



8-1972

An analysis of supply and demand factors influencing the use of lime in nine East Tennessee counties

Russell Harris

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To the Graduate Council:

I am submitting herewith a thesis written by Russell Harris entitled "An analysis of supply and demand factors influencing the use of lime in nine East Tennessee counties." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

Raymond Daniel, Major Professor

We have read this thesis and recommend its acceptance:

Merton B. Badenhop, B.R. McManus, F.F. Bell

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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July 20, 1972

To the Graduate Council:

I am submitting herewith a thesis written by Russell Harris, III entitled "An Analysis of Supply and Demand Factors Influencing the Use of Lime in Nine East Tennessee Counties." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

Raymond Doniel
Major Professor

We have read this thesis and recommend its acceptance;

B R McManus

M. B. Badenhop

Frank Bell

Accepted for the Council:

Hilton A. Smith
Vice Chancellor for
Graduate Studies and Research

AN ANALYSIS OF SUPPLY AND DEMAND FACTORS INFLUENCING
THE USE OF LIME IN NINE EAST TENNESSEE COUNTIES

A Thesis
Presented to
the Graduate Council of
The University of Tennessee

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by
Russell Harris III
August 1972

ACKNOWLEDGMENT

The author expresses his gratitude to those persons who have made this study possible. The author is especially grateful to Dr. Raymond Daniel, committee chairman, for guidance, assistance, and especially his helpful suggestions for this study.

The author also thanks the Agricultural Resource Development Branch Agricultural Development Division of the Tennessee Valley Authority for supporting this research project.

Special thanks are due also to Dr. Merton B. Badenhop, Dr. B. R. McManus and Dr. F. F. Bell, members of the author's graduate committee, for guidance and constructive criticism.

The author is indebted to Dr. Thomas J. Whatley and the Department of Agricultural Economics and Rural Sociology for making the writer's graduate studies possible.

The author expresses personal thanks to his parents, Mr. and Mrs. Russell Harris, Jr., for their support and understanding throughout his undergraduate and graduate work.

ABSTRACT

The objectives of this study were to determine (1) what factors are associated with lime manufacturing and distribution and farmer informational agencies that influence the farmers' usage of lime and (2) farmers' attitudes and characteristics associated with their use of lime.

The data were obtained by personal interview with 21 lime manufacturers and vendors in East Tennessee and by use of structured questionnaires that were mailed to 1,500 farmers in Anderson, Bradley, Hamilton, Knox, Loudon, McMinn, Meigs, Rhea, and Roane Counties of Tennessee. Fifteen percent of the mail questionnaires were returned completed. The following East Tennessee counties were, therefore, designated as high lime use counties based on this percent of need of lime used: Loudon, McMinn, Meigs, and Rhea. The farmers in these counties appeared to be utilizing more lime than were the farmers in the remaining five counties (Hamilton, Bradley, Roane, Anderson, and Knox) designated as the low lime use area.

The data on lime manufacturers and vendors were used to describe the lime industry in the above East Tennessee counties. Both multiple regression and tabular analysis were used in analyzing the farmer mail questionnaires.

Significant differences were found to occur in the percentage of cropland limed by farmers in these two basically similar farming areas of the Tennessee Valley in East Tennessee. However, it was not possible

to ascertain specific reasons for these differences based on an analysis of the firms involved in marketing and distribution of lime or on an analysis of differences in selected socioeconomic characteristics of farmers in these two areas.

Even though reasons for the differences in lime use between the two areas could not be determined, the following conclusions relative to the factors influencing the supply and demand for lime in the combined nine-county area were possible.

The structure of the lime industry in this area of East Tennessee is comprised of several different types of manufacturers and vendors. The agricultural lime business is a sideline for the manufacturers and only one of many activities carried on by the vendors. Lime represents on the average about 7 percent of the gross sales of quarry operations in this area. Farmer-vendors were the most common type of lime distributor.

An information system in the lime industry which would be responsible for acquainting farmers about the use of lime is nonexistent. Limited advertising is done by vendors to promote lime sales. It also appears that neither lime vendors nor all farmers have made any effort to contact agricultural informational agencies as to sources of educational material nor have they been informed as to the need or profitability of using lime in this area. Around 33 percent of all full- and part-time farmers did not know why lime was used. Also, around 40 percent of all farmers in the area indicated that it was not profitable to use lime in their area.

Farmers in this area of East Tennessee would also benefit from checking with several different types of lime vendors before purchasing lime. Lime prices in the area varied from a low of \$3.75 to a high of \$5.00 per ton for delivery and spreading.

It appeared that one method of increasing lime use in this area would be to encourage farmers to have soil tests made on their farms. Farmers in this study who utilized soil tests limed a significantly higher percentage of their cropland.

Although farmers with at least one year or more of college appear to have more knowledge concerning lime, around 30 percent of these farmers were still unaware that lime was used to reduce acidity nor did they feel lime was profitable. The most critical problem with respect to lack of knowledge concerning lime involves hobby farmers and non-farming landowners in this area of East Tennessee. About one-half of these individuals did not know that lime was used to reduce acidity nor did they consider lime to be profitable in their area.

The following socioeconomic variables were found not to be significantly related to the percent of cropland limed by farmers within this nine-county area of East Tennessee: age, farm acreage, rental agreement, gross farm sales, lime prices, customer satisfaction, or distance from source of lime.

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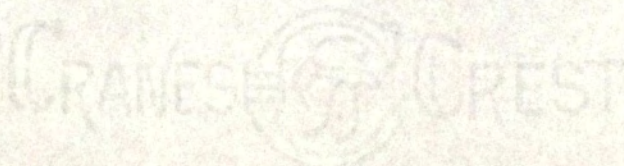
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CHAPTER I

INTRODUCTION

Agricultural lime is an important product to farmers and the agribusiness firms in Tennessee. In 1969, over 1.6 million tons of lime, at a total value of more than \$7.4 million, was used in Tennessee.¹ Potential uses of lime are estimated to be over 2.6 million tons with a total value of more than \$11.6 million based on an average price of \$4.45 per ton.² It is estimated that with an investment of \$189,000 for additional lime, Tennessee Elk River watershed farmers could expect an increased gross income of more than \$1.4 million from increased crop production.³

Even in East Tennessee where limestone is readily available, all farmers do not use optimal amounts of lime. According to soil test summaries of 1961-63, 26 percent of the soil samples tested in selected

¹R. B. Johnston and Harold G. Walkup, "Lime Distribution Costs and Problems," paper presented at workshop on Increasing Lime Use in the Tennessee Valley Region, Nashville, Tennessee, December 15-16, 1970.

²Ibid.

³R. Harris III, Estimated Costs and Returns from Increased Lime Use in the Elk River Counties, Agricultural Resource Development Branch, Tennessee Valley Authority, Muscle Shoals, Alabama, and the Agricultural Work Group, Elk River Development Association, Fayetteville, Tennessee, Circular Z-5, March 1970.

counties of East Tennessee area had a pH of 5.6-6.0, and 59.3 percent had a pH of 6.1 or greater. In 1967-70, an average of 26.1 percent of the samples had a pH of 5.6-6.0, and 53.8 percent had a pH of 6.1 or greater.⁴ Although soil conditions in these selected counties in the East Tennessee area have remained fairly constant over the past 10 years, the above tests tend to indicate that the percent of acid soils has increased. Thus, (1) yield potentials are not being realized, and (2) farm inputs such as lime and fertilizer are not being properly utilized since a pH maintenance of 6.0-7.0 is desirable for optimal plant growth for most crops.

The cost of lime continues to be very nominal considering the cost of fertilizer nutrients and the projected returns possible through a reduction of acidity in the soils, yet some farmers do not use adequate amounts of lime.⁵ Both farmers and the agribusiness sector would certainly benefit if optimum lime use could be obtained.

The information presented in this study should assist extension personnel and farmers in lime promotion programs and farm operations. Also, lime manufacturers and distributors could benefit from information provided in this study regarding structure of the industry and lime purchasing behavior of farmers.

⁴University of Tennessee Soil Testing Laboratories, Nashville, Tennessee, June 1971.

⁵R. M. Koch, "Why Dealers Do Not Promote Lime Use More Aggressively," paper presented at workshop on Increasing Lime Use in the Tennessee Valley Region, Nashville, Tennessee, December 15-16, 1970.

I. OBJECTIVES

The objectives of the study were to (1) determine what factors are associated with (a) lime manufacturing and distribution and (b) farmer informational agencies that influence the farmers usage of lime and (2) determine farmers' attitudes and characteristics associated with their use of lime.

II. RESEARCH PROCEDURE

The area selected for this study included nine counties in East Tennessee extending from around Knoxville south to Chattanooga. These counties were: Anderson, Bradley, Hamilton, Knox, Loudon, McMinn, Meigs, Rhea, and Roane. Criteria for selection of these counties were based on data representing two areas within the Tennessee Valley which were in similar soil association areas and which had similar cropping programs but which differed considerably in lime usage. More specifically, the area of selection involved county data on percent of need of lime used; percent of cropland harvested that was limed; percent of farms participating in Agricultural Soil Conservation Service (ASCS) programs; percent of cropland in corn, hay, soybeans, tobacco, and soil association areas (Table 1). Percent of lime need for each county was obtained by dividing the estimated tons of lime recommended for optimal crop production by the actual tons of lime reported being used in each county.⁶

⁶Data were obtained from the University of Tennessee Soil Testing Laboratories, Nashville, Tennessee, June 1971.

TABLE I

RANK OF COUNTIES BY PERCENT OF ESTIMATED LIME NEEDS AND OTHER FACTORS
IN THE SURVEY AREA

County	Percent of Lime Need Used	Percent of Harvested Cropland Limed	Percent of Farms Participating in ASCS Lime Area	Soil Assoc. Area	Percent of Cropland In			
					Corn	Hay	Soybeans Tobacco	
Hamilton	21	71	9	5 & 2	23	58	2	less than .5
Bradley	29	49	11	2	19	67	1	1
Roane	26	41	4	2	16	68	1	2
Anderson	25	22	6	5 & 2	13	77	less than .5	2
Knox	19	17	2	2	14	71	less than .5	2
Average	24		6.4		17	68	1.5	1.5
Rhea	38	52	9	5 & 2	20	54	5	less than .5
Meigs	35	67	8	2	16	60	2	2.0
McMinn	37	51	11	2	18	66	less than .5	2.0
Loudon	32	38	11	2	19	65	less than .5	3.0
Average	35.5	56.6	10		18	61	2	1.9

Source: 1964 Census of Agriculture, Tennessee.

The selection of lime manufacturers and vendors for personal interviews was based on a list of licensed limestone manufacturers and distributors in the above counties for 1971. All 21 lime manufacturers and distributors in these nine counties were interviewed regardless of their size of operation.

Structured questionnaires were mailed to 1,500 farmers in these nine counties. An attempt was made to obtain a representative sample of farmers within this area by selecting every tenth farmer's name from ASCS farmer mailing list in each county. This list was purported to include all farmers within the county.

III. REVIEW OF LITERATURE

The following studies dealing with lime and fertilizer distribution and usage were considered relevant to this study.

Cochran used the case study of a promotion program to discuss increasing lime sales.⁷ He cited the following reasons as being important in increasing the sale of lime by more than 30 percent over a three-year period: (1) offering a soil sampling service in which a full-time field representative is available to assist farmers in taking and testing soil samples; (2) advertising in local newspapers, magazines, and occasionally radio; (3) spreading of lime in the off season; and (4) offering to sell a complete plant food program.

⁷L. Cochran, "A Successful Lime Vendor Promotion Program," paper presented at workshop on Increasing Lime Use in the Tennessee Valley Region, Nashville, Tennessee, December 15-16, 1970.

In another promotional campaign, one county in Texas, through the efforts of the Texas Agricultural Limestone Association, purchased 40 carloads of lime.⁸ This was accomplished by (1) holding management schools on agricultural lime in which cost figures and how to sell agricultural lime for profit were presented, (2) spreaders working together, (3) 4-H and FFA boys taking soil samples for farmers, and (4) providing other farmer and vendor educational material.

Beal and Bohlen did a study on fertilizer dealers' knowledge, attitudes, and the perception of their role in fertilizer distribution and sales.⁹ Also farmers' opinions, attitudes, knowledge, and actions in relation to fertilizer were dealt with at length. The study showed that about one-fourth of the farmers cited good service, friendliness and helpfulness, and honesty and reliability as reasons for patronizing a certain fertilizer dealer. Over 80 percent of the fertilizer dealers offered credit, helped farmers plan fertilizer programs, had bulk applicators, called on farmers, and did soil sampling.

Pentecost did a study on bulk distribution of lime by selected cooperatives.¹⁰ Major areas of interest in the study were size and type

⁸ Ibid.

⁹ G. M. Beal and J. M. Bohlen, "Dealer and Farmer Attitudes and Actions Related to Fertilizer," Commercial Fertilizer, Vol. 96-97, April 1958, pp. 25-35.

¹⁰ B. H. Pentecost, Bulk Distribution of Lime by Selected Cooperatives in Three Southern States (Kentucky, Mississippi, Tennessee), Farmers Cooperative Service, USDA, Service Report 49, November 1959.

of service, type of equipment used, operating practices, costs of services, and possibilities for improving services to farmers.

Cooperative liming operations on a yearly basis ranged in sizes of 1,200 to 9,500 tons. The average price for lime delivered and spread to patrons was \$5.32 per ton with all but one of the cooperatives spreading 100 percent of the lime sold. Some associations were not located close enough to quarries to operate spreader trucks direct to the farm, so rail transportation for shipping lime to their yards was used. The extra transportation involved extra costs and sometimes delay in deliveries.

Obtaining credit was not a problem to patrons as only one association had a strictly cash basis policy. To improve lime distribution, cooperative managers said efforts should be concentrated in the following areas: (1) improving service during rush seasons, (2) keeping adequate records, (3) using written contracts to avoid misunderstandings, and (4) supplying patrons with more information on soil fertility.

Hammerstrom conducted a study on farmers' attitudes toward use of lime in the Elk River watershed.¹¹ He concluded that farm operators with low educational levels were not as receptive to adopting liming and other recommended practices. Age was a factor influencing lime use. Also, older farmers appeared to be more resistant to change, and farmers with low total sales were not liming. Farmers understood the agronomic

¹¹W. A. S. Hammerstrom, Farmer Attitudes Toward Use of Lime in the Elk River Watershed, Agricultural Resource Development Branch, Tennessee Valley Authority, Muscle Shoals, Alabama, November 1969.

benefits of lime, but only 13 percent indicated that lime use was sometimes more profitable than fertilizer or other farming practices. The study further showed that only 55 percent of the farmers had their soil tested, and only one-half of these farmers followed lime and fertilizer recommendations as much as 50 percent of the time. Also, 41 percent of those surveyed purchased more than one-half their lime through ASCS cost-sharing program. From this and related factors it was concluded that about two-thirds of all lime used on farms surveyed was cost-shared through the ASCS program.

Beal, Bohlen, and Campbell published a series of articles using the data in a 1958 study.¹² The study was concerned with the role of the fertilizer dealer in the effectiveness of service. Low profit, lack of time, credit problems, lack of facilities, and price cutting were reasons given by dealers for not merchandising fertilizer more aggressively. Over three-fourths of the 118 fertilizer dealers surveyed said their fertilizer markup was inadequate. A strong relationship was said to exist between farmers' knowledge about fertilizers and the level of fertilizer use. Since many factors that limit fertilizer use are really a result of lack of knowledge about fertilizer, and since fertilizer dealers appear to be a major source of farmer information about fertilizer, then dealers who perceive their profit margins to be inadequate probably did not bother to keep up with new fertilizer

¹²G. M. Beal, J. M. Bohlen, and H. L. Campbell, "Role of Fertilizer Dealer in Effectiveness of Service," Commercial Fertilizer, Volume 100-101, Part III, October 1960, pp. 54-56.

developments or to recognize that they should provide farmers with information about fertilizer as a part of their fertilizer related services.

Beal, Bohlen, and Campbell in a fourth series of articles dealt with factors limiting services offered by retail fertilizer dealers.¹³ They sought to answer the question that if the use of fertilizer merchandising techniques are related to fertilizer profits, why is it that more dealers are not offering these services or using these merchandising techniques? In response to this question, 32 percent cited low profit returns, 22 percent said lack of time, 12 percent said lack of facilities, 8 percent said having to offer credit, 2 percent cited heavy sales competition, and 11 percent said they were pushing fertilizer as hard as they could. However, data from this study seem to suggest that the dealers probably would be unable to make sufficient profit from fertilizer without using appropriate fertilizer merchandising techniques.

¹³G. M. Beal, J. M. Bohlen, and H. L. Campbell, "Factors Limiting Services Offered by Retail Fertilizer Dealers," Commercial Fertilizer, Vol. 100-101, Part IV, November 1960, pp. 34-37.

CHAPTER II

THEORETICAL AND ANALYTICAL FRAMEWORK

Economic and Behavioral Concepts

Most farmers have limited resources and in order for them to expand their operation they must borrow to purchase both operating and fixed capital items at an increasing rate.¹⁴ Interest rates have also continued to increase over the past decade. It, thus, becomes even more imperative for farmers to obtain prompt returns on their short-term investments. Unlike fertilizer, irrigation, or other farming practices which require short-term capital, crop response to lime is spread over a period of three to five years.

With farm prices fluctuating yearly and with only moderate success occurring in crop predictions due to adverse weather, diseases, and other factors, farmers are faced with a high degree of uncertainty as to income from year to year. Thus, decisions on allocation of resources between farm inputs are made with these factors in mind and farmers will normally invest in fertilizer and other inputs instead of lime.

It was assumed that the farmer's decision to purchase lime would be a function of his short-run investment opportunities and allocation

¹⁴R. J. Hopkins, "Knowledge and Attitude Toward the Use of Credit by Farmers in Middle and East Tennessee," unpublished Master's thesis, University of Tennessee, 1970.

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¹⁴R. J. Hopkins, "Knowledge and Attitude Toward the Use of Credit by Farmers in Middle and East Tennessee," unpublished Master's thesis, University of Tennessee, 1970.

of his resources among these different opportunities as well as other economic considerations. However, sociological factors also play a role in determining the behavior of a farmer in his decision-making process. Therefore, in order to consider all the ramifications involved in understanding the reactions of farmers to economic factors, it is necessary to rely in part on the theories and techniques of other behavioral disciplines in understanding the effects of these factors on the farmers' decision to use lime. This was done by incorporating an analysis of the impact of age, education, customer satisfaction, and type of farming situation on lime use in this study.

Analytical Procedure

Multiple linear regression analysis was used to relate the impact of selected socioeconomic factors on lime use by farmers within a nine county area of East Tennessee. Zero-one covariance analysis (dummy variables) was used to incorporate qualitative variables into the above regression problem.¹⁵ This procedure was selected over analysis of variance techniques, since it is possible with the above approach to incorporate both continuous and discrete variables into the same statistical model for analysis.

¹⁵For a discussion of dummy variables in multiple regression analysis see: Ben-David, Shaul, and Tomek, Allowing for Slope and Intercept Changes in Regression Analysis, A. E. Res. 179, Department of Agricultural Economics, Cornell University, Ithaca, New York, November 1965.

Since the survey of lime marketing firms in the nine-county area of East Tennessee included all lime manufacturers and distributors within the area and since this area was not selected to be representative of any larger population, the use of statistical procedures to identify statistical differences within the area was not needed. The entire population is included in the survey. Therefore, tabular analysis was the technique selected to aggregate and systematically present the data dealing with lime manufacturers and distributors.

CHAPTER III

ANALYSIS OF LIME MANUFACTURERS AND DISTRIBUTOR ATTITUDES AND PRACTICES

Previous studies have been concerned with farmers' attitudes toward lime use in specific areas without attempting to look at lime from the supply standpoint in the same area. As a result, conclusions were based on the demand without regard to the influence that suppliers may have on farmers' response. This study will bridge this gap by describing the lime industry as well as identifying factors influencing the attitudes of farmers concerning lime purchases.

The purpose of this chapter is to describe the lime manufacturers and distributors and to determine if differences in fertilizer utilization among counties in a nine-county area in East Tennessee can be attributed to differences in lime distribution systems. Since agricultural lime has been mainly recognized as a by-product of quarry operations, it is conceivable that little attention would be given by manufacturers and distributors to farmer needs for lime. Services and characteristics of lime suppliers in the counties utilizing relatively small quantities of lime will be compared with lime suppliers in counties where lime is more widely used.

Also included in this chapter is a brief discussion of the types of lime promotional programs which ASCS offices and county agents have had in progress during the past five years.

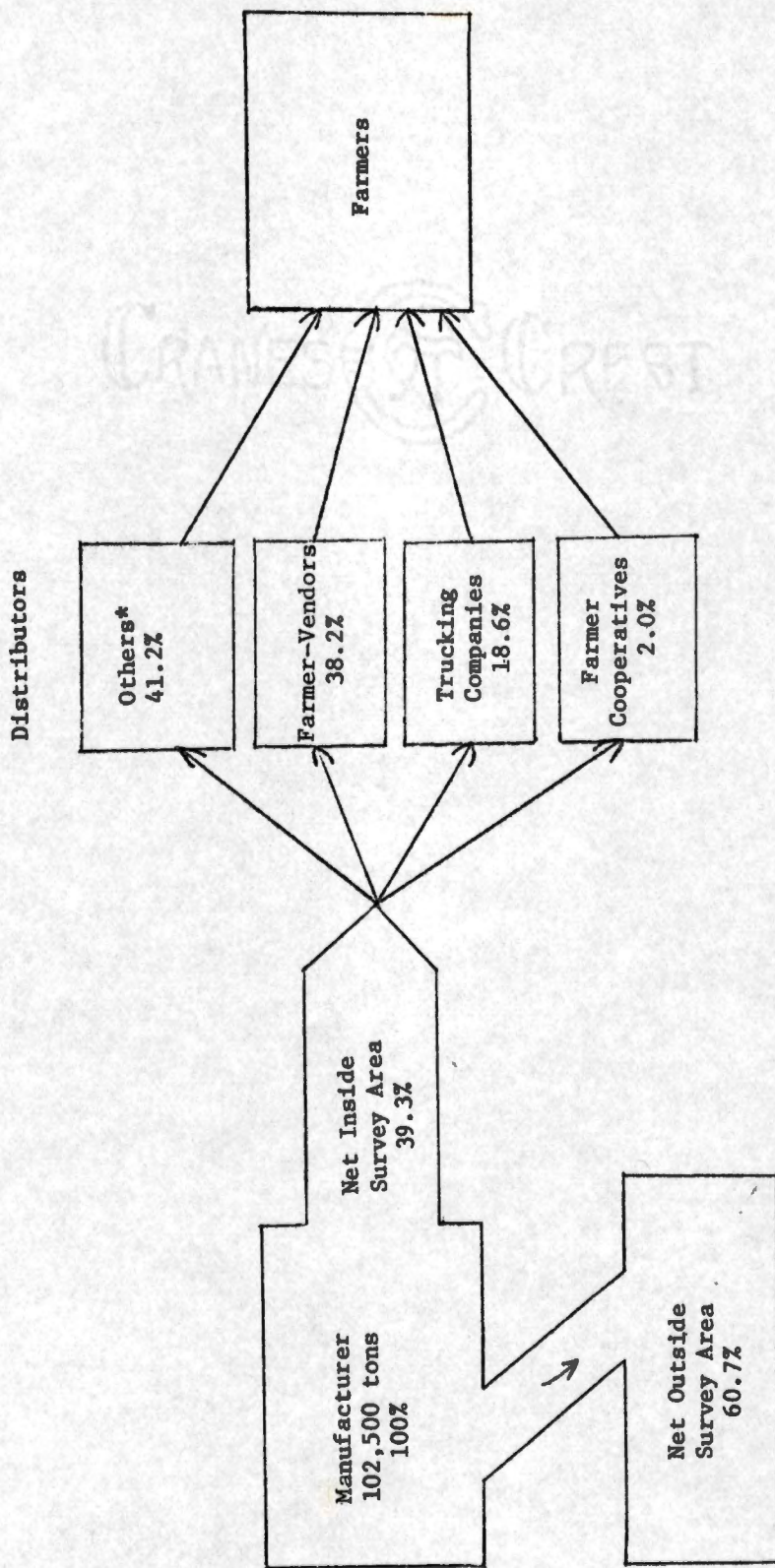
I. DISTRIBUTION CHANNEL FOR LIME PRODUCED
IN THE SURVEY AREA

Manufacturers in the study area produced over 102,000 tons¹⁶ of lime that was sold to farmers within the area or outside the survey area. Of this amount around 39 percent was handled by the distributors in the survey. Net exports of lime from the area were around 61 percent of the total amount produced (Figure 1).

Attention will be focused on the amount handled by distributors within the survey area so as to delineate the channel of lime movement from manufacturer to farmer in East Tennessee. Distributors were classified in this study into four major types: (1) farmer-vendor, (2) trucking companies, (3) farmer cooperatives, and (4) others.¹⁷ Over 41 percent of lime sold to farmers was handled by the distributors classified as others, farmers-vendors handled more than 38 percent of the lime, trucking companies handled almost 19 percent, and farmer cooperatives distributed about 2 percent (Figure 1).

¹⁶One manufacturer produced over 500,000 tons and was omitted. Even though it is believed that a large volume of lime was sold by this manufacturer to distributors and farmers in the survey area, it was omitted from analysis involving volume and prices as the inclusion was thought to yield misleading conclusions since the majority of his sales were outside the survey area.

¹⁷Grouped together in the "other" category in order to avoid disclosure were: a ready-mix concrete dealer, a lime and stone company, and a hardware store.



* Grouped together to avoid disclosure.

Figure 1. Distribution channel for lime produced in the survey area.

Manufacturers

All manufacturers of agricultural lime within the nine-county area were quarry operators that produced lime as a by-product from their quarry operation. These manufacturers were all corporations and had been in operation an average of 26.8 years (Table I, page 4). The percent of their business that was lime sales ranged from 1 to 20 percent with an average for all manufacturers of 6.7 percent (Table I). A total of 102,500 tons¹⁸ of lime was sold by all manufacturers. There were nine manufacturers in the nine-county area--three were located in the high lime use area (I) and the remainder was produced in the low lime use area (II).

Lime manufacturing was concentrated primarily in Knox County in the low lime use area and in Meigs County in the relatively high lime use area. Lime manufacturers sold an average of 9,140 tons of lime per year in area II and 18,933 tons per year in area I. Weighted average prices were \$2.10 and \$1.58 per ton in the high and low lime use areas, respectively (Table II).¹⁹

Some form of lime advertising was done by all manufacturers as a part of their overall advertising program. However, lime advertising

¹⁸One manufacturer produced approximately 500,000 tons and was omitted (see footnote 16, page 14).

¹⁹The calculation of the weighted average price per ton of lime was obtained by multiplying each item to be averaged by the tons pertinent to it, totaling these products, and dividing this total by the sum of all tons of lime.

TABLE II

CHARACTERISTICS OF MANUFACTURERS AND PRICE PER TON OF LIME BY HIGH LIME USE AREAS
AND LOW LIME USE AREAS WITHIN THE 9 EAST TENNESSEE COUNTIES

	Number of Manufacturers	Average Number Years of Operation (per firm)	Avg. % of Business Ag. Lime (per firm)	Average Tons of Lime Per Year (per firm)	Average Weighted Price Per Ton \$
Area I (high use)					
Loudon	1	--	--	--	--
McMinn	1	25	2	15,000	2.00
Meigs	1	12	20	21,800	2.25
Rhea	1	10	5	20,000	2.00
Area Total	3	15.3	9	18,933	2.10
Area II (low use)					
Anderson	1	--	--	--	--
Bradley	1	--	--	--	--
Hamilton	4	19	1	5,000	1.75 ^b
Knox	4	38	6.8	33,700 ^a	1.40
Roane	1	20	5	7,000	2.25
Area Total	6	32.3	5.5	9,140	1.58
Nine-County Area	9	26.8	6.7	11,389	1.86

^aOne manufacturer produced approximately 500,000 tons and was omitted.

^bWeighted price of all manufacturers in the county.

was primarily oriented toward distributors in their area or large-volume purchasers outside the survey area. Nothing specifically directed toward farmers was cited by the manufacturers. Even though this type of advertising could have been directed toward the farmers, this appeared not to be the case. The most frequently mentioned form of advertising directed at distributors was newspapers, followed by radio, personalized contacts, trade publications, direct mail, and television. The most popular means following radio was classified as others which included such things as show booths, brochures, pens, and sample bottles of lime. The form of advertising as mentioned by the manufacturers probably reflects the type of advertising done for their major source of business, such as gravel and other quarry materials, and thus conclusions drawn concerning advertising of lime by manufacturers may be misleading because of the inability to specifically show what percent of the advertising was directed toward lime sales.

Lime manufacturers in the survey area did not operate lime truck spreaders for farmers. However, they did sell directly to farmers who had spreading equipment. Lack of volume and lack of available low-cost trucking were cited as major problems in servicing local lime needs. With respect to large-volume sales outside the survey area, manufacturers cited lack of boxcars and lack of low-cost trucking, too high freight rates, and too small a market area available to East Tennessee lime manufacturers as major problems.

However, 67 percent of the manufacturers indicated that lime was a profitable item. Another 11 percent didn't know whether lime was profitable or not, and 22 percent said handling lime was not profitable.

Distributors

Distributors of lime in the nine-county area (that from hereon shall be called vendors) included farmer-vendors, trucking companies, farmer cooperatives, a ready-mix concrete dealer, a lime and stone company, and a hardware store. There were 12 distributors in the nine-county area with six in area I and six in area II. In area I there were two farmer-vendors, two farmer cooperatives, one trucking company, and one ready-mix concrete dealer that would deliver and spread lime. In area II there were three farmer-vendors, one trucking company, one lime and stone company, and one hardware store that would deliver and spread lime (Table III). The ready-mix concrete dealer, lime and stone company, and hardware store were grouped into an "other" category.²⁰ Vendors had been in business an average of 12.6 years with total years ranging from 1 to 31. As far as areas are concerned, the average years of experience in the high lime use area was around 11 years and in the low lime use area around 14 years (Table III).

Lime distribution by farmer-vendors was considered as a business exclusive of their farming operation with an average of 94 percent of

²⁰To avoid disclosure of the activities of individual firms, the ready-mix concrete dealer, lime and stone company, and hardware store were aggregated into the "other" category.

TABLE III
 CHARACTERISTICS AND PRICES OF LIME BY DIFFERENT TYPES OF VENDORS IN
 THE HIGH AND LOW LIME USE AREAS

	Number of Vendors	Years of Experience (per firm)	Average % of Business Ag. Lime	Average Tons of Lime Per Year (per firm)	Weighted Price of Lime Per Ton (per firm)	Estimated Gross Margin Per Ton (per firm)	% of Total Tons Lime Handled by Each Vendor
Area I (high use)							
Farmer-vendor	2	12	95	3,450	3.93	2.18	30.4
Trucking company	1	8	5	2,500	4.25	2.39	11.0
Farmer cooperative	2	8	5	400	4.38	2.33	3.5
Other ^a	$\frac{1}{6}$	$\frac{20}{11.3}$	$\frac{35}{40}$	$\frac{12,500}{3,783.3}$	$\frac{4.00}{4.02}$	$\frac{2.00}{1.92}$	$\frac{55.1}{100.0}$
Area	6						
Area II (low use)							
Farmer-vendor	3	9	93	2,833	4.25	2.29	48.3
Trucking company	1	20	1	5,000	4.25	2.85	28.4
Farmer cooperative	0	--	--	--	--	--	--
Other ^a	$\frac{2}{6}$	$\frac{18}{13.8}$	$\frac{50}{63.7}$	$\frac{2,050}{2,933.3}$	$\frac{4.02}{4.20}$	$\frac{2.16}{2.62}$	$\frac{23.3}{100.0}$
Area	6						
Nine-County Area	12	12.6	51.8	3,358.3	4.10	2.20	100.0

^aOthers include ready-mix concrete dealer, lime and stone company, and hardware store.

their total nonfarm business being lime sales. Hauling fertilizer and light gravel work comprised the other 6 percent. The cooperatives and trucking companies were engaged in many different selling activities. Only about 5 and 3 percent, respectively, of their gross sales were from lime. All "others" together averaged around 45 percent of their gross sales from lime. The volume of lime sold per vendor in the nine-county area averaged 3,358 tons per year, and total volume handled by vendors ranged from 100 to 12,500 tons. Farmer-vendors handled an average of 3,080 tons, trucking companies handled 3,750, farmer cooperatives handled 400, and others handled an average of 5,533 tons (Table III). In area I, the farmer-vendors handled 30.4 percent of the lime and others category handled 55.1 percent. Truckers and farmer cooperatives handled the remaining 15 percent of the lime in area I. In area II the farmer-vendors distributed 48.3 percent of the lime, truckers 28.4 percent, and others category 23.3 percent (Table III).

Most of the vendors in the nine-county area stated they would deliver any amount of lime but indicated they set a spreading minimum of one ton per acre. The weighted average price per ton for delivery and spreading charged by all vendors was \$4.10 with prices ranging from \$3.75 to \$5.00 per ton. Farmer-vendors had the lowest weighted average price in the high lime use area with \$3.93 per ton, others category was next with a price of \$4.00 per ton, followed by trucking companies with \$4.25 per ton and cooperatives with \$4.38 per ton. In the low lime use area, others category had the lowest weighted coverage price with \$4.02 per ton. Trucking companies and farmer-vendors had a price of \$4.25 per ton (Table III).

Information on operation costs for handling lime could not be obtained from the vendors; therefore, specific profit margins in lime distribution could not be calculated. However, some indication of the gross profit margin was estimated by taking the difference between weighted average f.o.b. prices and weighted average prices charged farmers for spreading lime. All vendors had an average gross profit margin of \$2.20 per ton. The estimated gross profit margins in the nine-county area as shown in Table III, page 20, were \$2.24, \$2.62, \$2.33, and \$2.08 for farmer-vendors, trucking companies, farmer cooperatives, and other, respectively. Trucking companies had the highest estimated gross margins in area I and area II with \$2.39 and \$2.85 per ton, respectively. Farmer cooperatives were next with an estimated gross margin of \$2.33 per ton in area I. There were no farmer cooperative lime vendors in area II. Farmer-vendors were next with \$2.18 and \$2.29 per ton in area I and area II, respectively. Other category had the lowest estimated gross margins with \$2.00 and \$2.16 in area I and area II, respectively. However, the actual profit margin for each firm would probably depend on volume and alternative uses for labor and equipment since lime prices charged by manufacturers do not vary with volume sold to vendors. Other major costs involved, such as initial investments in equipment, are fixed, so the higher the volume the lower the fixed costs per ton. All vendors did say that lime was profitable to handle but since none showed any operating costs, it was not possible to determine exactly how profitable their lime distribution business was.

Equipment used by vendors for spreading lime included spreader trucks that in most cases were also used for fertilizer delivery. One-half the vendors had only one spreader truck, and the remaining half had two or more trucks with half of these listing no alternative uses for their equipment and the others used theirs for fertilizer delivery. Since a large percent (42 percent) of the vendors were farmers, it can be assumed that they also used their equipment to spread their own lime and fertilizer. In fact, some of the farmer-vendors stated their reason for purchasing equipment was for their personal use.

In terms of offering credit to farmers, the most frequently mentioned form was 30 days net which in some forms of business is considered the same as cash sales. However, in this study it is being treated as a credit sale. About 86 percent of the vendors cited 30 day net as their credit plan and sold an average of 54.5 percent of the lime on credit (Table IV). Sixty-eight percent of the lime was sold on credit in area I and over 43 percent was sold on credit in area II.

Lime vendors did very little, if any, advertising and promotion of lime through what would be considered the more common means of advertising such as radio, television, and newspapers. Only three vendors said they were using one or more of the above-mentioned mass media. Two of these vendor categories (trucking company and other) were located in area I and one category (other) was in area II. The remaining vendors relied on such things as cards, pencils, signs on trucks, contacts with ASCS and county agents, reputation, and location as their means of promoting and advertising lime to the farmers.

TABLE IV

TONS OF LIME, PRICE PER TON, GROSS MARGINS AND LIME SOLD THROUGH ASCS PROGRAMS
BY VENDORS IN THE 9-COUNTY AREA ON A COUNTY BASIS

	Number of Vendors	Average Tons of Lime (per firm)	Total Tons ASCS Office (per county)	Weighted Average Price Per Ton	Gross Margin Per Ton	% Business on Credit (per firm)	Weighted % of Total Lime Sold Through ASCS (per county)
Area I (high use)							
Loudon	3	1,867	3,790	4.28	2.42	73	77
McMinn	1	12,500	9,375	4.00	2.00	50	75
Meigs	1	200	80	4.00	1.75	95	40
Rhea	1	4,400	1,760	3.75	1.75	50	40
Area	6	3,783.3	15,005	4.02	1.92	68.0	66.1
Area II (low use)							
Anderson	1	2,500	1,500	4.25	2.39	25	60
Bradley	3	2,367	4,800	4.12	2.26	40	78
Hamilton	1	3,000	2,400	4.25	2.50	25	80
Knox	1	5,000	5,000	4.25	2.85	90	100
Roane	1	---	---	---	---	---	---
Area	6	2,933.3	13,700	4.20	2.62	43.3	77.8
Nine-County Area	12	3,358.3	28,705	4.10	2.20	54.5	71.2

Seven of the 12 lime vendors did no advertising or promotion of lime in the nine-county area. None of the five farmer-vendors reported using any type of mass media advertising. They relied on contacts with the ASCS and "word of mouth" recommendations of farmers. Since farmer-vendors are not entirely dependent upon lime sales and have alternative uses for their labor and liming equipment, there is not as much of an incentive for them to promote and advertise their lime business. However, vendors who were not farmers did not have the option of using their equipment for their personal use and were therefore more involved in advertising lime. There were seven other vendors who were not farmers of which five utilized some form of advertising. Even these vendors made only limited use of the more common mass media advertising as the majority said their forms of advertising were pens, posters, cards, signs on truck, ASCS offices, and county agents' offices. ASCS offices were found to be involved in most of the lime sold as more than 70 percent of the lime went through their offices in their cost-sharing program (Table IV); therefore, all lime vendors appeared to rely heavily upon direct contact with farmers and ASCS offices as their major means of advertising and promotion.

The lime vendors thought that most farmers were not using adequate amounts of lime, and nine of the 12 vendors said they suggested soil sampling to farmers as a means of determining their lime needs. Some vendors aided in soil testing by offering information and mailing soil samples to laboratories as part of their services to customers.

Competition in the survey area had increased by at least one vendor in six of the nine counties in the area in the last 10 years. Other counties had either decreased or remained the same.

II. ROLE OF COUNTY AGENTS AND ASCS OFFICES IN LIME DISTRIBUTION

County agents and Agricultural Soil Conservation Service (ASCS) directors were visited in each of the counties in the study. The visits were for the purpose of determining programs and promotional campaigns that were in progress or had been in progress in the last five years. Over 70 percent of the lime sold in these counties was being cost-shared through ASCS programs, therefore, it can be seen that this agency plays a major role in the sale of lime. Since the ASCS program is of economic importance to the farmer in getting lime spread, the question would arise as to the relationship among farmers and ASCS offices in getting lime spread. Farmers are exposed to signup periods in which they become eligible for cost-sharing in their purchase of lime. Presently the county agents and ASCS officers were not involved in a major emphasis on their lime program. But all counties had some form of general promotional campaigns that were carried on by way of radio, newsletters, or group meetings during the liming season. Of these, radio and mailed releases were cited most frequently as their means for communicating with farmers and lime distributors.

Both ASCS and extension personnel felt that farmers in their counties should use more lime, however, they did not consider the lack

of lime use to be a very critical problem. Thus, they were not putting any special emphasis on lime use in their programs but were giving special consideration to other farm management and marketing problems which were judged to be more important. Also, changes in ASCS programs during the past year may alter the role of ASCS in lime sales. Farmers are now required by ASCS regulations to have soil tests made on land to determine lime and fertilizer needs before they could become eligible for the ASCS cost-sharing program. Most ASCS personnel thought the use of lime by farmers would decrease initially and probably increase again in the next few years.

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CHAPTER IV

ANALYSIS OF FARMERS' ATTITUDES AND CHARACTERISTICS

ASSOCIATED WITH LIME USE

For manufacturers and distributors in the lime industry to better understand their market area and be able to make useful decisions in the marketing of their products, information is needed about farmers' attitudes and interests concerning lime use. This chapter will deal primarily with attitudes and factors that affect farmers' use of lime.

I. CHARACTERISTICS OF SURVEY RESPONDENTS

Of the 1,500 questionnaires that were mailed, 15 percent responded with completed or usable questionnaires. The farmers responding to the questionnaires had the following characteristics.

More than one-third (34 percent) of these farmers were 60 years or older, 27 percent were between the ages of 50 and 59 years, and about 33 percent were between the ages of 30 and 49. Also, almost 50 percent of these farmers had 8-12 years of education. Over 35 percent had some college training with approximately 8 percent of the college trained group having graduate degrees. The farming situation in the nine-county area was comprised mainly of part-time farmers, as over 46 percent of the farmers were in this category. About 21 percent were full-time farmers and over 17 percent were hobby farmers, while 13.5 percent of those surveyed considered themselves only as landlords (Table V).

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TABLE V
CHARACTERISTICS OF FARMERS IN THE 9-COUNTY AREA

	Area I (high lime use area)		Area II (low lime use area)		Nine-County Area	
	No.	%	No.	%	No.	%
Age						
Under 30	5	6.1	7	4.7	12	5.2
30-39	10	12.2	18	12.2	28	12.2
40-49	19	23.2	28	18.9	47	20.4
50-59	25	30.5	38	25.7	63	27.4
60 or over	22	26.8	56	37.8	78	33.9
X	1	1.2	1	0.7	2	.9
Total	82	100.0	148	100.0	230	100.0
Education						
Under 8 years	14	17.1	19	12.8	33	14.4
8-12 years	47	57.3	66	44.6	113	49.1
1-3 years college	9	11.0	22	14.9	31	13.5
4 years college	5	6.1	20	13.5	25	10.9
Part graduate study	2	2.4	5	3.4	7	3.0
Graduate degree	3	3.7	15	10.1	18	7.8
X	2	2.4	1	0.7	3	1.3
Total	82	100.0	148	100.0	230	100.0
Farm Situation						
Full-time	22	26.8	26	17.6	48	20.9
Part-time	35	42.7	72	48.6	107	46.5
Hobby farmer	12	14.6	29	19.6	41	17.8
Landowner	11	13.4	20	13.5	31	13.5
X	2	2.4	1	.7	3	1.3
Total	82	100.0	148	100.0	230	100.0

X = No response to this question.

Note: Totals may not add due to rounding.

The breakdown of the type farming operation in the survey is consistent with the 1964 U. S. Census of Agriculture for the nine-county area, as 40 percent of the farmers in the survey area were part-time in 1964.²¹

II. DATA LIMITATIONS

An attempt was made to select a representative sample of farmers within the nine-county area. However, due to the lack of response to the mail questionnaires and the low number of usable questionnaires that were returned, the representativeness of the data is in doubt. Therefore, the application and use of the following statistical analysis is quite limited and should be interpreted with considerable caution.

III. STATISTICAL ANALYSIS

The linear multiple regression model was used to ascertain the relationship between the following selected socioeconomic factors and the percent of cropland limed by farmers. Use of lime by farmers was hypothesized to be related by the following factors: age and education of the farmer, type and size of farm operation, rental arrangements, gross farm sales, use of soil tests, price of lime, customer satisfaction with lime dealers, and distance from source of lime.

²¹1964 U. S. Census of Agriculture, Tennessee, U. S. Department of Commerce, Bureau of the Census, Volume 1, part 31.

The Model

The basic model was:

$$Y = a + \sum_{i=1}^{n=27} b_i X_i + u$$

where:

- Y = percent of cropland limed by the farmer within the past five years
- a = constant term
- b_i = estimated b coefficient
- X_i = the i^{th} socioeconomic variable
- u = the error term.

Socioeconomic (Independent) Variables

The independent variables utilized in the above regression model were measured as follows:

1. Area (X_1) - The value of this variable was coded 1 if the farmer lived in area II (low lime use area) and 0 if in area I (high lime use area).
2. Age ($X_2 - X_5$) - Farmer ages were subdivided into five age groups: under 30, 30 to 39, 40 to 49, 50 to 59 and over 60. Zero-one analysis of covariance (dummy variables) was used to introduce these categories into the equation, i.e., if the farmer were under 30, then $X_2 = 1$ and otherwise $X_2 = 0$; if the farmer were 30 to 39, then $X_3 = 1$, 0 otherwise;

if the farmer were 40 to 49, then $X_4 = 1$, 0 otherwise; if the farmer were 50 to 59, then $X_5 = 1$, 0 otherwise. The omitted class represented the over 60 age group.

3. Education ($X_6 - X_{10}$) - Education of farmers was subdivided into six education categories: under eight years, 8 to 12 years, one to three years college, four years college, part graduate study, and graduate degree. Dummy variable technique was again used, i.e., if the farmer had under eight years of education, then $X_6 = 1$, 0 otherwise; if the farmer had 8 to 12 years education, then $X_7 = 1$, 0 otherwise; if the farmer had one to three years college, then $X_8 = 1$, 0 otherwise; if the farmer had four years of college, then $X_9 = 1$, 0 otherwise; if the farmer had part graduate study, then $X_{10} = 1$, 0 otherwise. The omitted class was farmers with graduate degrees.
4. Farm situation ($X_{11} - X_{13}$) - Farmers were subdivided into the following categories: full-time, part-time, hobby farming, and landowner only. With the use of dummy variables, these variables were entered into the equation, i.e., if full-time farmer, then $X_{11} = 1$, 0 otherwise; if part-time farmer, then $X_{12} = 1$, 0 otherwise; if hobby farmer, then $X_{13} = 1$, 0 otherwise. The omitted category was landowner only.
5. Farm acreage ($X_{14} - X_{18}$) - The percentage of the following acres of land in the farm operation was entered directly into the analysis:

- a. Percent of cropland (X_{14}) - percent of cropland in the farm operation.
 - b. Percent of acres owned (X_{15}) - percentage of the land which the farmer owned.
 - c. Percent of rented acres (X_{16}) - percent of land in the farming operation which the farmer rented from others.
 - d. Percent of land rented (X_{17}) - percent of the total farm operation which the farmer rented to others.
6. Type of rental agreement ($X_{18} - X_{21}$) - Renter agreements were subdivided into the following categories: owner pays all of lime cost, renter pays all of lime cost, each pays half, no agreement, and no rented land in farm operation. Using dummy variables, these categories were entered into the analysis, i.e., if the owner pays all of lime cost, then $X_{18} = 1$, 0 otherwise; if the renter pays all of lime cost, then $X_{19} = 1$, 0 otherwise; if each paid half, then $X_{20} = 1$, 0 otherwise; if no agreement, then $X_{21} = 1$, 0 otherwise. No rented land in farm operation was the category omitted.
7. Total farm sales (X_{22}) - Total dollar sales of the farm operator.
 8. Total acres in farm (X_{23}) - Total number of acres in the farm operation.
 9. Soil tests (X_{24}) - Dummy variables were used to enter this variable into the equation, i.e., if the farmer made soil tests, then $X_{24} = 1$, 0 otherwise.

10. Price of lime (X_{25}) - The price per ton paid by the farmer at the time of purchase.
11. Customer satisfaction (X_{26}) - Dummy variables were used to enter this variable, i.e., if the farmer were satisfied with the service he received, then $X_{26} = 1$; if not, then $X_{26} = 0$.
12. Distance from source of lime (X_{27}) - Represents miles that the farmer indicated his farm was from the source of lime.

IV. RESULTS

The results of estimating the model are given in Table VI. The above selected socioeconomic variables explained a significant ($P \leq .05$) proportion of the variability in the percent of cropland limed. However, only 34 percent of the total variation in percent cropland limed was explained by the variables included in the above model.

Initially the nine-county area was subdivided into high and low lime use areas with the use of U. S. Census and other secondary data. The results of the above model substantiated that the same was true for the sample of farmers in this study. The farmers in the area designated as a low lime use area (area II) limed a significantly ($P \leq .05$) lower percentage of their cropland than farmers in the area designated as the high lime use area (area I), after taking into account age, education, and the other socioeconomic factors listed above.

Although age of farmers was not significantly related to percent cropland limed (at the 90 percent or higher level), there was a tendency for farmers under 50 years of age to apply more lime than farmers 50

TABLE VI

ESTIMATED COEFFICIENTS, STANDARD ERRORS, AND RESPECTIVE F-VALUES
FOR SELECTED VARIABLES ON PERCENT OF CROPLAND LIMED
IN A SELECTED 9-COUNTY AREA OF EAST TENNESSEE

	Estimated Coefficients	Estimated Standard Error	F-Value
Constant	34.91		
Area II	2.04	5.00	9.56*
Age			
Under 30	2.04	11.07	.03
30-39	5.04	7.77	.42
40-49	1.35	6.61	.04
50-59	-9.88	6.18	2.56
60 or over ^a	--	--	--
Education			
Under 8 years	-34.66	9.46	13.42*
8-12 years	-26.37	7.74	11.60*
1-3 years college	-12.49	9.43	1.76
4 years college	-15.65	9.74	2.58
Part graduate study	-42.95	33.20	1.67
Graduate degree ^a	--	--	--
Farm Situation			
Full-time	22.98	10.44	4.84*
Part-time	18.66	9.48	3.87*
Hobby farmer	3.94	10.31	.15
Landowner ^a	--	--	--
Farm Acreage			
Acres cropland (%)	.03	.03	1.01
Acres owned (%)	.00	.03	.02
Acres rented (%)	-.04	.04	.09
Acres rented others (%)	-.05	.41	1.73
Total acres in farm	.02	.03	.55

TABLE VI (continued)

	Estimated Coefficients	Estimated Standard Error	F-Value
Type Rental Agreement			
Owner pays all	2.36	2.25	1.10
Renter pays all	18.21	11.14	2.68
Each pays half	8.11	10.93	.55
No agreement	1.28	20.02	.01
No rented land ^a	--	--	--
Other Variables			
Total farm sales	-.00	.00	2.06
Soil tests	11.44	5.26	4.73*
Price of lime	1.48	1.06	1.94
Customer satisfaction	-3.05	6.80	.20
Distance from source	.31	.22	2.10

$$R^2 = .3417$$

* Significant at the .05 level.

^a Omitted to avoid singularity.

years or older. Farmers who had at least some college training and those with college degrees used significantly ($P \leq .05$) more lime than hobby farmers and landowners. These results are what one would expect as younger farmers are more likely to follow farming practices that are beneficial to their farming programs.

Soil tests were found to be significantly ($P \leq .05$) positively related with lime use. Farmers who had soil tests were more likely to use lime. The remaining variables were found to be nonsignificantly (at the 90 percent or higher level) related to the percent of cropland limed by farmers. However, the following general relationships were found to exist. Farmers operating rented land under the agreement that the tenant paid for all lime appeared to lime a higher percentage of their cropland than farmers utilizing other types of agreements. Farmers, who purchased higher priced lime, also appeared to lime a higher percentage of their cropland. Distance from the distributor of lime also was positively related to percent of cropland limed.

Further statistical tests of the differences between the subgroups within each area (high and low lime use areas) were not undertaken. The lack of representativeness of the final sample and the small numbers in each cell of the subsamples prohibit further statistical analysis among the two areas. Therefore, tabular analysis was undertaken to ascertain general relationships which may help explain the differences in lime use between the two areas.

The analysis was concentrated on the following factors between the two areas: age and education of the farmer, types of farms, use of

soil tests, lime prices, distance from lime source, use of ASCS programs, rental agreements and other attitudes of farmers toward lime use.

Factors Influencing Differences in Lime Use of Farmers in the High and Low Lime Use Areas

Age and education. There appeared to be very little differences in the ages of farmers surveyed in the two areas. Only about 6 percent more farmers in the low lime use area were 50 years or older. However, about 42 percent of the farmers in the low lime use area had at least one year of college as opposed to only about 23 percent of the farmers in the high lime use area (Table V, page 29).

Type of farm and soil testing. Limited difference in farm type or soil testing was apparent between the high and low lime use areas. About 33 percent of the farmers in the low lime use area were hobby farmers or landowners, as compared with only 28 percent in the high lime use area (Table V).

Also, about 65 percent of the farmers in the low lime use area had soil tests made as compared with about 59 percent in the high lime use area (Table VII). About 45 percent of the farmers in the high lime use area said they followed lime recommendations over 75 percent of the time, as compared with 47 percent in the low lime use area (Table VIII). The percentage difference was also about the same between the two areas as to soil testing and use when specific age, education and type farming situation categories were compared (Tables VII and VIII).

TABLE VII

NUMBER AND PERCENT OF FARMERS IN EACH AGE, EDUCATION, AND
FARM SITUATION CATEGORY WHICH USE SOIL TEST FOR HIGH
AND LOW LIME USE AREAS

	High Use Area		Low Use Area		Total	
	No.	%	No.	%	No.	%
Age						
Under 30	3	60.0	5	71.4	8	66.7
30-39	7	70.0	13	72.2	20	71.4
40-49	13	68.4	11	39.3	24	51.1
50-59	12	48.0	27	71.1	39	61.9
60 or over	13	59.0	39	69.6	52	66.7
X	0	0	1	100.0	1	50.0
Total	48	58.5	96	64.9	144	62.6
Education						
Under 8 years	6	42.9	10	52.6	16	48.5
8-12 years	28	59.6	47	71.2	75	66.4
1-3 yrs. college	5	55.6	17	77.3	22	71.0
4 yrs. college	5	100.0	14	70.0	19	76.0
Part grad. study	1	50.0	5	100.0	6	85.7
Graduate degree	3	100.0	3	20.0	6	33.3
X	0	0	0	0	0	0
Total	48	58.5	96	64.9	144	62.6
Farm Situation						
Full-time	16	72.7	19	73.1	35	72.9
Part-time	21	60.0	52	72.2	73	68.2
Hobby farmer	8	66.7	13	44.8	41	51.2
Landowner	3	27.3	11	55.0	14	45.2
X	0	0	1	100.0	1	33.3
Total	48	58.5	96	64.9	144	62.6

X = No response to this question.

Note: Totals may not add due to rounding.

TABLE VIII

FARMER AGE, FARMER EDUCATION, AND FARM SITUATION COMPARED WITH PERCENTAGES OF LIME RECOMMENDATIONS FOLLOWED FOR THE 9-COUNTY AREA

	Never		< 25%		25-50%		50-75%		75-100%		Other or Combination		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Farmer Age (Years)														
Under 30	0	0	0	0	1	8.3	2	16.7	7	58.3	2	16.7	12	5.2
30-39	3	10.7	0	0	0	0	3	10.7	20	71.4	2	7.1	28	12.2
40-49	6	12.8	0	0	1	2.1	9	19.1	18	38.3	13	27.7	47	20.4
50-59	12	19.0	2	3.2	5	7.9	6	9.5	27	42.9	11	17.5	63	27.4
60 or over	6	7.7	4	5.1	5	6.4	8	10.3	34	43.6	21	26.9	78	33.9
X	0	0	0	0	0	0	0	0	1	50.0	1	50.0	2	.9
Total	27	11.7	6	2.6	12	5.2	28	12.2	107	46.5	50	21.7	230	100.0
Farmer Education														
Under 8 years	7	21.2	1	3.0	0	0	2	6.1	10	30.3	13	39.4	33	14.3
8-12 years	10	8.8	1	.9	10	8.8	15	13.3	59	52.2	18	15.9	113	49.1
1-3 years college	3	9.7	0	0	1	3.2	5	16.1	15	48.4	7	22.6	31	13.5
4 years college	0	0	3	12.0	0	0	2	8.0	16	64.0	4	16.0	25	10.9
Part grad. study	1	14.3	0	0	0	0	3	42.9	2	28.6	1	14.3	7	3.0
Graduate degree	6	33.3	1	5.6	1	5.6	1	5.6	5	27.8	4	22.2	18	7.8
X	0	0	0	0	0	0	0	0	0	0	3	100.0	3	1.3
Total	27	11.7	6	2.6	12	5.2	28	12.2	107	46.5	50	21.7	230	100.0

TABLE VIII (continued)

Farm Situation	< 25% of Time		25-50% of Time		50-75% of Time		75-100% of Time		Other or Combination		Total			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
Full time	2	4.2	0	0	4	8.3	7	14.6	26	54.2	9	18.8	48	20.9
Part time	12	11.2	3	2.8	6	5.6	15	14.0	54	50.5	17	15.9	107	46.5
Hobby farmer	6	14.6	3	7.3	2	4.9	3	7.3	15	36.6	12	29.3	41	17.8
Landowner, no farming	7	22.6	0	0	0	0	3	9.7	11	35.5	10	32.2	31	13.5
X	0	0	0	0	0	0	0	0	1	33.3	2	66.7	3	1.3
Total	27	11.7	6	2.6	12	5.2	28	12.2	107	46.5	50	21.7	230	100.0

X = No response to this question.

Note: Totals may not add due to rounding.

In the nine-county area, almost 50 percent of the farmers stated they followed their soil test recommendations between 75 to 100 percent of the time. Less than 12 percent said they never followed their soil test recommendations. Over half the farmers who were 60 years or greater followed their soil test recommendations over 50 percent of the time. On the average, regardless of age, education, or type farming situation, the soil test recommendations were followed from 50 to 100 percent of the time by over 48 percent of the farmers. When looking at age, these figures are considered favorable to soil tests because the more common assumption is that older farmers tend to use their own judgment in their application of lime.

Knowledge concerning the benefits of lime. The majority of the farmers knew something about the agronomic benefits of lime, as almost two-thirds of the farmers knew that lime reduced soil acidity. The other third of the farmers either answered by saying they did not know or listed several answers to the question. The response was about the same between the two areas as about 65 percent of the farmers in the high use area and almost 61 percent of the farmers in the low use area knew that lime reduced soil acidity (Table IX). However, it is phenomenal that with the vast amount of material available that emphasizes the need for lime that still 38 percent of the farmers in the nine-county area did not know that lime should be used to reduce soil acidity. In fact, 13 percent of the farmers indicated that they didn't really know why farmers should use lime. Another 19 percent checked a combination of

TABLE IX
BENEFITS OF LIME USE BY FARMER AGE, FARMER EDUCATION, AND TYPE FARM SITUATION
FOR THE HIGH AND LOW LIME USE AREAS IN THE 9 COUNTY AREA

	Increase Water Holding Capacity			Reduce Soil Acidity			Line not Necessary in Area			Don't Know			Others or Combination Assesmt			Total									
	High Use		Low Use	High Use		Low Use	High Use		Low Use	High Use		Low Use	High Use		Low Use	High Use		Low Use							
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%							
Farmer Age (Years)																									
Under 30	1	20.0	0	0	1	20.0	2	28.6	0	0	0	0	2	40.0	1	14.3	1	20.0	4	57.1	5	41.7	7	58.3	
30-39	1	10.0	0	0	6	60.0	15	83.3	0	0	0	0	1	10.0	3	16.7	2	20.0	0	0	10	35.7	18	64.3	
40-49	0	0	0	0	14	73.7	18	64.3	0	0	0	0	2	10.5	4	14.3	3	15.8	6	21.4	19	40.4	28	59.6	
50-59	1	4.0	3	7.9	18	72.0	23	60.5	1	4.0	0	0	2	8.0	4	10.5	3	12.0	8	21.1	25	39.7	38	60.3	
60 or over	0	0	2	3.6	14	63.6	31	55.4	0	0	3	5.4	3	13.6	7	12.5	5	22.7	13	23.2	22	28.2	56	71.8	
X	0	0	0	0	0	0	0	100.0	0	0	0	0	1	100.0	0	0	0	0	0	0	1	50.0	1	50.0	
Total	3	3.7	5	3.4	53	64.6	90	60.8	1	1.2	3	2.0	11	13.4	19	12.8	14	17.1	31	20.9	82	35.7	148	64.3	
Farmer Education																									
Under 8 years	0	0	2	10.5	7	50.0	5	26.3	0	0	1	5.3	5	35.7	8	42.1	2	14.3	3	15.8	14	42.4	19	57.6	
8-12 years	3	6.4	3	4.5	31	66.0	41	62.1	1	2.1	1	1.5	4	8.5	8	12.1	8	17.0	13	19.7	47	41.6	66	58.4	
1-3 years college	0	0	0	0	8	88.9	13	59.1	0	0	0	0	0	0	3	13.6	1	11.1	6	27.3	9	29.0	22	71.0	
4 years college	0	0	0	0	3	60.0	14	70.0	0	0	0	0	1	20.0	0	0	1	20.0	6	30.0	5	20.0	20	80.0	
Part grad. study	0	0	0	0	2	100.0	4	80.0	0	0	1	20.0	0	0	0	0	0	0	0	0	2	28.6	5	71.4	
Graduate degree	0	0	0	0	2	66.7	13	86.7	0	0	0	0	1	33.3	0	0	0	0	2	13.3	3	16.7	15	83.3	
X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	100.0	1	100.0	2	66.7	1	33.3	
Total	3	3.7	5	3.4	53	64.6	90	60.8	1	1.2	3	2.0	11	13.4	19	12.8	14	17.1	31	20.9	82	35.7	148	64.3	
Farm Situation																									
Full time	1	4.5	0	0	15	68.2	15	57.7	0	0	0	0	2	9.1	3	11.5	4	18.2	8	30.8	22	45.8	26	54.2	
Part time	1	2.9	4	5.6	26	74.3	50	69.4	1	2.9	1	1.4	1	2.9	7	9.7	6	17.1	10	13.9	35	32.7	72	67.3	
Bobby farmer	0	0	0	0	5	41.7	19	65.5	0	0	1	3.4	4	33.3	4	13.8	3	25.0	5	17.2	12	29.3	29	70.7	
Landowner, no farming	1	9.1	1	5.0	5	45.5	5	25.0	0	0	1	5.0	4	36.4	5	25.0	1	9.1	8	40.0	11	35.5	20	64.5	
X	0	0	0	0	2	100.0	1	100.0	0	0	0	0	0	0	0	0	0	0	0	0	2	66.7	1	33.3	
Total	3	3.7	5	3.4	53	64.6	90	60.8	1	1.2	3	2.0	11	13.4	19	12.8	14	17.1	31	20.9	82	35.7	148	64.3	

X = No response to this question.

Note: Totals may not add due to rounding.

reasons why lime should be used or gave other reasons of their own for using lime which were not related to soil acidity. Age appeared not to be related to knowledge of lime use in that 64 percent of the farmers under 50 years of age indicated that one would use lime to reduce soil acidity as compared with 61 percent of the farmers 50 years or older. Farmers with at least one year of college appeared to know more concerning why lime should be used in that around 70 percent indicated lime reduces acidity as compared with only around 58 percent of the farmers who had 12 years or less schooling. The largest difference in knowledge concerning why lime should be used was between full- and part-time farmers as compared with hobby farmers and landowners. Sixty-eight percent of the full- and part-time farmers indicated that lime should be used to reduce soil acidity while only around 47 percent of the hobby farmers and landowners gave this answer.

It appears that farmers with a high school or less education and farmers who consider themselves as hobby farmers as well as nonfarming landowners do not understand the reason for using lime. Also, around 30 percent of the farmers with some college training and around 32 percent of all full- and part-time farmers are unaware of why lime should be used (Table IX).

Knowledge concerning the influence of nitrogen on acidity. The use of nitrogen fertilizers has been increasing steadily over the years and most possess acid-forming properties. In order to correct this acidity, the need for lime increases. Although a majority of the

farmers did have some knowledge about the agronomics of lime use, they were not educated as to the effect of nitrogen fertilizer use and its relation to lime. Sixty-five percent of the farmers did not know that the need for lime increases as they used more nitrogen fertilizers. Ten percent of this group actually said that nitrogen fertilizers had no effect on the soil. Forty-seven percent of these farmers had no opinion on the question or listed several answers. When considered by area, almost 32 percent of the farmers in the high use area and about 38 percent in the low use area knew that some nitrogen fertilizers increase the need for lime. Seventy percent of the farmers in the high lime use area between the ages of 30 to 39 had no opinion on the question, and over 64 percent of the farmers in the high use area and 84 percent of the farmers in the low use area with less than eight years of education had no opinion or had several answers to the question, thus, indicating much larger differences between education levels and age groups than between the high and low lime use areas (Table X).

Attitude of farmers toward lime cost and profitability of lime.

In the past, lime prices have been considered as being relatively inexpensive when compared with some other farm inputs. Over 60 percent of the farmers said lime prices were such that lime use was highly profitable in their area. About 28 percent of the farmers had no opinion on the question. Nine percent said they would break even from lime use, and 4 percent of the farmers stated they would lose money if they purchased lime. Over 68 percent of the farmers in the high use area and

TABLE X

USE OF NITROGEN FERTILIZERS AND THEIR EFFECTS COMPARED WITH FARMER AGE, FARMER EDUCATION, AND TYPE FARM SITUATION FOR HIGH AND LOW LIME USE AREAS IN THE 9-COUNTY AREA

	Reduce Soil Acidity			Increase Soil Acidity			No Effect on Soil			No Opinion or			Total							
	Decrease Lime Needs			Increase Lime Needs			Acidity and Lime Needs			Combination Answer			High Use			Low Use				
	No.	%	Area	No.	%	Area	No.	%	Area	No.	%	Area	No.	%	Area	No.	%	Area		
Farmer Age (Years)																				
Under 30	0	0	0	0	0	0	2	40.0	2	28.6	3	60.0	3	42.9	5	41.7	7	58.3		
30-39	0	0	0	3	30.0	9	50.0	0	0	2	11.1	7	70.0	7	38.9	10	35.7	18	64.3	
40-49	1	5.3	2	7.1	7	36.8	8	28.6	4	21.0	3	10.7	7	36.8	15	53.6	19	40.4	28	59.6
50-59	1	4.0	2	5.3	8	32.0	16	42.1	3	12.0	4	10.5	13	52.0	16	42.1	25	39.7	38	60.3
60 or over	2	9.1	4	7.1	8	36.4	21	37.5	2	9.1	2	3.6	10	45.5	29	51.8	22	28.2	56	71.8
X	0	0	1	100.0	0	0	0	0	0	0	0	1	100.0	0	0	1	50.0	1	50.0	
Total	4	4.9	9	6.1	26	31.7	56	37.8	11	13.4	13	8.8	41	50.0	70	47.3	82	35.7	148	64.3
Farmer Education																				
Under 8 years	1	7.1	0	0	4	28.6	3	15.8	0	0	0	0	5	64.3	16	84.2	14	42.4	19	57.6
8-12 years	0	0	8	12.1	17	36.2	22	33.3	7	14.9	5	7.6	23	48.9	31	47.0	47	41.6	66	58.4
1-3 years college	0	0	1	4.5	3	33.3	11	50.0	2	22.2	2	9.1	4	44.4	8	36.4	9	29.0	22	71.0
4 years college	1	20.0	0	0	1	20.0	9	45.0	2	40.0	3	15.0	1	20.0	8	40.0	5	20.0	20	80.0
Part grad. study	0	0	0	0	1	50.0	4	80.0	0	0	0	0	1	50.0	1	20.0	2	28.6	5	71.4
Graduate degree	1	33.3	0	0	0	0	6	40.0	0	0	0	0	2	66.7	6	40.0	3	16.7	15	83.3
X	1	50.0	0	0	0	0	1	100.0	0	0	0	1	50.0	0	0	2	66.7	2	33.3	
Total	4	4.9	9	6.1	26	31.7	56	37.8	11	13.4	13	8.8	41	50.0	70	47.3	82	35.7	148	64.3
Farm Situation																				
Full time	0	0	1	3.8	10	45.5	14	53.8	1	4.5	1	3.8	11	50.0	10	38.5	22	45.8	26	54.2
Part time	2	5.7	5	6.9	11	31.4	34	47.2	6	17.1	9	12.5	16	45.7	24	33.3	35	32.7	72	67.3
Hobby farmer	2	16.7	2	6.9	2	16.7	7	24.1	3	25.0	3	10.3	5	41.7	17	58.6	12	29.3	29	70.7
Landowner, no farming	0	0	0	0	2	18.2	1	5.0	1	9.1	0	0	8	72.7	19	95.0	11	35.5	20	64.5
X	0	0	1	100.0	1	50.0	0	0	0	0	0	1	50.0	0	0	2	66.7	2	33.3	
Total	4	4.9	9	6.1	26	31.7	56	37.8	11	13.4	13	8.8	41	50.0	70	47.3	82	35.7	148	64.3

X = No response to this question.

Note: Totals may not add due to rounding.

over 58 percent of the farmers in the low use area stated that it was profitable to purchase lime. Only about one-half of the farmers in the low lime use area under 50 years of age considered lime to be profitable, as compared with around 71 percent of the farmers of the same age group in the high lime use area. With other farmers almost two-thirds considered lime use to be profitable in both areas. There appeared to be little difference between farmers who had more than a high school education and those who had less education as to their attitudes toward the profitability of lime use except in the high lime use area. In this area only around 58 percent of the farmers who had more than high school academic training considered lime profitable, compared with around 74 percent of those with high school or less training. It is also interesting to note that around three-fourths of all full-time and part-time farmers in both areas considered lime profitable, as compared with less than one-half of the hobby farmers and landowners (Table XI). Thus, it appears that one reason farmers in the low lime use area do not use more lime is because they feel it is not profitable. This is true of younger farmers (under 50) in this area and especially true of hobby farmers and landowners throughout the nine-county area.

Another attitude expressed by farmers that could account for some of the reason for less than optimum use of lime throughout the nine-county area would be the lack of knowledge concerning the profitability of lime as compared with other farm practices. Research by TVA and others has shown lime to be one of the most profitable, if not the most

profitable farming practice which crop farmers can utilize.²² Only 10 percent of the farmers in the nine-county area considered liming more profitable than fertilizing and other farm practices. There was very little difference of opinion between farmers in the high and low lime use areas with 12 percent of the farmers in the high lime use area and 10 percent of the farmers in the low lime use area saying that liming was more profitable (Table XII).

Optimum returns from fertilizer normally occur within the course of a year, while optimum returns from lime usually occur two to five years after lime is applied. Over 66 percent of the farmers were aware of the fact that optimum yield increases occur two to five years after lime is applied. One hundred and forty-one of the farmers were 50 years of age or older, and about 72 percent of these were aware of the time period for optimum crop response to lime. The full-time and part-time farmers seemed to be well educated on this fact as about 68 percent knew lime applications were good for a period of two to five years after liming. Still, a higher percent of all farmers (22 percent) either had no opinion or listed several answers to the question (Table XIII). The percentages were about the same for the two areas as 72 percent in the high lime use area and 64 percent of the farmers in the low lime use

²²Russell Harris III, Estimated Costs and Returns from Increased Lime Use in the Elk River Counties, Agricultural Resource Development Branch, Tennessee Valley Authority, Muscle Shoals, Alabama, and the Agricultural Work Group, Elk River Development Association, Fayetteville, Tennessee, Circular Z-5.

TABLE XII

THE PROFITABILITY OF DIFFERENT FARM PRACTICES COMPARED WITH FARMER AGE, FARMER EDUCATION,
AND TYPE FARM SITUATION FOR HIGH AND LOW LIME USE AREAS IN THE 9-COUNTY AREA

	Fertilizer			Liming			Other or Combination							
	High Use		Low Use	High Use		Low Use	High Use		Low Use		High Use		Low Use	
	No.	%	Area Mo.	%	Area No.	%	Area No.	%	Area Mo.	%	Area No.	%	Area Mo.	%
Farmer Age (Years)														
Under 30	3	60.0	4	57.1	0	0	0	0	3	42.9	5	41.7	7	58.3
30-39	3	30.0	7	38.9	0	0	3	16.7	8	44.4	10	35.7	18	64.3
40-49	6	31.6	7	25.0	2	10.5	4	14.3	11	57.9	19	40.4	28	59.6
50-59	10	40.0	14	36.8	6	24.0	5	13.2	9	36.0	25	39.7	38	60.3
60 or over	8	36.4	20	35.7	2	9.1	3	5.4	12	54.5	33	28.2	56	71.8
X	0	0	0	0	0	0	0	0	1	100.0	1	50.0	1	50.0
Total	30	36.6	52	35.1	10	12.2	15	10.1	42	51.2	81	35.7	148	64.3
Farmer Education														
Under 8 years	3	21.4	5	26.3	2	14.3	2	10.5	9	64.3	12	42.4	19	57.6
8-12 years	17	36.2	21	31.8	6	12.8	6	9.1	24	51.1	39	41.6	66	58.4
1-3 years college	4	44.4	9	40.9	2	22.2	4	18.2	3	33.3	9	29.0	22	71.0
4 years college	2	40.0	10	50.0	0	0	1	5.0	3	60.0	9	45.0	5	20.0
Part grad. study	2	100.0	3	60.0	0	0	1	20.0	0	0	1	20.0	2	28.6
Graduate degree	1	33.3	4	26.7	0	0	1	6.7	2	66.7	10	66.7	3	16.7
X	1	50.0	0	0	0	0	0	0	1	50.0	1	100.0	2	66.7
Total	30	36.6	52	35.1	10	12.2	15	10.1	42	51.2	81	35.7	148	64.3
Farm Situation														
Full-time	8	36.4	5	19.2	3	13.6	3	11.5	11	50.0	18	69.2	22	45.8
Part-time	14	40.0	31	43.1	4	11.4	9	12.5	17	48.6	32	44.4	35	32.7
Hobby farmer	2	16.7	12	41.4	3	25.0	3	10.3	7	58.3	14	48.3	12	29.3
Landowner, no farming	5	45.5	4	20.0	0	0	0	0	6	54.5	16	80.0	11	35.5
X	1	50.0	0	0	0	0	0	0	1	50.0	1	100.0	2	66.7
Total	30	36.6	52	35.1	10	12.2	15	10.1	42	51.2	81	35.7	148	64.3

X = No response to this question.

Note: Totals may not add due to rounding.

TABLE XIII

USE OF LIME AS RELATED TO INCREASES IN CROP PRODUCTION BY FARMER AGE, FARMER EDUCATION, AND TYPE FARM SITUATION FOR THE 9-COUNTY AREA

	None Due to Lime		Only During Yr. Lime Applied		2 to 5 Yrs. After Application		Permanent Increases from Lime		Other or Combination Answer		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Farmer Age (Years)												
Under 30	1	8.3	1	8.3	7	58.3	1	8.3	2	16.7	12	5.2
30-39	1	3.6	2	7.1	18	64.3	3	10.7	4	14.3	28	12.2
40-49	1	2.1	5	10.6	26	55.3	3	6.4	12	25.5	47	20.4
50-59	0	0	0	0	50	79.3	2	3.2	11	17.5	63	27.4
60 or over	0	0	1	1.3	51	65.4	6	7.7	20	25.6	78	33.9
X	0	0	0	0	1	50.0	0	0	1	50.0	2	.9
Total	3	1.3	9	3.9	153	66.5	15	6.5	50	21.7	230	100.0
Farmer Education												
Under 8 years	1	3.0	0	0	19	57.6	1	3.0	12	36.4	33	14.3
8-12 years	2	1.8	6	5.3	76	67.3	6	5.3	23	20.4	113	49.1
1-3 years college	0	0	2	6.5	22	71.0	1	3.2	6	19.4	31	13.5
4 years college	0	0	0	0	17	68.0	2	8.0	6	24.0	25	10.9
Part grad. study	0	0	0	0	7	100.0	0	0	0	0	7	3.0
Graduate degree	0	0	1	5.6	10	55.6	5	27.8	2	11.1	18	7.8
X	0	0	0	0	2	66.7	0	0	1	33.3	3	1.3
Total	3	1.3	9	3.9	153	66.5	15	6.5	50	21.7	230	100.0

TABLE XIII (continued)

Farm Situation	None Due to Lime		Only During Yr. Lime Applied		2 to 5 Yrs. After Application		Permanent Increases from Lime		Other or Combination Answer		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Full-time	1	2.1	1	2.1	37	77.1	1	2.1	8	16.7	48	20.9
Part-time	0	0	7	6.5	76	71.0	10	9.3	14	13.1	107	46.5
Hobby farmer	1	2.4	1	2.4	27	65.9	1	2.4	11	26.8	41	17.8
Landowner, no farming	1	3.2	0	0	11	35.5	3	9.7	16	51.6	31	13.5
X	0	0	0	0	2	66.7	0	0	1	33.3	3	1.3
Total	3	1.3	9	3.9	153	66.5	15	6.5	50	21.7	230	100.0

X = No response to this question.

Note: Totals may not add due to rounding.

area were aware of optimum returns from lime occurring two to five years after liming.

Distance from lime source. The availability of lime within a reasonable distance (less than 25 miles) would not appear to be a reason for low use of lime by farmers as 74 percent of the farmers said that lime was readily available within a reasonable distance. In looking at Table XII, page 50, the figures are about the same for the two areas as over 73 percent of the farmers in the high use area and 75 percent of the farmers in the low use area stated that lime was readily available within a reasonable distance (Table XIV).

Use of ASCS programs to purchase lime. ASCS programs played a major role in the farmers' purchasing habits concerning lime. Over 48 percent of the farmers in the nine-county area purchased lime through ASCS programs between 50 to 100 percent of the time. Thirty-six percent of the group mentioned above purchased lime through the ASCS program between 75 to 100 percent of the time. Of the farmers who purchased lime through ASCS programs between 50 to 100 percent of the time:

(a) over 58 percent were under 30 years of age, (b) more than 52 percent were 60 years of age or over, (c) almost 54 percent had 8-12 years of education, and (d) almost 58 percent were part-time farmers. More than 39 percent of the farmers 30 to 39 years of age and over 41 percent of the farmers who were hobby farmers did not purchase any lime through the ASCS cost-sharing programs. Over 53 percent of the farmers in the

TABLE XIV
THE AVAILABILITY OF LIME COMPARED WITH FARMER AGE, FARMER EDUCATION, AND TYPE FARM SITUATION
FOR HIGH AND LOW LIME USE AREAS IN THE 9-COUNTY AREA

	Readily Available < 25 Miles			Available from Distant Source > 25 Miles			No Opinion or Other Answer			Total		
	High Use		Low Use	High Use		Low Use	High Use		Low Use	High Use		Low Use
	No.	%	Area	No.	%	Area	No.	%	Area	No.	%	Area
Farmer Age (Years)												
Under 30	4	80.0	3	42.9	0	0	3	42.9	1	20.0	1	14.2
30-39	10	100.0	15	83.3	0	0	3	16.7	0	0	0	0
40-49	14	73.7	21	75.0	4	21.1	3	10.7	1	5.3	4	14.3
50-59	17	68.0	29	76.3	4	16.0	8	21.1	4	16.0	1	2.6
60 or over	15	68.2	42	75.0	3	13.6	5	8.9	4	18.2	9	16.1
X	0	0	1	100.0	0	0	0	0	1	100.0	0	0
Total	60	73.2	111	75.0	11	13.4	22	14.9	11	13.4	15	10.1
Farmer Education												
Under 8 years	10	71.4	11	57.9	2	14.3	1	5.3	2	14.3	7	36.8
8-12 years	36	76.6	51	77.3	6	12.8	10	15.2	5	10.6	5	7.6
1-3 years college	7	77.8	14	63.6	1	11.1	7	31.8	1	11.1	1	4.5
4 years college	3	60.0	17	85.0	2	40.0	2	10.0	0	0	1	5.0
Part grad. study	1	50.0	4	80.0	0	0	1	20.0	1	50.0	0	0
Graduate degree	3	100.0	13	86.6	0	0	1	6.7	0	0	1	6.7
X	0	0	1	100.0	0	0	0	0	2	100.0	0	0
Total	60	73.2	111	75.0	11	13.4	22	14.9	11	13.4	15	10.1
Farm Situation												
Full-time	17	77.3	22	84.6	3	13.6	3	11.5	2	9.1	1	3.8
Part-time	29	82.9	53	73.6	4	11.4	15	20.8	2	5.7	4	5.6
Hobby farmer	7	58.3	24	82.8	3	25.0	3	10.3	2	16.7	2	6.9
Landowner, no farming	6	54.5	11	55.0	1	9.1	1	5.0	4	36.4	8	40.0
X	1	50.0	1	100.0	0	0	0	0	1	50.0	0	0
Total	60	73.2	111	75.0	11	13.4	22	14.9	11	13.4	15	10.1

X = No response to this question.

Note: Totals may not add due to rounding.

high lime use area and nearly 46 percent in the low lime use area purchased lime through the ASCS programs between 50 to 100 percent of the time (Table XV).

Rental agreements. There were only 30 rental agreements in the two areas as area I had six and area II had 24 agreements. These numbers represented over 8 percent of the total responses for area I and about 18 percent for area II. There were 10 owner pays for all lime rental agreements of which 80 percent of these were in area II (low lime use). Almost 77 percent of the renter pays for all lime agreements were located in area II. There was a total of three half-and-half rental agreements and all of these were in area II. A major portion of the farmers (78 percent) left the question concerning the rental agreements unanswered. This reaction would indicate that the type of rental agreements would not be a factor in low lime use because they are almost non-existent in the two areas as only around 14 percent of the farmers reported any type of rental agreements.

Summary. Based on the information collected with the mail questionnaire, it was not possible to determine why farmers in the low lime use area actually limed a smaller percentage of their cropland than did farmers in the designated high lime use area. There was evidence, however, that a large percentage of the farmers with 12 years or less education and those who considered themselves hobby farmers or landowners did not know the benefits of lime and therefore limed a smaller percent

TABLE XV
 FARMER AGE, FARMER EDUCATION, AND TYPE FARM SITUATION COMPARED WITH THE PERCENTAGE OF LINE
 PURCHASED THROUGH THE ASCS COST-SHARING PLAN FOR THE HIGH AND
 LOW LINE USE AREAS IN THE 9-COUNTY AREA

	None		0-25%		25-50%		50-75%		75-100%		Total	
	High Use Area	Low Use Area	High Use Area	Low Use Area	High Use Area	Low Use Area	High Use Area	Low Use Area	High Use Area	Low Use Area	High Use Area	Low Use Area
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Farmer Age (Years)												
Under 30	2	40.0	0	0	0	0	1	20.0	0	0	0	0
30-35	5	50.0	6	33.3	0	0	2	11.1	2	20.0	5	71.4
35-40	4	21.1	9	32.1	1	5.6	2	10.0	2	20.0	6	33.3
40-45	3	12.0	8	21.0	7	21.1	3	10.7	3	15.6	16	42.1
50-55	3	13.6	13	23.2	2	3.6	1	4.3	3	13.6	10	45.5
60 or over	0	0	0	0	0	0	0	0	0	0	0	0
X Total	17	20.7	36	28.3	4	6.1	9	11.0	18	12.2	30	36.6
Farmer Education												
Under 6 years	4	26.6	5	26.3	0	0	1	5.3	1	7.1	0	0
6-12 years	9	19.1	15	22.7	3	6.4	1	14.9	7	14.9	10	10.6
1-3 years college	2	22.2	5	25.0	0	0	2	22.2	4	18.2	3	33.3
4 years college	0	0	0	0	1	5.0	0	0	1	5.0	2	40.0
Part grad. study	0	0	0	0	0	0	2	40.0	0	0	0	0
Graduate degree	1	33.3	6	40.0	1	6.7	0	0	1	6.7	1	33.3
X Total	17	20.7	36	28.3	4	6.1	9	11.0	18	12.2	30	36.6
Farm Situation												
Full-time	5	22.7	6	23.1	3	13.6	3	11.5	5	22.7	10	38.5
Part-time	5	14.3	11	15.3	1	2.9	4	11.4	9	12.5	18	51.4
Bobby farmer	4	33.3	13	44.8	0	0	2	6.9	2	6.9	3	25.0
Landowner, no farming	2	16.2	6	30.0	0	0	0	0	1	5.0	4	36.4
X Total	17	20.7	36	28.3	4	6.1	9	11.0	18	12.2	30	36.6

X = No response to this question.

Note: Totals may not add due to rounding.

than the more educated or full- and part-time farmers. However, around 18 percent more of the farmers in the low lime use area had more than 12 years of education. But around 5 percent more of the farmers in the low lime use area were hobby farmers or landowners. Also, slightly more farmers in the high lime use area knew that lime reduces soil acidity and about 10 percent more felt lime was profitable (Table XVI).

TABLE XVI
 TYPE OF RENTAL AGREEMENTS FOR THE HIGH AND LOW LIME USE
 AREAS IN THE 9-COUNTY AREA

Type Rental Agreement	High Use Area		Low Use Area		Total	
	No.	%	No.	%	No.	%
Owner pays all	2	20.0	8	80.0	10	4.8
Renter pays all	4	23.5	13	76.7	17	8.1
Half-and-half	0	--	3	100.0	3	1.4
No agreement	8	50.0	8	50.0	16	7.7
Blank	58	35.6	105	64.4	163	78.0
Total	72	34.4	137	65.6	209	100.0

CHAPTER V

SUMMARY

The objectives of this study were to determine (1) what factors are associated with lime manufacturing and distribution and with farmer informational agencies that influence farmer usage of lime and (2) farmers' attitude and characteristics associated with their use of lime.

The data were obtained by personal interview with 21 lime manufacturers and vendors in East Tennessee and by use of a structured questionnaire that was mailed to 1,500 farmers in Anderson, Bradley, Hamilton, Knox, Loudon, McMinn, Meigs, Rhea, and Roane counties of Tennessee. Fifteen percent of the mail questionnaires were answered and returned.

Based on previous secondary data dealing with the amount of lime used by farmers and the amount of lime estimated to be optimal for that county, a percent of need of lime used was calculated for each county.²³ The following East Tennessee counties were, therefore, designated as high lime use counties (area I) based on this percent of need of lime used: Loudon, McMinn, Meigs, and Rhea. The farmers in these counties appeared to be utilizing more lime than were the farmers in the remaining five counties: Hamilton, Bradley, Roane, Anderson, and Knox, the designated low lime use area (area II).

²³University of Tennessee Soil Testing Laboratories, Nashville, Tennessee, June 1971.

The data on lime manufacturers and vendors were used to describe the lime industry in the above East Tennessee counties. Both multiple regression and tabular analysis were used in analyzing the farmer mailed questionnaires.

Lime Manufacturers and Vendors

There were 21 different lime manufacturers and vendors located within the two areas. The nine manufacturers included in the study produced over 102,000 tons of lime.²⁴ All nine were limestone quarries which considered agricultural lime a by-product of their primary operations. Six quarries were located in area I and three in area II. Manufacturers' lime marketing practices and policies were quite similar between the two areas. They owned no spreading equipment nor were they interested in selling to farmers unless the farmer was willing to pick up the lime at the quarry. As a result, practically all agricultural lime sales were directed to lime vendors. The most noticeable difference between the two areas was in the f.o.b. price of lime. The average f.o.b. price of lime was 52 cents per ton higher in the high lime use area (area I) than in the low lime use area (area II) with prices ranging from \$1.25 to \$2.25 per ton in area I and from \$2.00 to \$2.25 per ton in area II.

There were 12 vendors located in the survey area with six in area I and six in area II. More differences were found among the

²⁴ One manufacturer producing over 500,000 tons was omitted; see footnote 16, page 14.

different types of vendors than between the two areas. The two farmer cooperatives in area I which spread lime also assisted farmers by mailing soil samples to be tested. One vendor in area II listed consultation on lime problems as a service he offers; however, the remainder of the lime vendors indicated that lime spreading was their only service. Lime vendors charged an average of \$4.02 per ton for spreading lime in area I and \$4.20 per ton in area II. Lime vendors in area II also averaged 70 cents per ton higher gross margin than vendors in area I (Table III, page 20). These differences in lime prices would not appear to be sufficiently large enough to explain the difference in lime use between the two areas.

Only three vendors indicated they used either radio or newspaper advertising. Two were located in area I and one in area II. Seven of the remaining lime vendors did no advertising or promotion of lime except reliance on ASCS, county agents, and farmer contacts.

No long-term credit was extended by any of the vendors. However, all but one of the vendors considered payment within 30 days of application the same as cash with respect to lime sales.

Influence of Selected Socioeconomic Factors on Lime Use Between the High and Low Lime Use Areas

Neither age nor education appeared to be an important factor in determining differences in lime use between the high and low lime use areas. Farmers in both areas were similar with respect to age and overall education. In fact, 42 percent of the farmers in the low lime use

area indicated they had at least one year of college as compared with 23 percent in the high lime use area. This relationship was exactly opposite to what one would have expected.

Also, the basic farming situation did not appear to explain differences in lime use between the two areas. Around 66 to 69 percent of the farmers in both areas consisted of full- and part-time farmers. The number and type of rental agreements in the two areas was too small to allow for adequate analysis of their impact on lime use.

The use of soil tests in each area also did not help explain why farmers in the high lime use area limed a higher percent of their cropland than farmers in the low lime use area because a higher percentage of farmers in the low lime use area used soil tests.

One factor which may help some in explaining the differences in lime use between the two areas is farmer attitudes toward lime. About the same percentage in each area knew that lime was used to reduce acidity and knew that nitrogen fertilizers increase acidity. However, 10 percent more of the farmers in the high lime use area felt that it was profitable to use lime in their area. All other factors considered in this study appeared to be rather similar between the two areas.

Thus, with the use of these selected socioeconomic factors, it was not possible to adequately ascertain why farmers in the designated high lime use area limed a significantly larger percentage of their row crops than farmers in the low lime use area. However, neither farmers in the designated high or low lime use area made adequate applications

of lime. Soil test data indicate that farmers apply only around 36 and 24 percent of the lime needed in the high and low lime use areas, respectively (Table I, page 4). Therefore, a brief summary of factors which appeared to be relevant in explaining this lack of lime use in the combined nine-county area would be of interest.

Influence of Selected Socioeconomic Factors on Lime Use in the Combined Nine-County Area

Education, soil tests, and type of farming situation were found to be significantly ($P \leq .05$) related to the percent of cropland limed throughout the nine-county area. Farmers with high school or less education, hobby farmers, and nonfarming landowners limed a significantly smaller percentage of their cropland than farmers with more than a high school education and also full- and part-time farmers.

Farmers who had soil tests made limed a significantly ($P \leq .05$) greater percentage of their cropland than farmers in the nine-county area who did not use soil tests. Thus, if farmers can be encouraged to have soil tests made, it appears that they will then lime a higher percentage of their cropland. However, a study of all soil tests made by the experiment station indicated that around 482,500 tons of lime is needed in this nine-county area of East Tennessee for optimal crop production.²⁵ Therefore, it would appear that some other factors were

²⁵University of Tennessee Soil Testing Laboratories, Nashville, Tennessee, June 1971.

involved in determining why farmers in this area of East Tennessee did not lime a higher percentage of their cropland.

Knowledge concerning why lime was used and attitudes with respect to the profitability of lime should be important in determining the farmer's willingness to use lime. Even though around two-thirds of all farmers indicated that lime was used to reduce acidity, it was interesting that one-third of all full- and part-time farmers appeared to be unaware of why lime was used. With respect to hobby farmers and non-farming landowners, this lack of knowledge concerning lime use was even more critical in that more than one-half of these individuals did not appear to know that lime was used to reduce acidity. Age did not appear to be related to knowledge of lime use. Farmers with at least one year of college education appeared to know more concerning why lime should be used. However, still around 30 percent of these farmers did not indicate that lime was used to reduce acidity as compared with around 42 percent of the farmers who had 12 years or less schooling.

Farmers were even less aware of the fact that some nitrogen fertilizers influence soil acidity as 65 percent of the farmers did not know that lime needs increased as more nitrogen fertilizers were used.

Around 10 percent more farmers who had one year or more college training appeared to know that nitrogen fertilizers increased the need for lime. However, over 56 percent of these more educated farmers appeared to be unaware of the influence of nitrogen on soil acidity. Again, small differences in knowledge concerning the influence of nitrogen was apparent between age groups. With respect to full- and part-time

farmers, around 56 percent were also unaware of the influence of nitrogen fertilizers on acidity. Few of the hobby farmers and nonfarming landowners were informed about the influence of nitrogen fertilizers on lime needs.

Only around 60 percent of all farmers indicated that lime prices were such that it was profitable to purchase lime, while another 10 percent indicated that a farmer in his area would only break even if he purchased lime. There was little difference between age groups and between farmers who had more than a high school education and those having less education with respect to their attitudes toward the profitability of lime use. Also, around three-fourths of all full- and part-time farmers considered lime to be profitable compared with less than one-half of the hobby farmers and nonfarming landowners. Farmers in this area considered fertilizer to be more profitable than lime; only 10 percent felt that lime was more profitable.

Most farmers were aware that returns from lime use would be spread over a period of two to five years. Around three-fourths of the farmers also indicated that lime was readily available within a reasonable distance and nearly half of these farmers were using ASCS programs to purchase lime between 50 to 100 percent of the time.

There was not an adequate number of rental agreements in the survey area to adequately determine the influence of different agreements on lime use. Almost 86 percent of the farmers did not report any kind of rental agreement.

I. COMPARISON OF RESULTS WITH PREVIOUS STUDIES

In previous studies it has been shown that there was a critical need for lime vendors to stimulate farmers to use more soil tests. Also, lime vendors were encouraged to use mass media advertising, hold management schools on agricultural lime, and provide farmers with educational materials dealing with lime use.²⁶ Results obtained in this study indicated that lime vendors in this nine-county area of East Tennessee would also benefit from these suggestions. Lime vendors appeared to be doing only limited advertising or promotion designed to inform farmers in this area of East Tennessee as to the need for and profitability of using lime.

Pentecost did a study dealing with bulk distribution of lime by selected cooperatives in Kentucky, Tennessee, and Mississippi and concluded that these lime vendors would benefit by improving service during rush seasons, keep adequate records of lime cost, use written contracts and supply patrons with more information dealing with soil fertility.²⁷ All the different vendors in this area of East Tennessee would also benefit greatly from these suggestions. Vendors in this area were

²⁶ G. M. Beal, J. M. Bohlen, and H. L. Campbell, "Factors Limiting Services Offered by Retail Fertilizers," Commercial Fertilizer, vol. 100-101, Part IV, November, 1960, pp. 54-56; also see Cochran, "A Successful Lime Vendor Promotion Program," paper presented at workshop on Increasing Lime Use in Tennessee Valley Region, Nashville, Tennessee, December 1970.

²⁷ B. H. Pentecost, Bulk Distribution of Lime by Selected Cooperatives in Three Southern States (Kentucky, Mississippi, Tennessee), Farmers Cooperative Service, USDA, Service Report 49, November 1959.

unable to supply adequate cost information with respect to their liming operations. A majority were of the opinion that it was profitable to handle lime. However, for many it was just an alternative use for their spreading equipment.

Lime vendors in this study appeared to have different problems in distributing lime than do the fertilizer dealers. In a study of fertilizer sales by Beal, Bohlen, and Campbell, fertilizer dealers indicated that low profit, lack of time, credit problems, lack of facilities, and price cutting were major problems.²⁸ However, lime vendors in East Tennessee indicated that their major problems were seasonality of lime sales, lack of alternative uses for spreading equipment, and low volume of lime sales.

In a study of the Elk River watershed in Tennessee by Hammerstrom, farmers with low educational levels and older farmers appeared to be less receptive to adopting liming practices.²⁹ However, in this study age did not appear to be an important factor with respect to lime use. Also, in the Elk River area, almost 83 percent of all farmers knew that lime was used to reduce soil acidity as compared with only around 66 percent of the farmers in this area of East Tennessee. Around 73 percent

²⁸G. M. Beal, J. M. Bohlen, and H. L. Campbell, "Factors Limiting Services Offered by Retail Fertilizer Dealers," Commercial Fertilizer, Vol. 100-101, Part IV, November, 1960, pp. 34-37.

²⁹W. A. S. Hammerstrom, Farmer Attitudes Toward Use of Lime in the Elk River Watershed, Agricultural Resource Development Branch, TVA, Muscle Shoals, Alabama, November 1969.

of the Elk River farmers also felt that it was profitable to use lime in their area as compared with only 60 percent of these East Tennessee farmers.

II. CONCLUSIONS AND IMPLICATIONS

Significant differences were found to occur in the percentage of cropland limed by farmers in two basically similar farming areas of the Tennessee Valley in East Tennessee.³⁰ However, it was not possible to ascertain specific reasons for these differences based on an analysis of the firms involved in marketing and distribution of lime or on an analysis of differences in selected socioeconomic characteristics of farmers in these two areas.

Even though reasons for the differences in lime use between the two areas could not be determined, the following conclusions relative to the factors influencing the supply and demand for lime in the combined nine-county area were possible.

The structure of the lime industry in this area of East Tennessee is comprised of several different types of manufacturers and vendors. The agricultural lime business is a sideline for the manufacturers and only one of many activities carried on by the vendors. Lime represents on the average about 7 percent of the gross sales of quarry operations in this area. Farmer-vendors were the most common type of lime distributor.

³⁰Area I (high lime use area) included the following East Tennessee counties: Loudon, McMinn, Meigs, and Rhea; area II (low lime use area) included: Anderson, Bradley, Hamilton, Knox, and Roane.

An information system in the lime industry which would be responsible for acquainting farmers about the use of lime is nonexistent. Limited advertising is done by vendors to promote lime sales. It also appears that neither lime vendor nor all farmers have made any effort to contact agricultural informational agencies as to sources of educational material nor have they been informed as to the need or profitability of using lime in this area. Around 33 percent of all full- and part-time farmers did not know why lime was used. Also, around 40 percent of all farmers in the area indicated that it was not profitable to use lime in their area.

Farmers in this area of East Tennessee would also benefit from checking with several different types of lime vendors before purchasing lime. Lime prices in the area varied from a low of \$3.75 to a high of \$5.00 per ton for delivery and spreading. It appeared that one method of increasing lime use in this area would be to encourage farmers to have soil tests made on their farms. Farmers in this study who utilized soil tests limed a significantly higher percentage of their cropland.

It is also apparent that farmers of all ages in this area of East Tennessee need to be made more aware of why lime is used and the profitability of using lime. Also, all farmers should be made more aware of the influence of nitrogen fertilizers on soil acidity.

Although farmers with at least one year or more of college appeared to have more knowledge concerning lime, around 30 percent of these farmers were still unaware that lime was used to reduce acidity nor did they feel lime was profitable. The most critical problem with

respect to lack of knowledge concerning lime involves hobby farmers and nonfarming landowners in this area of East Tennessee. About one-half of these individuals did not know that lime was used to reduce acidity nor did they consider lime to be profitable in their area.

The following socioeconomic variables were found not to be significantly related to the percent of cropland limed by farmers within this nine-county area of East Tennessee: age, farm acreage, rental agreement, gross farm sales, lime prices, customer satisfaction, or distance from source of lime.

III. SUGGESTIONS FOR FUTURE RESEARCH

The purpose of this study was to identify factors which influence supply and demand for lime in a nine-county area of East Tennessee. However, the socioeconomic factors investigated in this study did not appear to adequately explain major differences in lime use. Differences in the type of lime vendors or in the services and practices of these vendors also did not appear to be directly related to differences in lime use.

Therefore, more in-depth research dealing with agronomic and economic characteristics of farms within this area should be undertaken to determine if such differences in lime use are actually based on sound agronomic and economic farm practices. Should this research indicate this not to be the case, then additional research should be undertaken as to the most appropriate method to use in convincing farmers that lime should be used in their area.

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