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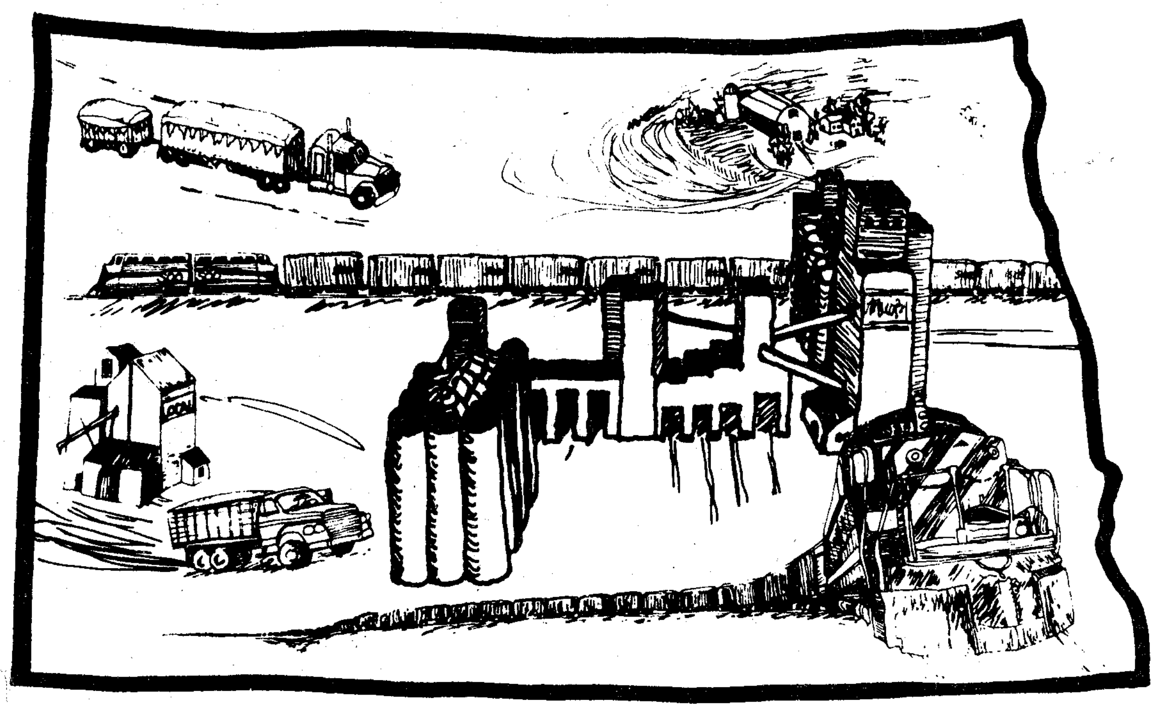
COST ANALYSIS OF POTENTIAL NORTH DAKOTA SUBTERMINAL SYSTEMS

by
Craig A. Chase and Delmer L. Helgeson



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HIGHLIGHTS

The grain elevator industry is an essential and integrated part of the marketing system in North Dakota. A more efficient marketing system can benefit society either in the form of increasing producer income through higher grain prices, reducing consumer expenditures through lower retail prices, or both. The grain marketing system is currently moving through a period of change brought on by a larger supply of grain, proposed branch line abandonments, and deregulted rail rates.

The purpose of this study was to analyze the cost structures associated with subterminal facilities. An economic-engineering approach was used to determine the construction and operation costs of four different sizes of subterminal facilities operating at three different plant capacities. Profitability of subterminals was determined mainly by the volume of grain handled. If a subterminal marketed enough grain, it was able to incur both decreasing average fixed and average variable costs. The larger subterminals were found to be more profitable than the smaller facilities indicating the existence of economies of size in both the fixed and variable cost components. Profitability can be dramatically increased given the availability of internal financing for the construction cost and nondepreciable fixed costs.

The authors express their appreciation to Todd and Sargent, Inc., Grain Facility Design, and Grain Terminal Association for providing information on plant design and construction and operation costs. Without their help, this study could not have been completed. We express our appreciation to the members of the Department of Agricultural Economics and the Upper Great Plains Transportation Institute who reviewed and gave helpful suggestions on the final draft. Finally, we wish to thank John F. Mittleider and Randal C. Coon for their help in reviewing the rough drafts and computer programming assistance.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

AN OVERVIEW

North Dakota Grain Handling, Transportation, and Merchandising Study

North Dakota's branchline system was developed in the late 1800's and early 1900's primarily for the purpose of moving farm commodities to markets outside the state and bringing freight such as farm inputs and other needed goods to the state's communities. The only other form of surface transportation available for moving bulk freight when the rail network was being developed (excluding some minor river transportation) was the horse-drawn freight wagon. The limited distance that a team of horses and wagon could travel influenced the design of the early branchline railroad network. This development pattern resulted in branchlines that were no further apart than 10 to 20 miles, and even the most remote producing areas were accessible to rail transportation.

Development of the country grain merchandising system was also influenced by the limited distance a team of horses and wagon could travel, the relative density of the branchline network, and available technology at that time. This resulted in a large number of country elevators spaced only a few miles apart on grain gathering rail lines. Although much of what existed in the past still exists today in the form of the branchline network, economic and technological forces that influenced its development have changed since the turn of the century. Other factors that may influence rationalization of the railroad network and the country grain merchandising system are currently at work.

Factors which will influence the future grain handling transportation and merchandising system include branchline abandonment, implementation of multiple car and unit train grain rates, and capital replacement decisions. Other factors include differing rates of cost increases in the two modes, thereby shifting their competitive relationship. Competition between producing regions will also influence the future system. Efficiencies gained as a result of changes in marketing systems by competing producing regions will possibly influence a move to obtain those same efficiencies by other producing regions. The changing technology of farm trucks and the improved quality of our highway system makes it possible for producers to move grain much farther today than previously. These forces may very well influence changes in the state's traditional grain merchandising system. Government policies such as railroad deregulation may also have some impact on the system.

As a result of these impending changes that could alter a rather traditional grain handling, transportation, and merchandising system, many private and public decisions will have to be made. These include decisions regarding location, economic viability, size of plant, investment in grain facilities, investment in transportation equipment and infrastructure, efficiencies of merchandising, purchases of farm production equipment, and storage capacity. If such decisions are to be made on an informed basis, it is important that basic information about the industry be developed and published. It was for this reason that the Upper Great Plains Transportation Institute and the Department of Agricultural Economics of North Dakota State University have undertaken a study entitled "North Dakota Grain Handling, Transportation, and Merchandising Study." Cooperators in the study include Burlington Northern Railroad, Farm Bureau, Farmers Union, Grain Terminal Association, North Dakota Agricultural Experiment Station, North Dakota Department of Agriculture, North Dakota Grain Dealers Association, North Dakota Highway Department, North Dakota Public Service Commission, St. Paul Bank for Cooperatives, and the Soo Line Railroad Company. The purpose of this study is to provide relevant information to decision makers in meeting the challenge of a changing business environment in handling, transportation, and merchandising grain in North Dakota.

The study is composed of a number of research projects that will result in 13 separate publications of which this is one. The publications planned for release at varied time intervals are:

- Description of the Existing Country Elevator System
- Cost Analysis of Existing Country and Farm Storage System
- Cost Analysis of Subterminal Elevators
- Existing and Past Patterns of North Dakota Grain Movements
- Description of Rail Rate Structure, Multiple Car Movements, and Rates and Analysis of Shipper Owned Equipment
- Description and Analysis of Exempt Carrier Industry
- Economics of Branchline Operation
- Farm Truck Costs
- Seasonal Behavior of Marketing Patterns for Grain from North Dakota
- Grain Merchandising

- Marketing Using Delayed Pricing Controls
- Analytical Model for Analyzing Economic Efficiencies of Subterminals
- North Dakota Grain Handling, Transportation, and Merchandising Study: Summary, Conclusions, and Policy Implications

These reports, as they are completed, will be available upon request from the Department of Agricultural Economics or the Upper Great Plains Transportation Institute, North Dakota State University.

COST ANALYSIS OF POTENTIAL NORTH DAKOTA SUBTERMINAL SYSTEMS

by

Craig A. Chase and Delmer L. Helgeson*

The grain elevator industry is an essential and integrated part of the marketing system in North Dakota. The majority of the grain produced in this area is shipped out of state, so the local country elevator becomes a vital link between the producer and the ultimate consumer. For example, over 2.1 billion bushels of grain were produced in North Dakota between 1974 and 1978, while 1.6 billion bushels (77 percent of total grain produced) were shipped out of state (Table 1).[1]

TABLE 1. PRODUCTION AND OUT-OF-STATE SHIPMENTS OF SELECTED CROPS, NORTH DAKOTA, 1974-78[a]

Year	Production[b]	Out-of-State Shipments[c] Number	Percent
	(thousand bushels)	(thousand bushels)	
1974	319,466	276,687	87
1975	415,485	303,534	73
1976	430,210	292,857	68
1977	441,460	341,206	77
1978	542,326	434,571	80
Total	2,148,947	1,648,855	77

[a]Crops include spring wheat, durum, barley, oat, and sunflower.
[b]Hundredweight of sunflower were converted into bushels at a 30 lb. per bushel rate. Production estimates were received from North Dakota Agricultural Statistics (Fargo: North Dakota Crop and Livestock Reporting Service, May 1981).
[c]Shipments were received from Gene C. Griffin and Ken Casavant, "An Evaluation of North Dakota Grain Movements," p. 4.

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*Research Assistant and Professor, respectively, Department of Agricultural Economics.

[1]See Gene C. Griffin and Ken Casavant, "An Evaluation of North Dakota Grain Movements," North Dakota State University, Agricultural Economics Report No. 145, August 1981.

A need exists to review the elevator industry's overall efficiency since a more efficient system can benefit society either in the form of increasing producer income through higher grain prices, reducing consumer expenditures through lower retail prices, or both. The marketing system in North Dakota is currently moving through an adjustment period as a result of institutional and technological changes. For instance, increased yields due to technological advances have allowed the producer to grow a larger crop, which in turn forces the elevator manager to provide a faster and more efficient method for merchandising the larger supply of grain. Additionally, many elevator managers are forced to view the possibility of rail branch line abandonment and make major financial and marketing adjustments. The manager may wish to make adjustments in receiving and load-out capacities to allow for shipments by 26 or 52 multiple car units, if continued rail service is expected. A comparison must be made between the costs and benefits associated with each alternative. Sound decisions on the size and location of an elevator must be made under the existing and alternative systems.

Objectives

The purpose of this study was to analyze the costs associated with constructing and operating various potential subterminal systems. Four subterminal sizes were evaluated and included 300,000; 500,000; 850,000; and 1,100,000 bushel capacity elevators. Specific objectives were to: (1) determine the average fixed, average variable, and average total costs and compare them to average revenue; and (2) provide information concerning average variable and total fixed costs for the network flow model of the overall grain merchandising study.[2]

Economic-Engineering Approach

The economic-engineering or synthetic-firm approach is used to determine the average cost per unit attainable by firms of various sizes using modern technology and efficient use of all resources to produce a given level of

[2] Transshipment of grain movements are accomplished through network flow models. Research is currently in progress with publications forthcoming.

output.[3] Cost information on plant design and construction of the building and equipment is provided by architects, contractors, and engineers. Job analyses indicate the number of employees and the skill level required in the various sections of the plant. Other variable and fixed costs are projected on the basis of known data. All information concerning plant operation is broken down into stages. These stages are synthesized into hypothetical plant models of different sizes. The models are aggregated and a cost function is estimated. Costs are referred to as synthetic because they are not attained from actual operations.

The economic-engineering approach was deemed appropriate since it pinpoints the differences in costs attributable solely to differences in size between firms--not to differences in plant utilization, management practices, or use of substandard technologies. Technology and management practices can be assumed to remain at a constant level since the plants are hypothetical. Other advantages of this approach are: (1) a large sample is not required, and (2) contractors and equipment manufacturing firms are much less reluctant to share engineering and accounting data than are operators of specific plants.

Economic Analysis

Short-Run Versus Long-Run Costs

Internal operating costs include those costs associated with merchandising, handling, storing, and drying of grain within the subterminal. For purposes of this study, these activities were grouped into one item and referred to as handling costs.

The short run can be defined as that period where certain inputs (e.g., plant size) are fixed in nature while others (e.g., labor and machinery) are variable. Changes in output in the short run may occur only by changing the amount of variable inputs used. Costs associated with these inputs are referred to as variable costs. By the same analogy, fixed costs are those costs associated with the use of fixed inputs. The summation of the fixed and variable cost components at any level of output is the total cost of handling that output.

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[3] F. Larry Leistritz, "Alternative Research Procedures for Determining Economies of Size," (unpublished paper, North Dakota State University, November 1972), p. 8.

The long run occurs when all inputs, including plant size, are variable and is commonly referred to as the "planning horizon."[4] Under this situation a manager can alter plant size to any changes in input or output levels that may occur due to outside influences. No distinction is made between total variable cost and total cost, as was the case in the short run.

Fixed costs were divided into two groups: depreciable and nondepreciable. Depreciable fixed assets are those items which are subject to a loss of value due to wear and/or obsolescence. Examples of depreciable fixed assets are machinery and elevator and driveway structures. Nondepreciable fixed cost items are those which do not vary with the level of output and do not have a cost resulting from wear and/or obsolescence. These items may include costs associated with manager and supervisor salaries, bonds, licenses, taxes, and insurance.

Total Revenue

Total revenue was defined as the total dollar sales volume received over one year. Total revenue became the summation of the amount of each type of grain handled times the price received for each grain.

Capacity Utilization

Capacity utilization refers to the proportion of maximum possible plant capacity which is actually used during a production period. Each subterminal was assumed to operate at 100 percent capacity. However, three different turnover ratios (5, 10, and 15) were used to take into consideration variances in throughput.

Economic-Engineering Model

The simulation model considers the relationship between the economic concept of costs and returns with engineering concepts and provides a basis for development of simulated cost and returns for a specific process. The

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[4]This term is used in a majority of economic texts. For an example, see Edwin Mansfield, Principles of Microeconomics, 2nd Ed. (New York: W. W. Norton and Company, Inc., 1977), p. 195.

model was an adaptation of previous work accomplished at Texas Tech University.[5]

Determination of Fixed Cost

Fixed costs were divided into depreciable and nondepreciable fixed cost as previously described. Depreciable items were run through the series of calculations listed below to determine the annual equivalent cost of each item. Annual equivalent cost includes depreciation, interest, and repair costs of a depreciable item on a yearly basis.

(1) $FOB_i = (FOB \times NUM)\,(1 + INST)$

where FOB_i = installed cost of building, machinery, or equipment item i

FOB = FOB cost of one unit (one machine, one square foot of a building, etc.)

NUM = number of units required

$INST$ = installation cost of one unit based on a percentage of FOB cost.[6]

(2) $$DI_i = FOB_i \left[\frac{R\,(1 + R)^{yrs}}{(1 + R)^{yrs} - 1}\right] - SAL_i \left[\frac{R}{(1 + R)^{yrs} - 1}\right]$$

where DI_i = annual depreciation and interest cost of item i

R = interest rate

YRS = years of useful life

SAL_i = salvage value of item i in dollars.

(3) $REP_i = (FOB)\,(NUM)\,(REP)$

where REP_i = fixed repair costs of item i in dollars

REP = fixed repairs as a percentage of FOB cost.

(4) $AEC_i = DI_i + REP_i$

where AEC_i = annual equivalent cost of item i.

Annual equivalent costs for nondepreciable fixed cost items were calculated using the following equation:

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[5] Billy R. Hise, Don E. Ethridge, and Dale L. Shaw; "Processing Plant Cost Estimation System: Documentation and User's Guide;" Texas Tech University; Agricultural Economics Report No. T-1-189; April 1980.

[6] Installation cost may include concrete, electrical, paint, labor, and any other costs associated with the installation of the depreciable fixed cost item.

(5) AEC_k = (FOB x NUM) (1 + R)

where AEC_k = annual equivalent cost of item k.

Annual equivalent costs were totaled after each fixed cost item was calculated to obtain a total fixed cost for all items. This also provided a cost of construction for a new plant by totaling the installed cost of all depreciable items.

Determination of Total Variable Cost

Variable costs were estimated using the following formula:

(6) $VC_{ij} = (NUM_j)\ (PR_i)$

where VC_{ij} = variable cost of resource i at capacity utilization j

NUM_j = number of units of the resource required at capacity utilization j

PR_i = cost per unit for resource i.

The variable costs associated with the operation of a subterminal facility were obtained from feasibility studies of proposed and operating costs of existing facilities.[7] All variable cost items resulted from the handling process and were totaled to obtain a total variable cost at the turnover level stated in the model (i.e., $TVC_j = \Sigma_i VC_{ij}$).

The total variable cost then was used to calculate the interest on operating capital as follows:

(7) $CO_j = \frac{1}{2}TVC_j\ (R) + VOL_j\ (APP)\ (DAYS)\ (R)$

where CO_j = interest on operating capital at capacity utilization j

TVC_j = total variable cost at capacity utilization j

R = interest rate

VOL_j = volume of grain handled at capacity utilization j

APP = average purchase price of grain handled

DAYS = average number of days the grain is stored.

The total variable cost associated with this capacity level becomes:

(8) $TVC_{j2} = TVC_j + CO_j$

where TVC_{j2} = total variable cost at capacity utilization j including interest on operating capital.

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[7]Operating costs of existing facilities were obtained from Craig A. Chase, Delmer L. Helgeson, and Terry L. Shaffer; "Statistical Cost Analysis of Existing North Dakota Country Elevator Industry;" North Dakota State University; Agricultural Economics Report No. 155; September 1982.

Determination of Total Revenue

The model has the capability of handling multiple products, combination of products, and different product prices. Total revenue was calculated by totaling the revenue from each separate product as follows:

$$(9)\ TR = \sum_{i=1}^{n} (Q_i \times P_i)$$

where TR = total revenue

Q_i = quantity handled of product i

P_i = price of product i

n = number of products.

Determination of Average Fixed and Variable Cost

Estimates of the following variables were computed at each level of capacity specified: average fixed cost, average variable cost, average total cost, average revenue, total fixed cost, total variable cost, total cost, and total revenue. Total fixed cost remains the same at each level of capacity utilization or annual volume handled. Average fixed cost is the fixed cost per unit of output and varies as output varies. Average fixed cost is the total fixed cost of the plant divided by the output of the plant at the specific capacity utilization:

$$(10)\ AFC_j = \frac{TFC}{(X)\ (CP_j)}$$

where AFC_j = average fixed cost at the j^{th} level of capacity utilization

TFC = total fixed cost at the j^{th} level of capacity utilization

X = plant output (or input) at 100 percent capacity utilization

CP_j = percent of total plant capacity utilization at the j^{th} level of capacity utilization (100 percent = 1.00).

Total variable cost changes from one utilization level to the next. Average variable cost is calculated from the total variable cost for each capacity utilization level by the following formula:

$$(11)\ AVC_j = \frac{TVC_j^*}{(X)\ (CP_j)}$$

where AVC_j = average variable cost at the j^{th} level of capacity utilization

TVC_j^* = total variable cost at the j^{th} level of capacity utilization.

Total cost associated with each level of capacity utilization was obtained by adding total fixed and total variable costs. The average cost at each level may be obtained by either dividing total cost by the output or adding average variable and average fixed costs:

(12) $AC_j = \frac{TFC + TVC_j^*}{(X)\ (CP_j)}$

where AC_j = average cost at the j^{th} level of capacity utilization.

Determination of Total and Average Revenues

A 100 percent utilization factor was used to calculate total revenue. The associated total revenue figures of the varying levels of utilization were computed using the following formula:

(13) $TR_j = TR \times CP_j$

where TR_j = total revenue at the j^{th} level of capacity utilization

TR = total revenue at 100 percent capacity utilization.

Average revenue was then calculated as follows:

(14) $AR = \frac{TR}{(X)}$

where AR = revenue per unit of plant output (or input).

Data Inputs

Plant size, capacity utilizations, and operating capacities were estimated by examining the grain throughput of proposed subterminals and existing facilities. Three turnover ratios (5, 10, and 15) were used as plant operating capacities. A capacity utilization level of 100 percent was used for each turnover ratio.

Plant specifics were developed once a general plant was defined. The number of units, capacity, FOB cost, years of useful life, salvage value, installation cost, and fixed repairs of the required machinery and equipment were obtained from contractors and engineers. Installation cost was zero since it was already included in the FOB cost for each item. Salvage value also was assumed to be zero since no marketable alternative use for the machinery and structure was apparent. Salvage value on land was used to maintain the current value of the land. No value appreciation on land was assumed to result from improvements. Revenue for the subterminal was based on the amount of each product handled and the respective product prices.

Cost and Revenue Characteristics

The economic feasibility of constructing and operating subterminal elevators has become an increasingly important topic of discussion as railroad companies have announced their intent to abandon certain branch lines throughout the state. Questions arise as to where subterminal elevators should be built, how many there should be, and how much they cost. Construction costs of a new facility were estimated and included such items as land, trackage, and contingencies in addition to the structure itself.

Four subterminal sizes were evaluated and included 300,000; 500,000; 850,000; and 1,100,000 bushel capacity elevators. Each facility consisted of a concrete bin network and a driveway structure adjacent to the elevator. Specific storage capacities and bin structures are presented in Table 2.

The cost per bushel of constructing the concrete storage varied indirectly with size of facility, indicating the existence of economies of size. The 300,000 bushel subterminal cost $2.45 per bushel to construct while the per bushel costs associated with the building of the 500,000; 850,000; and 1,100,000 bushel facilities were $2.35, $2.25, and $2.15, respectively.

Driveway Structure

The driveway structure remained the same for all elevators despite the size changes. The structure was adjacent to the concrete storage and consisted of two fully enclosed driveways with electrically operated doors. One driveway consisted of a 70-foot hydraulic truck dumper for semi-trucks, while the other was a 100-foot deck with a twin lift for tandem trucks. Both driveways were supported by a 60-ton scale and grain was received by a 1,000 bushel receiving pit. An 800-square-foot testing office was attached to the driveway structure.

Elevator Equipment

Elevator machinery varied according to the size of facility. Capacity of the receiving legs and conveyor systems was increased as the facility size increased. (A complete summary and listing of machinery by size of facility is

TABLE 2. BIN NETWORK OF FOUR PROPOSED SUBTERMINAL FACILITIES

Elevator Size	Number and Type of Bin	Bin Size	Capacity Per Bin	Cost
bushels		feet	bushels	dollars
300,000	4 storage	30 x 120	60,450	
	6 working		3,420-11,630	
	1 shipping		8,280	
Total	11 bins		287,370[a]	735,000
500,000	6 storage	30 x 135	72,596	
	6 working		3,230-10,820	
	1 interface		16,510	
	1 shipping		8,280	
Total	14 bins		496,386[a]	1,175,000
850,000	8 storage	36 x 120	85,190	
	6 working		11,510-25,690	
	2 interface		23,810	
	1 shipping		14,310	
Total	17 bins		852,560[a]	1,912,000
1,100,000	10 storage	32 x 140	90,800	
	6 working		4,415-21,315	
	3 interface		21,975	
	1 rail shipping		12,730	
	1 truck shipping		4,945	
Total	21 bins		1,076,860[b]	2,365,000

[a]Bin capacities were calculated as effective storage space with 5 percent compaction.
[b]Bin capacities were calculated as effective storage space with 7 percent compaction in the storage bins and 5 percent compaction in all other bins.

presented in Table 3.) The facilities also included different types of dust control, drier, aeration and temperature, and electrical systems.

Elevator Machinery

Very little difference in type of machinery occurred between the 300,000 and 500,000 bushel facility. Both were equipped with two 7,500 bushel per hour receiving legs of which one was capable of feeding an 8,000 bushel per hour cleaner. The distribution system for the 500,000 bushel facility added a single revolving valve distributor to the 300,000 bushel 14-inch lined system

TABLE 3. TYPE OF ELEVATOR MACHINERY BY SIZE OF FACILITY

300,000	500,000
2--7,500 BPH receiving legs	2--7,500 BPH receiving legs
1--8,000 BPH cleaner	1--8,000 BPH cleaner
1--14" distribution system	1--14" distribution system
1--7,500 BPH conveyor system	1--7,500 BPH conveyor system
3--10,000 BPH truck load-outs	3--10,000 BPH truck load-outs
1--40,000 BPH rail load-out	1--40,000 BPH rail load-out
1--300 lb. three-station manlift	1--300 lb. three-station manlift
850,000	**1,100,000**
2--10,000 BPH receiving legs	2--15,000 BPH receiving legs
1--10,000 BPH drag scalper	2--15,000 BPH drag scalpers
1--11,000 BPH cleaner	2--16,000 BPH cleaners
1--14" distribution system	1--16" distribution system
1--10,000 BPH conveyor system	1--15,000 BPH conveyor system
3--10,000 BPH truck load-outs	6--15,000 BPH truck load-outs
1--40,000 BPH rail load-out	1--40,000 BPH rail load-out
1--500 lb. four-station manlift	1--300 lb. three-station manlift

which utilized a double 14-duct roto-flo distributor. Either facility was capable of shipping by any of three 14-inch lined truck load-outs or one 26-inch lined rail load-out system. An in-line sampler was included in the rail load-out. The only other difference in equipment between the two facilities was in the conveyor system. The 500,000 bushel subterminal consisted of two additional storage bins which needed drag conveyors for moving grain for mixing and shipping purposes.

The 850,000 and 1,100,000 bushel facilities were equipped with receiving legs of 10,000 and 15,000 bushels per hour, respectively. The smaller subterminal had the capability of one leg feeding a 10,000 bushel per hour drag scalper and an 11,000 bushel per hour cleaner. Both legs could feed grain through a 15,000 bushel per hour scalper and a 16,000 bushel per hour cleaner in the larger facility. The 1,100,000 bushel subterminal contained a 16-inch lined distribution system, while the 850,000 facility contained a 14-inch lined system. Both systems included a double roto-flo and two single revolving valve distributors. Conveyor system capacity was increased from 10,000 to 15,000 bushels per hour as the facility storage increased from 850,000 to 1,100,000 bushels. The rail load-out systems were the same as the 300,000 and 500,000 capacity facilities. The truck load-out for the 850,000 bushel subterminal also was the same as the smaller facilities. The 1,100,000 bushel facility had six load-out spouts with the capacity of shipping 15,000 bushels per hour. The 15,000 bushel per hour load-out spouts were 16-inch lined systems. The only other difference between the two facilities was the length and number of drag conveyors needed to move the grain from the storage bins for blending and shipping purposes.

Dust Control and Other Systems

The type of dust control system remained the same as the size of facility increased. The system provided for the collection of dust at both receiving pits, bucket elevator boots and heads, each distributor, and load-out spouts. The cost of the system increased directly with elevator size. Estimates for dust control were received from proposed facility construction plans.

The drier system for the 300,000 and 500,000 bushel facilities consisted of a gravity-fed 1,200 bushel per hour drier which returned the dried grain by a conveyor. The two larger facilities were equipped with a gravity-fed 1,500 bushel per hour drier and a conveyor return.

The size of aeration and temperature systems increased directly with size of facility. One 25-horsepower aeration fan was inserted in each of the storage bins regardless of size of facility. Two 3/4-horsepower overspace fans were added to each of the storage bins in the 850,000 and 1,100,000 bushel subterminals. A three-cable temperature system was used in each of the storage bins. This system also was added to the interface bins of the two larger facilities.

The size of the required electrical system increased directly with the size of subterminal. Estimates for the electrical work needed were received from proposed subterminal construction plans.

Land

Land was priced at $2,000 per acre. A minimum of five acres was assumed necessary for a subterminal elevator. Additional acreages were bought to accommodate the larger facilities. The land was assumed to be outside the city limits, diminishing the problems associated with dust and railroad trackage limits.

Railroad Trackage

Trackage was estimated at a cost of $60 per lineal foot based on information received from proposed subterminal reports and substantiated by railroad officials. The length of trackage was estimated at 65 feet per car space needed. The 300,000 bushel facility was assumed to handle 26 cars. An optimum of 3,500 feet (i.e., 53 times 65 feet allows for room for 26 cars on each side of the rail load-out plus room for the car mover) was deemed necessary. The three larger facilities were primarily constructed as 52-car subterminals, resulting in 7,000 feet of required trackage.

Railcar Mover

The railcar mover used in this analysis was a general purpose 1,500-horsepower, 130-ton locomotive and cost $80,000. It was assumed that this size mover was necessary to move 26 or 52 loaded cars which eliminates the need to switch if moving cars by three to five car groups.

Trackmobiles capable of moving smaller groups of cars are available and may be purchased for $20,000 to $30,000 depending upon the condition and size of the engine.

Office Building and Furniture

The two smaller facilities included a 2,000-square-foot building at a cost of $30 per square foot. The building offers ample room for clerical and managerial staff, coffee room, closet, storage space, and a front lobby. The larger facilities included a 3,000-square-foot building at a cost of $35 per square foot. Office furniture was estimated to cost $20,000 for the 300,000 and 500,000 bushel facilities and $30,000 for the 850,000 and 1,100,000 bushel facilities. Estimates for the square footage, cost of the buildings, and furniture were received through proposed subterminal construction cost estimates.

Contingencies

Contingencies include building permits and any temporary services that may be conducted. They also take into consideration the possibility of cost overruns from the previously mentioned cost items. Contingencies increased directly with the size of subterminal.

Operating Costs of Proposed Subterminal Facilities

Operating costs also were included for the four proposed sizes of subterminals. Operating costs consisted of both fixed and variable costs. Fixed costs included such items as insurance, bonds, taxes, and managers' salaries, while support labor, office and elevator supplies, and power were classified as variable.

Fixed Cost Items

Insurance on the structure was estimated at $.45 per $100 valuation. The contents charge was calculated using the following equation:

contents insurance = $.45/$100 valuation x maximum amount x provisional charge (i.e., usage)

where maximum amount = elevator capacity times the value of the grain (value of grain was estimated at $4.50/bushel)

provisional = 50 percent.

The total insurance bill was the summation of the structure and contents charges.

The warehouse license fee and the corporate surety bond were based on the storage capacity of the elevator.[8] The license fee for the 300,000 bushel elevator was $30, while the fees for the 500,000 bushel and the two larger facilities were $50 and $60, respectively. The bond schedule for North Dakota approximately states that a $1,000 bond be required for each 1,000 bushels of storage up to 500,000 bushels. Elevators with a capacity in excess of 500,000 bushels are required to furnish an additional bond of $5,000 for each 25,000 bushels or a fraction thereof.[9] The cost of these bonds was estimated at $10.20 per $1,000 value of the bonds.

Property taxes were estimated as 1 percent of the total market value of the facility and sitework. Total market value was defined as the total construction cost less contingencies, office furniture, and railcar mover.

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[8]For a listing of the license and bonding practices see 1980 Directory of Licensed and Bonded Country Elevators in North Dakota, (Fargo: North Dakota Grain Dealers Association, 1980), pp. 172-73.

[9]Ibid.

Manager and assistant manager salaries were estimated from feasibility studies of proposed subterminal sites. Directors' fees, dues, and annual meeting costs were based on proposed subterminals and existing cost structure of the elevator industry.[10]

Variable Cost Items

The size of the labor force was based on data from studies of proposed subterminals and increased as size of facility increased. The wages for a secretary or secretary/clerk were estimated at $4.50 per hour. Bookkeepers, elevator supervisors, and laborers received $5.00, $9.00, and $7.00 per hour, respectively.[11] Employee benefits were estimated at 15 percent of total salaries, while payroll taxes currently stand at 6.65 percent of total salaries. Unemployment compensation was estimated at 2.1 percent of the first $8,400 of earned wages for each employee (i.e., $176.40/employee). Workmen's compensation was based on $6.55 per $100 of the first $3,600 of earned wages for each employee (i.e., $235.80/employee). All other variable cost items were estimated from proposed subterminal operating cost budgets and costs associated with the existing elevator industry.

Interest

Interest charges were divided into two types: (1) interest on the fixed costs and (2) interest on the operating capital. The interest on the fixed costs was calculated in the formula for determining the annual equivalent cost of construction and was previously defined. The calculation used the interest rate discount factor of 14 percent over the estimated life of the fixed cost item.[12]

Interest on operating capital was further divided into two groups: (1) interest on the variable costs and (2) interest on the purchased grain.

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[10]Chase, Helgeson, and Shaffer; op. cit.; Agricultural Economics Report No. 155.

[11]Hourly wage rates were received from Job Service of North Dakota.

[12]Fourteen percent discount factor was used since the St. Paul Bank for Cooperatives loan rate was 13.65 percent at the time of this writing. The discount factor should be adjusted to movements in the interest rate.

Interest on the variable cost was estimated by charging 17 percent interest for a six month period on the total variable operating cost figure. The six-month charge takes into consideration the fact that all the variable costs did not occur at any one time during the year. The interest on the purchase of grain was determined by the total volume of grain purchased multiplied by the average purchase price of $3.88 for a period of 15 days at 17 percent. A period of 28 days at 17 percent was also analyzed. Each lag was to take into consideration the time involved between the buying and selling of a lot of grain.

The average purchase price of $3.88 per bushel was estimated by a two step process. The prices paid by the subterminal were based on 1980 state seasonal averages.[13] For example, spring wheat was estimated at $4.05 per bushel. Durum, oats, barley, and sunflower were estimated at $5.35, $1.75, $2.70, and $3.20 per bushel, respectively.[14] These prices were then multiplied by the respective amount of each grain handled by the subterminal. The amounts of each grain handled were based on the percentage of each crop when compared to the total state production of all crops during 1980.[15] For example, spring wheat production represented 33.5 percent of the total state production of all crops. Durum, oats, barley, and sunflower percentages were 23.2, 4.3, 15.2, and 23.7, respectively. The average prices were multiplied by the respective amounts of each grain handled to obtain the total purchase price of grain. This amount was then multiplied by the 17 percent interest charge for the number of days carried (i.e., the number of days carried was either 15 or 28).

Trading Margins

Margins received by the subterminal were assumed to be 20 cents per bushel for spring wheat, durum, and barley and 15 cents per bushel for oat and sunflower, resulting in a weighted average of 18.6 cents. These margins take into consideration 26 and 52 multiple car unit rate discounts and the

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[13] *1981 North Dakota Agricultural Statistics*, (Fargo: North Dakota Crop and Livestock Reporting Service, 1981), p. 75.

[14] Sunflower was converted from hundredweight to bushel units on a 30 pound per bushel basis.

[15] *1981 North Dakota Agricultural Statistics*, pp. 18-19.

opportunity of the subterminal managers to forward contract and hedge grain. The margins were based on projections of proposed subterminal operating budgets and margins received by the existing elevator industry. Margins were used to determine the average total revenue received by the subterminal.

Cost and Profitability Analysis

Cost estimates for the 500,000 bushel facility follow, while the estimates for the 300,000; 850,000; and 1,100,000 bushel facilities are located in Appendix A.[16] The annual total cost of constructing and operating a 500,000 bushel capacity subterminal would be approximately $964,000 (Table 4). This estimate would increase to $1,083,000, due to interest charges, if the elevator carried the grain inventory for 28 days.

Profitability of subterminals was determined mainly by the volume of grain handled. If a subterminal marketed enough grain, it was able to incur both decreasing average fixed and average variable costs. The 500,000 bushel capacity subterminal becomes feasible if 7,500,000 bushels (i.e., turnover of 15) are handled (Table 5). A profit of 5.8 cents per bushel would be received, given a 20-cent gross trading margin and an inventory carryover period of 15 days. The profit would decrease to 4.2 cents per bushel if the inventory were held for 28 days. Profitability statements for the 300,000; 850,000; and 1,100,000 bushel capacity subterminals are located in Appendix B.

The larger subterminals were found to be more profitable than the smaller facilities. This was due to the larger subterminals taking advantage of the existence of economies of size in both the fixed and variable cost components. For example, average fixed cost decreased from 17.4 to 9.8 cents per bushel as the size of subterminal increased from 300,000 to 1,100,000 bushels, assuming a turnover of 10. Average variable cost decreased from 2.9 cents per bushel for the 300,000 bushel capacity subterminal to 1.9 cents per bushel for the largest subterminal.

Profitability can be dramatically increased given the availability of internal financing for the construction cost and nondepreciable fixed costs. An operator of a 500,000 bushel capacity subterminal with a throughput of

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[16]The 500,000 bushel size subterminal was used in the analysis since it is the most common size of facility currently being constructed.

TABLE 4. ANNUAL CONSTRUCTION AND OPERATING COST OF A 500,000 BUSHEL CAPACITY SUBTERMINAL

Depreciable Fixed Costs

Item Name	Cost	No.	Life	Repairs	Salvage Value	Annual Equivalent Cost
Land (in acres)	$ 2,000.00[a]	10	40	$ 0.00	$20,000.00	$ 2,800.00
Elevator Structure	1,175,000.00	1	40	5,600.00	0.00	171,015.38
Driveway Structure	420,000.00	1	40	2,000.00	0.00	61,128.93
Elevator Machinery	550,000.00	1	10	2,600.00	0.00	108,082.69
Dust Control	125,000.00	1	10	600.00	0.00	24,564.27
Drier System	120,000.00	1	10	600.00	0.00	23,581.70
Electrical	150,000.00	1	10	700.00	0.00	29,477.11
Aeration and Temp.	50,000.00	1	10	250.00	0.00	9,825.70
Railroad Trackage (in feet)	60.00[a]	7,000	40	6,700.00	0.00	65,832.83
Railcar Mover	80,000.00	1	10	2,400.00	0.00	17,737.13
Office Building	60,000.00	1	40	300.00	0.00	8,732.70
Office Furniture	20,000.00	1	10	100.00	0.00	3,930.28
Contingencies	200,000.00	1	10	0.00	0.00	38,342.84
Total Depreciable Fixed Cost						$565,051.56
Construction Cost	$3,390,000.00					

Nondepreciable Fixed Costs

Item Name	Cost	Annual Equivalent Cost
Insurance	$18,488.00	$ 21,076.32
Bonds	5,100.00	5,814.00
Taxes	30,300.00	35,225.98
Manager Salary	30,000.00	34,199.98
Asst. Manager Salary	22,500.00	25,649.98
Director Fees	1,200.00	1,368.00
Dues	300.00	342.00
Annual Meeting	1,100.00	1,254.00
Warehouse License	50.00	57.00
Total Nondepreciable Fixed Cost		$124,987.26

Total Fixed Cost = $565,051.56 + $124,987.26 = $690,038.82

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TABLE 4. ANNUAL CONSTRUCTION AND OPERATING COST OF A 500,000 BUSHEL CAPACITY SUBTERMINAL (CONTINUED)

Item Name	Variable Cost No.	Cost	
Bookkeeper	1	$ 10,400.00	
Secretary	1	9,368.00	
Laborers	3	43,680.00	
Employee Benefits		17,390.00	
Payroll Taxes		7,710.00	
Unemployment Compensation		1,230.00	
Workmen's Compensation		1,650.00	
Office Supplies		4,000.00	
Elevator Supplies		4,500.00	
Power		11,000.00	
Telephone		2,500.00	
Subscriptions		600.00	
Advertising		3,000.00	
Special Meeting		500.00	
Travel and Convention		4,000.00	
Legal Fees		750.00	
Rodent Control		520.00	
Tax and Div. Work		500.00	
Data Processing		800.00	
Residence Expense		500.00	
Protein Tests		1,500.00	
Total Variable Cost		126,098.00	
Interest on Variable Cost		10,718.00	
Interest on Grain Purchased[b] (28 days)		137,417.00	(256,511.00)
Total Operating Cost		$274,233.00	
Total Annual Cost (Variable and Fixed)		$964,271.82	($1,083,365.82)

[a]To arrive at total construction cost, multiply by the number of required units [i.e., land ($2,000/acre)(10 acres) and railroad trackage ($60/ft.)(7,000 ft.)].

[b]Assumes a turnover of 10.

TABLE 5. PROFITABILITY OF A 500,000 BUSHEL CAPACITY SUBTERMINAL ASSUMING THREE DIFFERENT TURNOVER RATES OF FIVE, TEN, AND FIFTEEN

Item Name	Turnover 5		10		15	
Average Total Revenue	$4.065		$4.065		$4.065	
Less Average Cost of Grain Purchased	3.879		3.879		3.879	
Gross Trading Margin	.186		.186		.186	
Less: Average Fixed Cost	.276		.138		.092	
Average Variable Cost[a]	.050		.025		.017	
Average Interest on Variable Cost	.004		.002		.001	
Average Interest on Grain Purchased (28 days)	.055	(.123)	.027	(.051)	.018	(.034)
Average Net Revenue	-$ .199	(-$.267)	-$ .006	(-$.030)	$ .058	($.042)

[a]These numbers represent a decreasing linear average variable cost function or implicitly assume no change in total variable costs as throughput is altered from a turnover of five to a turnover of ten. In fact some of the variable cost accounts such as power would vary with output, resulting in a more constant average variable cost over the range of output. Most of the variable cost accounts would change very little over this range (such as advertising and subscriptions), making them a fixed cost over this range of output. Total variable costs contained herein are constant throughout the specified range of output. These accounts do change, however, as the scale of plant is altered (see tables in Appendix A).

5,000,000 bushels (i.e., turnover of 10) could save 4.2 cents per bushel by reducing the debt load from 100 to 50 percent (Tables 6 and 8).[17] Additional savings of 7.6 cents per bushel would accrue if the entire debt of construction and fixed costs were internally financed (i.e., zero debt load) (Tables 7 and 8). If internal financing for the construction of a 500,000 bushel elevator were available and the subterminal handled 5,000,000 bushels of grain, it would receive a profit of 7 cents per bushel (i.e., 7.6 cents per bushel

[17]The savings accruing due to additional internal financing does not consider opportunity costs of equity capital. If opportunity costs are to be considered, the accrued savings due to internal financing could be dramatically reduced.

TABLE 6. SAVINGS ACCRUING TO ALTERNATIVE SUBTERMINAL SIZES ASSUMING 50 PERCENT DEBT LOAD ON FIXED ASSETS

Item Name	Size of Terminal (in bushels)			
	300,000	500,000	850,000	1,100,000
Total Depreciable Fixed Cost	$275,557.29	$363,360.25	$485,066.70	$568,186.49
Total Nondepreciable Fixed Cost	93,127.45	116,670.66	148,406.86	171,601.25
Total Fixed Cost	368,684.74	480,030.91	633,473.56	739,787.74
Savings Over 100% Debt Load	$153,285.62	$210,007.91	$285,377.23	$333,501.76

TABLE 7. SAVINGS ACCRUING TO ALTERNATIVE SUBTERMINAL SIZES ASSUMING ZERO DEBT LOAD ON FIXED ASSETS

Item Name	Size of Terminal (in bushels)			
	300,000	500,000	850,000	1,100,000
Total Depreciable Fixed Cost	$157,575.00	$201,725.00	$267,745.00	$316,760.00
Total Nondepreciable Fixed Cost	87,035.00	109,038.00	138,698.00	160,375.00
Total Fixed Cost	244,610.00	310,763.00	406,443.00	477,135.00
Savings Over 100% Debt Load	$277,360.36	$379,275.82	$512,407.79	$596,154.56

TABLE 8. SAVINGS ACCRUING TO ALTERNATIVE SUBTERMINAL SIZES ASSUMING A TURNOVER OF TEN

Item Name	Size of Terminal (in bushels)			
	300,000	500,000	850,000	1,100,000
Average Net Revenue[a]	-$.046	-$.006	$.030	$.040
Average Savings (50% Debt Load)	.051	.042	.034	.030
Average Savings (0% Debt Load)	$.092	$.076	$.060	$.054

[a]Assumes a 14 percent interest rate over the estimated life of each fixed asset. Includes both depreciable and nondepreciable fixed assets.

TABLE 9. COSTS ASSOCIATED WITH ALTERNATIVE SUBTERMINAL SIZES ASSUMING 100 PERCENT DEBT LOAD ON FIXED ASSETS

Item Name	300,000 bu.	500,000 bu.	850,000 bu.	1,100,000 bu.
Construction Cost	$2,505,000.00	$3,390,000.00	$4,587,000.00	$5,380,000.00
Annual Equivalent Fixed Costs[a]	521,970.36	690,038.82	918,622.79	1,073,289.56
Annual Variable Costs	86,185.00	126,098.00	163,500.00	205,680.00
Interest on Variable Costs	7,325.00	10,718.00	13,898.00	17,483.00
Interest on Purchase of Grain[b] (28 days)	82,450.00 (153,907.00)	137,417.00 (256,511.00)	233,608.00 (436,069.00)	302,317.00 (564,324.00)
Total Operating Cost	175,960.00	274,233.00	411,006.00	525,480.00
Total Annual Cost (28 days)	$ 697,930.36 ($ 769,387.36)	$ 964,271.82 ($1,083,365.82)	$1,329,628.79 ($1,532,089.79)	$1,598,769.56 ($1,860,776.56)

[a]Assumes a 14 percent interest rate over the estimated life of each fixed asset.
Includes both depreciable and nondepreciable fixed assets.
[b]Assumes a turnover of 10 for each size of subterminal.

savings minus the loss of .006 cents per bushel from Table 5). Savings accruing to the four size subterminals assuming a turnover of five and 15 are located in Appendix C. A summary of the costs associated with each size subterminal is presented in Table 9.

Remodeling and average variable costs of existing elevator facilities (Appendix D) and construction costs of minimum investment facilities (Appendix E) were analyzed. The structures are capable of shipping by 26 and 52 multiple car units, respectively. All results received were inputted into the network flow model.

Summary and Conclusions

Summary

An economic-engineering approach was used to determine the per bushel profitability of four subterminal facilities, ranging in capacity from 300,000 to 1,100,000 bushels. Information on plant design and construction costs of buildings and equipment was provided by architects, contractors, and elevator industry personnel. Estimates of operating costs were received from previous research on the cost structure of the existing country elevator industry and operating costs schedules of subterminal feasibility studies.

Cost and Profitability Analysis

The annual cost of constructing and operating a 500,000 bushel capacity subterminal, the most common sized facility currently being constructed, would be approximately $964,000. A profit of 5.8 cents per bushel would be received if 7,500,000 bushels of grain could be handled through the facility.

Profits to the subterminals were found to increase as size increased because of the existence of economies of size in the fixed and variable cost components. Profitability increased dramatically given the availability of internal financing for the initial construction cost and nondepreciable fixed costs.

Conclusions

Subterminal elevators can become an important part of the existing country elevator industry in North Dakota due to the inherent economies of size which may be received if operated efficiently. However, the initial cost of construction may become a prohibitive factor in the construction decision.

Due care must be taken on the number, size, and location of current and proposed subterminal sites. The storage capacity of the existing elevator system in North Dakota currently is underutilized. Additional construction of facilities may add to the underutilization which already exists, causing additional financial burdens to the industry.

Several factors must be addressed when deciding whether to build or remodel: the viability of existing branch lines, extent of new facility construction and remodeling of existing facilities within a competitive region, and the potential for elevator mergers. Changes within the elevator industry are occurring and will continue to occur. Elevator management must be fully aware of these changes before construction/remodeling decisions are made.

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APPENDIX A

APPENDIX TABLE A-1. ANNUAL CONSTRUCTION AND OPERATING COST OF A 300,000 BUSHEL CAPACITY SUBTERMINAL

Depreciable Fixed Costs						
Item Name	Cost	No.	Life	Repairs	Salvage Value	Annual Equivalent Cost
Land (in acres)	$ 2,000.00[a]	5	40	$ 0.00	$10,000.00	$ 1,400.00
Elevator Structure	735,000.00	1	40	3,500.00	0.00	106,975.56
Driveway Structure	420,000.00	1	40	2,000.00	0.00	61,128.93
Elevator Machinery	450,000.00	1	10	2,200.00	0.00	88,431.31
Dust Control	90,000.00	1	10	450.00	0.00	17,686.27
Drier System	120,000.00	1	10	600.00	0.00	23,581.70
Electrical	120,000.00	1	10	600.00	0.00	23,581.70
Aeration and Temp.	40,000.00	1	10	200.00	0.00	7,860.56
Railroad Trackage (in feet)	60.00[a]	3,500	40	3,360.00	0.00	32,916.46
Railcar Mover	80,000.00	1	10	2,400.00	0.00	17,737.13
Office Building	60,000.00	1	40	290.00	0.00	8,732.70
Office Furniture	20,000.00	1	10	100.00	0.00	3,930.28
Contingencies	150,000.00	1	10	0.00	0.00	28,757.12
Total Depreciable Fixed Cost						$422,719.72
Construction Cost	$2,505,000.00					

Nondepreciable Fixed Costs		
Item Name	Cost	Annual Equivalent Cost
Insurance	$13,695.00	$ 15,612.30
Bonds	3,060.00	3,488.40
Taxes	22,250.00	25,364.98
Manager Salary	27,500.00	31,349.98
Asst. Manager Salary	18,500.00	21,089.98
Director Fees	900.00	1,026.00
Dues	250.00	285.00
Annual Meeting	850.00	969.00
Warehouse License	30.00	65.00
Total Nondepreciable Fixed Cost		$ 99,250.64

Total Fixed Cost = $422,719.72 + $99,250.64 = $521,970.36

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APPENDIX TABLE A-1. ANNUAL CONSTRUCTION AND OPERATING COST OF A 300,000 BUSHEL CAPACITY SUBTERMINAL (CONTINUED)

Item Name	Variable Cost No.	Cost	
Bookkeeper	1/2	$ 5,200.00	
Secretary	1	9,360.00	
Laborers	2	29,120.00	
Employee Benefits		10,760.00	
Payroll Taxes		5,960.00	
Unemployment Compensation		990.00	
Workmen's Compensation		1,420.00	
Office Supplies		2,750.00	
Elevator Supplies		3,500.00	
Power		7,500.00	
Telephone		1,750.00	
Subscriptions		300.00	
Advertising		1,750.00	
Special Meeting		350.00	
Travel and Convention		2,500.00	
Legal Fees		500.00	
Rodent Control		350.00	
Tax and Div. Work		325.00	
Data Processing		500.00	
Residence Expense		300.00	
Protein Tests		1,000.00	
Total Variable Cost		86,185.00	
Interest on Variable Cost		7,325.00	
Interest on Grain Purchased[b] (28 days)		82,450.00	(153,907.00)
Total Operating Cost		$175,960.00	
Total Annual Cost (Variable and Fixed)		$697,930.36	($769,387.36)

[a]To arrive at total construction cost, multiply by the number of required units [i.e., land ($2,000/acre)(5 acres) and railroad trackage ($60/ft.)(3,500 ft.)].

[b]Assumes a turnover of 10.

APPENDIX TABLE A-2. ANNUAL CONSTRUCTION AND OPERATING COST OF AN 850,000 BUSHEL CAPACITY SUBTERMINAL

Depreciable Fixed Costs

Item Name	Cost	No.	Life	Repairs	Salvage Value	Annual Equivalent Cost
Land (in acres)	$ 2,000.00[a]	20	40	$ 0.00	$40,000.00	$ 5,599.99
Elevator Structure	1,912,000.00	1	40	9,200.00	0.00	278,282.31
Driveway Structure	420,000.00	1	40	2,100.00	0.00	62,584.93
Elevator Machinery	750,000.00	1	10	3,600.00	0.00	147,385.56
Dust Control	150,000.00	1	10	720.00	0.00	29,477.11
Drier System	150,000.00	1	10	720.00	0.00	29,477.11
Electrical	180,000.00	1	10	850.00	0.00	35,372.55
Aeration and Temp.	100,000.00	1	10	480.00	0.00	19,651.41
Railroad Trackage (in feet)	60.00[a]	7,000	40	6,700.00	0.00	65,832.83
Railcar Mover	80,000.00	1	10	2,400.00	0.00	17,737.13
Office Building	105,000.00	1	40	500.00	0.00	15,282.23
Office Furniture	30,000.00	1	10	150.00	0.00	5,895.42
Contingencies	250,000.00	1	10	0.00	0.00	47,928.54
Total Depreciable Fixed Cost						$760,507.12
Construction Cost	$4,587,000.00					

Nondepreciable Fixed Costs

Item Name	Cost	Annual Equivalent Cost
Insurance	$27,058.00	$ 30,846.12
Bonds	5,810.00	6,623.39
Taxes	42,270.00	48,187.80
Manager Salary	35,000.00	39,899.98
Asst. Manager Salary	25,000.00	28,499.98
Director Fees	1,600.00	1,824.00
Dues	400.00	456.00
Annual Meeting	1,500.00	1,710.00
Warehouse License	60.00	68.40
Total Nondepreciable Fixed Cost		$158,115.67
Total Fixed Cost = $760,507.12 + $158,115.67 =		$918,622.79

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APPENDIX TABLE A-2. ANNUAL CONSTRUCTION AND OPERATING COST OF AN 850,000 BUSHEL CAPACITY SUBTERMINAL (CONTINUED)

Variable Cost			
Item Name	No.	Cost	
Bookkeeper	1	$ 10,400.00	
Secretary	1	9,360.00	
Secretary/Clerk	1/2	4,680.00	
Laborers	4	58,240.00	
Employee Benefits		21,400.00	
Payroll Taxes		9,490.00	
Unemployment Compensation		1,510.00	
Workmen's Compensation		2,120.00	
Office Supplies		5,250.00	
Elevator Supplies		6,000.00	
Power		15,000.00	
Telephone		3,250.00	
Subscriptions		850.00	
Advertising		3,500.00	
Special Meeting		750.00	
Travel and Convention		5,000.00	
Legal Fees		1,000.00	
Rodent Control		700.00	
Tax and Div. Work		750.00	
Data Processing		1,250.00	
Residence Expense		750.00	
Protein Tests		2,250.00	
Total Variable Cost		163,500.00	
Interest on Variable Cost		13,898.00	
Interest on Grain Purchased[b] (28 days)		233,608.00	(436,069.00)
Total Operating Cost		$ 411,006.00	
Total Annual Cost (Variable and Fixed)		$1,329,628.79	($1,532,089.79)

[a]To arrive at total construction cost, multiply by the number of required units [i.e., land ($2,000/acre)(20 acres) and railroad trackage ($60/ft.)(7,000 ft.)].

[b]Assumes a turnover of 10.

APPENDIX TABLE A-3. ANNUAL CONSTRUCTION AND OPERATING COST OF A 1,100,000 BUSHEL CAPACITY SUBTERMINAL

Depreciable Fixed Costs

Item Name	Cost	No.	Life	Repairs	Salvage Value	Annual Equivalent Cost
Land (in acres)	$ 2,000.00[a]	20	40	$ 0.00	$40,000.00	$ 5,599.99
Elevator Structure	2,365,000.00	1	40	11,400.00	0.00	344,214.00
Driveway Structure	420,000.00	1	40	2,100.00	0.00	62,584.93
Elevator Machinery	1,000,000.00	1	10	4,800.00	0.00	196,514.13
Dust Control	175,000.00	1	10	840.00	0.00	34,389.96
Drier System	150,000.00	1	10	720.00	0.00	29,477.11
Electrical	190,000.00	1	10	900.00	0.00	37,337.69
Aeration and Temp.	130,000.00	1	10	600.00	0.00	22,875.33
Railroad Trackage (in feet)	60.00[a]	7,000	40	6,700.00	0.00	65,832.83
Railcar Mover	80,000.00	1	10	2,400.00	0.00	17,737.13
Office Building	105,000.00	1	40	500.00	0.00	15,282.23
Office Furniture	30,000.00	1	10	150.00	0.00	5,895.42
Contingencies	275,000.00	1	10	0.00	0.00	52,721.39
Total Depreciable Fixed Cost						$890,462.14
Construction Cost	$5,380,000.00					

Nondepreciable Fixed Costs

Item Name	Cost	Annual Equivalent Cost
Insurance	$33,045.00	$ 37,671.30
Bonds	6,320.00	7,204.79
Taxes	49,950.00	56,942.97
Manager Salary	40,000.00	45,599.98
Asst. Manager Salary	27,500.00	31,349.98
Director Fees	1,600.00	1,824.00
Dues	400.00	456.00
Annual Meeting	1,500.00	1,710.00
Warehouse License	60.00	68.40
Total Nondepreciable Fixed Cost		$ 182,827.42
Total Fixed Cost = $890,462.14 + $182,827.42 =		$1,073,289.56

- CONTINUED -

APPENDIX TABLE A-3. ANNUAL CONSTRUCTION AND OPERATING COST OF A 1,100,000 BUSHEL CAPACITY SUBTERMINAL (CONTINUED)

Variable Cost			
Item Name	No.	Cost	
Bookkeeper	1	$ 10,400.00	
Secretary	1	9,360.00	
Secretary/Clerk	1	9,360.00	
Elevator Supervisor	1	18,720.00	
Laborers	4	58,240.00	
Employee Benefits		26,040.00	
Payroll Taxes		11,540.00	
Unemployment Compensation		1,760.00	
Workmen's Compensation		2,360.00	
Office Supplies		6,500.00	
Elevator Supplies		7,500.00	
Power		18,000.00	
Telephone		4,500.00	
Subscriptions		1,000.00	
Advertising		4,000.00	
Special Meeting		1,000.00	
Travel and Convention		6,500.00	
Legal Fees		1,300.00	
Rodent Control		850.00	
Tax and Div. Work		1,000.00	
Data Processing		1,750.00	
Residence Expense		1,000.00	
Protein Tests		3,000.00	
Total Variable Cost		205,680.00	
Interest on Variable Cost		17,483.00	
Interest on Grain Purchased[b] (28 days)		302,317.00	(564,324.00)
Total Operating Cost		$ 525,480.00	
Total Annual Cost (Variable and Fixed)		$1,598,769.56	($1,860,776.56)

[a]To arrive at total construction cost, multiply by the number of required units [i.e., land ($2,00/acre)(20 acres) and railroad trackage ($60/ft.)(7,000 ft.)].

[b]Assumes a turnover of 10.

APPENDIX B

APPENDIX TABLE B-1. PROFITABILITY OF A 300,000 BUSHEL CAPACITY SUBTERMINAL ASSUMING THREE DIFFERENT TURNOVER RATES OF FIVE, TEN, AND FIFTEEN

Item Name	Turnover 5		10		15	
Average Total Revenue	$4.065		$4.065		$4.065	
Less Average Cost of Grain Purchased	3.879		3.879		3.879	
Gross Trading Margin	.186		.186		.186	
Less: Average Fixed Cost	.348		.174		.116	
Average Variable Cost	.057		.029		.019	
Average Interest on Variable Cost	.004		.002		.002	
Average Interest on Grain Purchased (28 days)	.055	(.103)	.027	(.051)	.018	(.034)
Average Net Revenue	-$ .278	(-$.326)	-$ .046	(-$.070)	$ .031	($.015)

APPENDIX TABLE B-2. PROFITABILITY OF AN 850,000 BUSHEL CAPACITY SUBTERMINAL ASSUMING THREE DIFFERENT TURNOVER RATES OF FIVE, TEN, AND FIFTEEN

Item Name	Turnover 5		10		15	
Average Total Revenue	$4.065		$4.065		$4.065	
Less Average Cost of Grain Purchased	3.879		3.879		3.879	
Gross Trading Margin	.186		.186		.186	
Less: Average Fixed Cost	.216		.108		.072	
Average Variable Cost	.038		.019		.013	
Average Interest on Variable Cost	.003		.002		.001	
Average Interest on Grain Purchased (28 days)	.055	(.103)	.027	(.051)	.018	(.034)
Average Net Revenue	-$ .126	(-$.174)	$ .030	($.006)	$ .082	($.066)

APPENDIX TABLE B-3. PROFITABILITY OF A 1,100,000 BUSHEL CAPACITY SUBTERMINAL ASSUMING THREE DIFFERENT TURNOVER RATES OF FIVE, TEN, AND FIFTEEN

Item Name	Turnover 5		10		15	
Average Total Revenue	$4.065		$4.065		$4.065	
Less Average Cost of Grain Purchased	3.879		3.879		3.879	
Gross Trading Margin	.186		.186		.186	
Less: Average Fixed Cost	.195		.098		.065	
Average Variable Cost	.037		.019		.012	
Average Interest on Variable Cost	.003		.002		.001	
Average Interest on Grain Purchased (28 days)	.055	(.103)	.027	(.051)	.018	(.034)
Average Net Revenue	-$ .104	(-$.152)	$ .040	($.016)	$ .090	($.074)

APPENDIX C

APPENDIX TABLE C-1. SAVINGS ACCRUING TO ALTERNATIVE SUBTERMINAL SIZES ASSUMING A TURNOVER OF FIVE

Item Name	Size of Terminal (in bushels) 300,000	500,000	850,000	1,100,000
Average Net Revenue[a] (28 days)	-$.278 (-.326)	-$.199 (-.267)	-$.126 (-.174)	-$.104 (-.152)
Average Savings (50% Debt Load)	.102	.084	.067	.061
Average Savings (0% Debt Load)	$.185	$.152	$.121	$.108

[a]Assumes a 14 percent interest rate over the estimated life of each fixed asset. Includes both depreciable and nondepreciable fixed assets.

APPENDIX TABLE C-2. SAVINGS ACCRUING TO ALTERNATIVE SUBTERMINAL SIZES ASSUMING A TURNOVER OF FIFTEEN

Item Name	Size of Terminal (in bushels) 300,000	500,000	850,000	1,100,000
Average Net Revenue[a] (28 days)	$.031 (.015)	$.058 (.042)	$.082 (.066)	$.090 (.074)
Average Savings (50% Debt Load)	.034	.028	.022	.020
Average Savings (0% Debt Load)	$.062	$.051	$.040	$.036

[a]Assumes a 14 percent interest rate over the estimated life of each fixed asset. Includes both depreciable and nondepreciable fixed assets.

APPENDIX D

Remodeling of Existing Elevators

An important aspect of any grain merchandising system is the number of elevators currently capable of shipping grain by 26-car multiple car units. For our purposes, Crop Reporting District (CRD) 3 which includes Towner, Cavalier, Pembina, Ramsey, Walsh, Nelson, and Grand Forks counties was analyzed. Another aspect was to determine the number of elevators in CRD 3 that could ship by 26-car units with a minimum amount of remodeling. Twenty-five elevators were selected as proposed remodeling sites. Of these sites, six were either capable of or currently shipping by 26-car multiple car units, one was currently under construction, and 10 elevators stated that remodeling could be accomplished if they so desired. Elevator sites currently capable of shipping by 26-car multiple car units were received from railroad officials. All other information on capabilities was received directly from the elevator managers.

Remodeling costs varied a great deal depending upon individual elevator needs. New machinery was estimated at a cost of $300,000 for facilities of approximately 300,000 bushels in storage capacity. Remodeling costs increased to $550,000 if the facility storage capacity was approximately 500,000 bushels. These estimates were based on proposed subterminal site projections and deemed to be adequate for shipment by 26-car and multiple car units. Railroad trackage was estimated at $60 per lineal foot, and room for 27 cars was determined to be a minimum. The optimum length of railroad trackage for a 26-car unit facility is 3,500 feet. However, in some cases of the existing elevator facilities, the optimum cannot be obtained. Thus, the minimum was used for the remodeling process. A switch costing $35,000 was added when the minimum amount of trackage was used. Additional storage was constructed at a cost of $2.25 per bushel. Storage was annexed if the proposed facility had less than 250,000 bushels of capacity. A 250,000 bushel facility was assumed to be appropriate since a 26-car unit train consists of 85,800 bushels and the grain shipped must be of the same grade and quality. This allows for adequate storage of different grades of the same crop and for storage of different crops.

The remodeling costs for each elevator were totaled, and an annual equivalent cost was determined as described in the previous section. A discount rate of 14 percent and an estimated useful life for the storage annexes and railroad trackage of 40 years were used while the life for the elevator machinery was estimated at 10 years. No salvage value was used in any of the remodeling cases.

Operating cost and grain-handled data were available for nine of the 17 remodeling sites. A weighted average variable cost was determined by dividing the total variable cost by the total volume of grain handled for the nine elevators. This figure was used as a representative AVC figure for the entire 17 elevators and inputted along with the total remodeling cost for each elevator into the network flow model. Transshipment of grain movements are accomplished through network flow models. Research is currently in progress with publications forthcoming.

APPENDIX E

Minimum Investment Facility

A third alternative to the building of a subterminal or remodeling of an existing elevator is the construction of a minimum investment, fast-loading facility. This facility includes a raised driveway which leads to an above-the-ground receiving pit. The pit has been covered on three sides by gravel or other material to provide stability for handling full semi-trucks. No structural shed is built to cover the pit and no office structure exists. A gravel conveyor is used to move the grain from the pit to the waiting hopper cars.

Minimum investment facilities necessitate that elevators be on an on-call basis and that the grain be preblended and graded since no storage exists on the site. The cost of this facility would be in the range of $70,000-$100,000 depending upon the size of pit, size and type of conveyor, and type of material used to stabilize the pit area. Estimates were received from grain elevator industry officials within both the cooperative and corporate sectors. Minimum investment facilities are currently located in Minnesota and North Dakota and are used primarily for loading corn because of the availability of like grade.

List of Tables

List of Appendix Tables