AN ANALYSIS OF MARKET TRADE AREAS AND COSTS OF POTENTIAL SUBTERMINAL GRAIN ELEVATORS IN NORTH DAKOTA

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INTRODUCTION

North Dakota's country grain marketing infrastructure has been experiencing change recently. Branch line abandonments and multiple car rates, along with institutional and technological advances, have altered the traditional country merchandising system. Foremost, the implementation of multiple car rates by railroads is prompting country elevator managers/owners to consider merger, consolidation, upgrading present facilities and/or construction of new facilities. Uncertainty, particularly with respect to future freight rate levels, is complicating industry decisions. Freight rate spreads, for example, often have direct bearing on whether new facilities are constructed or old ones upgraded.

OBJECTIVES

The purpose of this paper is to analyze the effect of market trade area size on costs of alternative grain elevator systems in North Dakota. In addition, marketing densities, which directly affect size of trade area, will be examined.

MARKETING DENSITY

North Dakota had 28.8 million acres of cropland in 1978 (Table 1). Acreage varied from a low of 2.2 million acres in Crop Reporting District (CRD) 8 to a high of 4.7 million acres in CRD 3 (See Figure 1 for a breakdown of North Dakota CRDs). Cropland comprised 64 percent of total land mass in the state. Highest cropland concentration was in CRD 6 where cropland accounted for 88 percent of CRD area. Lowest concentration was in CRDs 4 and 8.

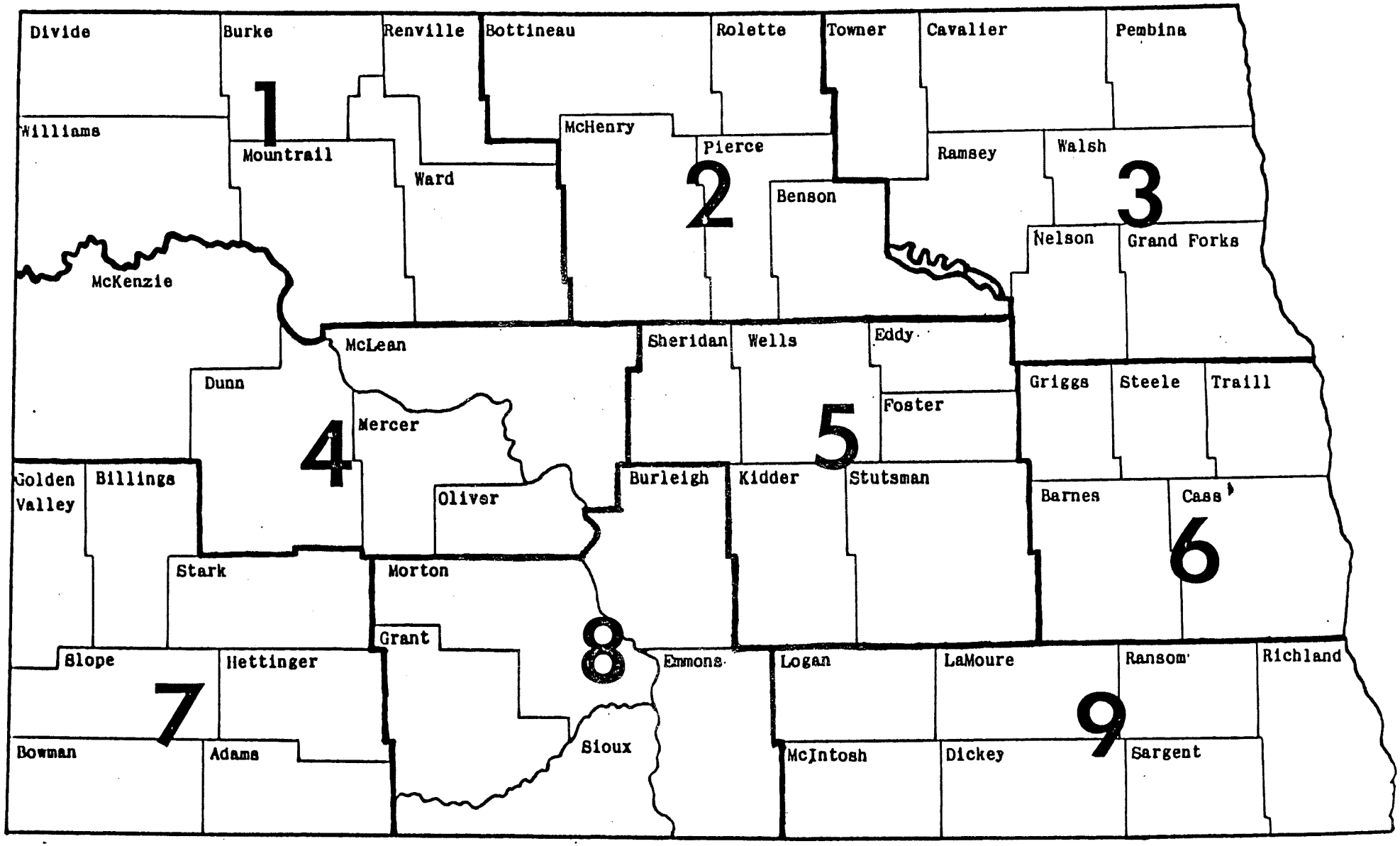

Figure 1. North Dakota Crop Reporting Districts.

TABLE 1. CROPLAND AREA BY CRD.				
CRD	CROPLAND	CROPLAND AREA	CRD AREA	PROPORTION CROPLAND TO CRD AREA
	(ACRES)	(SQUARE MILES)		(PERCENT)
1	4,066,806	6,354	9,232	68
2	3,157,230	4,933	6,910	71
3	4,700,891	7,345	8,646	84
4	2,360,321	3,688	8,555	43
5	3,099,010	4,842	7,190	67
6	3,111,704	4,862	5,509	88
7	2,571,600	4,018	7,987	50
8	2,198,776	3,436	7,817	43
9	3,339,150	5,217	7,435	70
STATE	28,829,994	44,695	69,273	64

SOURCE: North Dakota Crop and Livestock Reporting Service, *North Dakota Agricultural Statistics*, Ag. Stats. No. 49, October 1981.

Marketing densities are an indication of how concentrated grain marketings are at given locations. Market densities were calculated for each CRD (Table 2). Calculations reflect an average of cropland and CRD area. The following formula was used:

$$MD = (2 * M) \div (CRD_A + CROP_A)$$

where: MD = marketing density in bushels per square mile

M = grain marketed

CRD_A = CRD area (square miles)

$CROP_A$ = cropland area (square miles)

State average density for all grain was 7,832 bushels per square mile. Densities varied from a low of 1,931 bushels per square mile in CRD 8 to a high of 18,102 bushels per square mile in CRD 6.

TABLE 2. MARKETING DENSITIES* BY CRD.

CRD	CROP					
	ALL GRAIN	HRS WHEAT	DURUM	BARLEY	SUNFLOWER	CORN
	(BUSHELS PER SQUARE MILE)					
1	6,295	1,879	3,077	286	831	---
2	6,509	1,338	2,289	903	1,650	---
3	13,419	4,025	2,622	3,361	2,708	64
4	2,523	1,400	713	19	250	---
5	7,932	2,620	1,150	774	3,106	---
6	18,102	5,330	695	4,938	5,481	439
7	2,817	2,106	435	8	238	---
8	1,931	1,500	103	11	244	---
9	10,530	3,564	519	1,377	2,856	1,421
STATE	7,832	2,596	1,401	1,293	1,885	207

* Densities are based on 3-year average grain movements from 1979/80-1981/82 as reported in Ming, Dennis R., *North Dakota Grain and Oilseed Transportation Statistics, 1981-82*, UGPTI Report No. 48, Upper Great Plains Transportation Institute, North Dakota State University, Fargo, January 1983.

GRAIN ELEVATOR EXPANSION COSTS

Two cost elements will be developed in this section; (1) marginal farm truck costs (MFTC), and (2) marginal expansion costs (MEC). MFTC will refer to the additional cost to the producer of transporting grain further to market. MEC is the marginal cost of operating a new or upgraded facility relative to an "existing" facility.

While average total costs (ATC) of potential subterminal grain elevator systems in North Dakota have been developed in previous studies, effects of farm truck costs and alternative trade area sizes have not been analyzed to any extent. Other things equal, costs will increase for a given elevator as trade area size increases. Given a certain level of competition, elevator A will have to increase its "board price" in order to bid away grain from elevator B. Ignoring farmers' tastes and preferences and loyalties to elevator B, elevator A must increase its price by at least the additional cost to farmers of shipping grain to elevator A versus elevator B. This additional cost will be referred to as "marginal farm truck cost" (MFTC). MFTC will be calculated from the fringe of the expanded trade area. That is, MFTC will reflect the additional farm truck costs of shipping from the fringe of an expanded trade area versus shipping from the fringe of an original trade area.

COST COMPONENTS

Estimated costs were developed for existing and potential subterminal grain elevator systems in North Dakota (Table 3). Average variable cost (AVC) and average total cost (ATC) were estimated for the existing system[1] and for potential subterminal systems[2] in previous studies. Costs of upgrading existing facilities were taken from a case study of Bisbee, North Dakota, area elevator facilities[3]. Costs developed in these studies were updated to December 1982 levels using consumer price index (CPI).

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[1]Chase, Craig A., Delmer L. Helgeson and Terry L. Shaffer, *Statistical Cost Analysis of Existing North Dakota Country Elevator Industry*, NDSU, Ag Econ Report No. 155 and UGPTI Report No. 43, 1983.

[2]Chase, Craig A., and Delmer L. Helgeson, *Cost Analysis of Potential North Dakota Subterminal Systems*, NDSU, Ag Econ Report No. 156 and UGPTI Report No. 44, 1982.

[3]Zink, Daniel L., et. al., *Feasibility of the Cooperative Subterminal: A Case Study of Bisbee, North Dakota*, UGPTI, NDSU and Schrader & Assoc., July 1982.

Three alternative size facilities were considered: (1) 276,000 bushel storage capacity (existing facility); (2) 300,000 bushel storage capacity (26-car facility); and (3) 500,000 bushel storage capacity (52-car facility). Marketing density used in the analysis was based on the state average for all grains (Table 2).

Farm truck costs were based on a study of farmers in North Dakota.[4] Costs were updated to December 1982 levels using CPI. Updated costs were $1.202 per mile for single axle trucks and $1.503 per mile for tandem axle trucks. Average payload was 280 bushels for single axle and 550 bushels for tandem axle. Variable costs were found to be about 70 percent of total costs and were used as proxies for marginal costs. Costs were adjusted to reflect three single axle shipments per tandem axle shipment. Per bushel mile cost was .37¢ [(3 * $1.202) (1 * $1.503) ÷ (3 * 280 bushels) + (1 * 550 bushels)].

ALTERNATIVE SYSTEMS

Existing System

Average total cost (ATC) of the existing system was 15.4¢ per bushel (Table 3). Volume was 1.1 million bushels, market trade area 147 square miles and radius of trade area 6.8 miles. Farm truck costs were calculated based on movements from the fringe of a market trade area to the elevator (Figure 2). Thus, cost was calculated to be 5.0¢ (.37¢ per bushel mile times 13.6[5] miles).

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[4]Wilson, Wesley W., Gene C. Griffin and Kenneth L. Casavant, *Characteristics and Costs of Operation of North Dakota's Farm Trucks*, Upper Great Plains Transportation Institute, North Dakota State University, Fargo, forthcoming.

[5]Radius times two (round trip distance).

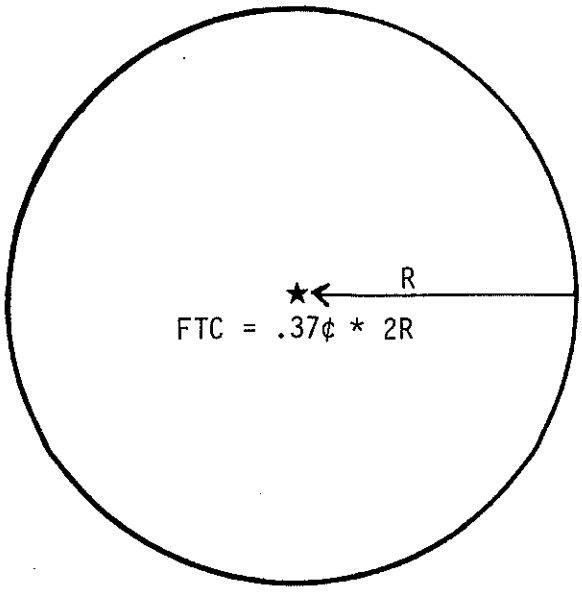

Figure 2. Calculation of Farm Truck Costs for Grain Movement from Fringe Area to Elevator.

26-Car Facilities

Elevators with 300,000 bushels of storage capacity were assumed to approximate 26-car loading facilities. Costs were considered for both upgrading and new construction. Turnover ratios of 10:1 and 15:1 were considered.

Highest cost 26-car facility was a newly constructed elevator with a turnover ratio of 10:1. Change in gross margin was calculated to be 14.4¢ per bushel relative to the existing system. Interpret change in gross margin as the marginal cost of operating the alternative system relative to the existing system. Change in gross margin was calculated as MEC plus MFTC. MEC refers to increases in costs due to expansion while MFTC refers to additional costs incurred from expanding market trade area. Least cost 26-car facility

was an upgraded elevator turning grain over 15 times. A 1.5¢ per bushel cost advantage over the existing system was realized with this type of arrangement. Assuming a less optimistic view with respect to turnover ratio (10:1 as opposed to 15:1) resulted in a 2.9¢ per bushel change in gross margin. A newly constructed 300,000 bushel storage capacity plant with 4.5 million bushels of grain volume resulted in costs that were 6.6¢ per bushel higher relative to the existing system.

TABLE 3. ESTIMATED COST COMPONENTS OF EXISTING AND POTENTIAL SUBTERMINAL ELEVATOR SYSTEMS IN NORTH DAKOTA, DECEMBER 1982.

	SIZE OF FACILITY						
ITEM	EXISTING 276,000 (4:1)[a]	NEW 300,000 (10:1)[a]	UPGRADED 300,000 (10:1)[a]	NEW 500,000 (10:1)[a]	NEW 300,000 (15:1)[a]	UPGRADED 300,000 (15:1)[a]	NEW 500,000 (15:1)[a]
AVC (¢/bu)	4.0	3.4	3.4	3.0	2.3	2.3	2.0
ATC (¢/bu)	15.4	27.5	16.0	22.8	18.4	10.3	15.2
AVC/ATC (%)	25.0	12.0	21.0	13.0	12.0	22.0	13.0
VOLUME (MILLION bu)	1.1	3.0	3.0	5.0	4.5	4.5	7.5
MARKETING DENSITY (bu/sq. mi.)	7,500	7,500	7,500	7,500	7,500	7,500	7,500
MARKET TRADE AREA (sq. mi.)	147	400	400	667	600	600	1,000
MARKET TRADE AREA RADIUS (mi.)	6.8	11.3	11.3	14.6	13.8	13.8	17.8
FARM TRUCK COST (¢/bu)	5.0	--	--	--	--	--	--
MEC (¢/bu)	--	12.1	0.6	7.4	3.0	-5.1	-0.2
MFTC (¢/bu)	--	2.3	2.3	4.1	3.6	3.6	5.7
MARGINAL COST/CHANGE IN GROSS MARGIN (¢/bu)	--	14.4	2.9	11.5	6.6	-1.5	5.5

[a] Turnover ratio (volume:storage capacity).

52 - Car Facility

Elevators with 500,000 bushels of storage capacity were assumed to resemble 52- car loading stations. Only new construction for this type of facility was considered. It is unlikely that many existing facilities would readily be able to upgrade to 52-car plants. Thus, new construction was viewed to be the only feasible option. Turnover ratios considered were 10:1 and 15:1.

A 500,000 bushel elevator with five million bushels grain volume (turnover 10:1) experienced MEC of 7.4¢ per bushel and MFTC of 4.1¢ per bushel relative to the existing system. Change in gross margin was 11.5¢ per bushel. Increasing volume to 7.5 million bushels resulted in considerable economies of utilization. MEC were -0.2¢ per bushel. MFTC, because of a rather large market trade area (1,000 square miles), were 5.7¢ per bushel. Overall, this type of system required gross margins of 5.5¢ per bushel above the existing system.

Care should be taken when comparing the grain elevator system discussed above. Costs presented are average figures for each type of system and derivations either way (plus or minus) would likely occur if the plants were actually placed in operation. Upgrading versus new construction, according to costs presented, appears to be the "better" alternative. However, costs of upgrading may be substantially higher than the rough $400,000 used in the analyses. Also, many existing elevators may not be readily upgraded due to exogenous factors. An important relationship to observe in the relationship between costs and volume (economies of utilization). Because the systems

have relatively high fixed costs, increased utilization significantly reduces average total cost. For example, a 500,000 bushel facility turning grain over 10 times would experience marginal costs that are 6.0¢ per bushel higher than a 500,000 facility turning grain over 15 times.

Marginal farm truck costs may not be applicable in all situations. If viable competition does not exist for a given plant, MFTC may not have to be considered. That is, a higher elevator board may not be required to attract the business. However, if competition does exist, a higher board price may be required to attract the additional grain volume. In many instances board price may have to be increased by more than MFTC in order to assemble additional grain volume.

MARGINAL COSTS BY CRD

Marginal cost (MC) of moving from the existing system to an alternative system was calculated by CRD (Table 4). Marginal costs were calculated based on CRD marketing densities, MEC and MFTC. Table 3 contains marginal costs (MEC + MFTC) based on state average crop marketing density (7,500 bushels per square mile). Figures from Table 4 were based on individual crop marketing densities[6] from each CRD (see Table 2).

Marginal cost (MC) of moving from the existing system to an alternative system varied by CRD primarily because of crop marketing densities. CRDs with larger densities experienced lower MC than CRDs with smaller densities. For example, MC of moving to a 500,000 bushel facility with five million bushels of grain volume varied from a low of

[6]Marketing densities were rounded to nearest 500 bushels.

10.0¢ per bushel in CRD 6 to a high of 15.2¢ per bushel in CRD 8. Market trade area size in CRD 6 was 278 square miles (R^7 = 9.4 miles). CRD 8 require a market trade area of 2,500 square miles (R = 28.2 miles).

TABLE 4. MARGINAL COSTS OF MOVING FROM EXISTING SYSTEM TO ALTERNATIVE SYSTEMS, BY CRD.

	Size of Facility					
	300,000 bu.		300,000 bu.		500,000 bu.	500,000 bu.
	(10:1)		(15:1)		(10:1)	(15:1)
CRD	New	Upgraded	New	Upgraded		
	---cents per bushel---					
1	14.6	3.1	6.9	-1.2	11.7	6.0
2	14.6	3.1	6.9	-1.2	11.7	6.0
3	13.8	2.3	5.7	-2.4	10.4	4.1
4	16.5	4.6	9.3	1.2	14.4	9.7
5	14.3	2.8	6.5	-1.6	11.3	5.8
6	13.6	2.1	5.3	-2.8	10.0	3.5
7	15.7	4.2	8.8	0.7	13.7	8.9
8	16.6	5.1	10.1	2.0	15.2	10.9
9	14.0	2.5	6.1	-2.0	10.8	4.6

[7]R = radius of market trade area.

CONCLUSIONS

Firms planning to expand existing plants to 26-car or 52-car loading facilities may have to consider more than just expansion costs. Given a competitive environment, managers may have to increase board prices by at least as much as marginal farm trucking costs incurred by farmers in order to attract additional grain volume. Otherwise, they may find it difficult to expand market trade ares. Producers may have to incur additional costs where competition does not exist to any extent. That is, if no viable competitive market exists, farmers will have to absorb a portion, or all, of the trucking costs.