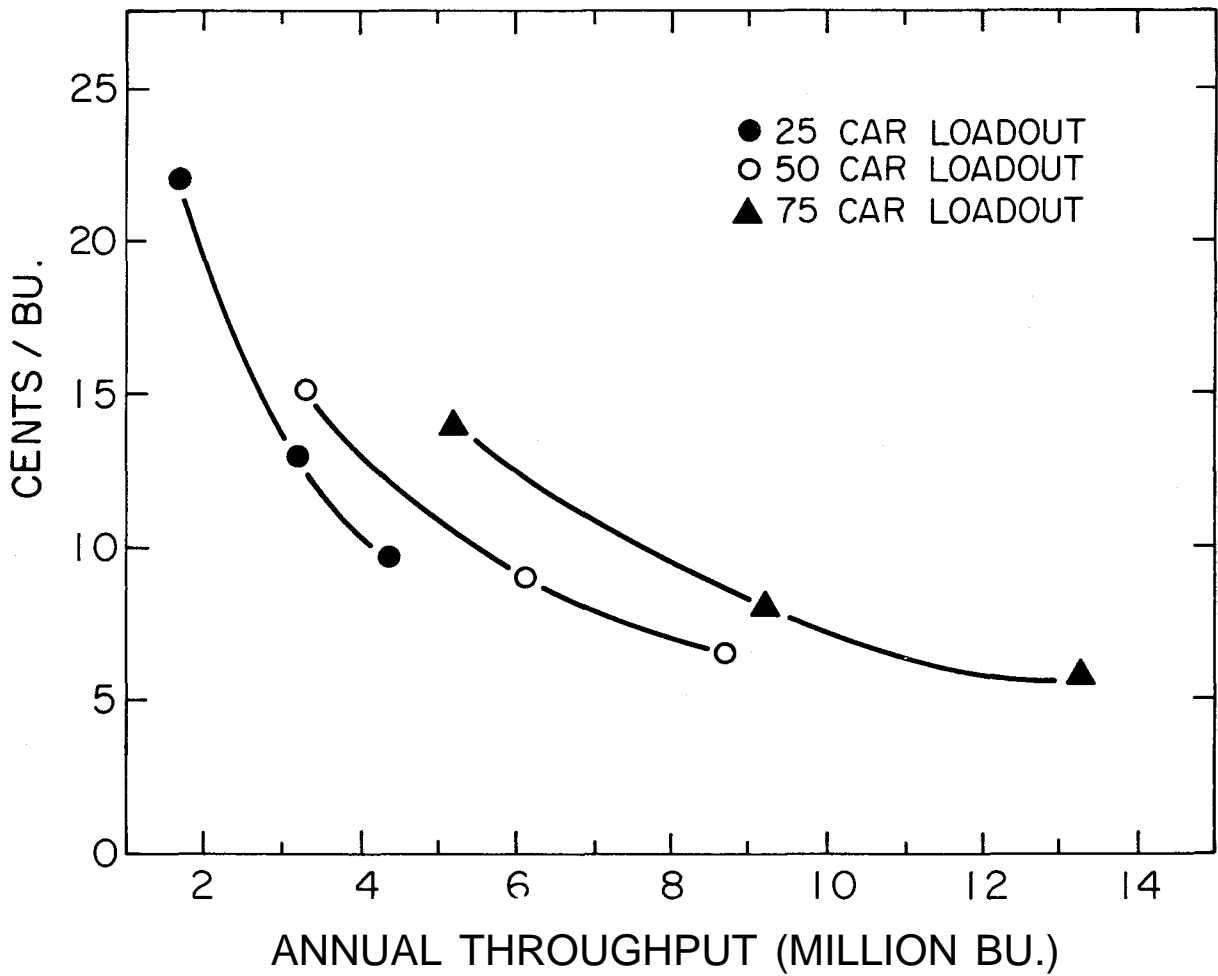


Figure 19. Cost curves for three model soybean elevators.

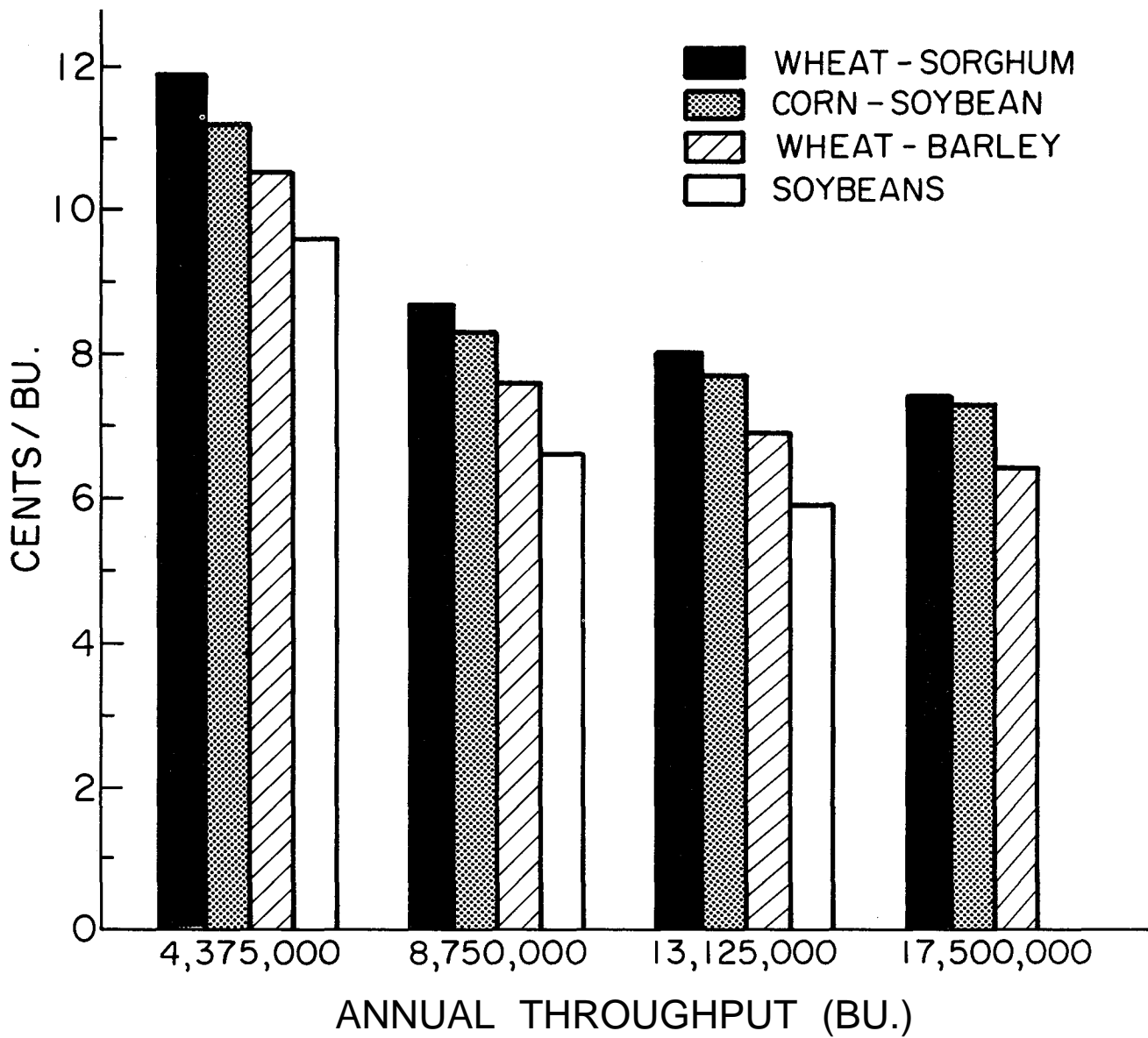


Figure 20. Per bushel cost comparison for model elevators, 50 trains per year

IMPLICATIONS OF STUDY

The U.S. grain industry is approaching the threshold of a transition to shipments by unit-trains as the prevailing rail methodology. This transition encompasses both domestic shippers and domestic receivers, which to this time generally have not employed unit-train technology. Inland export shippers and export elevators have been using unit-trains since the late 1960's. The transition to unit-trains is not unlike the one to hopper cars which began in the late 1950's. Those receivers and shippers who could not or were unwilling to adapt to hopper cars were bypassed and are no longer a part of the U.S. grain marketing system. Likewise, those who cannot or are unwilling to adapt to unit-train loadout and receipt will be bypassed by the emerging grain marketing-transportation system.

Industry does not view long-term storage as a viable means of sustaining the operation of facilities that will be built or retrofitted to serve a restructured U.S. grain marketing-transportation system. The capital burden of the railroads, which dictates limited free time to load unit trains, also dictates high-speed loadout. High-speed loadout equipment is capital intensive and can be justified only by moving large volumes of grain. A relatively low valued commodity such as grain simply cannot support a capital-intensive technology, such as unit-train loadout, unless the volumes handled are large. Thus, static storage as a means of cost recovery is not feasible, unless special conditions exist.

Further impetus is given to the movement toward unit-train loadout facilities because the majority of U.S. grain is now stored on farms. Consequently, facilities built for long-term storage in the past can no

longer generate sufficient revenues from grain storage to sustain a viable organization.

The huge grain storage facilities built in the 1950's, particularly in the Plains States, simply will not be replicated, except under special conditions. Neither will the grain marketing system be able to support a large population of new high-speed loadout facilities. Simple production density can be used to estimate a maximum number of such facilities. Corn growing areas will be able to support more such facilities than wheat growing areas. Producers in wheat areas delivering to such facilities will incur greater delivery costs than producers in corn growing areas because, to be economically viable, the facilities will be farther apart in wheat country than in corn country.

Further study is needed to evaluate the number, size, and location of unit-train loadout elevators that the U.S. grain marketing system could support under alternative production levels and transportation networks. In addition, further study is needed to encompass the costs associated with prior storage, prior purchase agreements, and transportation, which are prerequisites for train-loading elevators but were not included as a part of this study. Programmed receipts and prior purchases of grain from outlying storage facilities would be required to accomplish high volume throughput for extended time periods with the model elevators of this study. Thus, the cost to the marketing system for handling grain through train loadout facilities, as depicted by estimated cost curves showing economies of size, would likely be understated at the larger annual throughputs.

APPENDIX A

Estimated Investment and Operating Costs for Dust Control for Model Grain Elevators, 1982

Appendix Table 1 presents estimated investment and annual operating costs for dust control systems of the 15 model elevators of this study.

The estimated total cost per bushel for dust control declines for all models as the size of the elevator increases. Likewise, as annual throughput of any given model increases, estimated costs decline.

Dust control costs are estimated to range from about .6 cent to 1.45 cents per bushel for model elevators with 25-car loadout capacity, and from about .25 cent to .60 cent for model elevators with 100-car loadout capacity. The largest soybean model, with only 75-car loadout capacity, has an estimated dust control cost range of about .3 to .7 cent per bushel throughput.

APPENDIX B

Estimated Investment and Operating Costs for Grain Drying for Model Grain Elevators, 1982

Appendix Table 2 presents estimated annual fixed and variable costs associated with grain drying operations of the corn-soybean, wheat-sorghum, and soybean model elevators. Wheat-barley model elevators were assumed not to dry grain.

The estimated total annual drying costs in Appendix Table 2 are allocated to the bushels of grain dried. Generally, diseconomies of size in the grain drying operations of the model grain elevators are suggested. The only exception is the slight economy gained by the 50-car loadout soybean model elevator over the 25-car model. The diseconomies may be explained by the fact that drying was not intended to be a major activity of model elevator operations. The apparent slight economy in drying of the 50-car loadout soybean model is due to a less than proportional increase in investment and consequently related fixed costs relative to the 25-car loadout models. The reader may note that drying capacity of the model elevators was not sized according to throughput capability.

The estimated drying costs per bushel are essentially identical for similar sized corn-soybean and wheat-sorghum models. Per bushel estimated drying costs are lowest for the soybean model elevators in spite of the fact that investment, and consequently fixed costs, are highest for those models. Since soybeans were assumed to be dried down only two percentage points of moisture, compared with six percentage points for the other grains dried, the resultant relative decrease in fuel use was sufficient to reduce total drying costs to a level below that for the corn-soybean and wheat-sorghum model elevators.

Appendix Table 1. Estimated investment and operating costs for dust control for model grain elevators at three operating levels, 1982.

Cost Item	Model Elevators														
	Corn-Soybean				Wheat-Sorghum				Wheat-Barley				Soybean		
	25	50	75	100	25	50	75	100	25	50	75	100	25	50	75
	-Dollars-														
Investment	144,500	157,500	223,000	229,000	144,500	157,500	223,000	229,000	144,500	157,500	223,000	229,000	136,500	143,000	204,000
Annual Fixed Costs^a	20,014	21,804	30,872	31,642	20,014	21,804	30,872	31,642	20,014	21,804	30,872	31,642	18,897	19,796	28,241
Annual Variable Costs:^b															
20 trains/year	5,444	6,650	8,319	8,857	5,461	6,413	8,343	8,074	5,007	5,733	7,677	8,887	5,267	5,939	7,780
35 trains/year	6,275	8,094	9,540	10,347	6,305	7,680	9,583	8,977	5,511	6,489	8,417	10,399	6,146	7,176	9,025
50 trains/year	7,107	9,538	10,761	11,837	7,149	8,946	10,823	9,880	6,015	7,245	9,158	11,912	7,025	8,413	10,270
Total Annual Costs:															
20 trains/year	25,458	28,454	39,191	40,499	25,475	28,217	39,215	39,716	25,021	27,537	38,549	40,529	24,164	25,735	36,021
35 trains/year	26,289	29,899	40,412	41,989	26,319	29,484	40,455	40,619	25,525	28,293	39,289	42,041	25,043	26,972	37,266
50 trains/year	27,121	31,342	41,633	43,479	27,163	30,750	41,695	41,522	26,029	29,049	40,030	43,554	25,922	28,209	38,511
	-Cents/bushel-														
Total Costs:															
20 trains/year	1.45	.81	.75	.58	1.46	.81	.75	.57	1.43	.79	.73	.58	1.38	.74	.69
35 trains/year	.86	.49	.44	.34	.86	.48	.44	.33	.83	.46	.43	.34	.82	.44	.41
50 trains/year	.62	.36	.32	.25	.62	.35	.32	.24	.59	.33	.30	.25	.59	.32	.29

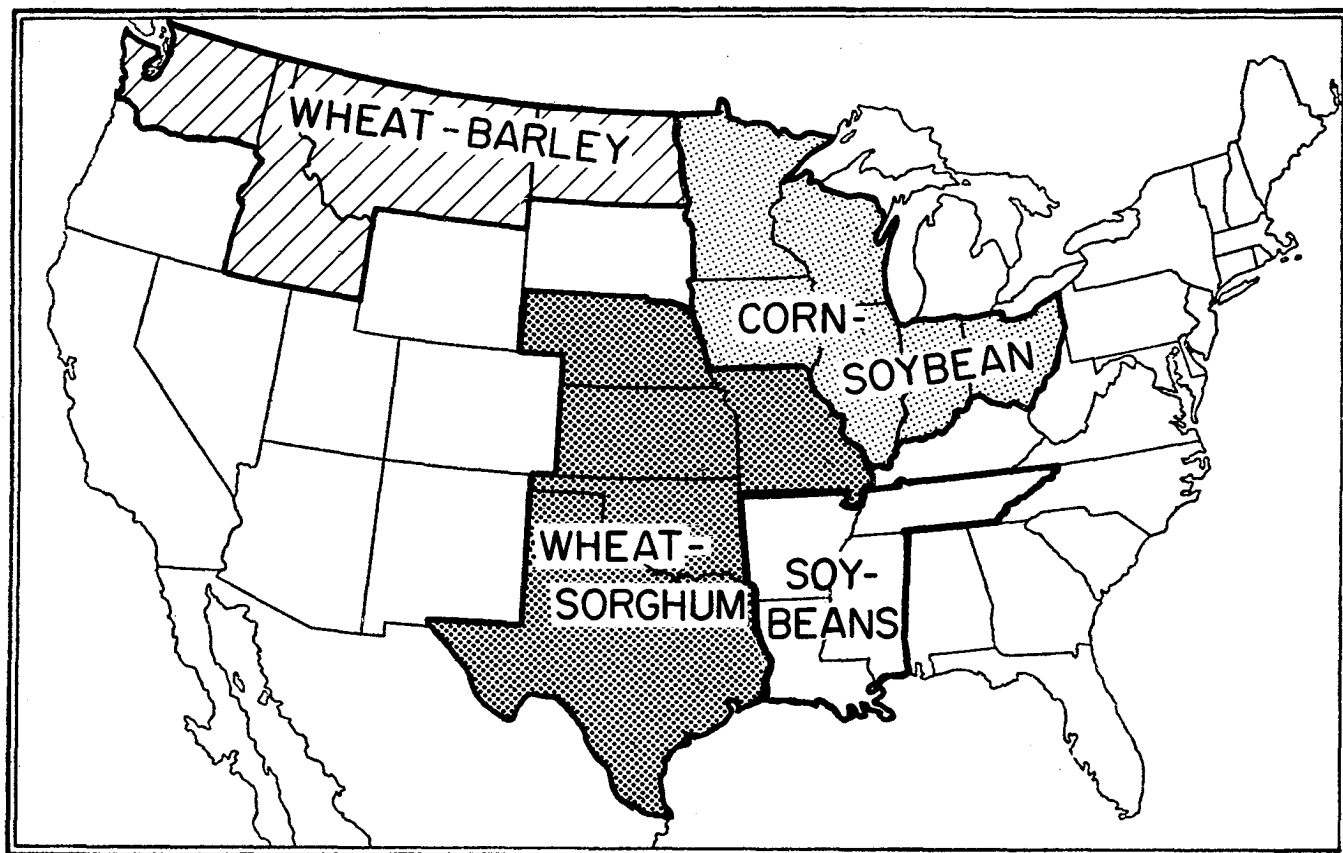
^aFixed costs include depreciation, interest, insurance, and property taxes, on the investment.

^bVariable costs include electricity and maintenance and repairs.

Appendix Table 2. Estimated drying costs for model grain elevators at various operating levels, 1982.

Item	Model Elevators											
	Corn-Soybean				Wheat-Sorghum				Soybean			
	Loadout	Capacity—Cars	Per Train		Loadout	Capacity—Cars	Per Train		Loadout	Capacity—Cars	Per Train	
	25	50	75	100	25	50	75	100	25	50	75	100
	-Dollars-											
Dryer Capacity (bu./hr.)	2,000	3,000	4,000	5,000	2,000	3,000	4,000	5,000	2,000	3,000	4,000	5,000
Bushels Dried Annually	576,000	864,000	1,152,000	1,440,000	576,000	864,000	1,152,000	1,440,000	576,000	864,000	1,152,000	1,440,000
Investment	164,000	250,500	378,000	469,000	164,000	250,500	378,000	469,000	244,000	363,000	500,500	
Annual Fixed Costs:												
Depreciation	10,933	16,700	25,200	31,267	10,933	16,700	25,200	31,267	16,267	24,200	33,367	
Interest	9,840	15,030	22,680	28,140	9,840	15,030	22,680	28,140	14,640	21,780	30,030	
Insurance	291	444	670	831	291	444	670	831	432	643	887	
Taxes	1,640	2,505	3,780	4,690	1,640	2,505	3,780	4,690	2,440	3,630	5,005	
Annual Variable Costs:												
Fuels	44,824	67,236	89,648	112,060	44,824	67,236	89,648	112,060	15,825	23,737	31,649	
Electricity	1,517	2,327	3,399	4,505	1,540	2,362	3,450	4,573	1,425	2,186	3,193	
Maintenance and repairs	4,920	7,515	11,340	14,070	4,920	7,515	11,340	14,070	7,320	10,328	15,015	
Total Annual Costs	73,965	111,757	156,717	195,563	73,988	111,792	156,768	195,631	58,349	86,504	119,146	
	-Cents/bushel-											
Drying Cost/Bushel Dried	12.84	12.93	13.60	13.58	12.85	12.94	13.61	13.59	10.13	10.01	10.34	

^cCosts for liquified petroleum gas for drying grain sorghum may err on the high side relative to corn since 6 points of moisture removed were assumed for both grains because of lack of more detailed data.



Models of unit-train loadout elevators are presented for these four grain growing areas of the United States.