Economic Report ER 81-3

Characteristics of Cooperative and Noncooperative Retail Fertilizer Distribution Firms in Minnesota

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J. W. Hammond, D. Hammer, and D. C. Dahl

Department of
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University of Minnesota
St. Paul, Minnesota 55108

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ACKNOWLEDGEMENT

This project was funded under a contract with the Agricultural Cooperative Service, USDA.

Several individuals assisted in the research. Thanks to Donald Vogelsang of the Agricultural Cooperative Service for his assistance in planning the research and reviewing drafts of our manuscript. We also want to thank Martin Fischer who assisted in the survey of the fertilizer firms.

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INTRODUCTION

The Problem

The retail distribution of fertilizer has increasingly shifted to farmer owned cooperatives. Nationally, in 1950-51, cooperatives retailed 15 percent of total U.S. sales to farmers; in 1975-76 they accounted for 36 percent. How or why agricultural cooperatives have achieved this share increase, however, is not well documented. Are farmers attracted to cooperatives because of a lower net price for fertilizer? Are they attracted by more and/or better services? Or are there other reasons? Did the fact that numerous strong local and regional cooperatives already existed when expanded fertilizer use began in the 1950's permit them to attain a position of prominance in the farm supply retailing?

In response to these and related questions, the Agricultural Cooperative Service (U.S. Department of Agriculture) commissioned several "comparative performance" studies designed to investigate the effectiveness of the cooperative movement. This report presents the results of one of these studies. Its primary purpose was to determine if there are differences in structure and performance between cooperative and noncooperative fertilizer retailers. If differences do exist they could account for cooperatives growing share of fertilizer markets and may indicate how the market shares will change in the future.

Objectives

The objectives of this study were:

1. to describe the general market structure and retail firm size and operating characteristics for cooperative and noncooperative fertilizer retailers in Minnesota.

2. to compare the performance of cooperatives and noncooperatives in retail fertilizer markets in Minnesota in terms of net prices paid by farmers, services provided with fertilizer and other aspects of the organization of these firms and their operating practices

3. to suggest additional research needs on cooperative impacts on market performance.

Research Procedures and Data

The basic technique of analysis for this study was to compare cooperatives and noncooperatives in terms of firm organization, business practices, and economic performance. A sample of firms was drawn for 18 local markets for fertilizer in Minnesota. In depth interviews were conducted for at least one cooperative or noncooperative in each market regarding the nature of competition in that market and the role that cooperatives play in it. Information on quoted prices, patronage refunds, services provided, volume of business, equipment, facilities, and operational policies were obtained. These data allowed for numerous comparisons between cooperative and noncooperative firms.

Standard statistical tests were used for determining the significance of observed differences between cooperatives and noncooperatives. The t-test was used to test the difference between two mean values of measured variables. The F-test was used to test for differences of multiple comparison of means. Chi-squared analysis was used to test for differences in proportions of sample firms with specified characteristics. The nature of the data and the number of comparisons determined the statistical test that was used. A brief description of each test is presented in Appendix A.

Sample Selection

The principle analytical objective of the survey was to measure the performance differences of cooperatives compared to noncooperatives retail fertilizer dealers in their market environment. Performance measures of firm types and market settings can be studied to determine if the presence of one type of firm may have influenced overall market performance results.

There were 730 retail distributors of fertilizer for farm use in Minnesota in 1978. The number was nearly equally split between cooperatives and noncooperatives, 335 and 395, respectively. This enumeration of distributors was determined from data collected by the Minnesota Agronomy Service in the Department of Agriculture and by using listings in local telephone directories.

To obtain data for comparison of cooperative and noncooperative fertilizer distributors, 60 firms were interviewed during the summer of 1978. This sample of 60 firms was selected to represent type of farming areas, type of firm, and nature of immediate competition facing each firm.

The types of farming areas in the state are those used by the state's Federal Crop and Livestock Reporting Service. These regions, illustrated in Figure 1, are the Lake States Dairy, Western Corn Belt, Spring Wheat, Lake States Forest, and Metro Counties. The Western Corn Belt region accounted for almost half of all distributors in the states with 344 retail fertilizer distributors, 180 noncooperatives, and 164 cooperatives. The Lake States Dairy region had 263 retail farm fertilizer firms; Region 3, Spring Wheat, has 95 retail firms; and Region 4, Lake States Forest, had 14 retail firms. Region 5, Metro Counties (Hennepin and Ramsey Counties), had 14 retail firms.

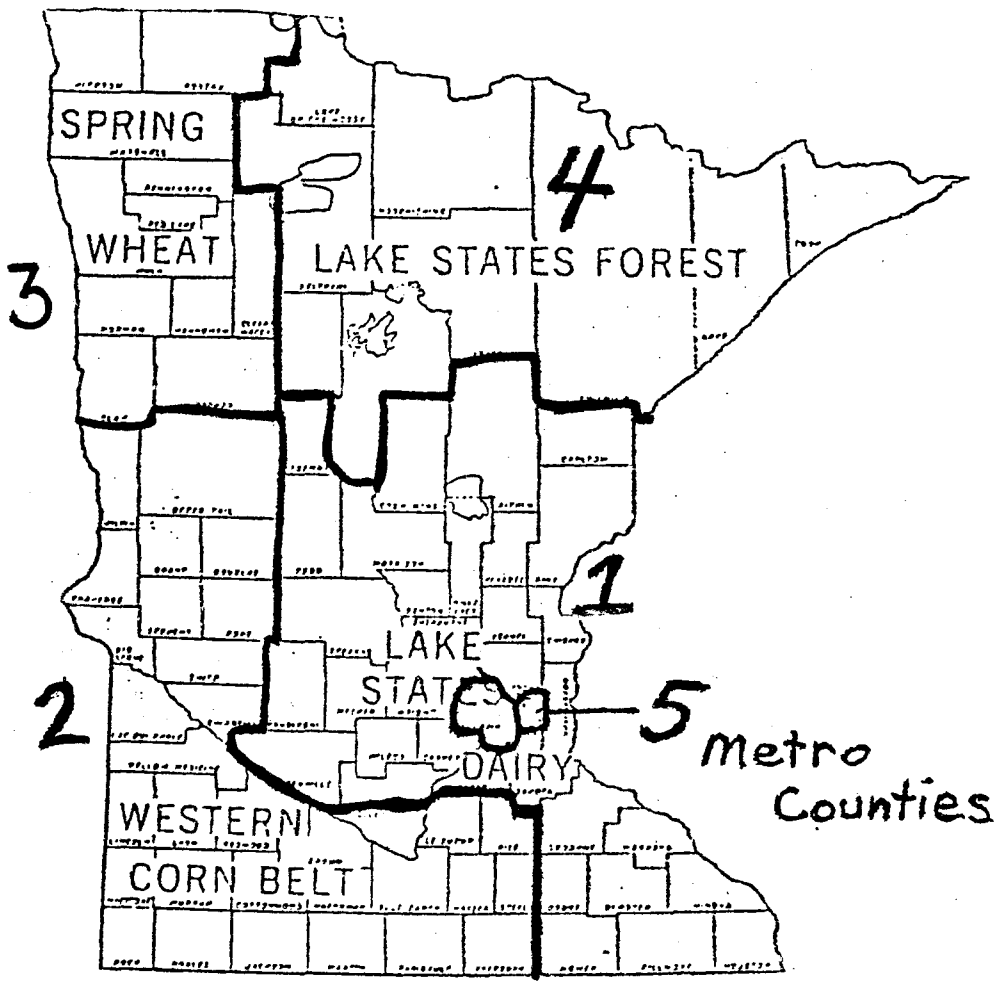


Figure 1. Types of farming areas in Minnesota--generalized by Crop Reporting Districts, U.S. Department of Agriculture.

For classification of firms according to type of immediate competition, all were grouped into town type. Five different town types were specified: (1) mixed towns (N-C), towns with at least one coop and one noncoop, (2) noncoop-noncoop towns (N-N), towns with at least two noncoops, no coops; (3) coop-coop towns (C-C), towns with at least two coops, no noncoops; (4) single coop towns (C), towns with only one coop, no noncoops; and (5) single noncoop towns (N), towns with only one noncoop, no coops. Of the five-town competition types, the mixed town types accounted for the largest number of retail fertilizer firms—210 noncoops and 180 coops, Table 1. The single coop town type had the second largest number of retail firms—111 retail coops.

The population listing of fertilizer distributors by farming regions and town competition types was used for selecting sample firms for interviews. Sample firms were randomly chosen by block design as follows. Twelve firms were selected for each town (or market) type, Table 2, For the mixed towns, coop-coop towns, and noncoop-coop towns, six towns each were selected with two firms in each of the town types. For the mixed town, a coop and noncoop were selected in each town. For the single coop and single noncoop town groups, 12 towns each were selected. Thus, in each town type, 12 firms were selected for interview. This procedure resulted in an equal number of coop and noncoop firms in the sample. The number of firms in each grouping was determined so that chi-square tests could be reliably used for some of our subsequent analyses and comparisons.

The number of sample firms in each region, Tables 3 through 5, was selected to yield an approximately proportional sample for the Spring Wheat, Corn Belt, and Lake States Dairy regions. No firms were selected from Regions 4 and 5 because of the relatively small agricultural sectors and the small numbers of farm fertilizer retailers in those regions.

GENERAL CHARACTERISTICS OF THE FERTILIZER INDUSTRY

To provide a perspective on the relationship of retail fertilizer distribution to the other sectors of the industry, let us first examine some of the general industry characteristics. In this section, we will briefly describe the fertilizer marketing and production processes, the size of fertilizer markets in Minnesota, and the number and functions of fertilizer firms in Minnesota.

The Production and Marketing Process

The production and marketing system for fertilizer has changed significantly since the early 1950's. Prior to that time, the primary nutrients, nitrogen (N), phosphate (P_2O_5), and potash (K_2O), were produced or mined and shipped to local manufacturing firms in liquid and

Table 1. State totals for the number of retail firms by town competition types, 1978.

Town category	Number of towns with fertilizer distributors	Number of Coops	Number of Noncoops	Total number of firms
Mixed towns	138	180	210	390
Coop-coop towns	20	44	--	44
Noncoop-noncoop towns	38	--	87	87
Single coop towns	111	111	--	111
Single noncoop towns	98	--	98	98
Totals	405	335	395	730

Table 2. Sample distribution for fertilizer firms in Minnesota.

Town category	Number of towns chosen	Number of coops chosen	Number of noncoops chosen	Total number of firms chosen
Mixed towns	6	6	6	12
Coop-coop towns	6	12	0	12
Noncoop-noncoop towns	6	0	12	12
Single coop towns	12	12	0	12
Single noncoop towns	12	0	12	12
Totals	42	30	30	60

Table 3. Number and kind of sample firms selected in Farming Region 1. Lake States Dairy

Town category	Number of towns chosen	Number of coops chosen	Number of noncoops chosen	Total number of firms chosen
Mixed towns	2	2	2	4
Coop-coop towns	2	4	0	4
Noncoop-noncoop towns	2	0	4	4
Single coop towns	4	4	0	4
Single noncoop towns	4	0	4	4
Totals		10	10	20

Table 4. Number and kind of sample firms selected in Farming Region 2. Western Corn Belt.

Town category	Number of towns chosen	Number of coops chosen	Number of noncoops chosen	Total number of firms chosen
Mixed towns	3	3	3	6
Coop-coop towns	3	6	0	6
Noncoop-noncoop towns	3	0	6	6
Single coop towns	6	6	0	6
Single noncoop towns	6	0	6	6
Totals		15	15	30

Table 5. Number and kind of sample firms selected in Farming Region 3. Spring Wheat.

Town category	Number of towns chosen	Number of coops chosen	Number of noncoops chosen	Total number of firms chosen
Mixed towns	1	1	1	2
Coop-coop towns	1	2	0	2
Noncoop-noncoop towns	1	0	2	2
Single coop towns	2	2	0	2
Single noncoop towns	2	0	2	2
Totals		5	5	10

ungranulated form. These local manufacturers chemically mixed and processed the materials into dry fertilizers which were bagged for distribution. Bagged fertilizer was shipped to retail outlets for sale to farmers (Figure 2).1/

Beginning in the 1950's, technological change made the manufacture of uniform granulated fertilizer by primary producers possible. This permitted fertilizers of different chemical content to be easily mixed together in a mechanical (nonchemical) bulk blending process. This innovation dramatically modified fertilizer marketing channels (Figure 3).2/

The production process for primary ingredients is still pretty much as it was in the pre-1950's period. Nitrogen is taken from the air and, with natural gas, is used to produce anhydrous ammonia, the basic input for nitrogen fertilizers. Phosphate and potash raw materials are mined. Ground phosphate rock is mixed with sulphuric acid to produce a more usable phosphate. Processing of potash is a washing process to eliminate impurities. The primary stocks are then transforms in granulation processes. Granulation may be done by the primary producer or by a specialized activity of a "granulator." Granulators have substituted in the marketing channel for the intermediate manufacturers, but are usually located at or near primary production sites. The granulators process the basic nutrients into a granular form, a form which is easier to store, handle, and blend. Granulators sell to three types of buyers: (1) to farmers, (2) to retail distributors who may bulk blend ingredients for sale to farmers or who sell the single nutirent product to farmers, or (3) to bulk blenders of dry and liquid fertilizers who sell to retail distributors (Figure 3).

Fertilizer is also marketed in liquid and gas form. The only gas of major significance is anhydrous ammonia, the basic ingredient for production of the dry nitrogen fertilizers. Some of the gas is directly shipped from processor to retailer or to a distribution wholesale center as a liquid under pressure, then to retailers. The anhydrous ammonia gas is not modified or blended in any way by the retailer. The retailer usually applies or provides the equipment to the customer for application of this gas fertilizer. Liquid marketing channels are similar to gas marketing channels.

Fertilizer Use in Minnesota

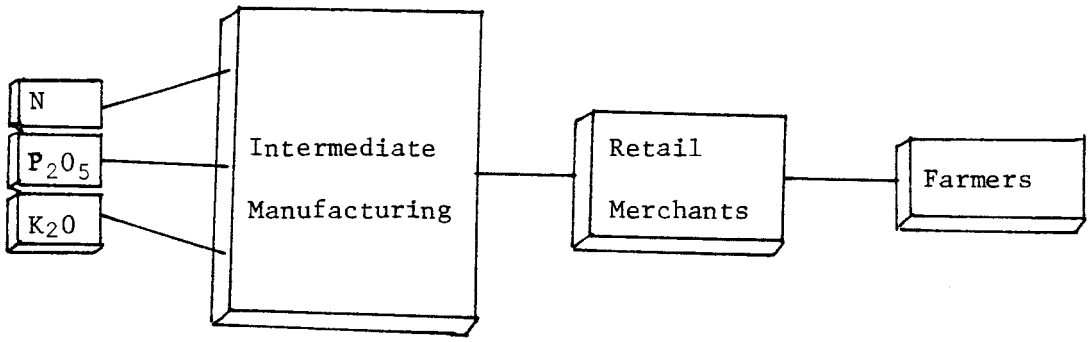
Minnesota is the eighth ranked state in the United States in total fertilizer use. Minnesota farmers used 1,966,306 tons of fertilizer in the 1978 fertilizer marketing year, July 1, 1977, through June 30, 1978.3/ California was first in fertilizer tonnage in 1978 with 3,921,945 tons.

1/ Dahl, Dale C. and Richard J. Magnani, "Structural Changes in Minnesota Fertilizer Distribution," Minnesota Agricultural Economist, No. 602, Agricultural Extension Service, University of Minnesota, August-September 1978.

2/ Ibid.

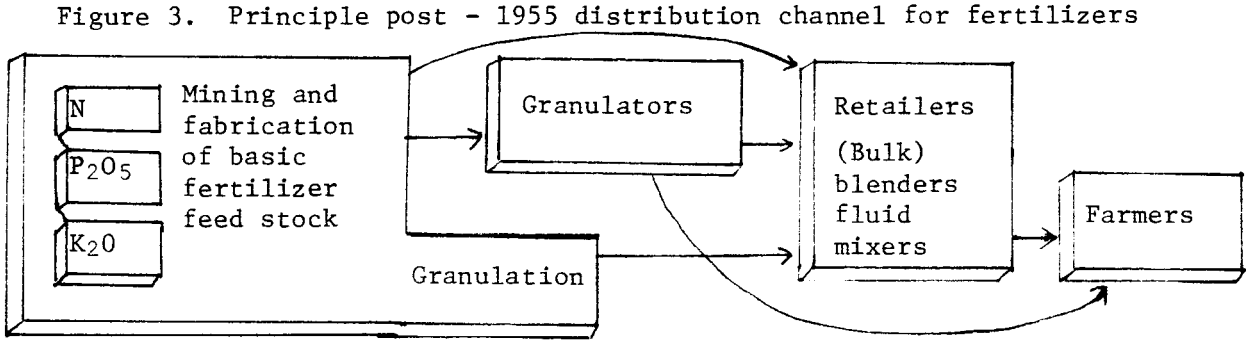
3/ Hargett, Norman, and Janice Berry, "1978 Fertilizer Summary Data" ISSN:0146-1850, National Fertilizer Development Center, Tennessee Valley Authority, Muscle Shoals, Alabama, p. 62.

Figure 2. Pre-1955 fertilizer distribution system*



*Taken directly from Dale C. Dahl and Richard J. Magnani, "Structural Changes in Minnesota Distribution, Minnesota Agricultural Economists, Agricultural Extension Service, No. 602, Aug.-Sept. 1978, p. 1.

Figure 3. Principle post - 1955 distribution channel for fertilizers



In terms of nutrient tons of use, Minnesota ranks fourth in the nation. Nutrient tons is the measure of the quantity of the primary fertilizer nutrients contained in a ton of applied fertilizer. It does not include the tonnage of filler or carriers used with the fertilizer. Minnesota farmers used 1,124,435 tons of nutrients in the 1978 fertilizer year. Illinois led the nation, with 1,918,525 tons of nutrients.

Commercial fertilizer use in Minnesota includes all three primary plant nutirents—nitrogen (N), phosphate (P_2O_5), and potash (K_2O) plus secondary and micronutirents. Some of these ingredients are blended into mixed fertilizers for sale and application by farmers. Sometimes they are sold and applied as one primary nutrient. These are commonly referred to as direct application fertilizers. Direct application fertilizer accounts for the largest share of sales, about two thirds of the market in 1978 (see Table 6). Note that direct application fertilizer has expanded its share of the total fertilizer market from 58 percent in 1974 to 64 percent in 1978. Nitrogen and potash fertilizers are most commonly used as direct application fertilizer. Phosphates are more commonly used in mixtures.

Of the direct application nitrogen materials used in Minnesota, anhydrous ammonia has the most tonnage—319,918 tons in the 1978 fertilizer year.4/ Urea, a dry bulk fertilizer, was second in tonnage in the nitrogen group, with 175,727 tons. Nitrogen solutions were third, with 119,959 tons.

Superphosphates, with over 22 percent P_2O_5, were the most important direct application phosphate materials consumed in Minnesota, with 74,211 tons sold in the 1978 fertilizer year. Ammonium phosphate was second, with 3,698 tons. Superphosphates, with less than 22 percent P_2O_5, were insignificant, with only 32 tons. Superphosphates with less than 22 percent P_2O_5 are essentially out of the picture in Minnesota because of the rising costs of transportation. The same amount of nutrient tons can be obtained with much lower transportation costs with higher concentrated superphosphates.

Of the direct application potash materials sold in Minnesota, 0-0-50 to 0-0-62 (potassium chloride 50 to 62 percent) grades had the most tonnage—501,603 tons consumed in the 1978 fertilizer year. All other direct potash materials amounted to 4,143 tons only.

4/ Ibid., p. 62.

Table 6. Fertilizer sales in Minnesota for the fertilizer market years, 1974 through 1978. a/

	1974	1975	1976	1977	1978
	tons				
Total fertilizer material	1,800,339	1,926,786	2,185,578	2,058,038	1,966,306
Mixed Fertilizer	747,813	756,751	806,523	744,918	686,293
Direct Application material	1,045,363	1,158,319	1,364,882	1,297,779	1,265,720
Secondary and micronutrients	7,163	11,726	14,173	14,341	14,293
	nutrient tons				
Total plant nutrients in all fertilizer materials	1,003,796	1,069,449	1,233,758	1,177,437	1,124,435
Total N	412,780	450,318	561,272	521,019	491,719
Total P_2O_5	267,937	290,000	321,888	295,622	274,678
Total K_2O	323,079	329,131	350,598	360,796	358,038

a/ Hargett, Norman, and Janice Berry, "1978 Fertilizer Summary Data," ISSN:0146-1850, National Fertilizer Development Center, Tennessee Valley Authority, Muscle Shoals, Alabama, p. 62.

Mixed fertilizers were not as important as direct primary application fertilizers in Minnesota. Mixed fertilizers have two or three of the primary nutrients—N, P_2O_5, and K_2O. The five principle mixed fertilizers sold in Minnesota in the 1978 fertilizer year were (1) diammonium phosphate (dap) 18-46-0, 339,013 tons; (2) 9-23-30, 28,589 tons; (3) 10-34-0, 24,451 tons; (4) 7-21-7, 18,146 tons; and (5) 6-24-24, 17,568 tons.5/

Minnesota Fertilizer Firms

There are no plants that produce primary fertilizer ingredients in Minnesota; all primary ingredients are imported from outside the state. Large numbers of granulators, liquid fertilizer processors, and retail distributors operate within the state however, (Table 6). These businesses are concentrated in the heavy crop-producing areas—the Red River Valley and the southern third of the state.

The data in Table 7 show that liquid fertilizer producers account for the largest share of fertilizer processing firms. Nitrogen is the only fertilizer that is granulated within Minnesota. The data show that the total number of processing firms increased slightly between 1973 and 1977.

There were more than 500 retailers of fertilizer in the state in 1977. All of them are engaged in some type of fertilizer blending. It appears that most provided dry blending.

Some of the fertilizer retailers handled only fertilizer, but 75 percent handled at least one other line of farm inputs in 1976 (Table 8). The other inputs fall into the standard purchased input groupings—seed, feed. petroleum, farm chemicals, or farm hardware. Noncooperative firms appear to specialize in fertilizer more often than cooperative firms (32 percent for noncooperative versus 18 percent for cooperatives).

Retail fertilizer firms averaged 5,482 tons of sales in 1977, but the largest number of distributors were in the size range from 2,000 to 3,000 tons of sales annually. Noncooperative firms averaged somewhat larger sales than cooperative firms—5,983 tons to 4,292 tons.6/

STRUCTURE OF MINNESOTA FERTILIZER MARKETS

The data from the survey of the 60 retailers provided information on operating and size characteristics of the firms.

5/ Commercial Fertilizers, Sp.Cr. 7 (11-78), Economics, Statistics, and Cooperatives Service, U.S. Department of Agriculture, p. 22.

6/ Dahl, Dale C., and Richard J. Magnani, op. cit., p. 13.

Table 7. Numbers and percentages of retailers and processors in Minnesota involved in fertilizer distribution, 1973 and 1977.

Activity	1973		1977	
	No.	Percent	No.	Percent
Processor of primary ingredients:				
Ammoniation granulators	6	1	5	.7
Aqua ammonia producers (using anhydrous ammonia)	40	7	24	4
Nitrogen solution manufacturing (urea-ammonium solutions)	2	.4	1	.2
Low-pressure nitrogen solution manufacturing	19	3	22	3
Liquid hot mix manufacturing (ammoniation of phosphoric acid)	4	.7	5	.7
Liquid cold mix manufactuers (dissolving potash for mixed liquid grades)	19	3	28	4
Suspension manufacturing	19	3	22	3
Retailers:				
All firms involved in bulk blending	422	76	494	77
Exclusive bulk blenders	341	62	414	64
Firms involved in both bulk blending and liquid blending	35	6	52	8
All firms involved in liquid blending	128	23	149	23
Exclusive liquid blenders	83	15	79	12
All firms in specialty products:	23	4	32	5
Exclusive specialty products	16	3	28	4
Total number of operations	552		642	

Source: Adapted from Dale C. Dahl and Richard Magnani, "Structural Changes in Minnesota Fertilizer Distribution," Minnesota Agricultural Economist, No. 602, Agricultural Extension Service, University of Minnesota, August-September 1978, p. 4.

Table 8. Numbers of fertilizer distributors by type of firm and products handled, 1976.

	Fertilizer only		Fertilizer and other farm inputs[a/]		Firm Totals
	No.	%	No.	%	
Firm type	170	25	509	75	679
Cooperatives	62	18	277	82	339
Noncooperatives. . . .	108	32	232	68	340

a/ Seed, feed, petroleum, farm chemicals, and/or farm hardware.

Source: Adopted from Dale C. Dahl and Richard J. Magnani, "Structural Changes in Minnesota Fertilizer Distribution," Minnesota Agricultural Economist, No. 602, Agricultural Extension Service, University of Minnesota, August-September, 1978, p. 4.

Ownership and Control

Control of local retail outlets depends on the type of business organization. For cooperatives, two types of organizations are operating— (1) locally owned and operated independent cooperatives who are affiliated members of regional federated supply cooperatives and (2) fully owned retail outlets of regional supply cooperatives. Two of the retailers were owned by suppliers and the other 28 were affiliated members of the regional cooperatives.7/

All noncooperative fertilizer retailers were single plant firms, 23 of the 30 noncooperative firms were independent, locally owned firms with one business location. Of these, nine were single proprietorships, five were partnerships, and seven were locally owned corporations. The other seven noncooperatives were franchise operations for manufacturers and wholesalers of fertilizer. Franchise arrangements are usually beneficial to the retail outlet in several respects. Financing, equipment, facilities, and technical assistance may be provided to the franchise firm. In many respects, the franchising noncooperative supplier provides to the retailer many services that are provided by regional cooperatives to their federated members.

Sources of Supply for Fertilizer

Fertilizer retailers buy from the processors and granulators described above. Some buy only from one regular supplier: others buy from several suppliers. Cooperatives appear to depend more frequently on one supplier than noncooperatives (Table 9). Eighteen of the 30 cooperatives buy fertilizer from only federated regional supply cooperative of which they are a member. Twelve buy fertilizer from more than one supplier, including noncooperative suppliers.

7/ Ibid., pp. 14-15.

Table 9. Source of supply for 60 Minnesota fertilizer retailers, 1978.

Type of retailer	One cooperative wholesaler	More than one cooperative wholesaler	One non-cooperative wholesaler	More than one non-cooperative wholesaler	At least one cooperative and one non-cooperative wholesaler
Cooperative	18	9	0	0	3
Noncooperative	3	0	12	8	7

Table 10. Degree of specialization for 60 Minnesota fertilizer retailers, 1978.

Firm type		Fertilizer sales as percent of total sales				
		0 to 19	20 to 39	40 to 59	60 to 79	80 to 99
Cooperatives	Number	15	5	5	3	2
	Percent	50	16	16	10	6
Noncooperatives	Number	9	3	7	6	5
	Percent	30	10	23	20	16
All Minnesota firms[a]	Number	286	95	148	113	88
	Percent	39	13	20	15	12

a/Computed by population weighting of sample frequencies

Noncooperative firms rely less frequently on one fertilizer supplier than noncooperatives, Table 9. Less than one half (12 firms) of the noncoops surveyed bought from one supplier. Others relied on two or more suppliers. Seven (almost 25 percent) bought from cooperative suppliers.

Specialization

The degree of specialization in fertilizer distribution varied considerably among firms, Table 10. Twenty-five of the cooperative retailers (83 percent) had less than 60 percent of sales accounted for by fertilizer. Nineteen of the noncooperative retailers had less than 60 percent of their sales accounted for by fertilizer. The data indicate that the firms are generally diversified. Only 11 percent of the firms specialize in fertilizer with 80 to 100 percent of total sales generated from fertilizer, Table 10.

The average percentage of total farm supply sales accounted for by fertilizer does not differ significantly between cooperatives and noncooperatives, Table 11. Fertilizer accounts for an average of 55 percent of farm supply sales for all firms. Fertilizer as a percent of total sales (farm supplies and marketings of farm products) does differ between cooperatives and noncooperatives, 29.7 and 43.2 percent respectively. This indicates that supply cooperatives are somewhat more diversified than noncooperatives into the marketing of farm products.

Both specialization and diversification have advantages. Multiproduct firms have advantages over specialized firms in that they can allocate the fixed costs of operation over a wider range of products as well as reduce the seasonality of business activity which is inherent in fertilizer distribution. On the other hand, firms that specialize in fertilizer distribution have the advantage of devoting all attention and expertise to fertilizer needs and technical advice for farmers.

Table 11. Fertilizer as a percent of sales for Minnesota cooperative and noncooperative retailers, 1978.

	Average percent of all farm supply sales	Average percent of all sales
Cooperatives	52.0	29.7
Noncooperatives	58.3	43.2
All Minnesota firms[a]	55.4	37.0
T-Test for difference between cooperatives and noncooperatives	-1.04	-1.86*

a/ Computed by population weighting sample percentages.

* Significant at ten percent probability level.

Size of Firms

Coops and noncoops sold approximately the same average dollar amount of fertilizer for the period July 1, 1977, to June 30, 1978 (Table 12). The difference that did exist was not statistically significant at the five percent probability level.

Table 12. Average dollar sales for specific firm group, fertilizer year 1977-78.

	Total fertilizer sales	Total firm sales
Cooperatives	$513,256.30*	$2,813,859.60*
Noncooperatives	$503,231.24*	$2,000,947.00*
All Minnesota Firms[a]	$507,832.74	$2,374,073.80

* The t-test indicates no statistically significant difference between cooperatives and noncooperatives at the 5 percent probability level.

a/ Computed by population weighting of sample averages

The average sample firm sold 3,649.8 tons of fertilizer from June 30, 1977, to July 1, 1978. Coops sold an average of 3,799.7 tons and noncoops sold an average of 3,499.7 tons. Thus, sample firms in 1978 averaged somewhat smaller sizes than the 1977 data indicated.

The size of sample firm is not much larger than that necessary to achieve necessary economies of size. In 1970, Rathjen found that a firm in Minnesota needed to sell at least 3,000 tons of fertilizer to break even.8/ The guide may be somewhat misleading because the averages are for total tonnage of fertilizer products. The actual nutrient content of primary nutrients (N, P_2O_5, and K_2O) sold has increased significantly over this time.

Product Form and Specification

Of the four major fertilizer forms—gas, liquid bulk, dry bulk, and bagged fertilizer, dry bulk accounted for the largest volume of sales for both cooperatives and noncooperatives, Table 13. Though the average annual volumes for all four fertilizers differ between cooperatives and noncooperatives, the difference is statistically significant at the 1% probability

8/ Rathjen, Robert A., An Economic Analysis of Fertilizer Retailing in Minnesota, Unpublished Ph.D. thesis. Department of Agricultural Economics, University of Minnesota, Dec. 1970, p. 111.

level for liquid bulk, only, with 335.8 tons for cooperatives and 1301.3 tons for noncooperatives. The difference between cooperatives and noncooperatives in average volume of dry bulk sales is significant at the 20 percent probability level. Cooperatives dry bulk sales exceed that of noncooperatives by 800 tons.

Table 13. Average tons of fertilizer sold for 60 Minnesota retailers, 1977-78 fertilizer year.

Type of firm	Fertilizer form			
	Gas[a]	Bagged fertilizer	Dry bulk	Liquid bulk
Cooperatives:[b]				
Tons	977.0	266.9	3,082.6	335.8
Noncooperatives:[b]				
Tons	1,163.5	213.6	2,247.3	1,301.3
All Minnesota firms:[c]				
Tons	1,074.8	235.1	2,663.9	964.5
T-test of difference between coop and noncoop	.62	.59	1.51	3.01*

a/ Anhydrous ammonia was the only gas fertilizer form sold by the sample firms in the 1977-78 fertilizer year.

b/ Average for firm's selling these fertilizer forms

c/ Computed by population weighting of sample averages

* Significant at 1 percent probability level

Dry bulk fertilizer was sold by 49 out of 60 firms in the survey. Urea (45-0-0) was the leading dry bulk nitrogen fertilizer. Superphosphate (44 percent) was the leading dry bulk phosphate product, and potash (0-0-60) was the leading dry bulk potash fertilizer. Diammonium phosphate (DAP) was the important dry bulk product that includes both nitrogen and phosphate (18-46-0).

Each of the dry direct application materials can be purchased and applied in that form by the farmer. However, the major trend since 1955 is blending of dry direct application materials by the distributors to get the exact analysis of N, P_2O_5, and K_2O necessary for the crop of field. For these transactions, the farmer is billed for each dry direct application product used in blended product. For example, if a farmer receives 18 tons of blended fertilizer of which six tons is urea (45-0-0), four tons is

phosphate (P_2O_5), 0-44-0, and eight tons is potash (K_2O), 0-0-60, the farmer is billed at the per-ton price for each fertilizer.

Liquid bulk fertilizer was sold by 35 out of 60 firms in the sample. The liquids sold by these firms were usually liquid nitrogen (28-0-0) or 10-34-0. A few of the firms—6 out of 60—specialize almost entirely in liquid bulk. These firms blend their liquid bulk product to specification like the dry bulk firms. These six liquid bulk retailers were noncoops located in the south-southwest region of the state.

Bag fertilizer was sold only by 27 (less than one-half) of 60 firms. It is a minor product form even for these distributors. Farmers use bag fertilizer for pop-up in corn fields or for small parts of acreage that were not fertilized with bulk fertilizer.

The six most commonly sold fertilizers for the 60 sample firms in 1978 were: (1) anhydrous ammonia gas, (2) liquid nitrogen, (3) urea, (4) diammonium phosphate, potash, and superphosphate. Numerous other forms and blends were sold, but in small quantities relative to these six. The average annual volume for each fertilizer is listed in Table 14. Differences in annual volumes between cooperatives and noncooperatives are significant for diammonium phosphate, superphosphate (46%) and liquid nitrogen at the 20 percent probability level. Liquid nitrogen sales of noncooperatives are about twice the sales of cooperatives. Cooperatives, on the other hand, have higher average sales of phosphates. Cooperatives diammonium phosphate are about 33 percent higher than those of noncooperatives.

This data analysis supports a view that was frequently expressed during our survey. That is, noncooperatives are moving more aggressively into the liquid fertilizer markets than cooperative firms. For other fertilizers, however, there is little, if any, difference between cooperatives and noncooperatives in volume of sales.

Table 14. Average tons sold of each of the six most common fertilizers[a] sold by the 60 Minnesota retail fertilizer firms by firm type, 1978.[a]

Type of firm	Average Quantity of: Anhydrous Ammonia	Potash	Urea	Diammonium Phosphate	Superphosphate 46 percent	Liquid nitrogen
	tons sold 1978					
Cooperatives	977	1271	474	1231	223	286
Noncooperatives	1163	1081	326	564	111	571
All Minnesota firms[b]	1087	1175	410	937	191	470
*t-test	-.62	.65	.90	2.06*	1.6	-1.7**

a / Average computed for firm's selling specific fertilizer only.

b / Computed by population weighting of sample averages.

* Indicates a significant difference at the 5 percent level.

** Indicates a significant difference at the 10 percent level.

Seasonality of Sales

Application of fertilizer is obviously a very seasonal process which causes extreme seasonality in retail fertilizer sales. In Minnesota, May is the heaviest month of application of fertilizer (Figure 4), but firms report a shift to applying more fertilizer at other times during the year, particularly in the fall. There are several advantages to fall application of fertilizer: (1) it may enable farmers to plant earlier in the following spring; (2) the retail firm can more easily deliver fertilizer in the fall than during the busy spring season; (3) the retail firm is more likely to be able to custom apply the fertilizer in the fall than during the spring; and (4) there is less soil compaction from machinery during the fall than in the spring.

The ideal time to apply fertilizer depends on soil, weather, nutrient, and crop. The potash products are more suitable to fall application than nitrogen and phosphate products. In most instances, potash application in the fall with plow-down is more effective than spring top-dressing because potash moves slowly through the soil. Nitrogen is best applied just before it is needed by the plants—spring or early summer. Phosphates can sometimes be applied in the fall if there is enough clay and organic matter to hold it to the soil.

The seasonal characteristics of fertilizer sales, deliveries, and payments by the farmer for the sample firms for 1977-78 are illustrated in Figure 4. Deliveries appear to follow immediately after sale. Payments lag sale and delivery by one to two months. The two peaks in sales and deliveries occur in May and October. Almost 50 percent of all fertilizer was sold and delivered in May.

The seasonality of ideal fertilizer usage makes the retailing of fertilizer an important time-allocating problem. The retail firm needs to plan for adequate supplies of fertilizer, equipment, and labor when the farmers want to put fertilizer on their land. In fact, it was reported by several interviewees that availability of fertilizer, delivery, and application equipment, not price, was the key factor in farmers' choice of fertilizer suppliers.

Almost all firms in the sample indicated that they try to spread fertilizer deliveries over the year. In this way, the equipment is used more than one month of the year. Plus, if sales are spread out, the firm does not need as much equipment to meet peak demand periods.

Plant and Equipment

The firm's fertilizer storage capacity, blending facilities and quantity and qaulity of application equipment determine the firm's ability

Figure 4. AVERAGE PERCENT OF TOTAL FERTILIZER SOLD, DELIVERED AND PAID FOR Each Month for Fertilizer Year 1977-78

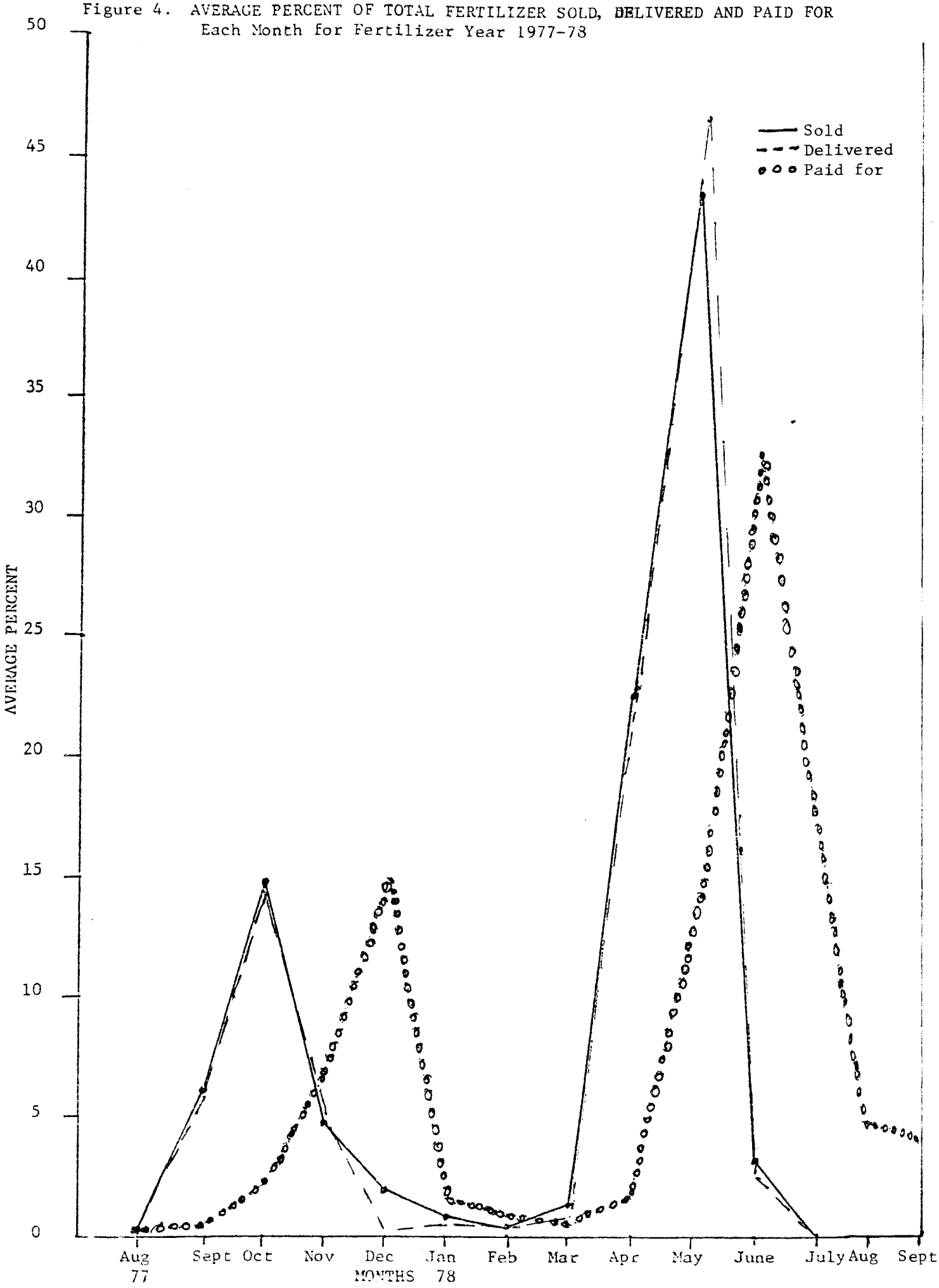


Table 15. Equipment and facilities for 60 Minnesota fertilizer retailers 1978.[a]

	Coops	Noncoops	t-test	All Minn. firms[b]
Average number of liquid applicators	1.58	1.21	1.86	1.34
Average liquid storage capacity (tons)	232	304	1.32	279
Average number of dry bulk spreader	5.6	4.8	2.00*	5.20
Average number of floaters	.96	.64	2.25*	.80
Average dry bulk storage capacity (tons)	1600	1226	2.53**	1412
Percent of firms with bulk blending equipment	63	63		63
Average number of nurse tanks for gas fertilizer	23.96	27.26	1.17	25.82
Average number of tool bars for gas fertilizer	1.5	1	1.61	1.22
Average gas fertilizer storage capacity (tons)	164	142	1.47	151

a/ Average for firms selling the specific fertilizer or form of fertilizer

b/ Computed by population weighting of averages for sample firms

* Significant at the 10 percent level

** Significant at the 5 percent level

to handle peak fertilizer use periods. It appears coops have more equipment and facilities than noncooperatives for dry bulk fertilizer. Blending equipment is an exception, however, This information somewhat supports the frequently asserted proposition that coops can serve customers better during peak periods. Thirty-eight (19 coops and 19 noncoops) of the 50 firms handling dry bulk fertilizer have some sort of mechanical blender for dry bulk fertilizers. Of the 50 firms selling dry bulk, the average number of dry bulk spreaders was 5.6 for coops and 4.8 for noncoops which are significantly different at the 10 percent probability level, Table 15. The average number of floaters was .93 for coops and .64 for noncoops, significantly different at the 5 percent probability level. The average dry bulk cooperative firms had 1600 tons of storage capacity for dry bulk compared to 1,326 tons for noncoops. This difference is significant at the 10 percent probability level.

Coops and noncoops have about the same equipment and facilities for gas fertilizer. This includes such items as nurse tanks that are used to haul gas from the retailer's storage to the farm, tool bars for application of gas on the field, and storage capacity. None of the observed cooperative/noncooperative differences are significant even at the 10 percent probability level.

For liquid fertilizers, noncoops and coops have the same storage capacity and equipment. None of the differences between cooperatives and noncooperatives are significant at the 10 percent probability level. Thus we estimated that the average Minnesota firm has 279 tons of storage capacity 1.34 applications per firm for liquid fertilizer.

Distribution Areas and Competition

Similar numbers and types of competitors were found for both cooperatives and noncooperatives. In the interviews, all respondents were asked to map their firm's distribution area and to indicate the number of competitors in this area. Each firm had an average of 5.36 competitors within that area, 3.12 cooperative competitors and 2.26 noncooperative competitors. Table 16. The number of competitors was similar for both cooperative and noncooperative firms, 5.07 and 5.46, respectively.

Table 16. Average number of competitors in distribution areas for responding Minnesota fertilizer firms, 1978.

Firm Type	Average number of cooperative competitors	Average number of noncooperative competitors	Average number of all competitors
Cooperatives	3.30	2.77	5.07
Noncooperatives	2.96	2.50	5.46
T-value for testing average numbers between coops and noncoops	-.82	-.54	-.85
All Minnesota firms [a]	3.12	2.26	5.36

a / Computed by population weighting of sample averages

Market share is an indicator of the level of competition in the relevant market. The relevant marketing area for computing this share for each distributor is difficult to define. It may include areas other than the actual distribution area of each retailer. Nevertheless, the concentration within the distribution area is a definable area; thus, we used this in computing average market concentration. They were computed from estimates by each of the sample firms of the share of total fertilizer sales in its distribution area accounted for by itself, its largest competitor, and its second largest competitor. The shares are relatively large, Table 17.

Table 17. Concentration of dry bulk fertilizer sales in distribution areas for responding Minnesota fertilizer firms, 1977-78.

Sample firm type	Sample firm	Sample firm's largest competitor	Sample firm's second largest competitor
	- - - - -Average percent of sales - - - - - - - - -		
Cooperatives	38.25	30.68	15.58
Noncooperatives	30.50	25.59	17.87
t-value (and significance) for testing average percents	1.26	1.31	-0.87
All Minnesota firms[a]	34.36	28.13	16.73

a/ Computed by population weighting of sample averages.

Each firm had an average of 34 percent of the dry bulk sales in its own distribution area, Table 17. The difference between cooperative and noncooperative shares were not statistically different at the 10 percent probability level. It is interesting that, on the average, the responding cooperative or noncooperative firm in each instance had the largest percent of that dry bulk sales in its distribution area of all competitors. This may indicate that each firm has some part of its distribution area where it has a locational advantage over all competitors. Note that concentration of sales is rather high in each firm's distribution area—79 percent for the largest three firms.

The concentration of sales for anhydrous ammonia was quite similar to those for dry fertilizer sales, Table 18. Each firm averaged 32 percent of the total sales of anhydrous ammonia in its own distribution area. Again, there was no statistical difference between cooperative and noncooperative shares. Also the responding firms averaged the highest share of sales in its distribution area, and the three largest sellers in the distribution area accounted for most of the sales.

Table 18. Concentration of anhydrous ammonia sales in distribution areas for responding Minnesota fertilizer distributors, 1977-78.

Sample firm type	Sample firm	Sample firm's largest competitor	Sample firm's second largest competitor
	- - - - - - - - - -Average Percent of Sales - - - - - -
Cooperatives	32.52(n=23)[a]	27.87(n=23)	17.40(n=18)
Noncooperatives	31.33(n=21)	24.00(n=21)	16.69(n=16)
t-value for coop-noncoop differences	.20	1.07	0.25
All Minnesota firms[b]	31.91(n=44)	25.91(n=44)	17.06(n=34)

a/ n indicates number of firms for which average was computed.

b/ Computed by population weighting of sample averages.

Buyers

Cooperatives have often asserted that they serve more of the small farmers than do the noncooperatives. To test this assertion, the percent of total fertilizer sales accounted for by the largest customer, the largest five customers, and the largest 25 customers of sample firms was computed for several fertilizers. Cooperatives and noncooperatives appear to serve the same size of purchasers in the anhydrous ammonia and liquid bulk product lines, average percentages of purchases were not statistically different, for all three customer groupings, Table 19.

For dry bulk and bag fertilizer, there are some statistical differences in the shares of purchases. The t-test indicates that the differences are significant for the largest 25 customers for dry bulk fertilizer and the five largest customers for bag fertilizer. Noncooperatives depend on their largest customers to a greater extent than do cooperatives. Because average size of cooperatives and noncooperatives is the same, these data do lend some support to the argument that cooperatives are serving the smaller volume purchasers.

COMPARATIVE PERFORMANCE ANALYSIS

Prices and Price Variations

Price levels are a major dimension of the economic performance of firms and markets. In this section, we analyze the impact of cooperative and other market and firm characteristics on the prices charged by Minnesota retail fertilizer distributors in 1978. Data on prices were obtained from the 60 sample firms for 11 different fertilizers. The following analysis examines only the six most commonly sold fertilizers—(1) anhydrous ammonia, (2) urea, (3) diammonium phosphate, (4) potash, (5) superphosphate (46 percent P_2O_5), and (6) liquid nitrogen. The products may be differentiated

Table 19. Average percent of sales accounted for by the largest customer, the five largest customers, and the 25 largest customers for 60 Minnesota fertilizer retailers, 1977-78.

Firm type	Average percent of sales by largest customer	Average percent of sales by five largest customer	Average percent of sales by 25 largest customers
		Anhydrous ammonia	
Cooperatives	8.59	27.91	54.41
Noncooperatives	8.24	25.29	63.38
All Minnesota firms[a]	8.41	26.55	59.06
t-test of coop-noncoop. differences	.17	.38	-1.36
		Liquid bulk fertilizer	
Cooperatives	6.42	27.33	52.08
Noncooperatives	12.85	26.60	61.80
All Minnesota firms[a]	10.87	26.85	58.41
t-test of coop-noncoop. differences	-1.02	.01	-.96
		Dry bulk fertilizer	
Cooperatives	6.08	19.42	44.04
Noncooperatives	8.18	24.68	62.80
All Minnesota firms[a]	7.13	22.06	53.44
t-test of coop-noncoop. differences	-1.28	-1.41	-2.93**
		Bag fertilizer	
Cooperatives	5.69	15.88	48.50
Noncooperatives	10.36	38.63	66.64
All Minnesota firms[a]	8.47	29.43	59.31
t-test of coop-noncoop. differences	-1.54	-2.15*	1.22

a/ Computed by population weighting of sample averages
* Significant at 5% probability level
** Significant at 1% probability level

by brand, by associated services and discounts, or by some other characteristic of the firm even though the chemical composition of the given fertilizer is identical.

The quoted retail fertilizer prices of the firms exhibited a considerable range during the spring of 1978. Superphosphate (46 percent) prices ranged from $140.00 to $179.00 per ton with an average for all firms of $154.72, Table 20. Largest absolute variations occurred for anhydrous

Table 20. Average quoted prices and price ranges for fertilizer for 60 Minnesota fertilizer retailers, 1978.

Fertilizer	Average price for sample firms	Range of prices
	- - -$/ton- - - -	- - - $/ton - - - -
Anhydrous ammonia	$167.28	$126.00 to $188.00
Urea.	162.64	137.00 to 181.00
Diammonia phosphate	185.69	175.00 to 200.00
Potash.	94.55	73.00 to 134.00
Superphosphate (46 percent) . . .	154.72	140.00 to 179.00
Liquid nitrogen	113.30	95.00 to 140.00

ammonia with a range from $126.00 to $188.00 per ton. There are more services which can be offered with anhydrous ammonia than other fertilizers which may explain its wider variation in quoted prices. The smallest absolute variation occurred for diammonium phosphate, with a range from $175.00 to $200.00 per ton.

Price Comparisons Between Firm Types

To determine whether or not the type of business accounted for some of the variation in fertilizer prices, we computed average 1978 prices for the sample firms and tested for significance of difference by the use of the statistical t-test. The null hypothesis, for the test is that the average price for each fertilizer does not differ between cooperative and noncooperative firms.

Quoted prices for fertilizer are, however, a somewhat misleading measure of the real price facing the farmer for any particular fertilizer for several reasons. The bundle of services and discounts associated with the fertilizer differ substantially from firm to firm. Some prices are

quoted for farmer pickup at the dealer's warehouse; some are quoted for fertilizer delivered to the farmer. Some prices are quoted as a delivered price, but a discount is given if picked up by the farmer. Furthermore, the net price to members of cooperative distributors may be reduced at the end of the year because of patronage distributions. Thus, our analyses and comparisons of prices were expanded to three standardized measures of 1978 retail fertilizer prices: (1) prices standardized to uniform services and discounts, (2) prices standardized to uniform services, discounts, and expected patronage refunds, and (3) prices standardized to uniform service, discounts, and actual 1978 patronage refunds. The standardization procedures were as follows.

The first standardized price was an estimate of the average price for a standard retail product. Each firm's price for the given fertilizer was adjusted to eliminate the effect of most services and discounts. For dry bulk fertilizer, the service and discount standardized price represented the per ton price that the firms would charge for urea, potash, superphosphate (46 percent P_2O_5), and diammonium phosphate which was to be paid for in cash when picked up at the retailer's dock. No custom application service was offered. The liquid nitrogen price represented the price for one ton of the product delivered to the farmer's field. The price does not include application, and it does require cash payment. The necessary adjustments when fertilizer was not priced for this standard product were based on the charges or discounts quoted by the distributor.

The other two standardized price series included adjustments for cooperative patronage refunds. These refunds received by the farmer reduce the price that the farmer pays for fertilizer. The amount of refund is unknown at the time of the fertilizer purchases. A priori, the farmer is likely to have some expectation of the cooperative's refund. We assumed that the refund for the immediately preceding year is a good indication of the expected refund. In this case, the cash and equity distributions for 1977 are the expected dividends for 1978. Both cash and equity distributions were discounted to take into account the foregone interest or earnings that the farmer could have obtained on the money retained by the cooperative. The cash dividends were discounted at 7.5 percent for nine months, because it is received nine months after May 1978, the month in which most fertilizer is purchased. The equity distributions were discounted at the same rate for the reported years of retention by the cooperative. The discounted dollar amount of distributions received in 1977 per ton of fertilizer were deducted from the service discount-adjusted prices to obtain the expected refund standardized price for cooperatives (See Appendix B for further explanation).

To determine the actual 1978 patronage adjusted fertilizer prices, actual cooperative refunds in 1979 for 1978 were used to adjust the service and discount standardized price. These refunds due to patronage were also discounted to present value in the same manner described for the 1977 distribution. The 1978 distribution data were obtained by telephone follow-up interviews for all firms interviewed in the summer of 1978.

The average quoted prices and the three standardized prices for six fertilizers are presented in Table 21. The standardizations for service and discounts reduces average prices for all fertilizers. The average service discount-adjusted anhydrous ammonia price for all firms is $166.05 per ton, $1.61 less than the quoted price. Average service discount-adjusted prices range from $1.61 to $6.00 per ton less than the actual quoted price of the six fertilizers.

Adjustments for patronage and equity distributions affect, obviously, only the adjusted prices of cooperative firms. They reduce the average cooperative prices for fertilizer by $1.00 to $5.00 per ton, depending upon the year used for patronage distribution and the type of fertilizer. The largest adjustment—because of expected refund—was $5.03 for diammonium phosphate. For all fertilizers, the actual 1978 distributions were less than our estimate of expected distributions.

Average quoted fertilizer prices are higher for cooperatives than for noncooperatives for all but anhydrous ammonia, Table 21. When prices are standardized for services and discounts, all six average fertilizer prices for cooperatives are higher than for noncooperatives. When the prices are adjusted for cooperative dividends, a mixed picture emerges. Average cooperative fertilizer prices are less for anhydrous ammonia, superphosphate (46 percent), and liquid nitrogen, but higher for potash, urea, and diammonium phosphates regardless of the method used for adjusting for cooperative patronage refunds.

To determine whether the price differences between cooperative and noncooperative sample firms were statistically significant we used the t-test. This test was used for all fertilizers and for all four quoted and adjusted prices. Potash and diammonium prices were found to exhibit a significantly higher quoted price for cooperatives than for noncooperatives (see Table 21 for t values). When prices are standardized for services and discounts however, three fertilizers show significantly lower prices for noncooperatives—urea, potash, and diammonium phosphate.

The test of the difference between prices when cooperative prices are adjusted for patronage refunds indicates no signigicant difference between cooperative and noncooperative prices for any of the fertilizers. One can conclude that the differences between net fertilizer prices are merely random variations or are caused by factors other than firm type.

One other factor often asserted as affecting firm prices was the number and kinds of competitors facing firms. This was analyzed by computing the average fertilizer price for each fertilizer for each of the five town types in which the distributors operated: (1) one cooperative only, (2) one non-cooperative only, (3) at least two noncooperatives, (4) at least two cooperatives, and (5) at least one cooperative and one noncooperative.

Table 21. Average quoted and standardized prices for 60 Minnesota fertilizer retailers by type of firm, 1978.

Type of firm	Price	Average price for: Anhydrous Ammonia	Potash	Urea	Superphosphate, 46%	Diammonium Phosphate	Liquid Nitrogen
		$/ton					
Cooperatives	Quoted price	(23) 165.21	(24) 97.01	(20) 163.86	(18) 155.43	(24) 188.68	(9) 111.89
Noncooperatives		(21) 169.94	(21) 91.74	(13) 160.77	(6) 152.58	(16) 181.23	(14) 110.93
All Minnesota firms[a]		167.66	94.33	162.52	154.63	185.40	111.27
t-test for coop-noncoop differences		(-1.13)	(2.21)*	(.87)	(.59)	(2.07)*	(.21)
Cooperatives	Discount, service, standardized	(23) 166.26	(24) 93.74	(20) 159.20	(17) 150.84	(24) 183.68	(9) 106.90
Noncooperatives		(21) 165.87	(21) 86.12	(13) 153.07	(6) 149.19	(16) 174.91	(14) 105.13
All Minnesota firms[a]		166.05	89.87	156.54	150.37	179.82	105.75
t-test for coop-noncoop differences		(.13)	(2.78)*	(2.06)*	(.33)	(2.62)*	(.22)
Cooperatives	Discount, service, expected refund standardized price	(22) 161.90	(22) 91.28	(20) 154.29	(16) 147.01	(22) 178.65	(9) 103.47
Noncooperatives		(21) 165.87	(21) 86.12	(13) 153.07	(6) 149.19	(16) 174.91	(14) 105.13
All Minnesota firms[a]		163.96	88.66	153.76	147.63	177.00	104.54
t-test for coop-noncoop differences		(-1.29)	(1.74)	(.35)	(-.35)	(1.04)	(.38)
Cooperatives	Discount, service, actual 1978 refund standardized price	(22) 162.57	(22) 91.35	(20) 154.76	(16) 148.55	(22) 179.23	(9) 104.48
Noncooperatives		(21) 165.87	(21) 86.12	(13) 153.07	(6) 149.19	(16) 174.91	(14) 105.13
All Minnesota firms[a]		164.28	88.69	154.03	148.73	177.33	104.90
t-test for coop-noncoop difference		(-1.09)	(1.76)	(.51)	(-.28)	(1.25)	(-.13)

a/ Computed by population weighting of sample averages.

* Indicates a significant difference at the five percent probability level.

(Numbers in parentheses before each average price is number of firms used in average price calculation).

The average quoted as well as standardized prices for these town types (Table 22) exhibit some variation. Quoted price differences between town types ranged from about $8 to $12 per ton for the six fertilizers. The range of prices between town type is reduced somewhat when the prices are standardized for discounts and services and adjusted for cooperative refunds. The f-test, with 4 degrees of freedom in the numerator, was used to test for statistically significant differences between prices by town type. The f values are listed in parentheses after each set of prices by town type and fertilizer. These values indicate that prices charged by firms for these fertilizers are not influenced by existence of other distributors in the same town or by these competitors being cooperative or noncooperative firms. This holds for both quoted and standardized prices. Differences are either random or caused by factors other than town type.

Price Discounts

Several discounts are offered by retailers to buyers. The most common are discounts for cash payment and for dock pickup of fertilizer. This section describes these discounts and tests for differences between cooperatives and noncooperatives.

Fertilizer discounts were considered in a preceding section in terms of their impact on net fertilizer price. However, price is sometimes uncertain at the time of purchase because of subsequent patronage refunds (for cooperatives) and because of the variety and combinations of other services that may be provided. Thus, the current actual discounts may be a critical consideration in the farmer's purchase decisions regardless of the final net fertilizer price. In this section, we examine the discount practices of the sample firms.

There are usually several kinds of fertilizer discounts for each firm. The discounts offered farmers by the retailers in the sample for the 1977-78 fertilizer season were as follows:

(1) for cash payment of fertilizer
(2) for dock pickup of anhydrous ammonia
(3) for not using retailer's dry bulk spreader
(4) for buyer pickup of dry bulk fertilizer
(5) for buyer pickup of liquid nitrogen
(6) for not using the retailer's nurse tank
(7) for not using the retailer's tool bar
(8) volume discount

The number and proportion of firms offering each type of discount are listed in Table 23. The most frequently offered discount is the cash discount; more than half of the firms (37) offered this discount. The most infrequently offered discounts were discounts for not using the firm's spreader and farmer picking up dry and liquid fertilizer at firm's dock. These were only offered by one firm.

Table 22. Average quoted and standardized prices for 60 Minnesota fertilizer retailers by town type, 1978.

Town type (see footnote for description)	Price	Average price for: Anhydrous Ammonia	Potash	Urea	Super-phosphate, 46%	Diammonium Phosphate	Liquid Nitrogen
N-N	Quoted price	(8) 172.25	(9) 91.06	(7) 157.86	(2) 149.25	(6) 182.85	(6) 109.50
N-C		(11) 166.62	(9) 96.89	(6) 164.20	(4) 151.50	(9) 184.33	(7) 112.14
C-C		(8) 166.34	(9) 98.17	(7) 164.14	(7) 160.08	(7) 191.49	(3) 120.00
C		(9) 163.97	(11) 96.36	(8) 165.50	(7) 153.03	(11) 186.43	(3) 108.33
N		(8) 167.88	(9) 90.67	(5) 160.80	(4) 154.25	(7) 183.43	(4) 108.25
f-test for difference between town types		(.46)	(1.60)	(.66)	(.25)	(.82)	(.70)
N-N	Discount,	(8) 168.51	(9) 84.68	(7) 150.43	(2) 145.73	(6) 174.71	(6) 106.25
N-C	service-	(11) 163.91	(9) 91.59	(6) 156.18	(4) 145.72	(9) 177.23	(7) 104.32
C-C	standardized	(8) 166.06	(7) 94.86	(7) 159.63	(6) 156.05	(7) 186.52	(3) 114.80
C	price	(9) 165.61	(11) 93.60	(8) 161.28	(7) 149.29	(11) 181.93	(3) 102.04
N		(8) 167.16	(9) 86.49	(5) 155.21	(4) 150.92	(7) 179.52	(4) 103.93
f-test for difference between town types		(.26)	(1.93)	(1.87)	(.72)	(1.43)	(.81)
N-N	Discount,	(8) 168.51	(9) 84.68	(7) 150.43	(2) 145.73	(6) 174.71	(6) 106.25
N-C	service,	(11) 161.85	(9) 90.14	(6) 152.56	(4) 142.04	(9) 174.41	(7) 102.75
C-C	expected	(8) 158.92	(7) 90.24	(7) 152.06	(6) 149.44	(7) 177.81	(3) 109.90
C	refund stan-	(8) 163.52	(9) 92.58	(8) 158.36	(6) 147.90	(9) 178.84	(3) 100.28
N	dardized price	(8) 167.16	(9) 86.49	(5) 155.21	(4) 150.92	(7) 179.52	(4) 103.93
f-test for difference between town types		(1.24)	(.90)	(.76)	(.25)	(.33)	(.40)
N-N	Discount,	(8) 168.51	(9) 84.68	(7) 150.43	(2) 145.73	(6) 174.71	(6) 106.25
N-C	service,	(11) 161.34	(9) 89.79	(6) 151.76	(4) 142.17	(9) 173.77	(7) 102.88
C-C	actual refund	(8) 161.38	(7) 91.34	(7) 153.88	(6) 151.05	(7) 179.86	(3) 112.54
C	standardized	(8) 163.34	(9) 92.25	(8) 158.54	(6) 147.65	(9) 179.32	(3) 100.38
N	price	(8) 167.16	(9) 86.49	(5) 155.21	(4) 150.92	(7) 179.52	(4) 103.93
f-test for difference between town types		(.96)	(.90)	(.85)	(.35)	(.57)	(.60)

N-N = two or more noncooperatives in the town.
N-C = at least one cooperative and one noncooperative in the town.
C-C = two or more cooperatives in the town.
C = one cooperative only in the town.
N = one noncooperative only in the town.

The proportion of cooperatives and noncooperatives offering each service is listed in Table 23. If the discount was specific to a fertilizer, the proportions were computed only for those firms selling the specific fertilizer.

The observed difference in these proportions was tested for statistical significance with the chi-square test. The observed differences between coops and noncoops frequency of offering volume discounts and discounts for paying in cash were significant at the 10 percent level. In both cases, it appears noncoops offer volume discounts and discounts for paying in cash more often than coops. The differences are not significant for the other discounts. In other words, the frequency with which any of the rest of the discounts are offered is the same for cooperatives and noncooperatives.

The average value of the discount for sample firms in dollars per ton is listed in Table 24. Largest discounts are for cash payment and for farmers using their own tool bar. Disocunts for paying in cash ranged from an average of $3.73/ton for potash to $7.20/ton for diammonium phosphate. Volume discounts were relatively insignificant regardless of the size of sale. In fact, only nine firms offered volume discounts. Obviously, volume discounts are relatively unimportant in fertilizer discounting.

Farmer pick-up of fertilizer reduced price by $3.54 per ton for anhydrous ammonia and $2.00 per ton for liquid nitrogen and dry bulk fertilizer. However, the number of firms offering discounts for buyer pickup is quite small for all three fertilizer types.

The average discounts were also calculated by town type, Table 25. The average discounts for town types were tested by means of the f-test for differences between multiple averages. None of the average discounts were found to be significantly different because of town type, even at the 10 percent probability level.

Services and Their Prices

Services are a common merchandizing technique for fertilizer retailers. Sixteen different services were offered by the sample firms. They were:

(1) soil testing
(2) crop mapping
(3) delivery of anhydrous ammonia to farmers' fields
(4) delivery of aqua ammonia to farmers' fields
(5) delivery of liquid nitrogen to farmers' fields
(6) delivery of dry bulk fertilizer to the farmer

Table 23. Number and proportion of all and the surveyed 60 Minnesota retail fertilizer distributors offering selected discounts to farmer-buyers, 1978.

Discount type	All Minnesota firms offering discount[a]		Cooperative firms offering discount		Noncooperative firms offering discount		Chi-square test of difference between coops and noncops	Sign.
	No.	Proportion	No.	Proportion	No.	Proportion		
Farmer pickup of anhydrous ammonia	148	.28	5	.22	7	.33	.274	.601
Farmer pickup of liquid fertilizer	13	.03	0	0	1	.08	.051	.820
Farmer pickup of dry bulk	13	.02	0	0	1	.05	.011	.918
Farmer using own dry spreader	13	.02	0	0	1	.04	.007	.935
Farmer using own tool bar	358	.67	12	.52	1	.81	2.093	.148
Farmer using own nurse tank	51	.10	1	.04	3	.14	.384	.535
Discount for paying cash	455	.62	16	.57	21	.70	5.302	.023*
Volume discount	113	.15	3	.10	6	.20	2.772	.099**

* Significant at 5% level
** Significant at 10% level
a/ Computed by population weighting averages for sample firms

Table 24. Average value of fertilizer price discounts for 60 Minnesota fertilizer distributors, 1978.[a]

Discount type	Average value of discount in dollars per ton for: All Minnesota firms offering discounts[b]	All coops offering discounts	All noncoops offering discounts	t-test of difference between coop's and noncoops' avg. price disc.	Sign. of t-test
	$ per ton				
Cash discount for anhydrous ammonia	$6.84	$6.64	$6.98	1.14	(.86)
Cash discount for urea	6.83	6.72	6.94	2.65	(.18)
Cash discount for liquid nitrogen	5.10	5.14	5.09	1.10	(1.00)
Cash discount for superphosphate	5.13	5.50	4.09	5.33	(.34)
Cash discount for diammonium phosphate	7.20	6.72	7.83	1.60	(.43)
Cash discount for potash	3.73	3.74	3.73	1.28	(.66)
Farmer pickup of anhydrous ammonia	3.54	3.00	3.87	3.06	(.30)
Farmer pickup of liquid nitrogen	2.00	-	2	-	-
Farmer pickup of dry bulk	2.00	-	2	-	-
Farmer using own dry spreader	15.00	-	15	-	-
Farmer using own tool bar	6.31	6.18	6.38	1.16	(.82)
Farmer using own nurse tank	8.57	8.00	8.73	0.0	(1.00)
Volume in excess of 10 tons	1.00	1.00	1.00	0.0	(1.00)
Volume in excess of 20 tons	2.81	2.00	3.5	0.0	(1.00)
Volume in excess of 30 tons	4.18	2.42	5.67	9.14	(.20)
Volume in excess of 40 tons	5.39	3.50		37.33	(.052)

a Average discounts are computed for only those firms offering the discount.

b/ Computed by population weighting averages for sample firms.

Table 25. Average value of fertilizer price discount for 60 Minnesota fertilizer distributors by town type, 1978.[a]

Discount	Average prices by firms offering discount for towns with: One coop only	One non-coop only	Coops only, two or more	Noncoop only, two or more	At least one coop and one noncoop	F-test difference between average prices	Sign. of f-test
	$ per ton						
Cash discount for anhydrous ammonia	5.69 (6)	6.03 (4)	8.74 (3)	7.24 (6)	7.11 (6)	.80	(.54)
Cash discount for urea	6.83 (4)	5.53 (3)	6.74 (3)	6.11 (4)	8.53 (4)	.46	(.77)
Cash discount for liquid nitrogen	5.50 (1)	4.63 (3)	6.35 (2)	3.94 (4)	5.64 (6)	.70	(.61)
Cash discount for superphosphates	4.92 (4)	3.83 (2)	6.78 (3)	4.62 (1)	5.01 (3)	.65	(.65)
Cash discount for diammonium phosphates	6.15 (7)	6.26 (3)	7.83 (3)	7.26 (4)	8.36 (6)	.51	(.73)
Cash discount for potash	3.42 (7)	2.82 (5)	3.93 (3)	3.48 (6)	4.85 (7)	1.71	(.18)
Farmer pickup of anhydrous ammonia	4.43 (4)	3.30 (2)	3.25 (2)	3.0 (2)	3.0 (2)	1.90	(.28)
Farmer pickup of liquid nitrogen	-	-	-	2.00 (1)	-	-	-
Farmer pickup of dry bulk	-	-	-	2.00 (1)	-	-	-
Farmer using own dry spreader	-	-	-	15.00 (1)	-	-	-
Farmer using own tool bar	7.33 (3)	7.02 (7)	5.60 (5)	6.17 (6)	5.81 (8)	.37	(.83)
Farmer using own nurse tank	-	9.00 (2)	-	-	8.10 (2)	-	-
Volume in excess of 10 tons	1.00 (1)	1.00 (2)	-	-	-	-	-
Volume in excess of 20 tons	2.00 (1)	3.50 (2)	-	-	2.00 (1)	-	-
Volume in excess of 30 tons	2.13 (2)	4.00 (2)	-	9.00 (1)	3.00 (1)	-	-
Volume in excess of 40 tons	3.25 (2)	4.00 (2)	-	8.50 (2)	-	-	-

a/ Average discounts computed only for those firms offering the discount. Even if firm sells associated fertilizer but does not offer a discount, a zero is not figured in the average discount.

(7) custom application of anhydrous ammonia
(8) custom application of aqua ammonia
(9) custom application of liquid fertilizer
(10) custom application of dry bulk fertilizer
(11) use of retailer's nurse tank to transport anhydrous ammonia
(12) use of retailer's tool bar
(13) use of retailer's dry bulk fertilizer spreader
(14) credit for fertilizer purchases
(15) tissue testing of farmers' crops, and
(16) additions of micronutrients, pesticides, or seeds to the fertilizer

The presence or absence of services might be crucial to the farmer's fertilizer purchase decision. The availability of custom application or whether the farmer can borrow or rent the retailer's dry bulk spreader or tool bar would be important to the farmer without that equipment. The availability of soil testing is likely to be a crucial consideration for many farmers. The frequency with which firms offered each service is indicated in Table 26. It shows the proportion of firms offering each of the services. The most frequently offered service is credit, and the most infrequently offered service is delivery and application, Table 26. To test whether or not cooperatives and noncooperatives differed in their frequency of offering each service, we used a chi-square test for difference between the proportions. Columns 2 and 3 of Table 26 are the proportions of the firms offering each of the services. The chi-square test shows that at the 5% significant level, cooperatives offer tissue-testing more frequently than noncooperatives. At the 10% significant level, the chi-square test indicates that noncooperatives offer delivery of dry bulk fertilizer more frequently than cooperatives. For the remainder of the fourteen services, the chi-square tests indicate that cooperatives and noncooperatives do not differ in frequency of offering a particular service. Though the proportions differ slightly for the other 14 services, they are due only to random variation among firms of the sample.

It might be expected that the services that are offered by fertilizer distributors are influenced by immediate competition confronting the distribution. The proportion of firms offering each service for the five town types were calculated to answer this question, see Table 27. We observe again moderate differences between the proportions for each town type. The difference is significant at the ten percent probability level, however, for only one service, tissue testing. The difference is significant at the fifteen percent probability level, only for one more service, delivery of dry bulk fertilizer. It is not strong evidence of major impacts from the nature of immediate competition. The proportion of firms offering delivery of dry bulk fertilizer varies from 75 percent for towns with only one cooperative, to 89 percent for towns with more than one cooperative to 100 percent for towns with both cooperatives and noncooperatives, and towns with only noncooperatives. Here, we calculated the proportions only for firms that sold dry bulk fertilizer. This indicates that firms in town with noncooperatives offer delivery of dry bulk more frequently. However, firms in towns with cooperatives appear to offer tissue testing more frequently.

Table 26. Proportion of Minnesota fertilizer distribution offering specified services, 1978.

Service	Number & percentage of Minnesota firms offering service		Number & percentage of cooperative firms offering service		Number & percentage of noncooperative firms offering service		Chi-square test of difference between proportions
	No.	%	No.	%	No.	%	
Soil testing	506	83.0	23	79.3	25	86.2	.120
Crop mapping	193	26.4	9	30	7	23.3	.341
Delivery of anhydrous ammonia	485	91.0	21	91.3	19	90.5	.009
Delivery of aqua ammonia	--	--	--	--	2	100	a/
Delivery of liquid nitrogen	285	100	6	100	10	100	0
Custom application of anhydrous ammonia	257	48.2	10	43.5	11	52.4	.3487
Custom application of aqua ammonia	--	100	--	--	2	100	a/
Custom application of any liquid fertilizer	--	31.4	2	16.7	9	39.1	1.85
Custom application of dry fertilizer	482	79.8	21	77.8	18	81.8	.122
Rental of tool bar	533	100	23	100	21	100	0
Rental of nurse tank	533	100	23	100	21	100	0
Rental of dry spreader	591	97.8	27	100	21	96	1.26
Delivery of dry bulk	560	92.7	23	85.2	22	100	3.55b/
Provision of credit	730	100	28	100	30	100	0
Tissue testing	198	27.1	13	43	4	13	5.230c/
Adding micronutrients	449	61.5	19	63	18	6	0

a/ Too few responses to calculate chi-square statistics.
b/ Significant at the 10 percent probability level.
c/ Significant at the 5 percent probability level.
* Estimated by weighting sample proportions.

Table 27. Proportions of Minnesota fertilizer distributors offering specified services by town type, 1978.

Service	(Total)	Numbers and proportions of firms offering service by type of distribution in the town: One coop only No.	%	One non-coop only No.	%	Coops only, two or more No.	%	Noncoops only, two or more No.	%	Coops and noncoops No.	%	Chi-square statistic of difference between proportions	Sign. of chi-square
						$ per ton							
Soil testing	58	10(11)[a]	91	9(11)	82	7(12)	58	11(12)	92	11(12)	92	6.87	.1429
Crop mapping	60	4(12)	33	2(12)	17	2(12)	17	3(12)	25	5(12)	42	2.90	.5751
Delivery of anhydrous ammonia	44	8 (9)	89	7 (8)	88	7 (8)	88	7 (8)	88	11(11)	100	1.48	.8298
Delivery of aqua ammonia	2	-	-	-	-	-	-	1 (1)	100	1 (1)	100	b	
Delivery of liquid nitrogen	16	2 (2)	100	3 (3)	100	2 (2)	100	4 (4)	100	5 (5)	100	0	1.000
Custom application of anhydrous ammonia	44	4 (9)	44	5 (8)	63	2 (8)	25	4 (8)	50	6(11)	55	2.61	.6239
Custom application of aqua ammonia	2	-	-	-	-	-	-	1 (1)	100	1 (1)	100	b	
Custom application of any liquid fertilizer	35	1 (4)	25	3 (7)	43	1 (4)	25	3(11)	27	3 (9)	33	.6809	.9537
Custom application of dry bulk fertilizer	49	8(12)	67	6 (9)	67	8 (9)	89	8 (9)	89	9(10)	90	3.78	.4359
Rental of tool bar	44	9 (9)	100	8 (8)	100	8 (8)	100	8 (8)	100	11(11)	100	0	1.000
Rental of nurse tank	44	9 (9)	100	8 (8)	100	8 (8)	100	8 (8)	100	11(11)	100	0	1.000
Rental of dry spreader	49	12(12)	100	9 (9)	100	9 (9)		8 (9)	88	10(10)	100	4.54	.3382
Delivery of dry bulk fertilizer	49	9(12)	75	9 (9)	100	(9)	89	9 (9)	100	10(10)	100	7.13	.1291
Provision of credit	58	10(10)	100	12(12)	100	12(12)	100	12(12)	100	12(12)	100		1.000
Tissue testing	60	4(12)	67	1(12)	8	5(12)	42	1(12)	8	6(12)	50	8.70	.0690
Adding micronutrients	60	8(12)	67	7(12)	58	6(12)	50	7(12)	58	9(12)	75	1.83	.7664

a Numbers in parentheses are numbers of firms selling fertilizer for which the service would be required.

b Too few responses to calculate chi-square statistic.

The pricing of the services provided by firms is another dimension of performance in the fertilizer distribution market. Average prices charged for each of the 16 services are listed in Table 28. No charges were made by any firm for five services-crop mapping, delivery of aqua ammonia, custom application of aqua ammonia, tissue testing, and addition of micronutrients. Application of fertilizer is the most costly of the priced services. Dry fertilizer application was priced at $11.05 per ton. The highest service charge was for custom application of anydrous ammonia, $39.52 per ton.

Prices of the 11 services were computed for cooperative and non-cooperative firms. Statistical tests of the difference, using the t-test, indicated significant differences only for the price of custom application of anhydrous ammonia and rental charge for nurse tanks. Noncooperatives charged lower average prices for custom application of anhydrous and the rental of the firm's nurse tank. One would have to conclude, that service pricing is generally similar for cooperatives and noncooperatives.

We hypothesized that type of town competition influences pricing of services. Average service prices were computed for the five town types described earlier. These average service prices by town type are listed in Table 29. Average prices vary by town type for all of the priced services, but no consistent pattern appears. To test the statistical significance of differences in average prices by town type, we used the f-test for differences between multiple means. This test, at the 10 percent probability level, indicates no statistically significant differences.

Thus, analysis indicates little impact of cooperatives or the type of immediate competition on the offering of services associated with fertilizer or the pricing of those services.

Wholesale Prices

The wholesale cost of fertilizer is the largest and most significant input cost for fertilizer retailers. As described earlier, most retailers purchase fertilizer from intermediate manufacturers (granulators) and manufacturers of liquid and gaseous fertilizer. We also noted that cooperative retailers relied primarily on cooperative wholesalers and manufacturers for fertilizer and the noncooperative retailers relied primarily on non-cooperative suppliers. Thus do these suppliers charge different prices to retailers? To answer this question, we obtained wholesale prices for the six most common fertilizers for the sample firms. They are the 1978 prices in dollars per ton for fertilizer delivered to the retailers place of business.

These sample data show that the average wholesale prices paid by cooperatives in 1978 exceeded the noncooperatives prices for all six fertilizers, Table 30. The differences are statistically significant at the 10 percent probability level for potash and diammonium phosphate. The difference for urea approaches significance at the 10 percent level.

Table 28. Average price charged for selected services by Minnesota retail fertilizer distributors, 1978.

Service	Average price charged by[a] All Minnesota firms providing the service[c]	All coops providing the service	All noncoops providing the service	t-test of difference between coop and non-coop prices	Sign. of t-test
Soil testing ($/sample)	1.48[b]	.94[b]	1.87[b]	-1.44	(.166)
Crop mapping ($/service)	0	0	0	-	-
Delivery of anhydrous ammonia ($/ton)	.62	.57	.66	-.19	(.849)
Delivery of aqua ammonia ($/ton)	0	-	0	-	-
Delivery of liquid nitrogen ($/ton)	.43	.68	.30	.70	(.494)
Delivery of dry bulk ($/ton)	1.46	1.68	1.28	.75	(.457)
Custom application of anhydrous ammonia ($/ton)	39.70	37.10	41.71	-2.01	(.058)
Custom application of aqua ammonia ($/ton)	0	-	0	-	-
Custom application of liquid nitrogen ($/ton)	.52	.57	.51	.73	(.484)
Custom application of dry bulk ($/ton)	11.09	10.59	11.56	-.72	(.475)
Rental of tool bar ($/ton)	1.36	2.01	.76	1.43	(.160)
Rental of nurse tank ($/ton	.84	1.40	.32	1.85	(.072)
Rental of dry spreader ($/ton)	2.23	2.44	2.01	.85	(.358)
Provision of credit (%)	11.18	11.60	10.83	1.33	(.189)
Tissue testing ($/sample)	0	0	0	-	-
Adding micronutrients ($/ton)	0	0	0	-	-

a/ Average computed for only those firms offering the service

b/ Numbers in parenthesis are numbers of firms for which averages were calculated

c/ Calculated by population weighting sample averages

Table 29. Average prices charged for selected services by Minnesota retail fertilizer distributors by town type, 1978.

Service	N Total	Average prices by firms offering services for towns with[a/]: One coop only	One noncoop only	Coops only, two or more	Nonco-ops only, two or more	At least one coop and one noncoop	F-test of difference between average prices	Sign.
Soil testing ($/sample)	48	1.23(10)	2.58(9)	.86(7)	2.05(11)	.39(11)	1.49	.2227
Crop mapping ($/service)	16	0 (4)	0 (2)	0 (2)	0 (3)	0 (5)	--	
Delivery of anhydrous ammonia ($/ton)	-10	.75(8)	1.43(7)	0 (7)	0 (7)	.77(11)	1.35	.269
Delivery of aqua ammonia ($/ton)	2	---	---	---	0 (1)	0 (1)	--	
Delivery of liquid nitrogen ($/ton)	16	.55(2)	0 (3)	0 (2)	0 (4)	1.20(5)	1.12	.394
Develivery of dry bulk ($/ton)	46	1.39(9)	1.50(10)	2.00(8)	.39(9)	2.10(10)	1.94	.121
Custom application of anhydrous ammonia ($/ton)	21	37.09(4)	40.71(5)	34.50(2)	42.26(4)	39.98(6)	.86	.507
Custom application of aqua ammonia ($/ton)	2	--	---	---	0 (1)	0 (1)	--	
Custom application of liquid nitrogen ($/ton)	12	.60(2)	.56(3)	.50(1)	.46(3)	.52(3)	.44	.913
Custom application of dry bulk ($/ton)	40	10.02(8)	9.88(7)	11.12(8)	12.79(8)	11.27(9)	.60	.659
Rental of tool bar ($/ton)	44	2.74(9)	.30(8)	1.54(8)	.84(8)	1.47(11)	.82	.519
Rental of nurse tank ($/ton)	44	1.63(9)	.30(8)	1.03(8)	.22(8)	1.07(11)	.72	.579
Rental of dry spreader ($/ton)	49	2.89(12)	2.00(10)	2.32(9)	1.56(8)	2.23(10)	.78	.542
Provision of credit (%)	60	11.50(12)	11.00(12)	11.75(12)	10.75(12)	11.08(12)	.37	.831
Tissue sampling ($/sample)	17	0 (4)	0 (1)	0 (5)	0 (1)	0 (6)	--	
Adding micronutrients ($/ton)	37	0 (8)	0 (7)	0 (6)	0 (7)	0 (9)	--	

a/ Average computed for only those firms offering the service.

Table 30. Average Wholesale Prices Paid by 60 Minnesota Retail Fertilizer Dealers to get Fertilizer to Retailer Plant Site by Type of Firm, 1978.

Type of firm	Average Wholesale Price for: Anhydrous Ammonia	Potash	Urea	Superphosphate 46 Percent	Diammonium Phosphate	Liquid Nitrogen
	$/ton					
Cooperatives	134.40	79.06	141.02	129.71	160.35	94.08
Noncooperatives	132.52	70.79	135.19	123.28	152.37	93.55
All Minnesota firms	133.43	74.86	138.49	127.90	156.84	93.74
t-test* and associated significance	.59 (.56)	2.84** (.007)	1.57 (.13)	1.24 (.23)	2.57** (.02)	1.15 (.88)

* The t-tests are computed for the difference between average wholesale prices for cooperative and noncooperative firms.

** Indicates a significant difference at the 5 percent level.

The data on town type also indicates that cooperatives paid more for fertilizers in 1978, Table 31. Towns with at least two cooperative fertilizer retailers had the highest prices for all six fertilizers. Again, the differences for potash and diammonium phosphate were significant at the 10 percent level.

The cooperative-noncooperative differences in wholesale prices shown above should be interpreted in view of cooperative refund performance. Regional supply cooperatives have declared substantial refunds to member organizations in recent years (obtain data if possible). Unfortunately, this information was not obtained for this study. The refunds would offset, at least partially, some of the price differences that are observed.

Margins

Analysis to this point indicates that gross margins for noncooperatives should exceed those for cooperatives. We have observed that retail prices are essentially the same for cooperatives and noncooperatives while wholesale buying prices were higher for cooperatives. To verify this, we computed actual gross margins per ton of fertilizer for each of the six fertilizers. For cooperatives, these margins were computed for two different measures of retail prices. One was the margin between the wholesale price and the 1978 discount—service, and expected refund standardized retail price. The other was the margin between the wholesale price and the 1978 discount—service, and actual refund standardized retail price. As expected the cooperatives gross margins were lower for several of the fertilizers, Table 36. With the expected refund standardized prices, margins were lower for cooperatives for anhydrous ammonia, urea, and superphosphate at the 10 percent probability level. At the 15 percent level of significance potash margins are lower for cooperatives. The differences are substantial, $9.16 per ton for superphosphate and $5.18 per ton for urea.

With the actual refund standardized prices, margins for cooperatives were lower for urea and superphosphate at the 10 percent and for anhydrous ammonia at the 15 percent level. If data were available for cooperative suppliers' refunds, the differences in margins between cooperatives and noncooperatives would be less.

The comparisons of gross fertilizer margins by town types are consistent with the cooperative-noncooperative comparisons in that it shows towns with only cooperatives, either one or several cooperatives, to have the lowest margins. These differences are statistically significant at the 10 percent level for anhydrous ammonia, potash, superphosphate and diammonium phosphates for the margins calculated with the 1978 expected refund standardized retail prices. For margins computed with the actual 1978 refund standardized prices, the margins were significantly less at the 10 percent level for anhydrous ammonia, but at the 15 percent level for diammonium phosphate.

Table 31. Average Wholesale Prices Paid by 60 Minnesota Retail Fertilizer Dealers to get Fertilizer to Retailer Plant Site by Town Type, 1978.

Town Type (see footnote for description)	Average Wholesale Price for: Anhydrous Ammonia	Potash	Urea	Superphosphate 46 Percent	Diammonium Phosphate	Liquid Nitrogen
	$/ton					
N-N	135.63	65.84	130.33	122.35	152.47	95.33
N-C	134.85	75.89	139.55	125.83	154.57	91.98
C-C	137.73	80.98	140.20	136.94	166.07	98.33
C	130.45	79.41	143.84	124.70	158.06	92.33
N	128.75	74.22	138.25	123.75	154.16	92.13
f-test* and associated significance	1.08 (.38)	3.40 (.02)**	1.61 (.20)	1.82 (.17)	2.71 (.05)**	.40 (.80)

N-N = two or more noncooperatives in the town.

N-C = at least one cooperative and one noncooperative in the town.

C-C = two or more cooperatives in the town.

C = one cooperative only in the town.

N = one noncooperative only in the town.

* f-test computed for difference between average wholesale prices.

** indicates a significant difference at the 5 percent level.

Table 36. Average margins between standardized prices and wholesale prices for 60 Minnesota fertilizer retailers by type of firm, 1978.

Type of firm	Specific margin	Anhydrous Ammonia	Potash	Urea	Superphosphate 46 Percent	Diammonium Phosphate	Liquid Nitrogen
				$ per ton			
Cooperatives	Margin between wholesale	27.48	12.10	13.27	16.75	18.45	9.38
Noncooperatives	price and discount, ser-	33.34	15.33	18.45	25.91	22.54	11.58
All firms	vice expected refund	29.94	13.61	15.31	19.04	20.09	10.72
T-test* and associated significance	standardized price	-1.65 (.107)	-1.47 (.15)	-1.90 (.07)***	-2.31 (.03)**	-1,37 (.18)	-.87 (.40)
Cooperatives	Margin between wholesale	28.17	12.18	13.74	17.29	19.03	10.40
Noncooperatives	price and discount,	33.34	15.33	18.45	25.91	22.54	11.58
All firms	service actual 1978	30.69	13.65	15.60	19.45	20.43	11.12
T-test*	refund standardized price	1.48 (.15)	-1.43 (.16)	-1.73 (.09)***	-2.19 (.04)**	-1.20 (.24)	-.44 (.66)

* The T-tests are computed for the difference between average margins for cooperative and noncooperative firms.
** Indicates a significant difference at the 5 percent level.
*** Indicates a significant difference at the 10 percent level.

Table 37: Average margins between standardized prices and wholesale prices for 60 Minnesota fertilizer retailers by type of towntype, 1978.

Town Type (see footnote for description)	Specific margin	Average margin for: Anhydrous Ammonia	Potash	Urea	Superphosphate 46 Percent	Diammonium Phosphate	Liquid Nitrogen
N-N	Margin between wholesale	32.88	18.84	20.78	23.38	22.24	10.91
N-C	price and discount,	26.99	14.25	13.02	16.21	19.85	10.77
C-C	service, expected refund	21.18	9.26	11.86	12.61	11.74	11.57
C	standardized price	33.51	12.80	14.51	21.25	21.65	7.95
N		38.41	12.27	16.97	27.17	25.36	11.80
F-test*		3.05 (.03)**	2.08 (.10)***	1.35 (.28)	2.30 (.10)***	2.53 (.06)***	.18 (.94)
N-N	Margin between wholesale	32.88	18.84	20.78	23.38	22.24	10.91
N-C	price and discount,	26.49	13.90	12.22	16.34	19.20	10.90
C-C	service actual 1978	23.65	10.35	13.68	14.22	13.79	14.21
C	refund standardized	33.64	12.47	14.70	21.00	22.13	8.05
N	price	38.41	12.27	16.97	27.17	25.36	11.80
F-test*		2.48 (.06)***	1.74 (.16)	1.17 (.35)	1.74 (.19)	1.83 (.15)	.34 (.84)

N-N = two or more noncooperatives in the town
N-C = at least one cooperative and one-noncooperative in the town
C-C = two or more cooperatives in the town
C = one cooperative only in the town
N = one noncooperative only in the town

* F-test computed for difference between average margins
** Indicates a significant difference at the 5 percent level.
*** Indicates a significant difference at the 10 percent level.

Though not all the margin differences are significant, it is notable that for 9 of the 12 comparisons in Table 37 that towns with more than one cooperative, and only cooperatives, have the lowest margins. This implies that considerable competition exists among cooperative distributors.

In summary, our data on wholesale prices and on margins for 1978 partially support the hypothesis that cooperatives operate on narrower margins than noncooperative firms. For 1978, the lower margins enabled cooperatives to set retail prices at the same level as noncooperatives for most fertilizers. Again, it should be kept in mind that the cooperative margin excludes refunds from cooperative suppliers. Thus, gross margin for cooperatives will be somewhat higher than indicated by our data.

Summary

The principle objective of this study was to determine if cooperative firms operate and perform differently than noncooperative firms in retail fertilizer markets. We compared the two types of firms in several dimensions, size of firm, type of customer, prices charged, prices paid, margins, and uses of services and discounts as types of merchandising techniques for the year 1978. The data base used for most of the analysis was obtained in personal interviews of managers of 60 Minnesota fertilizer distributors during the summer of 1978. This sample was randomly selected from stratified groupings of the population of distributors in the commercial agricultural regions of the state. This sample accounted for about 8 percent of the total number of distributors in the state.

Our analysis found few significant differences between cooperatives and noncooperatives, either in the structure of the firms or in their pricing and merchandising practices. The average size of retailer in annual tons of all fertilizer sales were not significantly different. It does appear, however, that cooperative firms are more important in the distribution of dry bulk fertilizer while noncooperative firms are more important in the distribution of liquid bulk fertilizer.

Quoted prices for six fertilizers, superphosphate, urea, diammonium phosphate, potash, ammonium phosphate and liquid nitrogen, were compared for the two firm types and tested by means of the statistical t-test. Prices for potash only differed significantly between the two firm types. It indicated that noncooperative potash prices averaged $5.21 per ton less than quoted prices of cooperative distributors.

Quoted prices may not be, however, a good indication of relative fertilizer prices. There are numerous discounts, services, services with charges and without charges, and cooperative refunds that influence the net price for a standard fertilizer product. We standardized all prices for all six fertilizers to common services and for the cooperative refunds.

Comparison of the resulting prices show no significant differences between cooperative and noncooperative firm's prices for any of the fertilizers.

A wide number of services were offered by fertilizer retailers. They included: soil testing, delivery of fertilizer to the farmer's field, custom application, provision of application equipment, credit, and tissue testing. Of all the services the differences in frequency offered was significant only twice. Tissue testing is more frequently offered by cooperatives than by noncooperatives, 43 percent of the cooperatives vs. 13 percent for noncooperatives. Noncooperatives more frequently offer delivery of dry bulk than cooperatives. However, this difference in frequency is only significant at the 10% level.

Price charges for the various services were not significantly different between cooperatives and noncoopertives except for application of anhydrous ammonia. The average charge was $37.10 per ton for cooperatives $41.71 per ton for noncooperatives.

Differences between cooperatives and noncooperatives were observed for the prices paid to suppliers for fertilizer and in gross margins. Cooperatives paid higher prices to fertilizer suppliers in 1978 for potash, diammonium phosphate and urea.

Comparison of 1978 gross margins, after allowing for expected refunds to producers, shows that cooperatives operated on a substantially narrower margin for anhydrous ammonia, superphosphate, and urea, lower by $5.86, $9.16, and $5.18 per ton respectively. Though the differences were not quite as significant when actual refund adjusted prices were used for the margin calculation, the comparison still indicates lower operating margins for cooperatives. The cooperative margins would be increased somewhat if cooperative supplier refunds to retailers were considered. These data were not available, however.

Thus, the comparison for 1978 provides little explanation of why retail supply cooperatives have increased their share of farm fertilizer sales. Perhaps the year selected for the analysis was an observation from the more general relationships on factors other than those analyzed were significant. The finding that cooperatives appeared to be operating on a lower gross margin than noncooperatives could be a major part of the explanation. It is consistent with the cooperative principle of operating at cost. When cooperatives are able to buy fertilizer at the same price as noncooperatives, they would be able to set lower retail prices. An analysis of data for several years would be needed to test this hypothesis.

Appendix A

This appendix provides a brief description of the statistical tests and examples of their use in this study. Throughout the study, we have made comparisons in terms of probability statements. These statements are fundamental to statistical analysis. They are employed when samples are drawn from populations. The statements are frequently formulated in the nature of hypotheses test criterion, based on probabilities applied to accept or reject the hypothesis. The particular test criterion, its values, and its limits are referred to as tests of significance.

The hypotheses tested in this study involves comparisons of firm organization, market structure and market performance variables. Comparisons are between cooperative and noncooperative enterprises and among market types. Three different statistical tests were used (1) the "t" test, (2) the F-test and (3) the Chi-square test. The particular test of significance used in the comparisons depended upon (1) the hypothesis to be tested and (2) the form of the data. An application of each test follows.

The t-test

The t-test is applicable to comparison of means of two samples. The t value is computed by dividing the difference between sample means by the standard error of the difference between sample means:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{s_d}$$

where the $\bar{x}_i$ are the sample means and s_d is the standard error of the difference between the means. It is computed by first computing a pooled variance of the samples. The pooled variance

$$s_p^2 = \frac{(n-1)s_1^2 + (m-1)s_2^2}{(n-1) + (m-1)}$$

where n is the number of observation in sample 1 and m is the number of observation in sample 2 and s_i^2 are the variances of each of the samples. The standard error of the difference between the sample means is:

$$s_d = \sqrt{\frac{s_p^2}{n-1} + \frac{s_p^2}{m-1}}$$

In comparing retail prices for anhydrous ammonia we obtained the following sample data.

Cooperatives average price $165.26 per ton

Number of cooperatives selling anhydrous ammonia 22

Variance (s_1^2) of cooperative price 221.09

Noncooperative average price $169.55 per ton

Number of noncooperatives selling anhydrous ammonia 21

Variance (s_2^2) of noncooperative price 105.49

The pooled variance is, $s_p^2 = \frac{(22-1)\ (221.09) + (21-1)\ (105.49)}{(22-1) + (21-1)} = 164.70$

The standard error of the difference between the sample means is:

$$S_d = \sqrt{\frac{164.70}{22-1} + \frac{164.70}{21-1}} = 3.93$$

The computed t value for the difference between the sample mean price is

$$t = \frac{165.26-169.55}{3.93} = -1.09$$

With 41 degrees of freedom (m-n-2), this t value indicates that the difference is not significantly different at the 10 percent probability level. The t value would have to be at least 1. to indicate a significant difference at the 10 percent probability level.

The F-test

The f-test is designed to test whether the variance between sample means is greater than the variance within the samples. Analysis of variance with the F-test can be used to test whether means of classes or groups of data differ by more than would be expected by chance alone. Where only two groups or classes are being compared, the t-test is applicable. Where three or more groups are being compared, analysis of variance may be more appropriate.

The F value is computed by dividing the variance between groups, s_1^2, by the variance within groups, s_2^2.

$$F = \frac{S_1^2}{S_2^2}$$

The variance on between groups is

$$s_1^2 = \frac{\text{sum of squares of deviations of class means from group mean}}{\text{degrees of freedom for variation between classes}}$$

and the variance within groups is

$$s_2^2 = \frac{\text{sum of squares of deviations from group means}}{\text{degrees of freedom for variation with groups}}$$ 1/

Given the degrees of freedom, the F table can be used to determine the F values that will be observed at given probability levels. The calculated F value can be compared to table values to determine if the classification of grouping does account for different behavior.

One of our objectives was to determine whether fertilizer prices differed by town type. For liquid nitrogen, the following mean prices were observed for retailers when classified according to competition in their towns.

	Average price per ton	Number of firms
Coop-coop towns	$120.00	3
Coop-noncoop towns	112.14	7
Noncoop-noncoop towns	109.50	6
Towns with one coop only	108.33	3
Towns with one noncoop only	108.25	4
Variance between town types	$s^2 = 78.675$	
Variance within town types	$s_2^2 = 112.565$	

The computed F value is

$$F = \frac{78.675}{112.565} = .70 \text{ with 4 and 18 degrees of freedom}$$

The F table shows a value of 2.93 at the 5 percent probability level. The calculated F would have been easily observed by chance. We would conclude that town type has no impact on liquid ammonia prices.

The Chi-square test

The chi-square test is used to test for differences between observed frequencies of specified events for groups or samples of observations. In this study, we use the test to determine if cooperative and noncooperative fertilizer retailers differed in providing selected services for fertilizer users. The chi-square (χ^2) is calculated with the following formula:

$$\chi^2 = \sum_{i=1}^{k} \left[\frac{(f_i - F_i)^2}{F_i} \right]$$

1/ See Dixon, J. D. and F. J. Massey, Introduction to Statistical Analysis, 2nd ed., McGraw Hill, New York, 1957, pp. 139-208.

where the f_i are the observed frequencies of a given characteristic in each of the k groups and the F_i are the theoretical frequencies of the characteristics in each of the k groups if there is no difference between groups in frequency of occurrence. Observed values of χ^2 can be compared to values of the χ^2 distribution for given probability levels. The chi-square can be used to test for differences between a one way classification or for testing independence of two-way classifications.

One of our analyses involved a two-way classification. We wanted to determine if cooperative and noncooperative retailers differed in providing selected services for fertilizer users. A specific null hypothesis was that cooperatives and noncooperatives did not differ in the frequency with which the offered tissue testing to customers. The following table indicates the observed frequencies of offering and not offering tissue testing by firm type:

	Number of firms			
	Offering tissue testing		Not offering tissue testing	
Cooperative	Observed	13	Observed	17
	Expected	8.5	Expected	21.5
Noncooperative	Observed	4	Observed	26
	Expected	8.5	Expected	21.5

The expected frequencies are such that the proportions of firms offering and not offering the service are the same for cooperatives and noncooperatives.

The computed χ^2 statistic for these data is:

$$\chi^2 = \frac{(13-8.5)^2}{8.5} + \frac{(17-21.5)^2}{21.5} + \frac{(4-8.5)^2}{8.5} + \frac{(26-21.5)^2}{21.5} = 6.64*$$

The percentile values of the χ^2 distribution indicate that with one degree of freedom, this value of χ^2 or a higher value would be observed with a one percent probability. On that basis, we concluded that cooperatives and noncooperatives do differ with respect to the tissue testing service.

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* For actual application to data in this study the Yates correction for continuity was applied. It yield a somewhat different value of χ^2

Appendix B

The fertilizer prices in the pricing section of this study were adjusted to achieve a standard pricing base for all firms. One adjustment was made to eliminate the effect of any service or discount that affected the quoted prices. For example, some firms provided delivery of the fertilizer at the quoted price. Others gave price discounts for cash payment. Each firms quoted price, except for liquid nitrogen, was adjusted to reflect the price that it would have charged for fertilizer with dock pick-up by the buyer, no other services, and cash payment.

The second adjustment was made only for cooperatives to account for the current years cash patronage refund and the cash distribution of previous years' retained earnings. These cash refunds were also adjusted to a present value. For the current year's cash patronage refund, an annual discount rate of 7.5 percent was used and it was applied for a period of 9 months because the refunds are not usually received until about 9 months after the fertilizer is purchased. Fertilizer is most frequently purchased in May and refunds are not usually received till January or February of the following year. The formula for current year's (1977) cash refund present value is

$$\text{Present value of cash value} = \frac{\text{Cash refund}}{(1- .075)^{.75}}$$

The present value for the cash distribution for an equity retain held for n years with the same discount rate was

$$\text{Present value of cash distribution of equity retains held for n years} = \frac{\text{Cash value of equity distribution}}{(1 + .075)^{n}}$$

These two values were deducted from the standardized prices described about to obtain the net cooperative prices for fertilizer.