

March 6, 1968

To the Graduate Council:

I am submitting herewith a dissertation written by Thomas Kenneth Hunter entitled "Factors That Influence Utilization of Pesticides by Selected Vegetable Producers in Tennessee." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Agricultural Economics.

Joe A. Martin
Major Professor

We have read this dissertation
and recommend its acceptance:

M. B. Badenhop

W. E. Goble

R. L. Dotson

J. F. Whalley

Accepted for the Council:

Hilton A. Smith
Vice President for
Graduate Studies and Research

FACTORS THAT INFLUENCE UTILIZATION OF PESTICIDES BY
SELECTED VEGETABLE PRODUCERS IN TENNESSEE

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

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

by
Thomas Kenneth Hunter

June 1968

ACKNOWLEDGMENT

Appreciation is expressed to Dr. Thomas J. Whatley, Head of the Department of Agricultural Economics for making this study possible.

Special thanks are due Dr. Stanton P. Parry for his supervision and assistance during the course of this study and for his encouragement throughout the graduate program.

Appreciation is also extended to Drs. Cecil Fuller, Joe Martin, William Goble, Merton Badenhop, and Robert Dotson for their guidance and counsel.

Acknowledgment is made of the assistance given by the secretarial and statistical employees of the Department of Agricultural Economics for their assistance in processing the data and typing. Appreciation is expressed to Mrs. Georgia Troglen Bunn for typing the final manuscript.

Finally, a special word of appreciation to Marie, Sherrye and Tommy for their encouragement and understanding during the author's graduate program and the writing of this thesis.

TABLE OF CONTENTS

CHAPTER	PAGE
I. INTRODUCTION.	1
Problem Setting	2
Governmental Influence.	9
Objectives.	11
Procedure	12
Present State of Research	17
II. THE PESTICIDE MARKET IN TENNESSEE	22
Volume of Pesticides.	23
Value of Pesticides	25
Pesticides Sold for Commercial Agricultural Purposes.	25
Average Value Per Pound of Pesticide.	28
Estimates of Total Volume and Value Sold in 1965.	28
Retail Outlets.	32
III. DESCRIPTIVE ANALYSIS OF VEGETABLE PRODUCERS IN STUDY.	36
Size of Operation	36
Farming Experience.	39
Age of Producers.	39
Years of Education.	42
Total Farm Income	42
Tenure.	46
Contribution of Vegetables to Total Farm Income	46

CHAPTER

PAGE

III. (CONTINUED)

Enterprises Making Largest Contribution to Total Farm

Income.	46
Hired Labor	48
Pesticide Application Equipment	52
Method of Application	52
IV. VEGETABLE PRODUCERS' PESTICIDE PURCHASING BEHAVIOR.	55
Determination of Need for Pesticides.	55
Selection of Specific Pesticide Chemical.	55
Rate of Application	57
Distance to Source of Pesticides.	60
Major Source of Pesticide Purchases	60
Pesticide Expenditures.	64
Dealer or Brand Loyalty	67
Farm Sales by Dealers	67
Assistance from Chemical Companies.	70
Price Consciousness	72
Credit Terms Available.	72
Following Label Instructions.	75
Sources of Information Concerning Pesticides.	75
V. DELIBERATENESS OF PURCHASING DECISIONS.	83
Correlation Analysis.	93
Frequency of Response to Questions.	95

CHAPTER	PAGE
VI. VEGETABLE PRODUCERS' GENERAL KNOWLEDGE OF PESTICIDES	97
Correlation Analysis	101
Frequency of Responses to Questions.	105
VII. STATISTICAL ANALYSIS OF FACTORS AFFECTING UTILIZATION	
OF PESTICIDES.	109
Type of Analysis	109
Variables Included in the Analysis	112
Aggregate Utilization.	115
Utilization by Areas	116
West Tennessee	116
Middle Tennessee	117
East Tennessee	118
Comparison Between Areas	120
Effect of Rank Variables	121
VIII. SUMMARY AND CONCLUSIONS.	123
SELECTED BIBLIOGRAPHY	136
APPENDICES.	142
APPENDIX A.	143
APPENDIX B.	152
APPENDIX C.	153
APPENDIX D.	154
APPENDIX E.	158
APPENDIX F.	160

LIST OF TABLES

TABLE	PAGE
I. Estimated Average Annual Losses Due to Pests:	
United States	5
II. Percentage Value of Total Pesticide Sales: United	
States, 1963-1965	8
III. Acres of Cropland in Tennessee Treated with Pesticides,	
1964.	10
IV. Volume and Value of Pesticides Sold in Tennessee, 1965,	
121 Sample Firms.	24
V. Volume of Pesticides Sold for Commercial Agricultural	
Purposes in Tennessee, 1965, 121 Sample Firms	26
VI. Proportion of Pesticides Sold for Commercial Agricul-	
tural Purposes in Tennessee, 1965, 121 Sample Firms . .	27
VII. Average Value Per Pound of Pesticides Sold in Tennessee,	
1965, 121 Sample Firms.	29
VIII. Confidence Intervals for Estimating Aggregate Volume	
of Pesticides Sold in Tennessee, 1965, 90 Percent	
Level	30
IX. Confidence Intervals for Estimating Aggregate Value of	
Pesticides Sold in Tennessee, 1965, 90 Percent Level. .	31
X. Proportion of Pesticides Distributed Through Various	
Retail Outlets in Tennessee, 1965, 121 Sample Firms . .	34

TABLE

PAGE

XI.	Range in Size of Total Farm Units, 239 Vegetable Producers, Tennessee, 1965	37
XII.	Range in Acres of Cropland, 239 Vegetable Producers, Tennessee, 1965	38
XIII.	Range in Acres of Vegetables, 239 Vegetable Producers, Tennessee, 1965	40
XIV.	Years of Farming Experience, 239 Vegetable Producers, Tennessee, 1965	41
XV.	Age of Operators, 239 Vegetable Producers, Tennessee, 1965.	43
XVI.	Years of Education, 239 Vegetable Producers, Tennessee, 1965.	44
XVII.	Range of Total Farm Income, 239 Vegetable Producers, Tennessee, 1965	45
XVIII.	Type of Tenure, 239 Producers, Tennessee, 1965.	47
XIX.	Range of Percentage Contribution of Vegetables to Total Farm Income, 239 Producers, Tennessee, 1965	48
XX.	Distribution of Enterprises Making Largest Contribution to Total Farm Income, 239 Vegetable Producers, Tennessee, 1965	50
XXI.	Range of Hours of Hired Labor, 239 Vegetable Producers, Tennessee, 1965	51
XXII.	Distribution of Pesticide Application Equipment Owned, by Type, 239 Producers, Tennessee, 1965.	53

TABLE

PAGE

XXIII. Method of Application of Pesticides, 239 Producers, Tennessee, 1965	54
XXIV. Determination of When Pesticides are Needed, 239 Pro- ducers, Tennessee, 1965	56
XXV. Determination of Use of Specific Type of Pesticide, 239 Producers, Tennessee, 1965.	58
XXVI. Determination of Rate of Application, 239 Producers, Tennessee, 1965	59
XXVII. Distance from Farm to Source of Pesticides, 239 Pro- ducers, Tennessee, 1965	61
XXVIII. Producers' Reaction to Dealers Increasing Distance 3 Miles from Farm, 239 Producers, Tennessee, 1965 . . .	62
XXIX. Major Source of Pesticide Purchases, 239 Producers, Tennessee, 1965	63
XXX. Reasons for Purchasing from Only One Source, 155 Pro- ducers Using Only One Source, Tennessee, 1965	65
XXXI. Reasons for Purchasing from More Than One Source, 84 Producers Using More Than One Source, Tennessee, 1965 .	66
XXXII. Expenditures for Pesticides, 239 Producers, Tennessee, 1965.	68
XXXIII. Dealer or Brand Loyalty, 239 Producers, Tennessee, 1965 .	69
XXXIV. Degree of Utilization of Services of Chemical Company Representatives, 239 Producers, Tennessee, 1965	71

TABLE

PAGE

XXXV.	Frequency Producer Checked Pesticide Prices During the Previous Two Months, 239 Producers, Tennessee, 1965 . . .	73
XXXVI.	Length of Credit Terms Available on Pesticide Purchases, 239 Producers, Tennessee, 1965.	74
XXXVII.	Producers Expected Reaction to Credit Cancellation by Present Dealer, 239 Producers, Tennessee, 1965.	76
XXXVIII.	Degree of Following Instructions and Recommendations on Label, 239 Producers, Tennessee, 1965	77
XXXIX.	Frequency of Use of Sources of Information About Pesti- cides, West Tennessee, 117 Producers, 1965.	78
XL.	Frequency of Use of Sources of Information About Pesti- cides, Middle Tennessee, 62 Producers, 1965	79
XLI.	Frequency of Use of Sources of Information About Pesti- cides, East Tennessee, 60 Producers, 1965	80
XLII.	Most Important Source of Information About Pesticides, 239 Producers, Tennessee, 1965.	82
XLIII.	Result of Correlation Analysis Between Deliberateness Score and 12 Factors, 239 Vegetable Producers, Tennessee, 1965	94
XLIV.	Frequency Distribution of 239 Buyers Response to Ques- tions Related to Deliberateness of Decision on Pesti- cide Purchases, Tennessee, 1965	96
XLV.	Result of Correlation Analysis Between Knowledgeability Score and 12 Factors, 239 Vegetable Producers	104

TABLE

PAGE

XLVI.	Frequency Distribution of Producers Response to Questions Related to General Knowledge of Pesticides, 239 Vegetable Producers	106
XLVII.	Listing of Vegetables and Counties Included in the Study, West Tennessee, 1965	143
XLVIII.	Listing of Vegetables and Counties Included in the Study, Middle Tennessee, 1965	144
XLIX.	Listing of Vegetables and Counties Included in the Study, East Tennessee, 1965	145
L.	Number of Producers in Frame, Specified Number to be Interviewed, and Number Actually Interviewed, by Vegetable and County, Under Criterion One, West Tennessee	146
LI.	Number of Producers in Frame, Specified Number to be Interviewed, and Number Actually Interviewed, by Vegetable and County, Under Criterion One, Middle Tennessee	147
LII.	Number of Producers in Frame, Specified Number to be Interviewed, and Number Actually Interviewed, by Vegetable and County, Under Criterion One, East Tennessee	148
LIII.	Computation of Acreage to be Included in Sample and Number of Acres Actually Included, by Vegetable and County, Under Criterion 2, West Tennessee	149

TABLE

PAGE

LIV.	Computation of Acreage to be Included in Sample and Number of Acres Actually Included, by Vegetable and County, Under Criterion 2, Middle Tennessee	150
LV.	Computation of Acreage to be Included in Sample and Number of Acres Actually Included, by Vegetable and County, Under Criterion 2, East Tennessee	151
LVI.	Correlation Matrix, 23 Variables, 239 Vegetable Pro- ducers, Tennessee, 1965 (Variables 1-10).	161
LVII.	Correlation Matrix, 23 Variables, 239 Vegetable Pro- ducers, Tennessee, 1965 (Variables 11-20)	162
LVIII.	Correlation Matrix, 23 Variables, 239 Vegetable Pro- ducers, Tennessee, 1965 (Variables 21-23)	163

LIST OF FIGURES

FIGURE	PAGE
1. United States Production of Pesticides, 1954-1965.	4
2. Percentage of Total Pesticides Consumed by Various Markets:	
1962	6
3. Geographic Areas and Counties Included in Each Area	14
4. Percentage Distribution of Deliberateness in Making Pesticide	
Purchases: All 239 Vegetable Producers, Tennessee, 1965	88
5. Percentage Distribution of Deliberateness in Making Pesticide	
Purchases: 117 Producers, West Tennessee, 1965.	89
6. Percentage Distribution of Deliberateness in Making Pesticide	
Purchases: 62 Producers, Middle Tennessee, 1965	90
7. Percentage Distribution of Deliberateness in Making Pesticide	
Purchases: 60 Producers, East Tennessee, 1965	91
8. Percentage Distribution of Knowledgeability of Pesticides:	
All 239 Producers, Tennessee, 1965	99
9. Percentage Distribution of Knowledgeability of Pesticides:	
117 Producers, West Tennessee, 1965.	100
10. Percentage Distribution of Knowledgeability of Pesticides:	
62 Producers, Middle Tennessee, 1965	102
11. Percentage Distribution of Knowledgeability of Pesticides:	
60 Producers, East Tennessee, 1965	103

CHAPTER I

INTRODUCTION

The road we have long been traveling is deceptively easy, a smooth superhighway on which we progress with great speed, but at its end lies disaster.¹

With the above words, Miss Rachel Carson helped open the door to the argument of the advantages and disadvantages of the use of pesticides. The essence of the argument is that some persons believe that the hazards and unknown risks of large-scale use of pesticides may outweigh the gains to agriculture and public health; that upsetting the balance of nature could eventually be disastrous, and other methods of control should be developed. Others are of the opinion that the gains in agricultural productivity more than balance losses of other aspects and is reason enough for nonrestriction of their use.² This controversy is still raging and it is not the intent here to expound upon this argument but to mention that, as a result of it, much economic, agronomic, and chemical research has been undertaken with pesticide use. Indications are that more research is needed.

¹Rachel Carson, Silent Spring (Boston: Houghton Mifflin Company, 1962), p. 277.

²The Economics of Poisoning. No. 23 (Washington: Resources for the Future, Inc., September, 1966), p. 2.

I. PROBLEM SETTING

The need for pest control dates back many thousands of years as noted, for example, in the Old Testament.³ History is filled with man's attempts to control insects, weeds, blights and plagues in an effort to produce food, feed and fiber. Society has suffered when man has not been able to control the pests. A typical example is the potato blight in Ireland in 1845 and 1846 which practically destroyed the potato crops which were a major source of food for the people.⁴ As a result, about a million people died of starvation and disease. Many other illustrations of pest damage could be offered which show that necessity has forced farmers to adopt chemicals in an attempt to control insects, weeds, plant diseases, nematodes and rodents. Generally speaking, chemicals seem to be more effective and economical than other methods of control at the present time. As a result chemicals have become widely used for pest control.

There has been a tremendous increase in the development and use of chemical pesticides since the selective herbicidal action of 2-4D and the effectiveness of DDT was discovered in mid 1940's.

Continually new developments of insecticides, herbicides, fungicides and rodenticides are contributing to the widespread use

³The Holy Bible, Book of Joel: Chapter 1, Verse 4.

⁴Raymond P. Christensen, "Man's Historic Struggle for Food," Protecting Our Food: The Yearbook of Agriculture 1966 (Washington: Government Printing Office, 1966), p. 2.

of pesticides; and as a result of these developments, the pesticide industry has become big business. Figure 1 illustrates the growth of the pesticide industry in the United States for the past twelve years. With the exception of one year, 1957, each succeeding year's production was greater than the previous year's. The total production in 1954 was 419,274,000 pounds and by 1965 had more than doubled to 876,914,000 pounds. The value of this production at the manufacturers level increased from \$157,599,000 in 1954 to \$562,118,000 in 1965.⁵

In 1962, sales at consumer prices exceeded the one billion dollar mark for the first time reaching a level of \$1.04 billion. It is estimated that retail sales will reach \$2 billion by 1975.⁶

One of the major factors affecting the future expansion of the industry is the economic losses sustained by farmers from pests and diseases. Diseases, insects, nematodes, weeds and other pests cause an annual estimated loss of more than \$13 billion. Table I shows the extent of these losses. This will have a direct effect upon the industry as agriculture is the largest consuming market of the pesticide industry. Figure 2 shows that in 1962 the agricultural market consumed 38 percent of the total amount of pesticides produced. It is

⁵United States Department of Agriculture, Agricultural Stabilization and Conservation Service, The Pesticide Review 1966 (Washington: Government Printing Office, October, 1966).

⁶"Pesticides," Chemical Week, XCII, xxi (May 25, 1963), pp. 117-126.

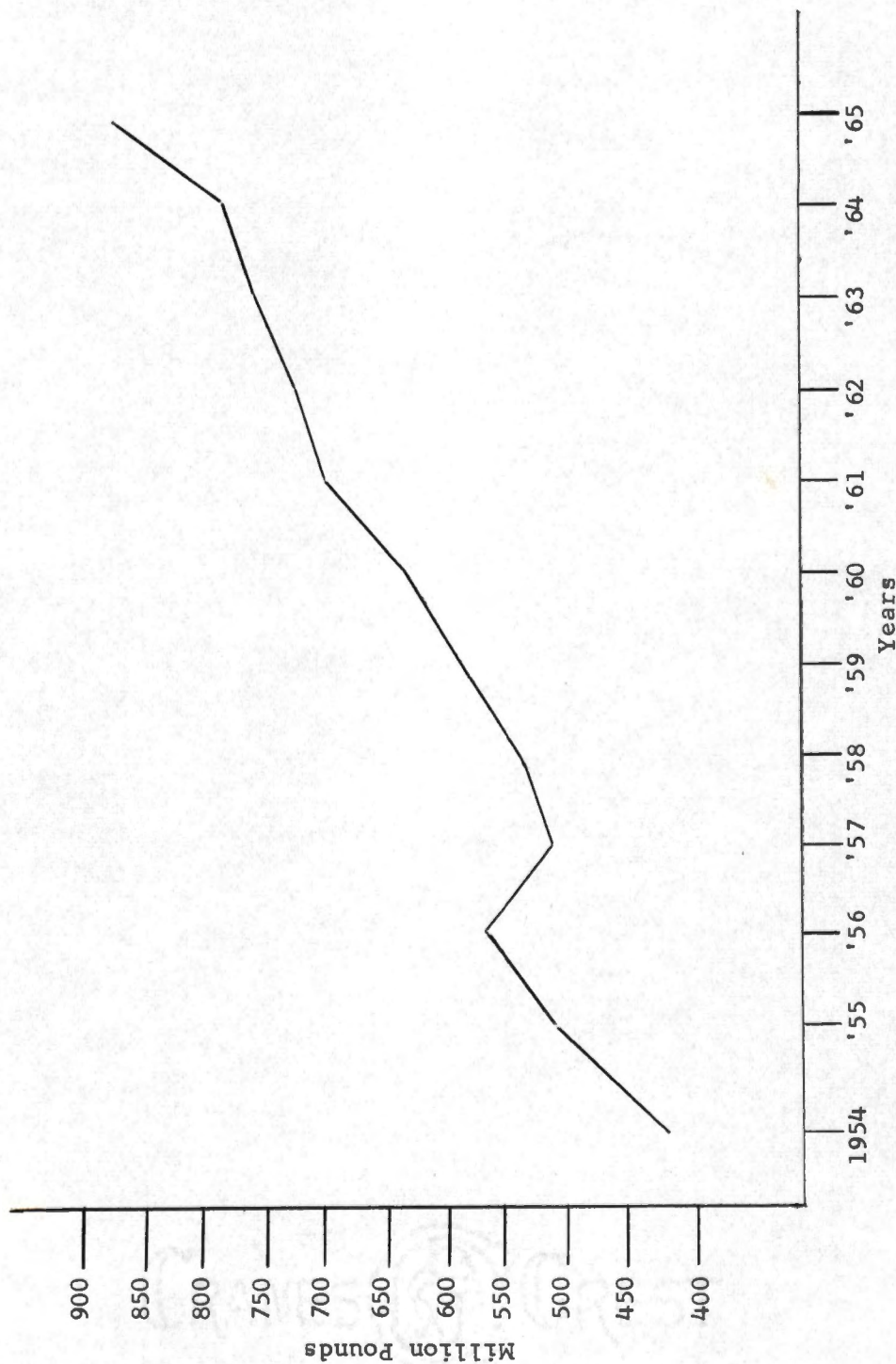


Figure 1. United States production of pesticides, 1954-65 (based on data from the Pesticide Review, October, 1966).

TABLE I
ESTIMATED AVERAGE ANNUAL LOSSES DUE TO PESTS: UNITED STATES

<u>CROPS</u>	
Plant Diseases	\$ 3,576,114,000
Nematodes	372,335,000
Insects	3,812,906,000
Weeds	<u>2,459,630,000</u>
Sub-total	\$10,220,985,000
<u>LIVESTOCK</u>	
Diseases	\$ 1,604,810,000
Internal Parasites	331,070,000
Insects	<u>877,850,000</u>
Sub-total	\$ 2,813,730,000
Grand Total	<u>\$13,034,715,000</u>

Source: United States Department of Agriculture, Losses in Agriculture, Agricultural Research Service, Agriculture Handbook No. 291, August, 1965, Tables 1-32, pp. 4-82.

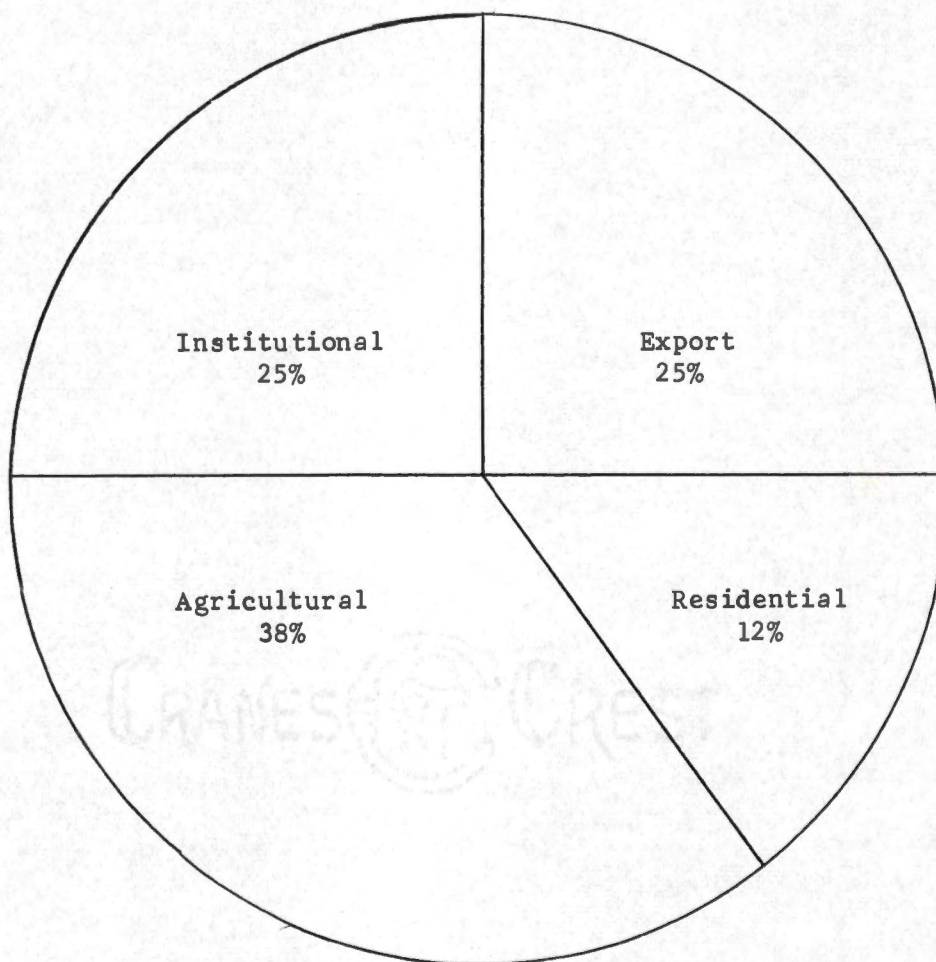


Figure 2. Percentage of total pesticides consumed by various markets: 1962 (from Chemical Week, May 25, 1963).

estimated that this proportion will change very little by 1975. In 1962 farmers spent about \$425 million for pesticides.⁷ Farmers' expenditures in 1964 had risen to \$514 million.⁸ About 90 percent of pesticides purchased by farmers are used on planted crops while about 4 percent are used on livestock and other agricultural uses account for the remaining 6 percent.⁹

Changes are also occurring within the pesticide industry. These changes are illustrated in Table II. Herbicides have increased from 31.4 percent of value of total sales in 1963 to 42.4 percent in 1965. This change is occurring because the rate of increase of herbicides is greater than for insecticides and fungicides. It is expected that herbicides will supplant insecticides as sales volume leader by 1975.

With this vast development of synthetic pesticides, their use has spread from a few crops to practically every crop presently being produced. It has been estimated that one acre out of every twelve in the contiguous 48 states was being treated with pesticides in 1962.

In 1964, Tennessee farmers reported a total of 344,195 acres of farm land were treated for control of insects and diseases and 554,723

⁷Ibid.

⁸Paul Andrienas and Austin Fox, Farmers' Expenditures for Pesticides in 1964, Agricultural Economic Report No. 106 (Washington: Government Printing Office, 1967), p. ii.

⁹"Pesticides," Chemical Week, XCII, xxi (May 25, 1963), p. 1187.

TABLE II
PERCENTAGE VALUE OF TOTAL PESTICIDE SALES: UNITED STATES, 1963-65

Year	Insecticides ^a	Herbicides	Fungicides
1963	56.1	31.4	12.5
1964	51.1	38.3	10.6
1965	47.8	42.4	9.8

^aAlso included in this grouping are fumigants, rodenticides and soil conditioners.

Source: United States Department of Agriculture, The Pesticide Review 1966, Agricultural Stabilization and Conservation Service, October, 1966, p. 4.

acres were treated for control of weeds, grass or brush. Table III gives a breakdown of these figures.

II. GOVERNMENTAL INFLUENCE

The government has a direct bearing upon the pesticide situation in two-ways--regulation and research.

The Federal Insecticide, Fungicide and Rodenticide Act of 1947 which was amended in 1959 is one of the basic pesticide laws.¹⁰ Its purpose is to protect users of pesticides from personal injury or economic loss by prohibiting adulteration or misbranding of pesticide products. This act requires that all pesticides be registered with the United States Department of Agriculture. By 1965 more than 57,000 different formulations were registered by the United States Department of Agriculture under this act.¹¹

The Federal Food, Drug and Cosmetic Act of 1938 first provided for consumer protection against pesticides in food supplies.¹² This act authorizes the establishment of tolerances for the amount of chemical residue allowed in the food product. In addition, all 50 states have laws regulating pesticides; and these products must be registered in each state where sale is intended.

¹⁰ Justus C. Ward, "A Dynamic Statue for Pesticides," Protecting Our Food: The Yearbook of Agriculture 1966 (Washington: Government Printing Office, 1966), p. 272.

¹¹ W. B. Sundquist, "Economic Research on Pesticide Use," Minnesota Farm Business Notes, No. 472, May, 1965, University of Minnesota, p. 1.

¹² "Pesticides," Chemical Week, XCII, xxii (June 1, 1963), p. 55.

TABLE III

ACRES OF CROPLAND IN TENNESSEE TREATED WITH PESTICIDES, 1964

Crop	Acres
Acreage Treated for Control of Insects and Diseases	
Grain	50,600
Alfalfa, Clover and Other Hay	45,052
Cotton	170,302
Vegetables	20,578
Fruit and Nuts	3,103
Seed Crops and Other Crops	54,560
	344,195
Acreage Treated for Control of Weeds, Grass or Brush ^a	
Corn	239,772
Cotton	232,528
Small Grain	2,808
Other Crops	59,317
	534,425

^aIn addition there were 20,298 acres of pasture and range land treated.

Source: United States Department of Commerce, Bureau of the Census, U. S. Census of Agriculture, 1964, Tennessee (Preliminary Reports, 1964).

The Federal government has been instrumental for the past two decades in providing funds for chemically oriented pest control research. However, as a result of increased needs for further research, the U. S. Congress provided funds in the Agricultural Appropriation Act for 1965 for research on several important aspects of pesticide use.¹³ These appropriations were made specifically for five categories of research, one of which is economic research on uses of pesticides. The objective is to integrate areas of research so policy-makers can be provided with information for developing recommendations concerning safe and economical control of agricultural pests.

III. OBJECTIVES

Recognizing the fact that agricultural producers must make decisions relative to pesticide usage, sources of information, type and sources of pesticides within the setting already suggested, the general purpose of this study was to examine vegetable producers purchasing patterns for pesticides. This information, once collected and analyzed, would give a clearer picture of a portion of the present pesticide market in Tennessee. These results could be used for establishing guides to regulation and to aid the industry in advertising,

¹³United States Congress, Senate, Committee on Appropriations, Agricultural Appropriations for 1965, Hearings before Subcommittee, 88th Congress, 2nd Session, on H. R. 11202, March 10-July 22, 1964 (Washington: Government Printing Office, 1964), pp. 1107-1108.

labeling, and advising farmers about product use, as well as providing guidelines for future educational work.

This study was limited to vegetable producers for two reasons. The first is that vegetable producers are concerned with a food product for human consumption which is receiving close scrutiny due to residue tolerances; and secondly, vegetables are of a nature which in most cases are highly susceptible to attack by pests which consistently entails the use of pesticides during the growing season. This study places its emphasis on marketing and deals more with the socio-economic aspect of pesticide sales and use.

The specific objectives of the study were: (1) to determine the aggregate volume of the pesticide market in Tennessee and proportionate sales through different retail outlets; (2) to examine vegetable farmers behavior and decisions in purchasing pesticides and factors affecting these; (3) to determine the degree of deliberateness associated with pesticide purchasing decisions by the producers; (4) to determine the general level of knowledgeability of the vegetable producers with respect to pesticides; and (5) to isolate the determinants that influence the utilization of pesticides by vegetable producers in Tennessee.

IV. PROCEDURE

To accomplish the first objective, information was needed from pesticide manufacturing firms that market pesticide products in the

state. These firms are required to register their products with the State Department of Agriculture. The names and addresses of these firms were obtained from the Department of Agriculture and a mail questionnaire was sent to each firm. Two follow-up questionnaires were sent to those firms that did not reply. Of the 585 firms registered in Tennessee, 316 or 54 percent responded to the mail questionnaire. Data needed for the other objectives were obtained by personal interviews with 239 vegetable producers in the state.

Only those vegetables whose production was considered of commercial importance were included in the study. The basic criterion of commercial importance was deemed as a minimum of 1,000 acres of total production in the state. On this basis thirteen crops were included in the study. These were: blackeye peas, cabbage, greens, irish potatoes, lima beans, melons, okra, snap beans, strawberries, sweet corn, sweet pepper, sweet potatoes, and tomatoes.

Due to geographic and climatic conditions the state was divided into three areas. These were the commonly delineated grand divisions of West, Middle, and East Tennessee. The Tennessee River divides West and Middle Tennessee, and the eastern escarpment of the Cumberland Mountain Range separates East and Middle Tennessee. Figure 3 shows the three areas of study and the counties included in each area.¹⁴ Those counties within each area with the highest acreage in 1964 of each of the 13 crops were selected as sample counties. Since some

¹⁴See Appendix A for a listing of the vegetables included in the areas and each county.

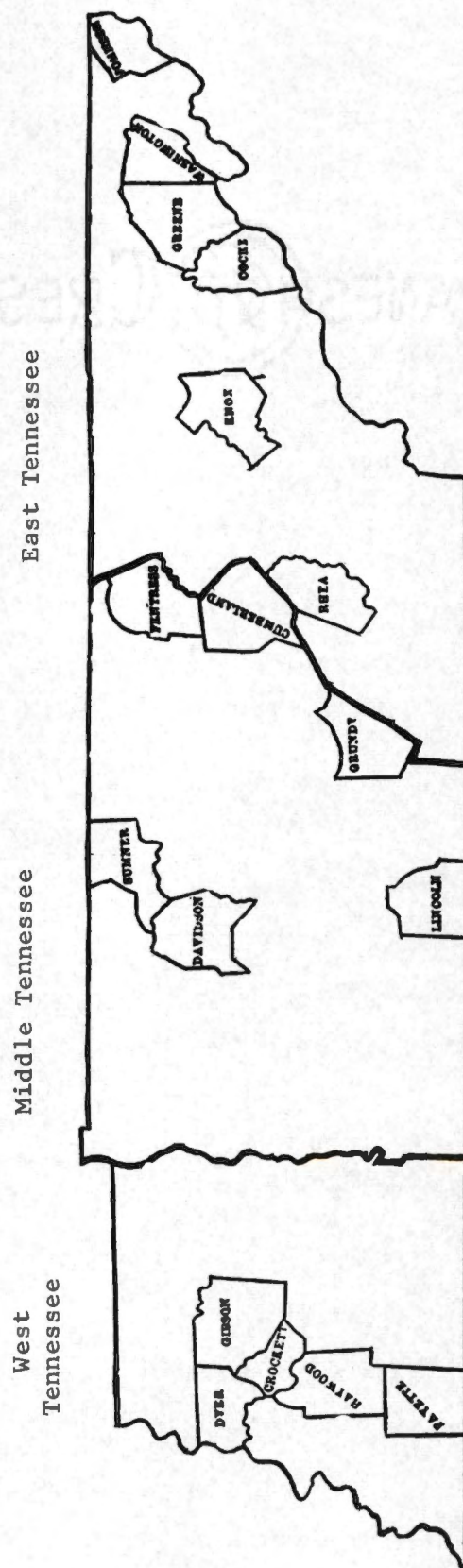


Figure 3. Geographic areas and counties included in each area.

counties had the largest acreage of more than one vegetable, only seventeen counties in the state were included in the study.

A listing or frame of the specific vegetable producers in each of the counties was obtained. The sources of this frame were county agricultural agents, marketing cooperatives, processors and other producers. A random sample from each of these frames by specific vegetable was selected by using a table of random numbers. The size of the sample was based upon two criteria: (1) the number of producers of that vegetable in the county, and (2) the proportion of total acres of that vegetable produced in the county to total acres of that vegetable produced in the state.

The sample size satisfying criterion 1 was: (1) if the total frame had ten producers or less, then the sample would include all of the producers; (2) if the frame of total producers was greater than ten but less than 100, then the sample size would be ten; (3) if the frame was greater than 100, then the sample size would be 10 percent of the frame.

It should be recognized at this point that the above sampling procedure may introduce some degree of biasness due to unproportionate samples by counties. However, the above method was used to be sure that each type of vegetable producer is adequately represented in the overall study.

The condition satisfying criterion 2 was that the total number of acres of the specific vegetable included in the sample by county

must be at least the same proportion to total acres in the county as the county's total acreage of that vegetable bears to total acres produced in the state. In some instances to meet this second condition required that the sample size under criterion 1 be increased. On this basis, 239 vegetable producers were selected as the sample size and interviewed for the study.¹⁵

The procedure to achieve an idea of the total picture of the extent of the pesticide market in Tennessee was to employ a statistical method of computing confidence intervals. Although the simpler procedure of $N \bar{x}$ ¹⁶ would suffice to make an estimate of the total, it was felt that the derivation of confidence intervals would more accurately reflect the aggregate. The confidence intervals for the aggregate analysis was based on the following formula:

$$P(\hat{A} - Z \hat{\sigma}_{\hat{A}} < \hat{A} < \hat{A} + Z \hat{\sigma}_{\hat{A}}) = 1 - \alpha$$

which states that the probability of the total aggregate being within the above interval is equal to 1 minus some α value, which was .10 in this analysis. With the other components defined as:

$\hat{A}$ = estimate of total aggregate or $N \bar{x}$

Z = Z score at .90 percent level of confidence

¹⁵For a breakdown of the sample size by area and county, see Appendix A.

¹⁶ N equals the number of firms selling pesticides and $\bar{x}$ equals the average amount sold by each firm.

σ_A = standard deviation of estimate of total aggregate or

$$\sqrt{N(N-n) \sigma_{\bar{x}}^2}.$$

The confidence interval states that we can be confident if this study was repeated, time after time, the actual aggregate amount would fall within the computed interval 90 percent of the time.

V. PRESENT STATE OF RESEARCH

Most research in the pesticide area has been of a technological or physical science-oriented nature. Scientists have been concerned with such things as the biology, ecology, physiology, pathology and metabolism of insects, plants and animals in an attempt to develop more effective pest control methods. In addition, emphasis has been placed on the toxicological and pathological effects of pesticide residues occurring in food and feed supplies as well as searching for improved methods of application. This is not to say that the above is not where emphasis should be placed but rather to say that as a result very little research of an economic nature is presently available. Fox and Andrienas point out that more economic research of pesticide use is needed for "development of policies governing the use of toxic chemicals in agricultural production and farm analysis of alternative methods of controlling plant and animal pests with respect to costs and returns."¹⁷ They develop an experimental design

¹⁷Austin S. Fox and Paul Andrienas, "Economic Research of Pesticide Use in Agriculture" (paper presented at the sixth meeting of the Weed Society of America, St. Louis, Mo., February 8, 1966), p. 1.

which could be used for obtaining input-output data needed for making an economic analysis. They also proposed an analytical procedure for use in evaluating the costs and returns of herbicides used on agricultural crops.

A study by R. L. Kohls concerning farmers' behavior and decisions in purchasing farm supplies gave consideration to feed, machinery and fertilizer.¹⁸ Some of the conclusions that he arrived at as a result of this study were: (1) the average general shopping range was around five miles from the farm which indicates a relatively limited shopping area in buying habits and preferences; (2) the majority of farmers do not actively compare very many alternate sources of supply in determining where to purchase as indicated by the fact that almost 60 percent had purchased their feed from the same source for at least eight years and about one-third had purchased 60 percent or more of their machinery from the same source; (3) the effective source of information about particular products varied from product to product but neighbors and friends were emphasized as the most important source of information; (4) convenience, product considerations, managerial and operational problems and prices all played major roles in the decision making of the farmers regarding purchasing supplies, but no clear ordering of reasons could be established; and (5) indications

¹⁸R. L. Kohls, Farmers' Behavior and Decisions in Purchasing Farm Supplies, Research Bulletin No. 749, Purdue University, Lafayette, Indiana, October, 1962, pp. 3-4.

were that the larger volume purchaser had greater market knowledge and put less emphasis on convenience and brand and more on service and management related factors and price.

Ordish and Toft suggest the hypothesis that the amount of food eaten by an insect and the amount of economic damage done bear a relationship to each other but not necessarily a direct one.¹⁹ In order to test this, they computed the ratio of direct damage to economic damage by caterpillars on early and late cabbage crops. Direct damage was defined as the amount of leaf eaten and economic damage as the leaves fouled and quality loss. For the early crop, the percent direct damage was calculated as 1 percent, and percent economic damage was figured as 90 percent resulting in ratio of direct to economic damage of 1:90. For the late crop, the direct:economic ratio was determined to be 1:3.6. This study points up the fact that in making insect damage reports, information should be provided so that an economic as well as an entomological assessment of the situation can be made.

The Economic Research Service undertook a nationwide sample survey of farmers in 1965 to measure the extent of pesticide use.²⁰ Of the farmers in the study, 94 percent used pesticides and these farmers spent \$456 million on pesticides in 1964. Farmers using

¹⁹G. Ordish and Helen Toft, "Loss of Economic Yield in Crops," (paper presented to the International Entomological Congress, London, England, 1964), p. 1.

²⁰Andrilenas and Fox, op. cit., p. ii.

pesticides spent an average of about \$300 annually on pesticides. Eighty-five percent of the total pesticide expenditure was used for crops while 11 percent was for animals and the remaining 4 percent was used for other purposes.

In a Kentucky study, buyer knowledge and the deliberativeness of buyers with respect to their fertilizer purchasing decisions was examined.²¹ The results showed that over half of the 248 farmers in the study were relatively non-deliberate in their fertilizer purchasing decisions. This may be interpreted as saying that over half of those interviewed made fertilizer purchasing decisions based on limited comparisons and superficial analyses of the alternatives. The purpose of the buyer knowledge portion was to determine the farmer's fertilizer knowledge levels. The results showed that about 36 percent of those interviewed could be classified as knowledgeable with regard to their understanding of relevant physical, biological and price relationships.

A study on farmer purchasing patterns for pesticides was conducted in Iowa in an effort to determine where the farmer buys his pesticides, his purchase patterns, and why he buys them where he does.²² Their conclusions in the study were that pesticide expenditures

²¹James E. Berry, "Purchase Patterns of Fertilizer" (unpublished Master's thesis, University of Kentucky, Lexington, 1964), pp. 68-95.

²²George M. Beal and Daryl J. Hobbs, "Farmer Purchasing Patterns for Pesticides," Farm Chemicals, CXXIII, x (October, 1960), pp. 32-36.

constitute a relatively small part of the total expenses; that farmers tended to purchase their pesticide products where it was convenient or where they purchase other farm supplies; they do not travel great distances to purchase their supplies and tend to deal with a merchant with whom they have dealt for a period of years and are more loyal to the dealer than to a specific brand or product.

CHAPTER II

THE PESTICIDE MARKET IN TENNESSEE

The pesticide industry in the United States has experienced tremendous growth since about the end of World War II. However, data were not available to determine the extent of the pesticide market in Tennessee, either by volume or value. Firms that manufacture or formulate pesticide products for sale in Tennessee must annually register their product with the Tennessee State Department of Agriculture. In 1965 there were 585 firms registered with this Department. To secure information concerning the types of pesticides, by value and volume, sold in the state in 1965, these firms were mailed questionnaires in early 1966.¹

After two follow-up mailings, 54 percent or 316 firms responded to the questionnaire. Of the 316, exactly one-half or 158 firms indicated that they did sell pesticides in Tennessee in 1965 while the remaining 50 percent said they had no sales in Tennessee in 1965. Of the 158 firms which indicated some sales in 1965, 121 furnished information that could be used for purposes of analysis while 37 firms indicated that their records were such that this information could not be furnished on a state basis or that company policy prohibited the release of information of this nature.

¹A copy of this questionnaire is included in Appendix B.

After reviewing the data obtained and noting the distribution of the respondents with respect to volume and value, the assumption was made that these firms responding to the questionnaire were a representative random sample from the population. The process of statistical inference is based on this assumption that the sample is representative of the population which it describes. Since information is almost never complete the statistician is forced to work with samples which are used to generalize about a population. Therefore, statistical inference is used for generalizing from the sample to the population.² It is on the basis of information obtained from these questionnaires that the analyses are made in this chapter.

I. VOLUME OF PESTICIDES

Table IV shows the amount of pesticides sold in Tennessee in 1965 by the 121 firms completing the mail questionnaire. They reported a total sales of 7,171,100 pounds of pesticides. Sales of insecticides was the largest and accounted for 56.1 percent of the total. Herbicides accounted for 28.4 percent of total sales, and the remaining 15.5 percent was distributed among fungicides, rodenticides and others.³

²Frank A. Pearson and Kenneth R. Bennett, Statistical Methods Applied to Agricultural Economics (New York: John Wiley and Sons, Inc., 1942), pp. 300-308.

³The "others" classification includes such pesticides as sterilants, disinfectants, etc.

TABLE IV
VOLUME AND VALUE OF PESTICIDES SOLD IN TENNESSEE, 1965,
121 SAMPLE FIRMS

Type	Volume		Value ^a	
	Pounds	Average/ Firm	Dollars	Average/ Firm
All Pesticides	7,171,100	59,265	6,895,601	56,988
Insecticides	4,024,654	33,262	3,282,602	27,129
Herbicides	2,034,759	16,816	2,123,743	17,552
Fungicides	487,293	4,027	396,671	3,278
Rodenticides	96,576	798	65,734	543
Others	527,818	4,362	1,026,851	8,486

^aValue at manufacturer's level.

II. VALUE OF PESTICIDES

The total value of pesticides sold by the 121 firms was \$6,895,601. This is value based on the pesticides at the manufacturer's level rather than retail level. Table IV also shows the complete breakdown of the value by types of pesticides and the average value per firm. As might be expected, the proportionate value is closely related to that of volume sold.

III. PESTICIDES SOLD FOR COMMERCIAL AGRICULTURAL PURPOSES

The firms were asked to indicate what proportion of their sales was produced for commercial agricultural purposes. Table V shows that about 4,156,786 pounds were produced for this purpose. This is about 57.9 percent of the total amount of all pesticides sold by the 121 firms. Insecticides accounted for the largest volume of all pesticides sold for commercial agricultural purposes (Table V). Herbicides accounted for about one-fourth of the total amount. Thus the type of pesticide for commercial agricultural purposes is not much different from the proportion by types of pesticides of all pesticides sold.

The relationship between the amount sold for commercial purposes and total amount sold is further pointed up in Table VI. This table shows that with the exception of rodenticides, over 50 percent of each type was sold for commercial agricultural purposes.

TABLE V

VOLUME OF PESTICIDES SOLD FOR COMMERCIAL AGRICULTURAL PURPOSES
IN TENNESSEE, 1965, 121 SAMPLE FIRMS

Type	Volume Lbs.	Average/Firm Lbs.
All Pesticides	4,156,786	34,354
Insecticides	2,494,107	20,612
Herbicides	1,026,506	8,484
Fungicides	317,292	2,622
Rodenticides	39,168	324
Others	279,713	2,312

TABLE VI

PROPORTION OF PESTICIDES SOLD FOR COMMERCIAL AGRICULTURAL
PURPOSES IN TENNESSEE, 1965, 121 SAMPLE FIRMS

Type	Total Volume Lbs.	Volume Used for Commercial Agric. Lbs.	Proportion Used for Commercial Agric. %
All Pesticides	7,171,100	4,156,786	57.9
Insecticides	4,024,654	2,494,107	61.9
Herbicides	2,034,759	1,026,506	50.4
Fungicides	487,293	317,292	65.1
Rodenticides	96,576	39,168	40.5
Others	527,818	279,713	52.9

The total value of all pesticides sold for commercial agricultural purposes as reported by the 121 firms was \$4,675,664.

IV. AVERAGE VALUE PER POUND OF PESTICIDE

Based on the information submitted by the 121 firms, the average value at the manufacturer's level of all pesticides sold in 1965 was 96¢ per pound. Table VII shows the average value by types of pesticide. The range was from \$1.95 per pound for the category of "others" to 68¢ per pound for rodenticides.

V. ESTIMATES OF TOTAL VOLUME AND VALUE SOLD IN 1965

In order to achieve an idea of the total picture of the extent of the pesticide market in Tennessee, a statistical method of computing confidence intervals was employed. The procedure used is explained in Chapter I.

The interval for the total amount of all pesticides sold in Tennessee in 1965 was between 12,213,444 and 22,456,582 pounds. The relative position of pesticides by type remained about the same as earlier as shown in Table VIII.

The confidence intervals for the value of pesticides is shown in Table IX. The interval for the value of all pesticides is between \$11,607,401 and \$21,730,579. Again as in the earlier situation, insecticides and herbicides account for the largest part of the total value.

TABLE VII
AVERAGE VALUE PER POUND OF PESTICIDES SOLD IN TENNESSEE,^a
1965, 121 SAMPLE FIRMS

Type	Average Value/Pound \$
All Pesticides	.96
Insecticides	.82
Herbicides	1.04
Fungicides	.81
Rodenticides	.68
Others	1.95

^aValue at manufacturer's level.

TABLE VIII
CONFIDENCE INTERVALS FOR ESTIMATING AGGREGATE VOLUME OF
PESTICIDES SOLD IN TENNESSEE, 1965, 90 PERCENT LEVEL

Type	Confidence Interval Lbs.
All Pesticides	$12,213,444 < A < 22,456,582$
Insecticides	$5,849,435 < A < 13,608,835$
Herbicides	$2,431,588 < A < 7,405,772$
Fungicides	$293,271 < A < 2,062,525$
Rodenticides	$93,914 < A < 372,916$
Others	$768,840 < A < 1,782,930$

TABLE IX

CONFIDENCE INTERVALS FOR ESTIMATING AGGREGATE VALUE OF PESTICIDES
SOLD IN TENNESSEE, 1965, 90 PERCENT LEVEL

Type	Confidence Level \$
All Pesticides	$11,607,401 < A < 21,730,579$
Insecticides	$5,475,099 < A < 10,395,367$
Herbicides	$2,339,120 < A < 7,928,800$
Fungicides	$304,010 < A < 1,613,620$
Rodenticides	$0 < A < 788,077$
Others	$947,284 < A < 4,017,026$

Thus on the basis of these data the pesticide market in Tennessee is a relatively large one with the total value at the manufacturer's level ranging roughly somewhere between \$12 million and \$22 million.

The total value of sales at the manufacturer's level (excluding exports) in the United States in 1965 was about \$364,000,000. Thus the proportion of total U. S. sales for Tennessee was between 3.3 and 6.0 percent.

Tennessee has roughly 1.4 percent of the total land in farm acreage in the United States and about 1.9 percent of the total cropland acres. Therefore, on this basis Tennessee agricultural producers can be said to be large participants in the pesticide market.

One other aspect probably should be mentioned here. There exists the problem that a portion of the pesticides sold in Tennessee may be purchased by producers in neighboring states that live near Tennessee border cities. Therefore, these pesticides would not be used in the state. Also there may be a few cases where sales made in Tennessee are to out-of-state retailers. Although this study contains no method of distinguishing between these possibilities, this problem should be recognized when viewing the above data.

VI. RETAIL OUTLETS

The survey of firms also provides data for estimating the proportion of all pesticides that are marketed through various types of

retail outlets. Each firm was asked to indicate what proportion of their total sales and by type of pesticide was distributed through various types of retail outlets. Table X shows the percentage of pesticides distributed through different types of retail outlets. General farm supply stores account for 29.6 percent of all pesticide sales; farmer cooperatives for 18.1 percent; feed and seed stores for 10.6 percent; and non-agricultural retail outlets 32.8 percent.

As indicated, 37.8 percent of all insecticides was distributed through general farm supply stores; feed and seed stores accounted for 16 percent while farmer cooperatives distributed 9 percent. About one-fourth of the insecticides were marketed through non-agricultural outlets, which gives an indication of the volume for non-agricultural uses.

Over 37 percent of the herbicides in the state were distributed by farmer cooperatives. General farm supply stores accounted for another 27.2 percent.

The category of "other" is by far the largest distributor of fungicides, accounting for 87.8 percent of the total amount. This large percentage is perhaps indicative of the amount purchased for home use, particularly for vegetable and flower gardens.

Practically the same is true for rodenticides as the category of "other" handled 68.9 percent of the total amount.

For the classification of "other" types of pesticides, the category of "others" distributed over half or 53.7 percent of the total while farmer cooperatives handled 26.4 percent.

TABLE X

PROPORTION OF PESTICIDES DISTRIBUTED THROUGH VARIOUS RETAIL
OUTLETS IN TENNESSEE, 1965, 121 SAMPLE FIRMS

Type of Retail Outlet	All Pesticides % ^a	Insecticides %	Herbicides %	Fungicides %	Rodenticides %	Others ^a %
General Farm Supply	29.6	37.8	27.2	3.3	7.1	4.4
Feed and Seed Stores	10.6	16.0	2.6	2.3	8.7	7.5
Farmer Cooperatives	18.1	9.0	37.6	4.5	10.0	26.4
Elevators	.2	.2	.3	.3	.8	.1
Direct Sales to Commercial Applicators	1.1	1.7	.4	.1	2.7	-
Implement Dealers	2.8	3.9	1.6	.3	.6	2.3
Country General Stores	.7	1.0	.1	.3	.7	1.0
Landscape and Nursery Firms	.8	.7	1.0	.8	-	.2
Direct Sales to Farmers	3.3	4.4	1.8	.3	.5	4.4
Other ^b	32.8	25.3	27.4	87.8	68.9	53.7

^aThe pesticide classification of "others" includes such pesticides as sterilants, disinfectants, etc.

^bThe retail outlet classification of "others" refers to non-agricultural type of outlets such as drug stores, discount houses, grocery stores, department stores, etc.

The points brought out by this data are that almost one-third of total pesticide sales in the state are made through non-agricultural retail outlets and three agricultural outlets account for about 58 percent of total sales.

The purpose of this chapter was to examine the magnitude of the pesticide market in Tennessee. Since this information was not available elsewhere, it will serve as a benchmark from which the effect of future trends in this area in the state can be measured. However the main purpose within the realm of this study was to determine the extent of availability of pesticides to the agricultural producers within the state. Since this study was concerned with those factors that influence the utilization of pesticides by vegetable producers in Tennessee, it was necessary to find out if pesticides in a sufficient quantity and sufficient variation by type were available to the producers. If these were not sufficient, then this would have a definite bearing upon the producer's decisions for the purchase of pesticides. However, after reviewing the data obtained from the manufacturers, it can be concluded that this aspect would have very little influence upon the producer's decisions and as a consequence, the producers are able to make their decisions concerning the purchase of pesticides within a competitive market.

COVERED BY CURE21

CHAPTER III

DESCRIPTIVE ANALYSIS OF VEGETABLE PRODUCERS IN STUDY

The factors that are included in this analysis are those included in the regression analysis to determine their influence on the utilization of pesticides by the vegetable producers in the sample. It was felt that a more detailed examination of these factors may help to better explain their influence or lack of influence in the pesticide utilization predictor curves.

I. SIZE OF OPERATION

The 239 vegetable producers in the sample operated a total of about 62,857 acres. The average size of farm unit was about 263 acres. As shown in Table XI, the producers in West Tennessee were larger operators than those in the other two areas. The average size of farm in this area was 369 acres and 24 percent of the producers had an operation of over 500 acres. The average size of farm was 190 acres for the producers in Middle Tennessee and 220 acres for those in East Tennessee.

The average acres of cropland for all the producers was 155 acres as shown in Table XII. The producers in West Tennessee had the largest average amount of cropland acres with 224 acres. The amount of cropland acres in East Tennessee was only 91 acres. Also, it should be noted that 20 percent of the producers in West Tennessee had over

TABLE XI
 RANGE IN SIZE OF TOTAL FARM UNITS, 239 VEGETABLE
 PRODUCERS, TENNESSEE, 1965

Acres	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Less than 50	12	16	20	15
50-100	18	26	32	23
101-200	24	31	18	24
201-300	8	10	10	9
301-400	6	6	8	7
401-500	8	8	5	8
Over 500	24	3	7	14
Mean Size	369 Acres	190 Acres	220 Acres	263 Acres

TABLE XII
 RANGE IN ACRES OF CROPLAND, 239 VEGETABLE PRODUCERS,
 TENNESSEE, 1965

Acres	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Less than 50	26	37	53	36
50-100	25	18	27	23
101-150	7	18	5	9
151-200	8	11	3	8
201-250	8	5	--	5
251-300	6	2	2	4
Over 300	20	9	10	15
Mean Acres of Cropland	224	134	91	155

300 acres of cropland while 53 percent of the producers in East Tennessee had less than 50.

The average acres of vegetable production of all sample producers in 1965 was 52 acres (Table XIII). Again the largest amount, 77 acres, was in West Tennessee. However, about 42 percent of the producers had 15 acres or less of vegetables while 15 percent had more than 100 acres of vegetable production. The average acreage of vegetables for the producers in East Tennessee was only 18 acres and 45 percent of the producers had more than 100 acres of vegetables. Middle Tennessee had the largest proportion of producers with over 100 acres of vegetables with 21 percent of the producers in this category. The average production of vegetables for all producers in this area was 52 acres which was the same as the average for all producers in the study.

II. FARMING EXPERIENCE

The vegetable producers in the study had an average of 25 years farming experience. About 44 percent of the producers had over 30 years farming experience while only 2 percent had less than 3 years experience. Not much difference in this aspect was noted between the three areas as indicated in Table XIV.

III. AGE OF PRODUCERS

The average age of the producers in the sample was 50 years. Only 10 percent of the producers were under 35 years of age while 55

TABLE XIII
 RANGE IN ACRES OF VEGETABLES, 239 VEGETABLE
 PRODUCERS, TENNESSEE, 1965

Acres	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Less than 5	21	25	45	28
5-15	21	19	35	24
16-25	10	11	3	9
26-40	13	15	3	11
41-55	8	5	1	5
56-70	5	2	3	4
71-85	2	2	2	2
86-100	5	--	3	3
Over 100	15	21	5	14
Mean Acres of Vegetables	77	52	18	52

TABLE XIV
YEARS OF FARMING EXPERIENCE, 239 VEGETABLE
PRODUCERS, TENNESSEE, 1965

Years	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Less than 3	1	3	3	2
3-9	6	6	12	7
10-18	12	26	14	17
19-24	16	19	20	17
25-30	15	12	9	13
Over 30	50	34	42	44
Mean Years Farming Experience	26	24	24	25

percent were over 50 years. The range of years is shown in Table XV. The average age of the producers in East Tennessee was 53 years which was slightly higher than the average in West Tennessee and Middle Tennessee which was 49 and 48 years, respectively. About 72 percent of the producers in East Tennessee were over 50 years of age and there were no producers under the age of 26.

IV. YEARS OF EDUCATION

The average years of education for all the producers was 9 years. About 32 percent of the producers had a high school or higher level of education. Six percent had completed college and 1 percent had done some graduate work. Table XVI shows the range of the years of education of the producers. In all three areas, 50 percent or more of the producers had 8 years or less of education. West Tennessee and East Tennessee had 8 and 10 percent, respectively, of the producers that had completed college, while in Middle Tennessee only 2 percent of the producers had completed college.

V. TOTAL FARM INCOME

The average amount of gross farm income could not be computed accurately as the producers were asked to indicate the income range pertaining to their situation in 1965. Table XVII shows the number of producers within the various ranges of total farm income. About 35 percent of all the producers indicated that their farm income was

TABLE XV

AGE OF OPERATORS, 239 VEGETABLE PRODUCERS, TENNESSEE, 1965

Years	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Less than 21	1	--	--	1
21-25	2	2	--	1
26-30	22	--	2	1
31-35	10	6	2	7
36-40	6	18	3	8
41-45	11	15	10	13
46-50	14	16	11	14
51-55	20	8	27	18
56-60	20	13	23	19
Over 60	14	22	22	18
Mean Age	49	48	53	50

TABLE XVI

YEARS OF EDUCATION, 239 VEGETABLE PRODUCERS, TENNESSEE, 1965

Education	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Less than 5 years	15	11	6	12
5-8	35	42	48	40
9-11	16	14	15	15
12	21	29	18	22
13-15	5	2	3	4
16	6	2	8	5
Over 16	2	--	2	2
Mean Education	9	9	10	9

TABLE XVII
RANGE OF TOTAL FARM INCOME, 239 VEGETABLE
PRODUCERS, TENNESSEE, 1965

Income \$	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Less than \$1000	7	11	7	8
1000-3999	17	24	41	25
4000-7999	19	28	17	21
8000-10000	10	11	13	11
Over 10,000	47	26	22	35

in excess of \$10,000 in 1965. The larger size of operations in West Tennessee is shown again as 47 percent of those producers had an income of over \$10,000 as compared with 26 percent in Middle Tennessee and 22 percent in East Tennessee.

VI. TENURE

Of the 239 producers in the study, 82 percent were owners or part-owners as shown in Table XVIII. West Tennessee had the greatest proportion of tenancy, with 32 percent of the producers in this category as compared with only 5 percent in both Middle Tennessee and East Tennessee.

VII. CONTRIBUTION OF VEGETABLES TO TOTAL FARM INCOME

Vegetable production appeared to be more important to the producers in Middle Tennessee as vegetables contributed more than 50 percent to total farm income for 38 percent of the producers as compared with 22 percent in West Tennessee and 18 percent in East Tennessee (Table XIX). Twenty-five percent of the producers indicated that vegetables contributed more than 50 percent to their total farm income.

VIII. ENTERPRISES MAKING LARGEST CONTRIBUTION TO TOTAL FARM INCOME

When the producers were asked which enterprise in their operation made the largest contribution to total farm income in 1965, the

TABLE XVIII
TYPE OF TENURE, 239 PRODUCERS, TENNESSEE, 1965

Area	Tenant %	Part-Owner %	Owner %
West Tennessee	32	37	31
Middle Tennessee	5	40	55
East Tennessee	5	38	57
State	18	38	44

TABLE XIX

RANGE OF PERCENTAGE CONTRIBUTION OF VEGETABLES TO TOTAL
FARM INCOME, 239 PRODUCERS, TENNESSEE, 1965

Contribution %	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Less than 5	2	6	10	5
5-10	9	18	30	17
11-20	14	6	5	10
21-30	21	7	22	17
31-40	16	6	3	10
41-50	16	19	12	16
Over 50	22	38	18	25

results shown in Table XX were obtained. Thirty-eight percent of the producers indicated that vegetables made the largest contribution to farm income. However, in West Tennessee, 50 percent of the producers said that cotton was the largest contributor while vegetables were making the largest contribution for 39 percent of the producers. In East Tennessee, tobacco was the greatest contributor to income for 47 percent of the producers and vegetables were for 20 percent of them.

IX. HIRED LABOR

With vegetable production having an intensive labor requirement and family labor not always ample to handle the complete load, the producers were asked to indicate the amount of labor hired in 1965. Table XXI shows the results of this question. It should be recognized that this is total hours of labor hired and does not necessarily reflect its total use toward vegetable production. The largest single range of hired labor was between 100 and 500 hours where 32 percent of the producers indicated this was the amount of labor they had hired in 1965. It should be noted that this pertains only to the 200 producers that did hire labor, as 39 of the producers said they did not hire any labor in 1965. About 28 percent of those hiring labor used more than 3000 hours of hired labor. As might be expected, West Tennessee was the largest user of hired labor with 103 of the 117 producers indicating that they used hired labor in 1965 and 38 percent of them hiring more than 3000 hours.

TABLE XX

DISTRIBUTION OF ENTERPRISES MAKING LARGEST CONTRIBUTION TO TOTAL
FARM INCOME, 239 VEGETABLE PRODUCERS, TENNESSEE, 1965

Enterprise	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Vegetables	39	58	20	38
Cotton	50	2	--	25
Tobacco	--	16	47	15
Beef Cattle	3	16	13	9
Dairy	1	--	12	3
Others ^a	7	8	8	10

^aIncludes swine, poultry, soybeans, corn, fruit, cane and hay.

TABLE XXI
 RANGE OF HOURS OF HIRED LABOR, 239 VEGETABLE PRODUCERS,
 TENNESSEE, 1965

Hours	West Tennessee ^a %	Middle Tennessee ^b %	East Tennessee ^c %	State ^d %
Less than 100	2	11	16	8
100-500	27	30	42	32
501-1000	12	14	10	12
1001-2000	15	26	6	14
2001-3000	7	4	4	6
Over 3000	37	15	22	28
Average Hours of Hired Labor	2960	1874	1679	2293

^a14 producers indicated they did not hire labor in 1965.

^b15 producers indicated they did not hire labor in 1965.

^c10 producers indicated they did not hire labor in 1965.

^dComputed on the basis of 200 producers that did hire labor in 1965.

X. PESTICIDE APPLICATION EQUIPMENT

One characteristic which was thought to have influence upon the use of pesticides by the producers was the type of pesticide application equipment owned. Of the 239 producers, 173 indicated they owned some type of application equipment. The breakdown by type is shown in Table XXII. About 60 percent of the producers indicated the ownership of tractor mounted application equipment, either sprayer or duster type. Six percent owned a Hi-boy and the remaining 34 percent owned a hand operated duster or sprayer.

XI. METHOD OF APPLICATION

About 55 percent of the producers indicated that tractor mounted sprayers or dusters were used with aerial application of spray or dust designated by 20 percent of the producers. The application of pesticides in the form of spray and dust was about equally divided among the producers, Table XXIII.

About 79 percent of the producers indicated that they applied their own pesticides while the other 21 percent relied upon a commercial applicator. Thirty-three percent relied upon commercial applicators in West Tennessee, only 15 percent in Middle Tennessee and 12 percent in East Tennessee followed this practice.

TABLE XXII
DISTRIBUTION OF PESTICIDE APPLICATION EQUIPMENT OWNED,
BY TYPE, 239 PRODUCERS, TENNESSEE, 1965

Type	West Tennessee ^a %	Middle Tennessee ^b %	East Tennessee ^c %	State ^d %
Hi-boy	10	5	--	6
Tractor Sprayer	43	27	31	36
Tractor Duster	29	38	9	24
Hand Sprayer	9	14	44	21
Hand Duster	9	16	16	13

^a38 producers did not own application equipment in 1965.

^b25 producers did not own application equipment in 1965.

^c3 producers did not own application equipment in 1965.

^dComputed on the basis of 173 producers that owned equipment.

TABLE XXIII

METHOD OF APPLICATION OF PESTICIDES, 239
PRODUCERS, TENNESSEE, 1965

Method	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Aerial Spray	15	11	3	11
Aerial Dust	14	6	2	9
Tractor Spray	23	32	20	24
Tractor Dust	33	26	32	31
Hand Dust	4	13	20	10
Hand Spray	5	10	23	11
Hi-boy Sprayer	6	2	--	4

CHAPTER IV

VEGETABLE PRODUCERS' PESTICIDE PURCHASING BEHAVIOR

The purpose of this chapter was to analyze the producers' purchase pattern and determine where pesticide purchases were made and the reason for purchasing from that particular source. The producers' sources of information concerning the application of pesticides were also investigated.

I. DETERMINATION OF NEED FOR PESTICIDES

Table XXIV shows the methods of determining how the producers made the decision that a pesticide was needed and the proportion of producers using each method. Sixty-four percent of the producers indicated that their decision to use pesticides was based upon a personal observation of the presence of pests or presence of damage.

II. SELECTION OF SPECIFIC PESTICIDE CHEMICAL

After it is determined that a pesticide is needed, a decision must be made on which specific pesticide should be used to combat the particular pest. This problem is compounded by the fact that in many cases there are several different chemicals which will adequately handle the problem and basically the same chemicals are manufactured under many different brand names. The largest proportion--38 percent--of the producers said that they relied upon past experience to

TABLE XXIV
DETERMINATION OF WHEN PESTICIDES ARE NEEDED, 239
PRODUCERS, TENNESSEE, 1965

Method	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Personal Observation of Pests or Damage	65	68	60	64
Preventive Schedule	14	26	33	23
Processors' Fieldmen	7	3	2	4
County Agent	3	3	5	4
Specified in Contract	11	--	--	5

determine which type or brand of pesticide to use. Over 70 percent depended on past experience in Middle Tennessee. About 13 percent of the producers indicated that they depended upon the recommendations of the Extension Service to determine which pesticide should be used (this varied from 5 percent in Middle Tennessee to 18 percent in East Tennessee); another 13 percent indicated that their decision was based upon USDA recommendations. Again Middle Tennessee was low in seeking agency advice. Thirteen percent indicated that they relied upon the dealer to recommend which type of pesticide to use. The complete breakdown on determination of type of pesticide to use is shown in Table XXV.

III. RATE OF APPLICATION

The amount of pesticides used is directly affected by the rate at which it is applied. Thus, producers must determine in some manner the proper rate at which the pesticide should be applied. The instructions on the label were used as the basis for 41 percent of the producers. As indicated in the preceding chapter, about 21 percent of the producers had their pesticides applied by commercial applicators and 21 percent of the producers said they left the rate of application up to the commercial applicators. About 20 percent of the producers said the rate was determined by past experience based on the amount which did an effective job previously, Table XXVI.

TABLE XXV
DETERMINATION OF USE OF SPECIFIC TYPE OF PESTICIDE,
239 PRODUCERS, TENNESSEE, 1965

Method	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Past Experience	20	73	40	38
Extension Service	14	5	18	13
Contract	15	--	--	7
Dealers	15	13	8	13
Commercial Applicators	11	--	1	5
USDA Recommendations	15	6	13	13
Processors' Fieldmen	10	3	12	9
Read Labels	--	--	8	2

TABLE XXVI

DETERMINATION OF RATE OF APPLICATION, 239 PRODUCERS,
TENNESSEE, 1965

Method	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Past Experience	13	25	28	20
Instruction on Label	46	44	27	41
Extension Service	3	6	5	4
Commercial Applicator	28	15	12	21
Just Completely Cover Plant	--	5	20	6
Processors' Fieldman	9	5	8	7
"Guess"	1	--	--	1

IV. DISTANCE TO SOURCE OF PESTICIDES

The data obtained would seem to indicate that convenience and tradition are two considerations in determining where pesticides are purchased. The average distance to the major source of purchase of pesticides was approximately 10 miles. About 74 percent of the producers made their purchase within 10 miles of their farm. Table XXVII shows the distances indicated by the producers.

When the producers were asked what they would do with respect to their pesticide purchases if their dealer moved his place of business three miles farther away from them, the responses in Table XXVIII were obtained. Approximately 69 percent said the extra distance would not make any difference while 12 percent indicated they would change dealers if the additional distance proved to be inconvenient. Only 19 percent said the increased distance would cause them to change dealers.

V. MAJOR SOURCE OF PESTICIDE PURCHASES

Realizing that conditions may dictate purchasing from different sources occasionally, the producers were asked to indicate where they made their major pesticide purchases. About 51 percent of the producers said that the Tennessee Farm Cooperative was their major source. Approximately 15 percent indicated that general farm supply stores were their major source of pesticides (Table XXIX).

TABLE XXVII
DISTANCE FROM FARM TO SOURCE OF PESTICIDES, 239
PRODUCERS, TENNESSEE, 1965

Miles	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Less than 1	2	8	2	3
1-3.9	43	24	16	31
4-6.9	22	21	27	23
7-9.9	16	20	13	17
10 and over	17	27	42	26
Average Distance	8	11	11	10

TABLE XXVIII

PRODUCERS' REACTION TO DEALERS INCREASING DISTANCE 3 MILES
FROM FARM, 239 PRODUCERS, TENNESSEE, 1965

Reaction	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Continue to Trade with Dealer	78	53	70	69
Continue to Trade for Time-being Until Extra Distance Proves Incon- venient	10	16	12	12
Change Dealers	12	31	18	19

TABLE XXIX

MAJOR SOURCES OF PESTICIDE PURCHASES, 239 PRODUCERS, TENNESSEE, 1965

Source	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
General Farm Supply Stores	12	19	18	15
Feed & Seed Stores	6	18	10	11
Tennessee Farmer Cooperative	58	39	52	51
Commercial Applicator	3	--	--	2
Country General Store	3	8	5	5
Direct from Manufacturer	3	8	7	5
Processor	15	8	8	11

Of the 239 producers in the study, 155 or about 65 percent of them said that they usually purchased their pesticides from only one source. When they were asked their reasons for purchasing from only one dealer, the results in Table XXX were obtained. The largest proportion--32 percent--said that they purchased from only one source due to convenience. About one-fourth of the producers said they used only one source because of price. Twelve percent of the producers said that the availability of credit was the reason for purchasing from only one source while another 10 percent said that it was due to custom.

When the 84 producers that indicated they purchased their pesticides from more than one source were asked their reasons for doing so, the results in Table XXXI were obtained. About 50 percent of them said they just bought where it was the most convenient to do so at the time they needed pesticides. Twenty percent indicated that it was their desire to spread their business around between the various merchants. Eighteen percent of these producers purchased from more than one source because in some cases what they wanted was not available. The remaining 12 percent purchased from more than one source because they wanted to try different brands of pesticides in an attempt to achieve more effective results.

VI. PESTICIDE EXPENDITURES

The 239 vegetable producers spent an average of approximately \$471 each for pesticides in 1965. The average varied from about \$723

TABLE XXX

REASONS FOR PURCHASING FROM ONLY ONE SOURCE, 155 PRODUCERS
USING ONLY ONE SOURCE, TENNESSEE, 1965

Reason	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Convenience	29	37	35	32
Price	19	43	23	25
Custom	9	9	13	10
Complete Stock	8	3	19	8
Credit	15	5	10	12
Farmer Operated	8	--	--	5
Quality	4	--	--	3
Service	7	--	--	4
"Relative"	1	3	--	1

TABLE XXXI

REASONS FOR PURCHASING FROM MORE THAN ONE SOURCE, 84 PRODUCERS
USING MORE THAN ONE SOURCE, TENNESSEE, 1965

Reasons	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Convenience	36	74	41	50
Product Unavailable	25	8	21	18
Desire to Spread Business Around	21	11	28	20
Try Different Brands	18	7	10	12

in West Tennessee to \$197 in East Tennessee. Forty-five percent of the producers spent less than \$100 for pesticides while almost one-fourth of them spent \$500 or more. About 13 percent spent over \$1,000 for pesticides. The array of pesticide expenditures for the producers in 1965 is shown in Table XXXII.

VII. DEALER OR BRAND LOYALTY

Indications are that the purchasers of pesticides are more loyal to their dealers than they are to any particular brand. The producers were asked the following question: "If your chemical dealer decided to change brand of pesticides and remained under the same management and followed the same operating procedure as before and handled another brand at the same price, would you stay with the dealer and change brands; stay with the dealer until the new brand proved unsatisfactory; or change dealers so you could obtain the brand you are now using?" The responses to this question are given in Table XXXIII. Only 8 percent of the producers indicated they would change dealers in order to continue using their present brand. This ranged from 10 percent in West Tennessee to only 3 percent in East Tennessee. This would seem to imply that there has not been much brand loyalty built up in the minds of the producers.

VIII. FARM SALES BY DEALERS

Evidently the dealers from whom the producer is purchasing his pesticides were not pushing sales to any large extent by direct on-the-

TABLE XXXII
EXPENDITURES FOR PESTICIDES, 239 PRODUCERS, TENNESSEE, 1965

Dollars	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Less than 100	38	48	58	45
100-399	26	27	29	27
400-699	10	10	4	9
700-1000	6	5	7	6
Over 1000	20	10	2	13
Average Expenditure	\$723	\$339	\$198	\$471

TABLE XXXIII

DEALER OR BRAND LOYALTY, 239 PRODUCERS, TENNESSEE, 1965

Reaction	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Stay with Dealer and Change Brand	59	47	75	60
Stay with Dealer for Time-being and Try New Brand	31	44	22	32
Change Dealer to Obtain Specific Brand	10	9	3	8

farm sales. According to data from the producers, only about one-fourth of the dealers made on-the-farm calls to sell them pesticides. However, there was an extreme variation from West Tennessee to East Tennessee. In West Tennessee 40 percent of the producers said the dealers made on-the-farm calls to sell pesticides while in East Tennessee only 7 percent and Middle Tennessee only 10 percent of the producers indicated on farm visits. This variation may be attributed to the difference in size of operation and type of crop.

IX. ASSISTANCE FROM CHEMICAL COMPANIES

With the increasing use of pesticides by agricultural producers many chemical companies now have staff members that visit the producers and help them with their particular problems. Realizing that the degree to which the producers utilized the services of these company representatives may have affected the extent to which pesticides were used, the producers were asked to categorize the degree to which they actually called upon the assistance of these people. About 83 percent of the producers indicated that they did not use the services of the representatives at all (Table XXXIV). Although 17 percent of the producers did use the services, only 12 percent indicated a large degree of use. The producers in West Tennessee utilized the services more than the producers from the other two areas of the state. Only 77 percent of the producers in West Tennessee indicated they did not use these services while in East Tennessee, 92 percent of the producers indicated this to be the case.

TABLE XXXIV

DEGREE OF UTILIZATION OF SERVICES OF CHEMICAL COMPANY
REPRESENTATIVES, 239 PRODUCERS, TENNESSEE, 1965

Degree of Utilization	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
None	77	87	92	83
Little	5	3	7	5
Very Much	18	10	1	12

TABLE XXXV

FREQUENCY PRODUCER CHECKED PESTICIDE PRICES DURING THE PREVIOUS
TWO MONTHS, 239 PRODUCERS, TENNESSEE, 1965

Frequency	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Never Checked	88	85	80	85
Seldom Checked	8	15	15	11
Frequently	2	--	5	3
Quite Frequently	2	--	--	1

TABLE XXXVI
LENGTH OF CREDIT TERMS AVAILABLE ON PESTICIDE PURCHASES,
239 PRODUCERS, TENNESSEE, 1965

Terms	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
None	2	18	12	8
30 Day	31	19	10	23
60 Day	4	2	--	3
90 Day	11	5	6	8
120 Day	7	3	--	4
Any Desired	45	53	72	54

The responses to this question are shown in Table XXXVII. Only 17 percent of the producers indicated they would look for another source of pesticides where credit could be obtained. However, 21 percent said that they would stay with their present dealer only as long as they could get by on available cash reserves, indicating the question of credit might become important in the future, depending upon conditions.

XII. FOLLOWING LABEL INSTRUCTIONS

One question that is of concern to a great many persons is that of how much attention do the users of pesticides pay to the instructions on the label. Ten percent of the sample producers admitted that they paid absolutely no attention to the label, while another 7 percent said they didn't follow the label very closely. The remaining 83 percent of the producers indicated that they followed the instructions on the label as closely as they possibly could (Table XXXVIII).

XIII. SOURCES OF INFORMATION CONCERNING PESTICIDES

Another question that needed to be answered was where did the vegetable producers go to secure information dealing with new developments in the pesticide field. Tables XXXIX, XL and XLI show the responses to this question for each area. In West Tennessee, neighbors and friends were indicated by the largest proportion of producers as

TABLE XXXVII

PRODUCERS EXPECTED REACTION TO CREDIT CANCELLATION BY
PRESENT DEALER, 239 PRODUCERS, TENNESSEE, 1965

Reaction	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Continue Trading with Dealer	58	80	52	62
Continue Until Impossi- ble to Pay Cash	21	10	33	21
Look for Other Sources of Credit	21	10	15	17

TABLE XXXVIII

DEGREE OF FOLLOWING INSTRUCTIONS AND RECOMMENDATIONS
ON LABEL, 239 PRODUCERS, TENNESSEE, 1965

Closeness	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
As Closely as Possible	84	71	94	83
Not Very Close	7	11	3	7
Pay No Attention	9	18	3	10

TABLE XXXIX

FREQUENCY OF USE OF SOURCES OF INFORMATION ABOUT PESTICIDES,
WEST TENNESSEE, 117 PRODUCERS, 1965

Source	Frequently %	Now and Then %	Seldom or Never %
Dealers and Salesmen	46	33	21
County Agricultural Agent	31	25	44
Neighbors and Friends	51	29	20
Ads in Magazines	23	32	45
Pesticide Company Bulletins	23	38	39
University Bulletins and Field Days	27	26	47
Articles in Farm Magazines	32	33	35
Radio and Television	21	35	44
Processors' Fieldmen	17	3	80

TABLE XL
 FREQUENCY OF USE OF SOURCES OF INFORMATION ABOUT PESTICIDES,
 MIDDLE TENNESSEE, 62 PRODUCERS, 1965

Source	Frequently %	Now and Then %	Seldom or Never %
Dealers and Salesmen	37	44	19
County Agricultural Agent	36	32	32
Neighbors and Friends	44	21	35
Ads in Magazines	16	39	45
Pesticide Company Bulletins	27	32	41
University Bulletins and Field Days	29	40	31
Articles in Farm Magazines	44	26	30
Radio and Television	16	27	57
Processors' Fieldmen	3	2	95

TABLE XLI
 FREQUENCY OF USE OF SOURCES OF INFORMATION ABOUT PESTICIDES,
 EAST TENNESSEE, 60 PRODUCERS, 1965

Source	Frequently %	Now and Then %	Seldom or Never %
Dealers and Salesmen	30	37	33
County Agricultural Agent	37	38	25
Neighbors and Friends	17	45	38
Ads in Magazines	10	32	58
Pesticide Company Bulletins	13	43	44
University Bulletins and Field Days	27	38	35
Articles in Farm Magazines	23	53	24
Radio and Television	5	22	73
Processors' Fieldmen	15	2	83

being the source used most frequently, followed closely in degree of frequency by dealers and salesmen. The processors' fieldmen were seldom or never used as a source of information by 80 percent of the producers. In Middle Tennessee, neighbors and friends as well as articles in farm magazines were cited as the sources most frequently used by all producers. The overall pattern of the responses in Middle Tennessee was not too dissimilar from those in West Tennessee. However, in East Tennessee the pattern was different. County Agricultural Agents were designated as the most frequently used source by the largest proportion of the producers. Dealers and salesmen were second but closely followed by University Bulletin and field days.

When the producers were asked to indicate which they considered as their most important source of information, the responses in Table XLII were obtained. County Agricultural Agents were listed by 31 percent of the producers as the most important source. The source listed less frequently was radio and television with only 2 percent of the producers indicating this source.

TABLE XLII

MOST IMPORTANT SOURCE OF INFORMATION ABOUT PESTICIDES,
239 PRODUCERS, TENNESSEE 1965

Source	West Tennessee %	Middle Tennessee %	East Tennessee %	State %
Dealers and Salesmen	27	27	15	24
County Agricultural Agent	24	40	35	31
Neighbors and Friends	21	12	9	15
Ads in Magazines	--	--	--	--
Pesticide Company Bulletins	--	--	--	--
University Bulletins and Field Days	8	11	20	12
Articles in Farm Magazines	8	6	5	7
Radio and Television	2	2	3	2
Processors' Fieldmen	10	2	13	9

CHAPTER V

DELIBERATENESS OF PURCHASING DECISIONS

The purpose of this chapter was to explore the pattern of behavior of the deliberateness of the buyers with respect to their pesticide purchasing decisions. The term deliberate decisions was used to refer to those decisions based on choice processes in which alternatives were consciously identified and evaluated against one another. This process involves inquiry and an attempt to evaluate the consequence of alternatives. Deliberate individuals was used to refer to those who use such processes in their pesticide purchasing decisions.¹

The data used in this chapter were obtained from a set of open response questions² and based on the Guttman scale analysis program.³ This program takes the information on the variables, assigns proper weights to the data, ranks the respondents from the most favorable to least favorable, and assigns a Guttman scale score for each respondent.

Each respondent's answer to the questions was evaluated according to one of three classifications. These were highly deliberate,

¹Eldon D. Smith, "The Deliberativeness of Economic Choices," The Southern Economic Journal, XXIX (July, 1962), p. 39-43.

²See Appendix C for the questions used.

³See Appendix D for the rationale of the Guttman scale analysis and the questions used.

moderately deliberate, or relatively non-deliberate. The evaluation of highly deliberate indicates that the respondent is one who uses technical material, price and quality information to a maximum, and actively seeks information and new knowledge.

Moderately deliberate indicates that the person may have checked around some but makes only limited comparisons. When he considers his pesticide purchases, only a superficial analysis is made. He just buys the cheapest with no consideration of side services or additional benefits. Relatively non-deliberate is one who makes no attempt to secure information about prices or associated services. Such a purchaser usually pays no attention to information from others.

In dealing with attitudes the correctness or incorrectness of a response cannot accurately be measured against some yardstick of objective truth or fact. The correct answers in an attitude scale are those which are logically judged to be a greater indication of the attitude while incorrect answers are those logically judged to be a lesser indication of the attitude.⁴

The seven indicated questions were then programmed, with one of the three possible evaluations for each question, according to the Guttman scale procedure. The resulting Guttman scores for the respondents ranged from 1 to 14, based on an increasing degree of deliberateness.

⁴D. E. Morrison and G. A. Kristjanson, Personal Adjustment Among Older Persons, Technical Bulletin 21, South Dakota State College, Brookings, South Dakota, 1958, p. 19.

A coefficient of reproducibility of .829 was obtained with a minimal marginal reproducibility of .594. The coefficient of reproducibility for individual questions ranged from .80 to .90. Reproducibility measures the proportion of instances in which any given individual's response to a particular question may be correctly reproduced from his scale score. A scale with 100 percent reproducibility means that each individual's scale score describes the exact pattern of his answers to all the questions. In order to obtain a larger coefficient of reproducibility the program suggested the questions be re-evaluated from a two way classification rather than a three way. By making the suggested adjustments and re-programming, a coefficient of reproducibility of .967 with a minimal marginal reproducibility of .915 was obtained. The coefficient of reproducibility for individual questions ranged from .90 to .98. It was felt that the increase in the coefficient of reproducibility was spuriously obtained because of the higher minimal marginal reproducibility.

Although the coefficient of reproducibility of .829 does not in the strictest sense satisfy the suggested Guttman criterion of scalability of .90, it was believed that the first scale obtained more accurately reflected the attitude of deliberateness than the one with the higher coefficient of reproducibility. The problem is one of how far the distribution of the data in a given situation may depart from the perfect scale model and still be judged to "scale." Riley refers to the .90 suggested by Guttman as an "arbitrary criterion" and a

"practical rule of thumb."⁵ Some areas which are not scalable are called quasi-scales; while their reproducibility may not be high, the error of reproducibility is random.⁶ In the case of quasi-scales, the scores of the subjects are believed to be determined by one major variable and some minor variables with the minor variables contributing to the error of reproducibility. Therefore if the error resolved by the minor variables is random, then the rank order of the subjects will ordinarily be in terms of the one major variable.⁷ It is for these reasons that the first program is considered as a quasi-scale and used in this analysis.

To facilitate analysis, respondents were trichotomized into non-deliberate, moderately deliberate and highly deliberate groups. Those respondents receiving quasi-scale scores of 1, 2, 3, and 4 were arbitrarily placed in the non-deliberate group. Respondents receiving quasi-scale scores of 5, 6, 7, 8, 9, and 10 were placed in the moderately deliberate group and those receiving quasi-scale scores of 11, 12, 13, and 14 were placed in the highly deliberate group.

⁵Matilda White Riley, Sociological Research I A Case Approach (New York: Harcourt, Brace and Wald, Inc., 1963), p. 476.

⁶Samuel A. Stouffer, Louis Guttman et al., "Studies in Social Psychology in World War II," Volume IV. Measurement and Prediction (Princeton, New Jersey: Princeton University Press, 1950), p. 79.

⁷Allen L. Edwards, Techniques of Attitude Scale Construction (New York: Appleton-Century-Crofts, Inc., 1957), pp. 197-198.

Although an arrangement of this sort is necessary for analysis, the shortcomings of such an arrangement should be noted. For example, those respondents scoring 4 are placed in the non-deliberate group while those scoring 5 are placed in the moderately deliberate group, while undoubtedly the difference between some of the individuals in these two groups is relatively small. The same would be true for those respondents scoring 10 and 11.

Generally the results of these analyses indicated that the pesticide purchasing decisions of slightly over half of the 239 vegetable producers in the study were made on limited comparisons and a superficial analysis. This is brought out in Figure 4 which shows that approximately 51 percent of the producers were in the moderately deliberate category. This implies that this group made little or no attempt to seek information about prices or associated services from different sources concerning their pesticide purchasing decisions. Only about 7 percent of the vegetable producers were in the highly deliberate category. These are the producers that use price and quality information to a maximum and actively seek information and new knowledge with regard to their pesticide purchasing decisions.

The distribution of the Guttman Quasi-Scale scores in the three areas of the state is depicted in Figures 5, 6, and 7. There is a marked difference between the percentage of highly deliberate producers in East Tennessee as compared with West Tennessee and Middle Tennessee. In East Tennessee only about 3 percent of the producers are in this

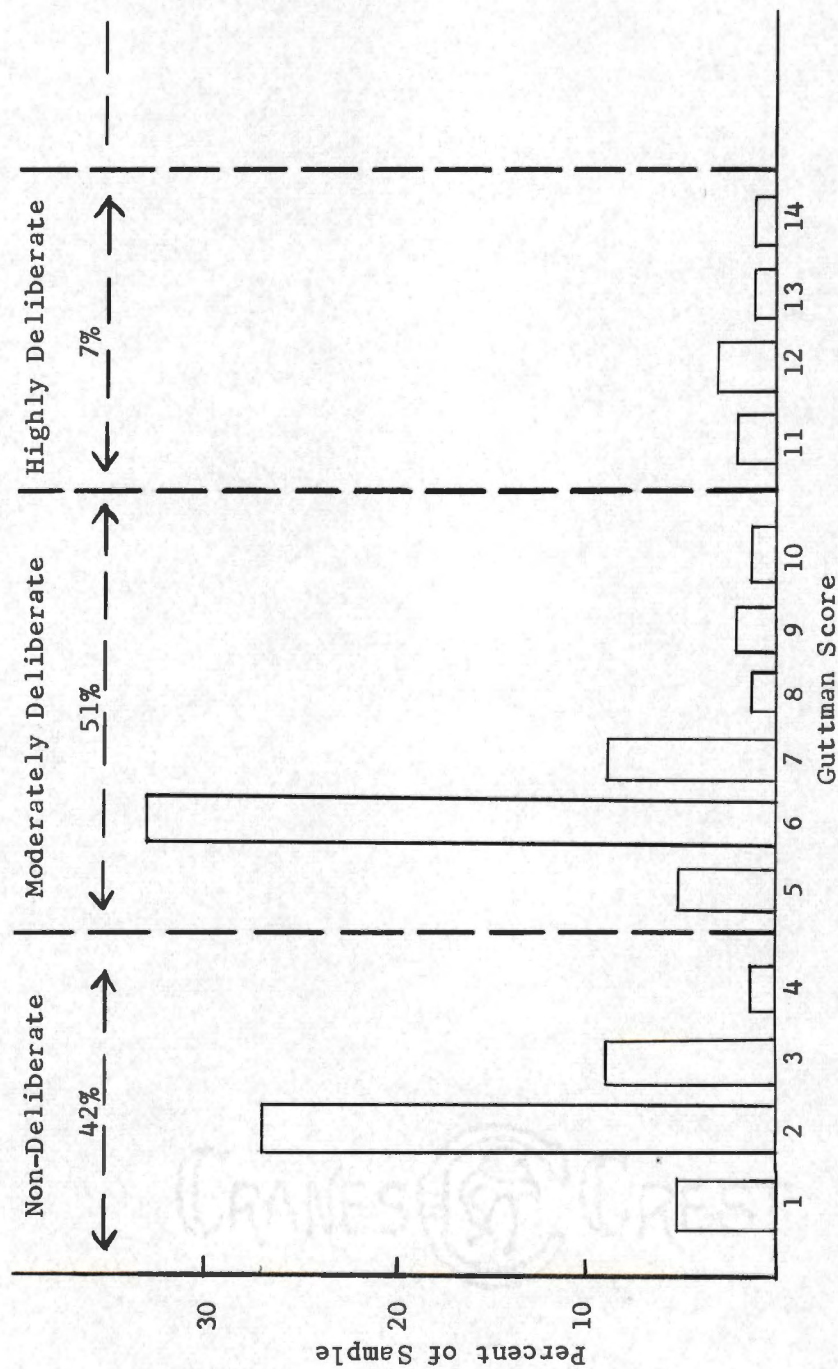


Figure 4. Percentage distribution of deliberateness in making pesticide purchases: all 239 vegetable producers, Tennessee, 1965.

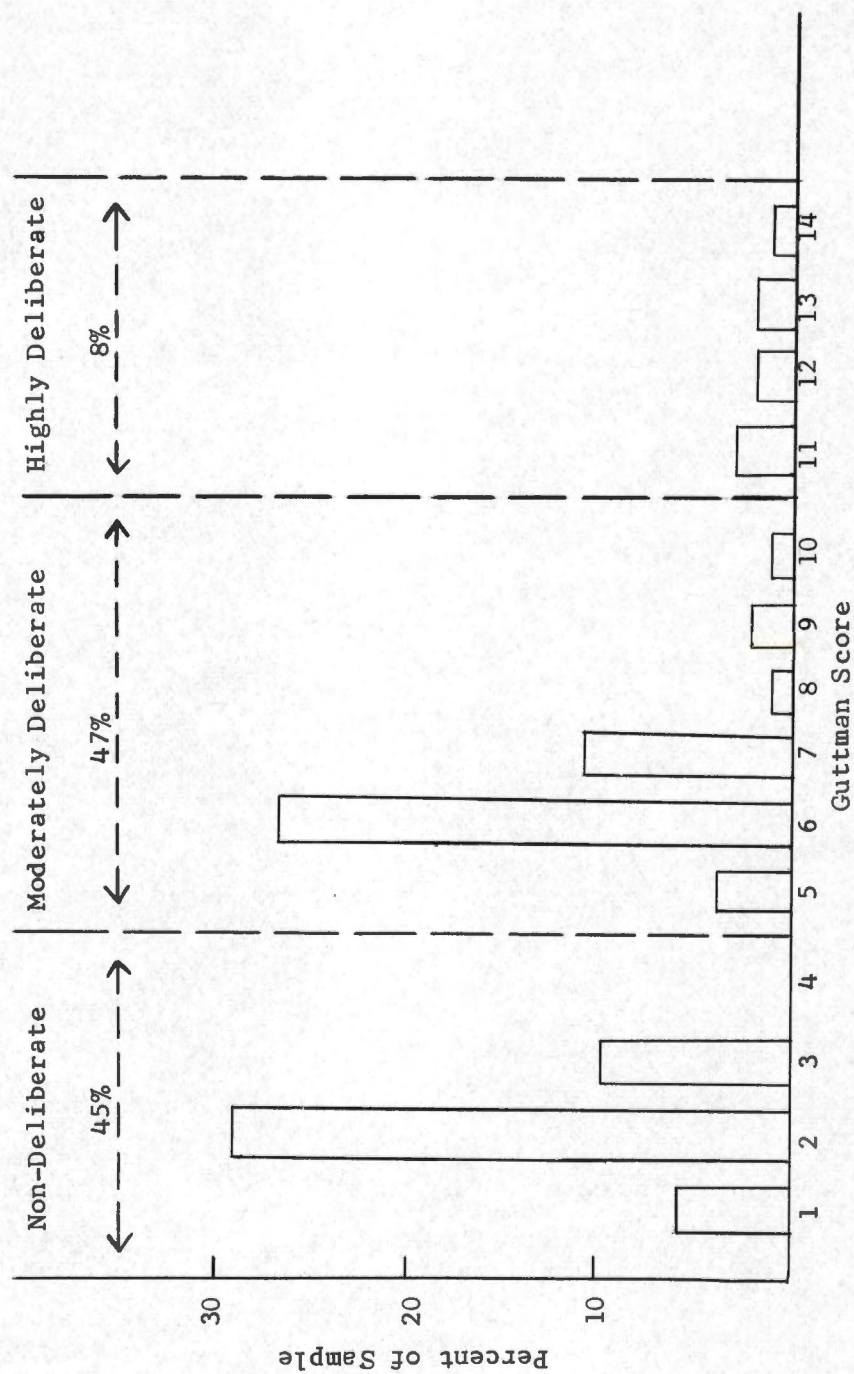


Figure 5. Percentage distribution of deliberateness in making pesticide purchases: 117 producers, West Tennessee, 1965.

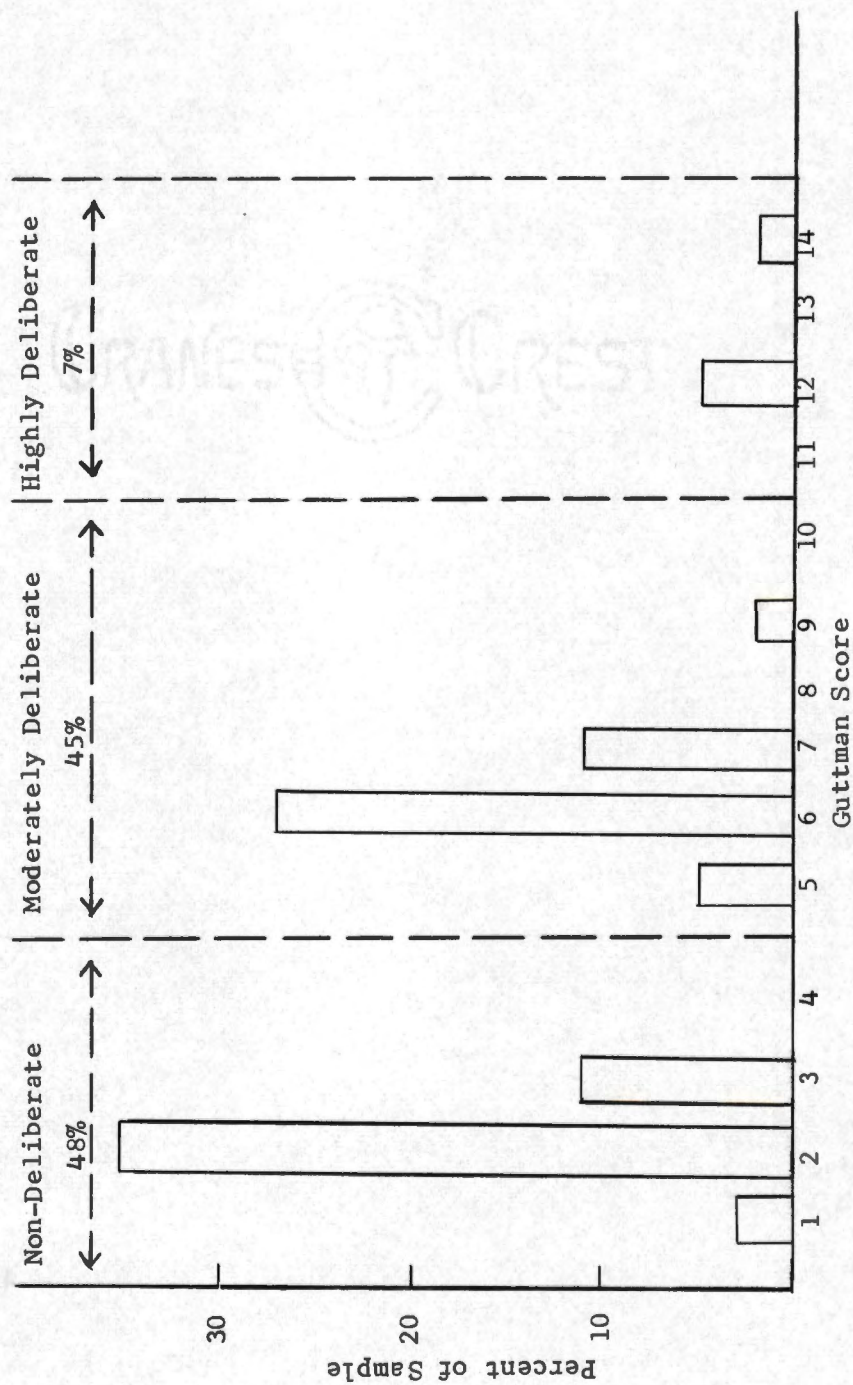


Figure 6. Percentage distribution of deliberateness in making pesticide purchases: 62 producers, Middle Tennessee, 1965.

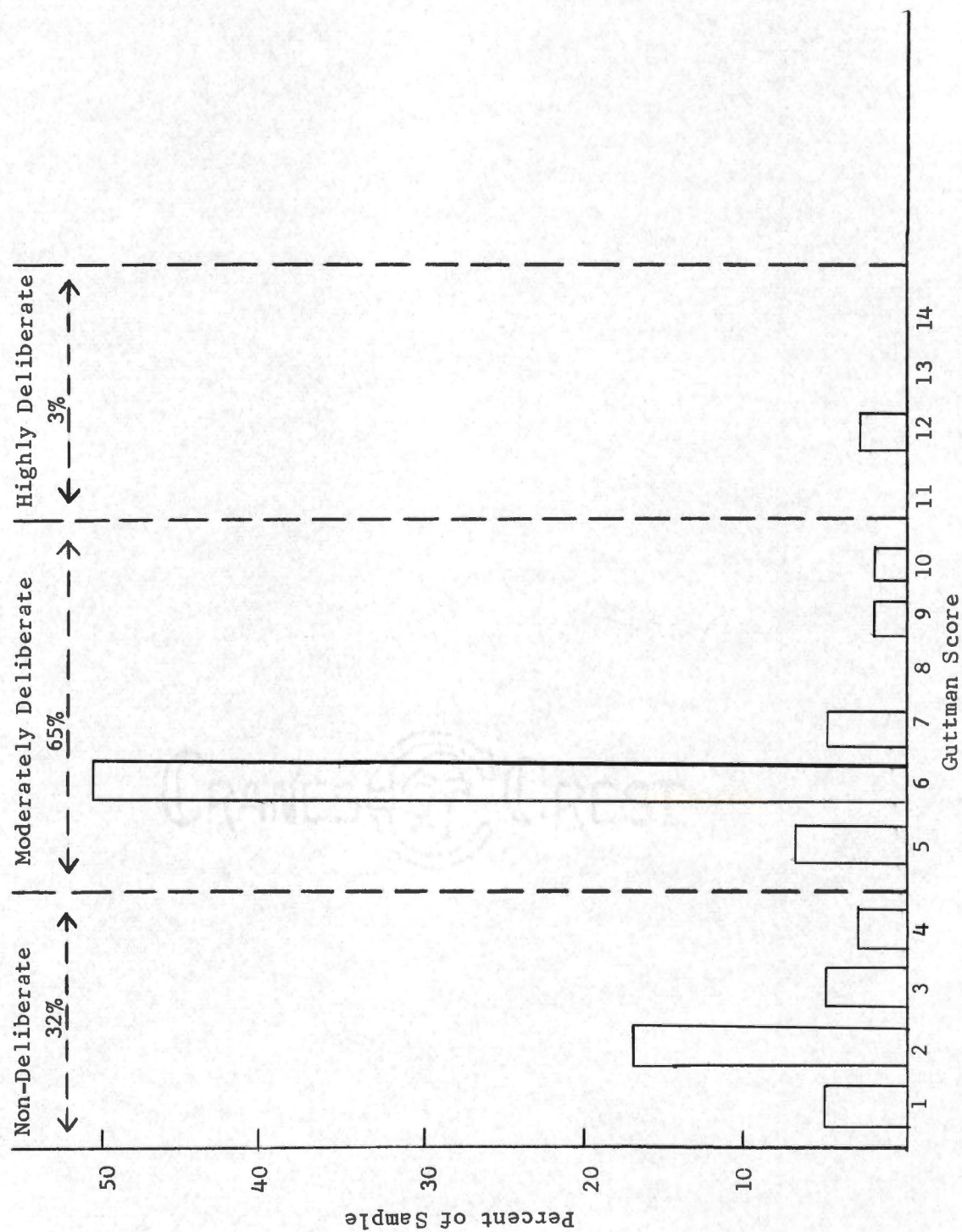


Figure 7. Percentage distribution of deliberateness in making pesticide purchases: 60 producers, East Tennessee, 1965.

category as compared with 8 percent in West Tennessee and 7 percent in Middle Tennessee. This may be attributed to the fact that the average expenditure for pesticides was only about \$198 in East Tennessee but about \$723 and \$339 for West Tennessee and Middle Tennessee, respectively. Thus the producers in East Tennessee may not have considered decision making with regard to pesticide purchases a problem worthy of a great deal of consideration.

Although a smaller percentage of the producers in East Tennessee were in the highly deliberate category, this area had by far the largest proportion of producers in the moderately deliberate category. About 65 percent of the producers in East Tennessee were in the moderately deliberate group as compared with 47 and 45 percent for West Tennessee and Middle Tennessee.

Very little difference is noted in the relatively non-deliberate category between West Tennessee and Middle Tennessee. About 45 percent of the producers in West Tennessee were in this category while about 48 percent of those in Middle Tennessee were in the group. However, only about 32 percent of the producers in East Tennessee were in the relatively non-deliberate category.

This suggests the fact that although a smaller proportion of the producers in East Tennessee made a complete analysis concerning their pesticide purchasing decision, a greater proportion of them did make a general superficial type of analysis than did the producers in West and Middle Tennessee.

I. CORRELATION ANALYSIS

A correlation matrix obtained from the multiple regression program revealed the coefficients in Table XLIII between the Guttman Quasi-Scale Score for deliberateness of pesticide purchasing decisions obtained from the preceding analysis and twelve other factors thought to have influence upon pesticide expenditures. These coefficients measure the interrelationship of these factors and deliberateness of pesticide purchasing decisions for the state and for each of three grand divisions.

Seven factors were significant when correlated with deliberateness for all 239 vegetable producers.⁸ These were acres of cropland, acres of vegetables, hours of hired labor, pesticide expenditures, education of producers, gross income, and knowledge of pesticides score.

Eight factors correlated with deliberateness at the 95 percent level in West Tennessee were the same as for all producers in the study plus the percentage that vegetables contribute to total income.

In Middle Tennessee only two of the twelve factors were significant when correlated with deliberateness at the 95 percent level. These were pesticide expenditures and knowledge score. Only gross income was significantly correlated with deliberateness at the 95 percent level in East Tennessee.

⁸At the 95 percent level.

TABLE XLIII

RESULT OF CORRELATION ANALYSIS BETWEEN DELIBERATENESS SCORE AND 12 FACTORS,
239 VEGETABLE PRODUCERS, TENNESSEE, 1965

Factor	Coefficient			
	All	Area		
		West Tennessee	Middle Tennessee	East Tennessee
Total Acres	.113	.148	.104	.244
Acres Cropland	.167 ^a	.270 ^a	.148	.217
Acres Vegetables	.229 ^a	.328 ^a	.217	.134
Percent Vegetables Contribute to Total Income	.082	.206 ^a	-.008	.041
Hours Hired Labor	.196 ^a	.218 ^a	.192	.156
Distance to Source of Pesticides	.122	.021	.173	.226
Pesticide Expenditures	.248 ^a	.303 ^a	.250 ^a	.119
Years Farming Experience	-.056	-.118	.071	-.112
Age of Producer	-.048	-.070	-.019	-.105
Education of Producer	.253 ^a	.420 ^a	.053	.086
Gross Farm Income	.267 ^a	.406 ^a	.095	.254 ^a
Knowledge Score	.365 ^a	.472 ^a	.294 ^a	.179

^aSignificant at the 95 percent level.

II. FREQUENCY OF RESPONSE TO QUESTIONS

The frequency tabulations in Table XLIV of the unqualified yes or no responses to the questions do not indicate relative deliberateness on the part of the purchasers. However, it does indicate the responses to the questions from which the respective Guttman scores were derived.

TABLE XLIV

FREQUENCY DISTRIBUTION OF 239 BUYERS' RESPONSE TO QUESTIONS RELATED TO DELIBERATENESS
OF DECISION ON PESTICIDE PURCHASES, TENNESSEE, 1965

	Vegetable Producers by Areas			
	West Tennessee	Middle Tennessee	East Tennessee	All Producers
	(Percent Answering Yes)			
(1) Purchased pesticides from same source as other farm supplies	62	81	73	69
(2) Purchased most recent pesticides at usual source	91	85	88	89
(3) Purchased same brand as usual	90	76	83	85
(4) Checked around for best price	15	23	22	19
(5) Bought on basis of ingredients rather than brand	62	77	62	66
(6) Bought on basis of ingredients rather than dealer confidence	74	84	68	75
Number of Observations	117	62	60	239

CHAPTER VI

VEGETABLE PRODUCERS' GENERAL KNOWLEDGE OF PESTICIDES

With the increasing use of pesticides for agricultural purposes and governmental regulations bearing upon their use, it becomes important for producers to have a basic knowledge of pesticides. The purpose of this chapter was to determine the general level of knowledge about pesticides of the vegetable producers in the study. The data used were obtained from a set of questions asked in a personal interview with the producers.¹ The Guttman scale analysis program was used to determine the level of knowledge of the respondents, based upon their answers. Each answer was evaluated according to one of the three classifications. These were highly knowledgeable, moderately knowledgeable, and non-knowledgeable. An analogy to this classification would probably be letter grades of A, C, and F.

When the questions were programmed by the Guttman procedure, a coefficient of reproducibility of .778 was obtained with a minimal marginal reproducibility of .599. The coefficient of reproducibility for individual questions ranged from .70 to .97. Again in an effort to increase the coefficient of reproducibility, fifteen of the questions were re-evaluated from a two way classification as suggested by the program. After re-programming, a coefficient of reproducibility

¹See Appendix E for the questions used.

of .955 was obtained with a minimal marginal reproducibility of .870. The coefficient of reproducibility for individual questions ranged from .82 to .98. For the same reasons as stated in Chapter V, it was believed that the first scale with the lower coefficient of reproducibility more accurately reflected the attitude of knowledge.

As in the previous case the respondents were trichotomized into three groups: non-knowledgeable, moderately knowledgeable and highly knowledgeable. Those respondents receiving quasi-scale scores of 1-12 were placed in the non-knowledgeable group. The respondents in the moderately knowledgeable group were those receiving quasi-scale scores of 13-27 and those with quasi-scale scores of 28-39 were placed in the highly knowledgeable group. Those shortcomings for such an arrangement as previously discussed apply here also.

When the twenty questions were programmed, a quasi-scale of Guttman scores was obtained ranging from 1 to 39, indicating an increasing degree of knowledge. The results of these analyses indicate that about 62 percent of the producers were in the highly knowledgeable and moderately knowledgeable categories as shown in Figure 8. The larger proportion, 40 percent, were in the moderately knowledgeable group.

As indicated in Figure 9, the results in West Tennessee are not considerably different, with the exception that a slightly higher proportion, 42 percent, are in the non-knowledgeable category and a lower proportion in the moderately knowledgeable group.

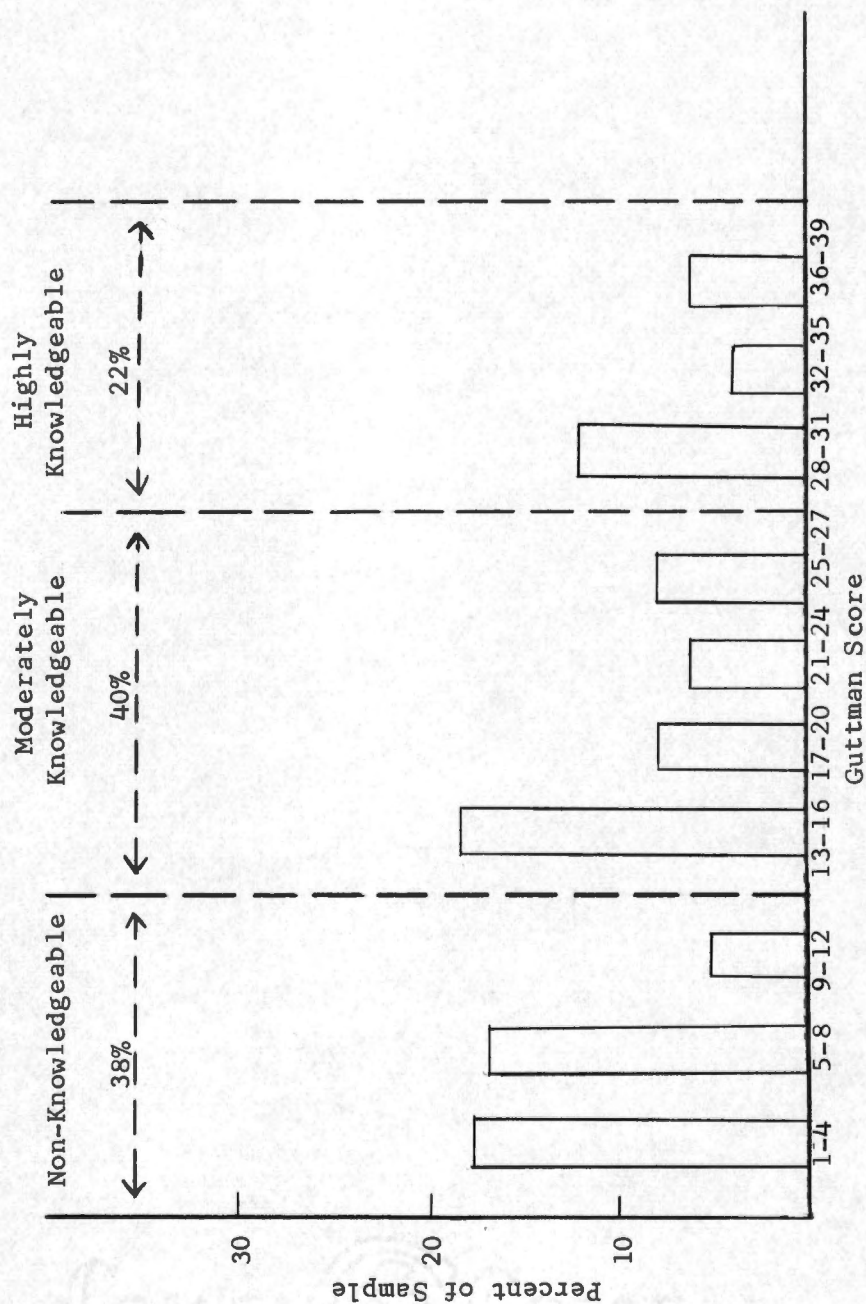


Figure 8. Percentage distribution of knowledgeability of pesticides: all 239 producers, Tennessee, 1965.

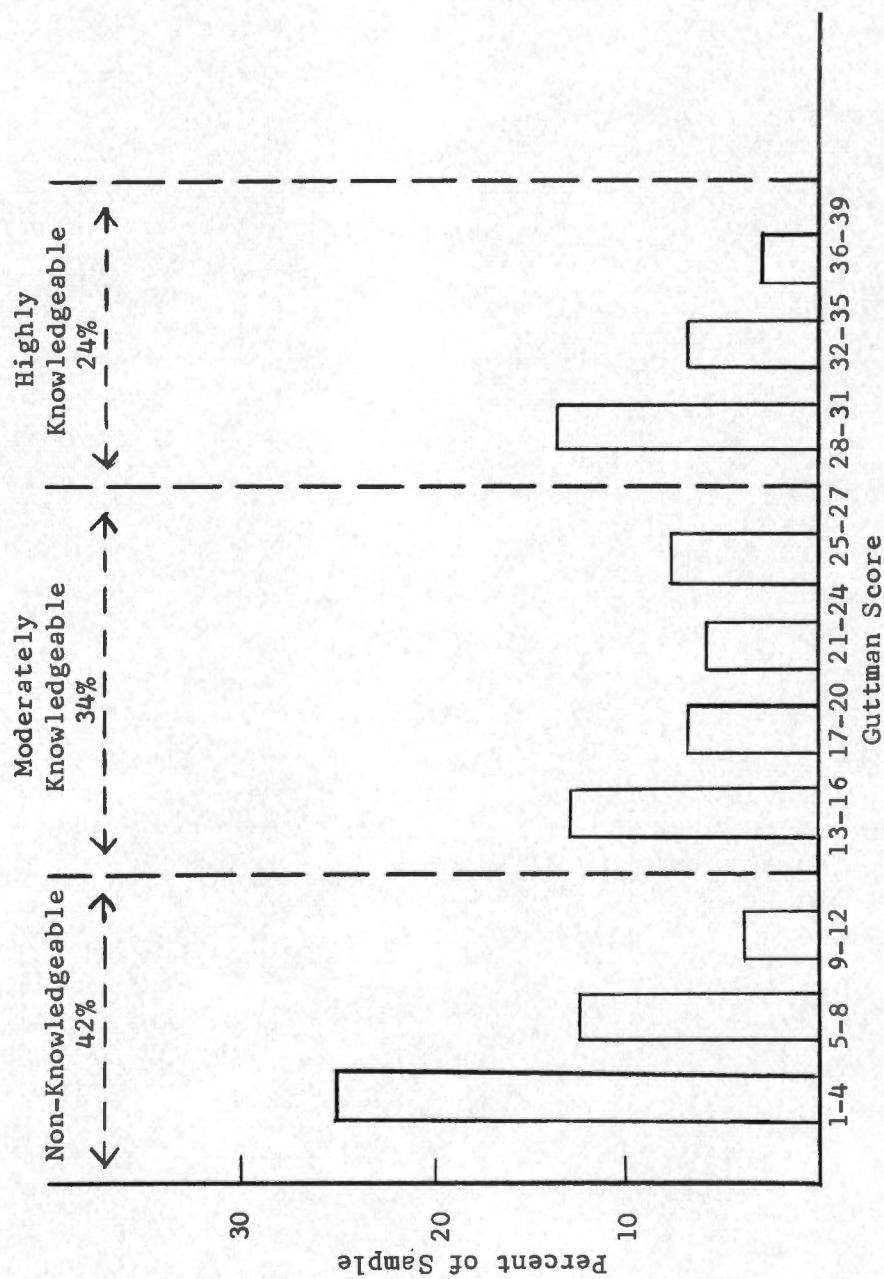


Figure 9. Percentage distribution of knowledgeability of pesticides: 117 producers, West Tennessee, 1965.

The results in Middle Tennessee are almost identical to the overall results as shown in Figure 10. The highly knowledgeable category has 2 percent less while the non-knowledgeable classification contains 2 percent more. The category of moderately knowledgeable contains exactly the same proportion.

In East Tennessee the proportion of producers in the highly knowledgeable category was slightly less, 18 percent, as was the proportion in the non-knowledgeable category, 30 percent, as shown in Figure 11. However, there was a substantial increase in the proportion in the classification of moderately knowledgeable, 52 percent.

Looking at the total proportion in the two categories of moderately and highly knowledgeable, it was noted that West Tennessee and Middle Tennessee were slightly less than the overall proportion. But the proportion in these two categories in East Tennessee was substantially larger than the overall.

I. CORRELATION ANALYSIS

Table XLV shows the correlation coefficients obtained from the multiple regression program between the Guttman Quasi-Scale Score for knowledgeability about pesticides and other factors having possible influence upon pesticide expenditures. The coefficients measure the degree of association between the factors and the knowledgeability about pesticides for the producers in the study.

At the 95 percent level of significance there were eight factors positively correlated with the knowledgeability scores for all 239

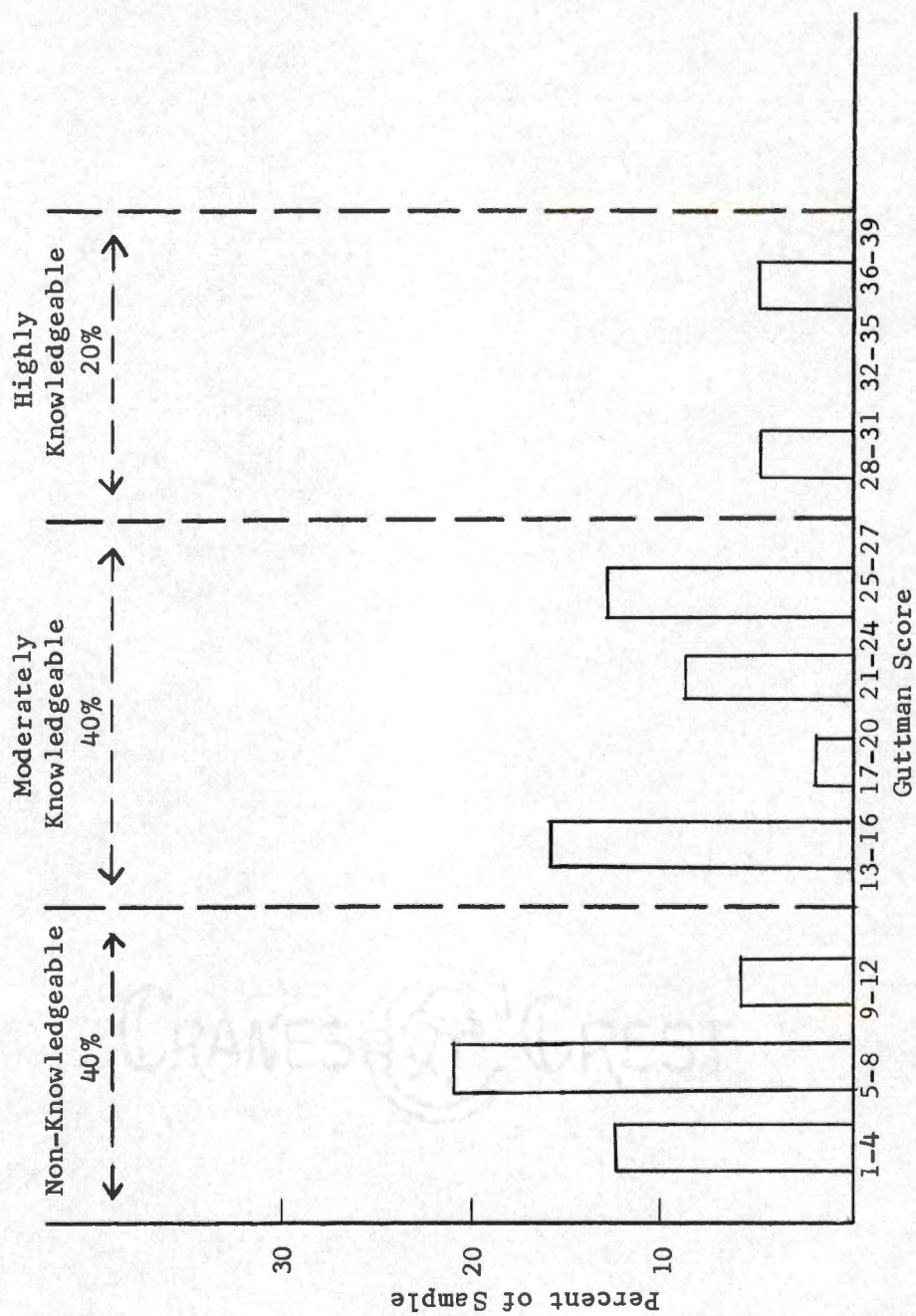


Figure 10. Percentage distribution of knowledgeability of pesticides: 62 producers, Middle Tennessee, 1965.

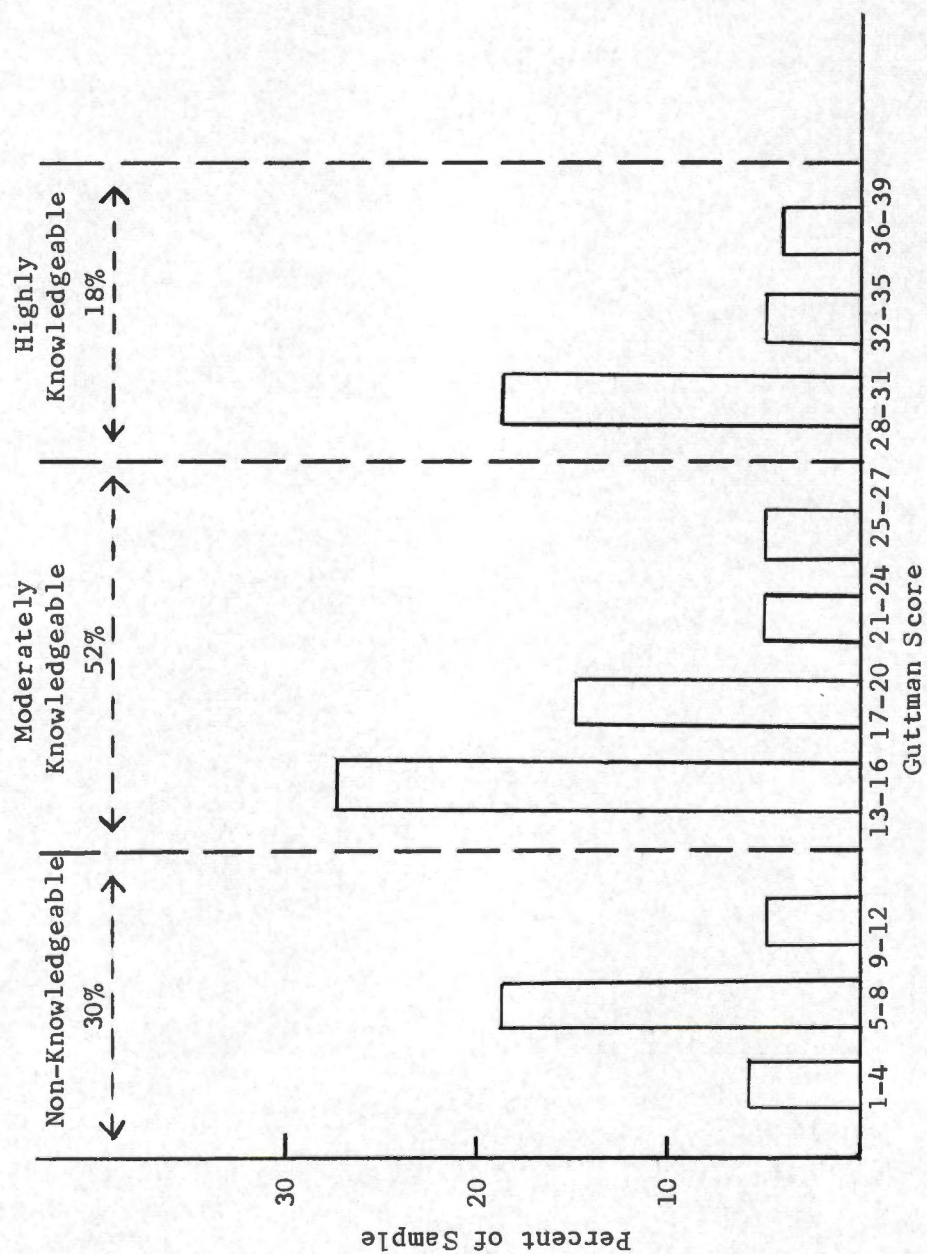


Figure 11. Percentage distribution of knowledgeability of pesticides: 60 producers, East Tennessee, 1965.

TABLE XLV

RESULT OF CORRELATION ANALYSIS BETWEEN KNOWLEDGEABILITY SCORE AND
12 FACTORS, 239 VEGETABLE PRODUCERS

Factor	Coefficient Area		
	All	West Tennessee	Middle Tennessee East Tennessee
Total Acres	.287 ^a	.373 ^a	.271 ^a .244
Acres Cropland	.324 ^a	.449 ^a	.214 .217
Acres Vegetables	.246 ^a	.359 ^a	.116 .134
Percent Vegetables Contribute to Total Farm Income	.117	.186 ^a	.017 .041
Hours Hired Labor	.369 ^a	.241 ^a	.167 .156
Distance to Source of Pesticides	-.071	-.278 ^a	.039 .226
Pesticide Expenditures	.351 ^a	.445 ^a	.235 .119
Years Farming Experience	-.223 ^a	-.150	-.151 -.112
Age of Producers	-.255 ^a	-.277 ^a	-.196 -.105
Education of Producers	.645 ^a	.701 ^a	.573 ^a .086
Gross Farm Income	.533 ^a	.703 ^a	.346 ^a .254 ^a
Deliberateness Score	.265 ^a	.472 ^a	.294 ^a .179

^aSignificant at the 95 percent level.

producers. These were total acres, acres of cropland, acres of vegetables, hours of hired labor, total pesticide expenditures, education of producer, gross income, and deliberateness score. There were two factors which were negatively correlated at the 95 percent level. These were years of farming experience and the age of the producer.

There were nine factors positively correlated with the knowledgeability score at the 95 percent level in West Tennessee. The factors that were significant along with their coefficients are shown in the illustration. Also in West Tennessee there were two factors which were negatively correlated with the knowledgeability score. These were distance to the source of pesticides and the age of the producer. Years of farming experience also was negatively correlated but was not significant at the 95 percent level.

There were only four factors significantly correlated with the knowledgeability score in Middle Tennessee. These were total acres, education of the producer, gross income and deliberateness score.

Only one factor was significantly correlated with the knowledgeability score at the 95 percent level in East Tennessee. This factor was gross income.

II. FREQUENCY OF RESPONSES TO QUESTIONS

In order to get an idea of the distribution of the answers to the knowledge questions, a frequency tabulation was made for the 239 producers. The results of these tabulations are shown in Table XLVI.

TABLE XLVI

FREQUENCY DISTRIBUTION OF PRODUCERS RESPONSE TO QUESTIONS RELATED
TO GENERAL KNOWLEDGE OF PESTICIDES, 239 VEGETABLE PRODUCERS

Question	Degree of Knowledgeability		
	Highly Knowledgeable %	Moderately Knowledgeable %	Non- Knowledgeable %
(1) What is meant by legal residue?	27	21	52
(2) What is meant by excessive residue?	26	25	49
(3) What is meant by illegal residue?	26	16	58
(4) How do you keep residues on vegetables within legal tolerances?	61	16	23
(5) What agency checks feeds and foods for residues?	40	2	58
(6) What is established tolerances for vegetables that you produce?	8	23	69
(7) Which of the following are classified as pesticides: insecticides, miticides, rodenticides, fungicides, herbicides, aquaticicides?	10	49	41
(8) DDT is a member of which following group? hydrocarbon, organic phosphate or carbamate?	12	1	87
(9) Malathion is a member of which following group? hydrocarbon, organic phosphate or carbamate?	6	1	93
(10) Which of the following would control corn ear worms? DDT, sevin, malathion, lindane?	16	61	23
(11) Which of the following would control aphids? DDT, malathion, sevin, parathion?	13	44	43
All of the following terms are found on pesticide labels. Define their meaning.			
(12) Wettable powder	69	10	21

TABLE XLVI (continued)

Question	Degree of Knowledgeability		
	Highly Knowledgeable %	Moderately Knowledgeable %	Non- Knowledgeable %
(13) Antidote	48	2	50
(14) Toxic poisoning	4	43	53
(15) Diluted	50	13	37
(16) Fungicide	28	24	48
(17) Larvae	23	28	49
(18) Agitate	67	3	30
(19) Herbicide	38	5	57
(20) Inert ingredients	34	11	55

This may point up some of the areas that may need to be emphasized in future educational work with vegetable producers in the state in the general area of pesticides.

CHAPTER VII

STATISTICAL ANALYSIS OF FACTORS AFFECTING UTILIZATION OF PESTICIDES

I. TYPE OF ANALYSIS

This phase of the study deals more specifically with the factors that influence the utilization of pesticides by the vegetable producers in the sample. Thus far these factors have been examined in a more general fashion but now it is necessary to determine which of the many factors actually do influence the use of pesticides by the producers. Also to determine the extent of influence and direction of effect by these factors.

Therefore the analysis will approximate an inquiry into the demand structure of pesticides by the vegetable producers. Demand may be defined as the various quantities of a good which consumers will take off the market at all possible prices, other things equal. In this study some of the ceteris paribus assumptions will be relaxed in order to examine several factors in an effort to minimize the unexplained variation in the data.

The demand equation has become systemized over time and reflects the response in amount taken to a change in price. However this will not be the approach taken here but an attempt will be made to derive a function which will express the producers willingness to

purchase pesticides subject to factors other than price. Since demand is the producer's expression of willingness to purchase a quantity at a given price. In this case, utilization will be the measuring unit, in terms of dollar expenditures, and the derived functions will be utilization predictor curves.¹

The program selected for analytical purposes was a stepwise regression model. This model is such that any variable which enters makes the greatest reduction in the error sum of squares. The Stepwise Regression Program computed a sequence of multiple linear regression equations in a stepwise manner, adding one variable to the regression equation at each step. The variable added was the one which made the greatest reduction in the error sum of squares. Also it was the variable which had the highest partial correlation with the dependent variable partialled on the variables which had already been added; and equivalently, was the variable which, if it were added, would have had the highest F value.² This analysis makes the assumption that the dependent variable is some linear function of the independent variable.

¹Edward M. McCoy, "Analysis of the Utilization of Outdoor Recreation in Tennessee" (unpublished Ph. D. dissertation, The University of Tennessee, Knoxville, Tennessee, 1966), p. 24.

²The University of Tennessee Computing Center, "BMD02R Stepwise Regression," The University of Tennessee, Knoxville, Tennessee, September 1, 1965, p. 1.

The objectives of the regression analysis in this study were, first to show the relationship between the values of the dependent variable (Y_i) and unit changes in various selected independent variables (X_i), and to obtain a measure of this relationship; and second, to provide a basis for making predictions of Y_i from X_i .

The statistical criteria used to determine goodness of fit of the regression equation were the R^2 and t_{bi} values. The t_{bi} is the symbol for the Student t-test of the estimated coefficients. The test of significance of b_i was given by $t_{bi} = b_i/S_{bi}$, where S_{bi} = standard error of the regression coefficient. The purpose of this test is to determine whether the b_i values are significantly different from zero at a given probability level. The b_i values being the regression coefficients that measure the effect of Y_i per unit change in X_i . A b_i value which is significant at the 10 percent level justifies a 90 percent confidence that the b_i value is significantly different from zero. If the β of the population actually is zero, then for repeated samples the b_i value, which is an estimate of β , would not be significantly different from zero 90 times out of 100.

R^2 is the symbol for the coefficient of determination which indicates the proportion of the squared variability in Y_i explained by the factors X_i . The coefficient of non-determination ($1-R^2$) is the proportion of squared variability not explained. R is the multiple correlation coefficient and indicates the degree of association

between Y_i and factors X_i .³ The goodness of fit or how well the equation fits the data is indicated by the size of the R^2 . Once the significance of the b_i values is determined, the statistical test is based primarily on the size of the R^2 . As R^2 approaches 1 the fit is improved and if $R^2 = 1$, then the fitted equation would pass through every observed point and would characterize the data perfectly.

II. VARIABLES INCLUDED IN THE ANALYSIS

In attempting to identify the most influential factors affecting utilization of pesticides by the vegetable producers, 22 variables were included in the regression analysis. As indicated earlier the purpose of the regression analysis was to determine the relationship of various factors (X_i) to utilization of pesticides (Y_i), measured by actual pesticide expenditures in 1965 and was of the following nature:

$Y = f(X_1, X_2, X_3, \dots, X_{22})$, where

Y = the index of utilization of pesticides

X_1 = the area of the state

X_2 = total acres of operation

X_3 = acres of cropland

X_4 = acres of vegetables

³Frank A. Pearson and Kenneth R. Bennett, Statistical Methods Applied to Agricultural Economics (New York: John Wiley and Sons, Inc., 1942), p. 176.

- X₅ = percent vegetables contribute to total farm income
- X₆ = hours of hired labor
- X₇ = type of pesticide application equipment owned
- X₈ = application of pesticides by producer or commercial applicator
- X₉ = distance to source of pesticides
- X₁₀ = years farming experience
- X₁₁ = age of producer
- X₁₂ = years of education
- X₁₃ = gross farm income
- X₁₄ = Guttman deliberateness score
- X₁₅ = Guttman knowledgeability score
- X₁₆ = most important enterprise from income standpoint
- X₁₇ = method of application of pesticides
- X₁₈ = degree of use of chemical company representatives
- X₁₉ = availability of assistance from pesticide dealers
- X₂₀ = type of tenure
- X₂₁ = source of pesticides
- X₂₂ = source of information concerning pesticides.

The index of utilization of pesticides is based on the actual expenditures for pesticides in 1965 as reported by the 239 vegetable producers. Thus this index includes not only expenditures for pesticides for use on vegetables but also pesticide expenditures for all other purposes in their total farming operation.

The area of the state relates to the location within the state as to western, central or eastern. This was considered as a rank variable and the values of 1, 2, or 3 were assigned respectively.

The total acres of operation were based upon the total size of the farm unit of the producers. Acres of cropland were based upon the actual cropland acreage within the overall operation and acres of vegetables was the vegetable acreage grown in 1965.

The percent that vegetables contributed to total farm income was based upon the proportion of total farm income that vegetables contributed in 1965. Hours of hired labor were based upon the total number of hours of labor hired by the producers in 1965.

Type of pesticide application equipment owned by the producer in 1965 was another rank variable with a value of from 1 to 5 assigned to the type.

Application of pesticides by producer or commercial applicator was another rank variable with a value of 1 or 2 assigned to the two possibilities.

Distance to source of pesticides was measured by the number of miles from the producer's farm to the major source of purchase of pesticides.

Years of farming experience, age of producer, and years of education were based upon each producers individual situation as of 1965.

Gross farm income was the total amount of farm income that the producer received in 1965.

The Guttman deliberateness score and Guttman knowledgeability score were the Guttman Quasi-Scale Score that each producer received on these particular analyses as discussed in Chapters V and VI.

The last seven variables included in the regression analysis, most important enterprise from contribution to farm income standpoint, method of application of pesticides, degree of use of chemical company representatives, availability of assistance from pesticide dealers, type of tenure, source of pesticide purchases, and source of information concerning pesticides, were all rank variables. Thus they were assigned values accordingly.

III. AGGREGATE UTILIZATION

The first regression analysis was for all the 239 vegetable producers in the sample. The following equation shows the obtained relationship:⁴

$$\hat{Y} = -130.83 + 4.41 X_4 + .07 X_6 - 6.24 X_9 + 20.49 X_{12} + 347.67 X_{18}$$

$$\text{Standard Error} = \quad (.338) \quad (.013) \quad (2.549) \quad (10.738) \quad (68.956)$$

$\hat{Y}$ = estimate of utilization of pesticides

X_4 = acres of vegetables

X_6 = hours of hired labor

X_9 = distance to source of pesticides

X_{12} = years of education

X_{18} = degree of use of chemical company representatives.

⁴Significant at the 90 percent level.

The variables in the equation are arranged in numerical order and not in the order in which they were added to the equation. All the coefficients were positive except the one for X_9 which was negative. The negative coefficient indicates that for each mile the producer has to travel to the source of pesticides, the amount of pesticide expenditure will decrease by \$6.24.

Multiple R for the above equation was .819. R^2 was .671 which means that the above five factors accounted for about 67 percent of the variation in Y. When all 22 variables were forced into the equation the R^2 only increased to .680 which means that the additional 17 variables only increased R^2 by .009.

IV. UTILIZATION BY AREAS

In an effort to determine if the factors influencing utilization of pesticides were different from one sector of the state to another, regression analyses were run for each of the three areas.

West Tennessee

With the exception of variable X_1 , which is the area of the state, the variables included in the programs were the same as for the aggregate utilization analysis. The following equation shows the significant variables:⁵

⁵Significant at the 90 percent level.

$$\hat{Y} = 1031.60 + 5.34 X_4 + .05 X_6 + 378.74 X_{18} - 111.40 X_{21}$$

Standard Error = (.473) (.023) (103.82) (43.84)

Multiple R for the equation was .863. R^2 was .744 and when the remaining 17 variables were forced into the equation R^2 only increased by .017.

$\hat{Y}$ = estimate of utilization of pesticides in West Tennessee

X_4 = acres of vegetables

X_6 = hours of hired labor

X_{18} = degree of use of chemical company representatives

X_{21} = source of purchase of pesticides.

When the predictive pesticide utilization equation for West Tennessee was compared with the predictive aggregate utilization equation, it can be seen that while distance to the source of pesticides and the years of education of the producers have an influence in the aggregate equation, they do not enter into the equation for West Tennessee. However, the source of purchase of pesticides does make an influence in this equation for West Tennessee.

Middle Tennessee

The same 21 variables were used for the regression in Middle Tennessee as were used in West Tennessee. The significant variables are shown in the following equation:⁶

⁶Significant at the 90 percent level.

$$\hat{Y} = -539.34 + .617 X_2 + .113 X_6 + 238.46 X_{18} + 469.16 X_{19}$$

Standard Error = (.207) (.012) (67.79) (124.33)

$\hat{Y}$ = estimate of utilization of pesticides in Middle Tennessee

X_2 = total acres of operation

X_6 = hours of hired labor

X_{18} = degree of use of chemical company representatives

X_{19} = availability of assistance from pesticide dealers.

Multiple R for the equation was .858. R^2 was .736 and when the remaining 17 variables were forced into the equation, R^2 increased by .057.

When compared with the predictive aggregate utilization equation, the predictive utilization equation for Middle Tennessee does not include acres of vegetables, distance to source of pesticides, or years of education. The only common elements are hours of hired labor and degree of use of chemical company representatives. Also included in the Middle Tennessee equation but not in the aggregate equation were total acres of the operation and assistance received from the pesticide dealer.

East Tennessee

As for the other two areas, the same variables were included in the regression analysis for East Tennessee. The ones that were significant are shown by the following equation:⁷

⁷Significant at the 90 percent level.

$$\hat{Y} = -445.53 + .622 X_2 + 2.75 X_3 + 3.65 X_4 + .052 X_6 - 3.64 X_9 \\ + 12.62 X_{12} - 450.31 X_{18} + 37.99 X_{21}$$

$$\text{Standard Error} = \begin{matrix} (.163) & (.473) & (.979) & (.016) & (2.083) \\ (7.573) & (112.18) & (17.781) & & \end{matrix}$$

$\hat{Y}$ = estimate of utilization of pesticides in East Tennessee

X_2 = total acres of operation

X_3 = acres of cropland

X_4 = acres of vegetables

X_6 = hours of hired labor

X_9 = distance to source of pesticides

X_{12} = years of education

X_{18} = degree of use of chemical company representatives

X_{21} = source of purchase of pesticides.

Multiple R for the equation was .899. R^2 was .809 and when the remaining variables were forced into the equation the R^2 increased to .839.

When the predictive utilization equation for East Tennessee was compared with the predictive aggregate utilization equation, it can be seen that all of the variables in the aggregate equation are included in the equation for East Tennessee. In addition there were three variables in the equation for East Tennessee which were not in the aggregate equation. These were total acres of the operation, acres of cropland and source of purchase of pesticides.

V. COMPARISON BETWEEN AREAS

Although the overall objective of the regression analysis was to find those factors which are the aggregate pesticide utilization determinants, it should be recognized that these factors will vary within areas of the state. This variation may arise not only from geographic and climatic conditions but sociological as well.

There were two factors which were common to all three areas, these being hours of hired labor and degree of use of chemical company representatives. All three areas showed the effect of the acreage in production. Acres in vegetables were determinants of utilization of pesticides in both West Tennessee and East Tennessee. Total acres in operation was a significant factor in Middle Tennessee and East Tennessee. Also in East Tennessee, the acreage as a determinant was reflected as acres of cropland was a significant variable.

Source of purchase of pesticides was a significant determinant of utilization in West Tennessee and East Tennessee. It should be noted, however, that the b coefficient for this factor was negative in West Tennessee while it was positive in East Tennessee.

There were two factors in East Tennessee which were significant but did not appear in the other two areas. These were distance to source of pesticides and years of education.

Since in many cases the partial correlation between variables influence the regression, the correlation matrix for the variables included in the regression analysis is depicted in Appendix F.

VI. EFFECT OF RANK VARIABLES

Due to the problem of placing a value on the coefficients of rank variables and the effect that these variables may have in the regression analysis, a regression was run excluding rank variables from the 21 formerly used. There were 10 rank variables, thus 11 variables were included in this analysis. These were as follows:

- X₁ = total acres of operation
- X₂ = acres of cropland
- X₃ = acres of vegetables
- X₄ = percent that vegetables contribute to total farm income
- X₅ = hours of hired labor
- X₆ = distance to source of pesticides
- X₇ = years of farming experience of producer
- X₈ = age of producer
- X₉ = education of producer
- X₁₀ = gross farm income
- X₁₁ = Guttman deliberateness score
- X₁₂ = Guttman knowledgeability score.

The same type of iterative procedure was used and provided the following predictive aggregate pesticide utilization equation:

$$\hat{Y} = -196.96 + 4.66 X_3 + .086 X_5 - 5.28 X_6 + 29.92 X_9$$

$$\text{Standard Error} = \quad (.351) \quad (.013) \quad (2.67) \quad (11.11)$$

In the first analysis that was made including the rank variables, only one was a significant determinant of utilization of pesticides. This analysis without the rank variables did not change the remaining significant determinants. The R^2 was .635 which was less than the .671 for the original regression. The difference of .036 was accounted for by the rank variable. The b values for the variables in the regression without the rank variables were higher than when they were included but the effect of each was the same.

Therefore in this case it can be concluded that the influence of the rank variables in the analysis does not make any noted difference on the effect of the other variables.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

During the past two decades agricultural production has involved the intensive use of pesticides to help control insects, diseases and other pests in an attempt to more economically produce agricultural commodities. Vegetable production is a segment which annually requires use of a large amount of pesticides to combat the many problems with which producers of the commodity are confronted. In addition this is a commodity which is produced for human consumption, much of which is consumed in the raw form.

The purposes of this study were to analyze the magnitude of the pesticide market in Tennessee; to determine vegetable producers behavior and decisions in purchasing pesticides; to determine the degree of deliberation of the vegetable producers with regard to pesticide purchasing decisions; to achieve a measurement of the general level of knowledge of vegetable producers about pesticides; and to isolate those factors which have the greatest amount of relationship with the measurement of utilization of pesticides. Producers of thirteen vegetable crops which were deemed to be of commercial importance in the state were included in the study. The state was divided into three geographic divisions for purposes of sampling the producers due to differing geographic and climatic conditions. Sample counties from each area were selected on the basis of that county with

the largest acreage of production of each of the thirteen crops in 1964. All thirteen vegetables were not included in each geographic area as each was not produced in sizeable quantities throughout the state. Producers were interviewed from a total of seventeen counties in the state. The number of counties was limited not only because of limited production of some of the vegetables in all areas of the state but also because several counties had the largest acreage of more than one vegetable. A total of 239 vegetable producers was interviewed from the seventeen counties and furnished the data used for analyses in the bulk of this study.

The data for the section pertaining to the pesticide market in Tennessee were obtained from a questionnaire sent to the 585 firms that were registered with the State Department of Agriculture in 1965 and eligible to sell pesticide products in the state. Fifty-four percent of the firms responded to the questionnaire. Of those answering the questionnaires, exactly one-half indicated some degree of pesticide sales in Tennessee in 1965. It was on the basis of data supplied by these firms that the analyses in Chapter II were made.

Based on sample data, one-half of the 585 firms which were qualified to sell pesticides in the state did actually make pesticide sales in Tennessee in 1965. Confidence intervals corresponding to the total amount and value of sales in Tennessee were computed on this basis. The confidence interval for the total volume of pesticides sold in Tennessee in 1965 at the 90 percent level was between

12,213,444 and 22,456,582 pounds. This represents a value at the manufacturer's level of between 11,607,401 and 21,730,579 dollars. Therefore it can be concluded that the pesticide industry in the State of Tennessee is big business. With annual sales in the neighborhood of 17 million dollars, which is the value at the manufacturer's level, this is about 4.6 percent of the total sales in the United States in 1965. Since Tennessee has about 1.4 percent of the total farm acreage in the United States, Tennessee agricultural producers are availing themselves of the benefits to be received from the use of pesticides.

The facet of the type of retail outlet through which pesticides were distributed was briefly examined. Almost 33 percent of all pesticides was distributed through non-agricultural type of retail outlets. The single agricultural type outlet accounting for the largest amount of distribution (29.6 percent) was the general farm supply store.

The responding firms indicated that about 58 percent of their pesticide sales were for commercial agricultural purposes. This implies that of the approximately 70 percent which were marketed through agricultural type outlets, a large share of these pesticides are used for purposes other than commercial agriculture.

A descriptive analysis was made of some of those characteristics which might have influence upon the use of pesticides by the vegetable producers in the study. The average size of farm unit for the 239 producers in the study was 263 acres as compared with an

average size of 114 acres¹ for all producers in the state. The average size of farms classified as commercial vegetable farms in the state was 125 acres.² The average acres of cropland was 155 acres for the producers in the study while all producers in the state had an average cropland acreage of about 61 acres.

The producers in the study had an average production of 52 acres of vegetables in 1965. As indicated in the text, the range of size of operation for the producers, as a whole and for each area, is probably more revealing than the averages.

The average age of the producers in the study was 50 years and had an average of 25 years of farming experience. Another factor which was later to add some insight into the use of pesticides by the producers was the years of education of the producers, which for the 239 producers in the study was nine years.

According to the census definition, a vegetable farm in one where the sales of vegetables in value constitute 50 percent or more of the total value of all farm products sold. There were 501 commercial vegetable farms in the state in 1964. About 60 or roughly 25 percent of the producers in the study indicated that vegetable sales comprised 50 percent or more of the total value of all farm products sold. Therefore, about 12 percent of the true vegetable farms in the state were included in this study. Also 38 percent of

¹Based on data in 1964 Tennessee Census of Agriculture.

²Based on data in 1964 Tennessee Census of Agriculture.

the producers in the study indicated that the production of vegetables made the largest contribution to total farm income of all enterprises in their operation.

Tenure pattern for the producers in the study did not differ greatly from the pattern of all producers in the state. Eighteen percent were tenants, 38 percent were part-owners and 44 percent were owners, for the producers in the study while the census shows a breakdown for all producers as being 16 percent tenants, 19 percent part-owner and 65 percent owners.

Thirty-nine of the producers in the study did not hire any labor in 1965 while the 200 producers that did, hired an average of 2293 man hours. This is approximately equivalent to one-man year of hired labor.

Thus it can be concluded from the foregoing observations that the producers in this study were on the average larger operators than the average of all producers in the state.

Another section of the study was devoted to exploring the producers purchase pattern and determining where pesticide purchases were made and why from that particular source. Also investigated were the producers' sources of information relating to the use of pesticides.

Sixty-four percent of the producers in the study indicated that they relied upon personal observation of the presence of pests or damage for determining that the use of a pesticide was required.

After the need was determined 38 percent of the producers indicated that they depended upon past experience to dictate which particular pesticide to use. Although 20 percent of the producers said the rate of application of the pesticides was determined by past experience based upon the amount which previously had been effective, 40 percent indicated that they used the instructions on the label as the basis for determining the rate of application.

It would appear that convenience and tradition were two major considerations in determining where the producers purchased their pesticides. About 74 percent of the producers made their purchases within ten miles of their farm. The majority of the producers--51 percent--indicated that the Tennessee Farm Cooperative was their major source of pesticide purchases.

Also 65 percent of the producers said that they usually used only one source of purchases. Thirty-two percent of those using only one source said that this was due to convenience. Of the thirty-five percent of the producers who purchased pesticides from more than one source, about 50 percent of them said they bought where it was the most convenient at the time they needed pesticides.

The producers in the study spent an average of about \$471 for pesticides in 1965. This compared with an average of about \$300 for the producers in the study conducted by the Economic Research Service in 1964. The degree of price-consciousness among the producers was very low as approximately 85 percent of the producers indicated that

they had not checked prices at other sources within the two preceding months. Although eighteen of the producers indicated that the availability of credit was the reason for purchasing from only one source, 40 of the producers said that they would look for another source of pesticides if their dealer no longer made credit available to them.

The producers in the study seemed to be more loyal to the dealers than to a particular brand of pesticide. Only 8 percent indicated that if the dealer changed brands, they would change dealers in order to obtain the previous brand. However the dealers were not pushing pesticide sales to a large extent as the producers indicated only about one-fourth of the dealers made an on-the-farm visit to sell them pesticides. Although many chemical companies have field representatives who assist producers with their pesticide problems, very little assistance of this nature was used by the producers in this study as indicated by only 17 percent of the producers indicating that they had used this service.

Even though 83 percent of the producers indicated that they followed the instructions on the label as closely as they possibly could, the revealing fact was that 10 percent of the producers said they paid absolutely no attention to the label. This may be a matter of concern, considering the nature of the product.

Although neighbors and friends were indicated by the largest proportion of producers as being the source of information dealing with new developments which was used most frequently, county agricultural agents were listed by 31 percent of the producers as the

one most important source.

The section of the study dealing with the pattern of behavior of the deliberateness of the buyer with respect to their pesticide purchasing decision revealed that only 7 percent of the producers could be classified as highly deliberate. This classification meant that the respondent is one who used technical material, price and quality information to a maximum and actively seeks information and new knowledge. This is not to say that the remaining 93 percent were not deliberate to some degree. About 51 percent of the producers were classified as moderately deliberate with regard to their deliberateness concerning their pesticide purchasing decision and the remaining 42 percent were classed as being non-deliberate. The process used to rank the individuals according to their degree of deliberateness was the Guttman Scale Analysis Program.

Correlation analyses were made to measure the interrelationship of various factors thought to have an influence on deliberateness of pesticide purchasing decision. Seven factors correlated with deliberateness at the 5 per cent level: acres of cropland, acres of vegetables, hours of hired labor, pesticide expenditure, education of producers, gross income and knowledgeability of pesticides score.

Another phase of the study dealt with the producers general level of knowledge concerning pesticides. With the increasing use of pesticides by vegetable producers on an edible product, this was deemed to be worthy of consideration. Answers to questions dealing

with pesticides were obtained from the producers through personal interviews. The Guttman Scale Analysis Program was used in ranking the producers according to their level of knowledge about pesticides. The data revealed that about 22 percent of the producers could be classified as highly knowledgeable with regard to this area. However only 38 percent of the producers were classified as non-knowledgeable. One section of the questionnaire dealing with pesticides knowledgeability was based upon the ability of the producers to indicate their understanding of the meaning of various terms commonly found upon the labels of various pesticide products. This section was entered to see if vegetable producers had an understanding of these terms. Nine such terms were inserted and the degree of knowledgeability of the producers ranged from 21 percent non-knowledgeable to 57 percent non-knowledgeable for each of the nine terms.

Correlation analyses were made to measure the interrelationship of various factors thought to have an influence on pesticide knowledgeability. Eight factors correlated positively with pesticide knowledgeability at the 5 percent level: total acres, acres of cropland, acres of vegetables, hours of hired labor, pesticide expenditures, education of producers, gross farm income and deliberateness score. One factor (age of producer) was negatively correlated at the 5 percent level.

One of the main purposes of the study was to determine those factors that influence the utilization of pesticides by vegetable producers. The main concern was to derive a function that expressed the

producers willingness to purchase pesticides, subject to factors other than price. The derived functions were referred to as pesticide utilization predictor curves. The program used to derive the function was the stepwise regression model.

The regression analysis which was made for all 239 vegetable producers revealed five factors which significantly influenced the use of pesticides by the producers at the 90 percent level.

In the iterative process used, the first variable to enter the equation was acres of vegetables. This single variable accounted for an R^2 of .534.

The next variable to enter the equation was hours of hired labor which made an increase in R^2 of .084. The third variable to enter was degree of use of chemical company representatives. This variable made an additional increase in R^2 of .039. The next variable to enter was distance to source of pesticides. Although the increase to R^2 was only .005, the important consideration was the effect of the coefficient which was negative. The last significant variable to enter the equation was years of education which increased R^2 by .005. The R^2 as a result of these five factors was .671.

In West Tennessee there were four factors significant at the 90 percent level. The first to enter into the equation was acres of vegetables which accounted for an R^2 of .640. The next variable to enter made an increase in R^2 of .068 and was degree of use of chemical company representatives. The third variable which was source of

purchase of pesticides had a negative coefficient and contributed .022 to R^2 . The last variable which was significant was hours of hired labor and made a contribution of .014 to R^2 . All four variables accounted for an R^2 of .744.

There were also four significant determinants of utilization in Middle Tennessee. The first to enter was hours of hired labor. This factor accounted for an R^2 of .445. The second variable to enter the equation was assistance from pesticide dealers and made an addition to R^2 of .204. The degree of use of chemical company representatives was the third variable to enter and made a contribution of .055 to R^2 while total acres made a contribution of .033 and was the last variable to enter the equation. All four significant variables in Middle Tennessee accounted for an R^2 of .736.

Eight variables were significant in East Tennessee at the 90 percent level. The first to enter was acres of vegetables which accounted for an R^2 of .494. The second factor to enter the equation was acres of cropland and increased R^2 by .105. The next variable to enter was total acres of operation and made a contribution of .018 to R^2 . The degree of use of chemical company representatives was the fourth variable to enter and increased R^2 by .043. The effect of the coefficient for this variable was negative. Hours of hired labor was the fifth variable to enter the equation and contributed .031 to R^2 . The next variable to enter was the source of purchase of pesticides and increased R^2 by .033. Distance to source of pesticides was next

to enter and increased R^2 by .015. It also had a negative coefficient. The last variable was years of education and contributed .011 to R^2 . The total R^2 for all eight variables was .809.

Although this study was broad in nature and facet of scope in area of contents, it is hopeful that it can be used as a benchmark for future studies in determining factors that affect the use of inputs by agricultural producers.

It is felt that the section on the Tennessee pesticide market is something that has been needed for some time. However, this should be constantly updated as conditions change. Also future research in this area should probably enter into more detail concerning the distribution sector of the pesticide market.

It would appear that the producers need to be made more aware of the alternative sources of pesticides available to them and an awareness created as to additional considerations than just price when making their pesticide purchasing decisions.

One area that is pointed up as needing more educational endeavors in the future is that concerning their level of knowledge about pesticides. With the increased usage of pesticides, it becomes important that vegetable producers have an understanding of them.

The section on the factors affecting usage of pesticides by the vegetable producers offers some insight into the influence afforded by these factors. Although the factors included in the analysis explained some 67 percent of the variation in utilization

of pesticides by the producers, there still remains some 33 percent which is not explained. Future studies should attempt to include more variables which have an influence on pesticide utilization in an effort to increase the amount of variation explained. However to the extent that the sampled vegetable producers are representative of all Tennessee vegetable producers, these derived pesticide utilization predictor equations have isolated some of the significant determinants of utilization and their direction of effect.

SELECTED BIBLIOGRAPHY

CRANES & CREST

SELECTED BIBLIOGRAPHY

A. BOOKS

- Carson, Rachel. Silent Spring. Boston: Houghton Mifflin Company, 1962.
- Christensen, Raymond P. "Man's Historic Struggle for Food," Protecting Our Food: The Yearbook of Agriculture 1966. Washington: Government Printing Office, 1966.
- Edwards, Allen L. Techniques of Attitude Scale Construction. New York: Appleton-Century-Crofts, Inc., 1950.
- Frear, Donald E. Pesticide Handbook. State College, Pennsylvania: College Science Publishers, 1964.
- Leftwich, Richard H. The Price System and Resource Allocation. New York: Rinehart and Company, Inc., 1956.
- McNemar, Quinn. Psychological Statistics. New York: John Wiley and Sons, Inc., 1960.
- Pearson, Frank A., and Kenneth R. Bennet. Statistical Methods Applied to Agricultural Economics. New York: John Wiley and Sons, Inc., 1942.
- Remmers, Hermann H. Introduction to Opinion and Attitude Measurement. New York: Harper and Brothers, 1954.
- Riley, Matilda White. Sociological Research. I. A Case Approach. New York: Harcourt, Brace and Wald, Inc., 1963.
- Riley, Matilda White et al. Sociological Studies in Scale Analysis. New Brunswick: Rutgers University Press, 1957.
- Snedecor, George W. Statistical Methods Applied to Experiments in Agriculture and Biology. Ames, Iowa: The Iowa State University Press, 1956.
- Spiegel, Murray R. Schaum's Outline of Theory and Problems of Statistics. New York: Schaum Publishing Company, 1961.
- Stouffer, Samuel A. et al. "Studies in Social Psychology in World War II," Volume IV. Measurement and Prediction. Princeton: Princeton University Press, 1950.

Stuart, Alan. Basic Ideas of Scientific Sampling. London: Charles Griffin and Company, Limited, 1962.

The Holy Bible. Book of Joel: Chapter 1, Verse 4.

Ward, Justus C. "A Dynamic Statute for Pesticides," Protecting Our Food: The Yearbook of Agriculture 1966. Washington: Government Printing Office, 1966.

B. AGRICULTURAL EXPERIMENT STATION PUBLICATIONS

Berry, James E., Eldon D. Smith, and Robert W. Rudd. Selected Factors Affecting the Price of Fertilizer in Kentucky Retail Markets. Bulletin 698. Lexington: Kentucky Agricultural Experiment Station, 1965.

Chapman, Fred W., Thurston Brooks, and Kenneth Ford. Vegetable Production Density--Tennessee. Mimeo Series N. S. 214. Experiment: Georgia Agricultural Experiment Station, 1964.

Cleland, Charles L. Scaling Social Data. Southern Cooperative Series Bulletin No. 108. Knoxville: Tennessee Agricultural Experiment Station, 1965.

Kohls, R. L. Farmers Behavior and Decisions in Purchasing Farm Supplies. Research Bulletin 749. Lafayette: Purdue Agricultural Experiment Station, 1962.

Morrison, Denton E., and G. Albert Kristjanson. Personal Adjustment Among Older Persons. Technical Bulletin 21. Brookings: South Dakota Experiment Station, 1958.

Stone, Carol Lawrence. A Machine Method for Scaling as Many as Twelve Dichotomies. Stations Circular 329. Pullman: Washington Agricultural Experiment Station, 1958.

Whitehorn, N. C., and H. B. Sorenson. Practices and Problems of Pesticide Marketing in Texas. M. P. 824. College Station: Texas Agricultural Experiment Station, 1966.

C. JOURNAL ARTICLES AND PAPERS

Fox, Austin S., and Paul Andrienas. "Economic Research of Pesticide Use in Agriculture" (paper presented at the 6th meeting of the Weed Society of America, St. Louis, February 8, 1966).

Ordish, G., and Helen Toft. "Loss of Economic Yield in Crops" (paper presented at the International Entomological Congress, London, 1964).

Shaw, W. C. "A Survey and Economic Study of Pesticides" (paper presented at the Regional Pesticide School, Athens, Georgia, February 1-4, 1965).

Shaw, W. C. "Program of Research Regulation and Education on Pests and Their Control" (paper presented at the North-Central States Extension Workshop on Pesticides, Des Moines, Iowa, April 14, 1965).

D. GOVERNMENT PUBLICATIONS

Andrilenas, Paul, Theodore Eichers, and Austin Fox. Farmers Expenditures for Pesticides in 1964. Agricultural Economic Report No. 106. Economic Research Service. United States Department of Agriculture. Washington: Government Printing Office, 1967.

Dunham, R. S. Herbicide Manual for Non-Cropland Weeds. Agriculture Handbook No. 269. Agricultural Research Service. United States Department of Agriculture. Washington: Government Printing Office, 1965.

Eichers, Theodore R. Potential for Cooperative Distribution and Formulation of Pesticides in the South. Special Case Study 160. Farmer Cooperative Service. United States Department of Agriculture. Washington: Government Printing Office, 1962.

National Academy of Sciences. Report of the Pesticides Residue Committee. National Research Council. Washington: Government Printing Office, 1965.

Tennessee Department of Agriculture. Insecticide, Fungicide and Rodenticide Law. Division of Food and Drugs. Nashville: Ellington Agricultural Center, 1962.

Tennessee Department of Agriculture. List of Registrants and Brands of Pesticides Registered. Division of Food and Drugs. Nashville: Ellington Agricultural Center, 1965.

United States Congress. Agricultural Appropriations for 1965. Senate Committee on Appropriations. 88th Congress, 2nd Session, H. R. 11202. Washington: Government Printing Office, 1964.

United States Department of Agriculture. Losses in Agriculture. Agriculture Handbook No. 291. Agricultural Research Service. Washington: Government Printing Office, 1965.

United States Department of Agriculture. Pest Control by Chemical, Biological, Genetic, and Physical Means--A Symposium. ARS 33-110. Agricultural Research Service. Washington: Government Printing Office, 1966.

United States Department of Agriculture. Pesticides Documentation Bulletin. National Agricultural Library. Washington: Government Printing Office, 1965-67.

United States Department of Agriculture. Suggested Guide for the Use of Insecticides to Control Insects Affecting Crops, Livestock, and Households. Agriculture Handbook No. 290. Agriculture Research Service. Washington: Government Printing Office, 1965.

United States Department of Agriculture. The Pesticide Review 1966. Agricultural Stabilization and Conservation Service. Washington: Government Printing Office, 1966.

United States Department of Agriculture. The Pesticide Situation for 1964-1965. Agricultural Stabilization and Conservation Service. Washington: Government Printing Office, 1965.

United States Department of Commerce. United States Census of Agriculture, 1964, Tennessee. Volume I, Part 31. Bureau of the Census. Washington: Government Printing Office, 1966.

E. PERIODICALS

Baskin, Charles B., and Daniel B. Smith. "Pesticide Tolerance," Alabama Agribusiness, IV, xxiii (1966), p. 4.

Beal, George M., Joe M. Bahlen, and Daryl J. Hobbs. "Farmer Purchasing Patterns for Pesticides," Farm Chemicals, CXXIII, x (October, 1960), pp. 32-36.

Fischer, Lewis A. "Pest Control--An Economic Approach," Economic Planning, I, ii (1965), p. 1.

Johnson, Oscar, Norman Krog, and Lloyd Poland. "Pesticides-Insecticides, Miticides, Nematocides, Rodenticides," Chemical Week, XC, xxi (May 25, 1963), pp. 117-126.

Krog, Norman, Oscar Johnson, and Lloyd Poland. "Pesticides-Fungicides and Herbicides," Chemical Week, XCII, xxii (June 1, 1963), pp. 55-62.

Mapes, Glynn. "Safer Pesticides: Producers Work to Cut Chemical Contamination of Crops, Soil, Water," The Wall Street Journal, CLXVI, xxvi (August 6, 1965), p. 7.

Smith, Eldon D. "The Deliberateness of Economic Choices," Southern Economic Journal, XXIX, i (July, 1962), pp. 39-43.

Sundquist, W. B. "Economic Research on Pesticide Use," Minnesota Farm Business Notes, CDLXXII (May, 1965), p. 1.

E. UNPUBLISHED MATERIALS

Berry, James E. "Purchase Patterns of Fertilizer." Unpublished Master's thesis, University of Kentucky, Lexington, 1964.

G. OTHER SOURCES

Mullett, R. P. Pesticide Residue Restrictions for Vegetable and Field Crops. E. C. 549. Knoxville: Agricultural Extension Service, 1966.

The Economics of Poisoning. No. 23. Washington: Resources for the Future, Inc., September, 1966.

The University of Tennessee Computing Center. "BMD02R Stepwise Regression." Knoxville: The University of Tennessee, September 1, 1965.

CRANES  CREST

APPENDICES

CRANES  CREST

APPENDIX A

TABLE XLVII

LISTING OF VEGETABLES AND COUNTIES INCLUDED IN THE STUDY,
WEST TENNESSEE, 1965

County	Blackeye Peas	Cabbage	Greens	Lima Beans	Okra	Straw- berries	Sweet Peppers	Sweet Potatoes	Tomatoes
Dyer			X	X					
Crockett						X			
Gibson		X					X	X	X
Haywood					X				
Fayette	X								

TABLE XLVIII
 LISTING OF VEGETABLES AND COUNTIES INCLUDED IN THE STUDY,
 MIDDLE TENNESSEE, 1965

County	Cabbage	Irish Potatoes	Melons	Snap Beans	Straw- berries	Sweet Corn	Sweet Peppers	Sweet Potatoes
Sumner					X			
Davidson						X		
Lincoln			X					X
Grundy	X							
Fentress				X				
Cumberland		X					X	

TABLE XLIX

LISTING OF VEGETABLES AND COUNTIES INCLUDED IN THE STUDY,
EAST TENNESSEE, 1965

County	Cabbage	Melons	Snap Beans	Straw-berries	Sweet Corn	Sweet Peppers	Tomatoes
Rhea							X
Knox					X		
Cocke	X						
Greene						X	
Washington		X					
Johnson			X	X			

TABLE L

NUMBER OF PRODUCERS IN FRAME, SPECIFIED NUMBER TO BE INTERVIEWED, AND NUMBER ACTUALLY INTERVIEWED, BY VEGETABLE AND COUNTY UNDER CRITERION ONE, WEST TENNESSEE

County	Blackeye Peas	Cabbage	Greens	Lima Beans	Okra	Straw- berries	Sweet Peppers	Sweet Potatoes	Tomatoes
Dyer			23-10-10	30-10-10					
Crockett						42-10-13			
Gibson		42-10-11					35-10-10	44-10-10	61-10-10
Haywood					50-10-17				
Fayette	149-15-25								

TABLE LI

NUMBER OF PRODUCERS IN FRAME, SPECIFIED NUMBER TO BE INTERVIEWED, AND NUMBER ACTUALLY INTERVIEWED, BY VEGETABLE AND COUNTY, UNDER CRITERION ONE, MIDDLE TENNESSEE

County	Cabbage	Irish Potatoes	Melons	Snap Beans	Straw-berries	Sweet Corn	Sweet Peppers	Sweet Potatoes
Sumner					57-10-13			
Davidson						3-3-3		
Lincoln			26-10-10					20-10-10
Grundy	3-3-3							
Fentress				12-10-10				
Cumberland		3-3-3					12-10-10	

TABLE LII

NUMBER OF PRODUCERS IN FRAME, SPECIFIED NUMBER TO BE INTERVIEWED, AND NUMBER ACTUALLY INTERVIEWED, BY VEGETABLE AND COUNTY, UNDER CRITERION ONE, EAST TENNESSEE

County	Cabbage	Melons	Snap Beans	Straw-berries	Sweet Corn	Sweet Peppers	Tomatoes
Rhea							45-10-10
Knox					1-1-1		
Cocke	14-10-10						
Greene						41-10-10	
Washington		11-10-8*					
Johnson			25-10-11	16-10-10			

*Only 8 producers grew melons in 1965.

TABLE LIII

COMPUTATION OF ACREAGE TO BE INCLUDED IN SAMPLE AND NUMBER OF ACRES ACTUALLY INCLUDED, BY VEGETABLE AND COUNTY, UNDER CRITERION 2, WEST TENNESSEE

County	Blackeye Peas	Cabbage	Greens	Lima Beans	Okra	Straw- berries	Sweet Pepper	Sweet Potatoes	Tomatoes
Dyer			1000	2039					
Crockett					486				
Gibson		394					105	993	417
Haywood					953				
Fayette	3392								
State Total	9492	1264	2219	3828	2476	3061	1910	3146	2649
Proportion of County Total to State Total	.36	.31	.45	.53	.38	.16	.05	.32	.16
Minimum Acres to be Included in Sample	1221	122	450	1081	362	78	5	318	67
Number of Acres Actually Included in Sample	827	124	2205	1245	41	131	19	366	79

TABLE LIV

COMPUTATION OF ACREAGE TO BE INCLUDED IN SAMPLE AND NUMBER OF ACRES ACTUALLY INCLUDED, BY VEGETABLE AND COUNTY, UNDER CRITERION 2, MIDDLE TENNESSEE

County	Cabbage	Irish Potatoes	Melons	Snap Beans	Straw-berries	Sweet Corn	Sweet Peppers	Sweet Potatoes
Sumner					129			
Davidson						100		
Lincoln			305					350
Grundy	27							
Fentress				4232				
Cumberland		381					64	
State Total	1264	2234	1701	10599	3061	1010	1910	3146
Proportion of County Total to State Total	.02	.17	.18	.40	.04	.10	.03	.11
Minimum Acres to be Included in Sample	1	65	55	1683	5	10	2	39
Number of Acres Actually Included in Sample	41	32	116	2355	60	240	20	114

TABLE LV

COMPUTATION OF ACREAGE TO BE INCLUDED IN SAMPLE AND NUMBER OF ACRES ACTUALLY INCLUDED, BY VEGETABLE AND COUNTY, UNDER CRITERION 2, EAST TENNESSEE

County	Cabbage	Melons	Snap Beans	Straw-berries	Sweet Corn	Sweet Peppers	Tomatoes
Cocke	304						
Greene						168	
Johnson			1430	97			
Knox					95		
Rhea							316
Washington		47					
State Total	1264	1701	10599	3061	1010	1910	2649
Proportion of County Total to State Total	.24	.03	.13	.03	.04	.09	.12
Minimum Acres to be Included in Sample	72	1	186	3	4	15	38
Number of Acres Actually Included in Sample	125	41	609	10	100	20	71

APPENDIX B

1. DID YOU HAVE PESTICIDE SALES IN TENNESSEE IN 1965? YES NO
(If no, please return the incomplete questionnaire.)
(If yes, please complete and return the questionnaire.)
2. WHAT PROPORTION OF YOUR TOTAL PESTICIDE SALES IS MANUFACTURED FOR
COMMERCIAL AGRICULTURAL PRODUCERS? _____
3. PLEASE INDICATE YOUR TOTAL ANNUAL SALES BY TYPE OF PESTICIDE SOLD
IN TENNESSEE IN 1965.

TYPE OF PESTICIDE	POUNDS	VALUE	PERCENT OF EACH TYPE MANUFACTURED FOR COMMERCIAL AGRICULTURE
INSECTICIDES			
HERBICIDES			
FUNGICIDES			
RODENTICIDES			
OTHER			
TOTAL			

4. PLEASE INDICATE THE APPROXIMATE PERCENTAGE OF EACH TYPE OF PESTICIDE THAT YOUR FIRM DISTRIBUTED THROUGH THE FOLLOWING SUPPLY OUTLETS IN TENNESSEE IN 1965.

	INSECTI- CIDES	HERBI- CIDES	FUNGI- CIDES	RODENTI- CIDES	OTHERS
General Farm Supply Stores					
Feed and Seed Stores					
Farmer Cooperatives					
Elevators					
Directly to Commercial Applicators					
Implement Dealers					
Country General Stores					
Landscape and Nursery Firms					
Directly to Farmers					
Others (drug stores, hardware) (grocery, etc.)					
Total					

APPENDIX C

BUYER DELIBERATIVENESS

1. In general how do you usually decide where to buy your pesticides?
Record verbatim: _____
2. Do you usually buy your pesticides from the same place you buy your feed, seed, and other supplies? Yes ___ No ___ Are there any particular reasons why you (buy, don't buy) it at the same place?
Verbatim: _____
3. Thinking about your most recent purchase of pesticides, did you buy it at the same place you usually buy it? Yes ___ No ___ Did you have any particular reason for (changing, not changing)?
Verbatim: _____
4. Did you buy the same brand that you have been buying? Yes ___ No ___ Did you have any particular reason for (changing, not changing)?
Verbatim: _____
5. Did you check around to see where you might get the best deal on your pesticides? Yes ___ No ___ Why did you (check, not check) around?
Verbatim: _____
6. Do you buy on the basis of the ingredients in the pesticide or just buy a brand like Killer Joe or Insect Haven that you have confidence in? Brand _____ Contents _____
Verbatim: _____
7. (If brand) Is there any reason why you buy just on the basis of a brand rather than the ingredient in it?
Verbatim: _____
8. Do you buy on the basis of the ingredients in the pesticides or just buy from a dealer whom you have confidence in? Contents _____ Dealer _____
Verbatim: _____
9. (If dealer) Is there any particular reason why you buy from this dealer?
Verbatim: _____

APPENDIX D

GUTTMAN SCALE ANALYSIS¹

What does the "score" represent when it is assigned to an individual on a deliberateness of purchasing decision or pesticide knowledge scale? It indicates the rank-order position of the particular individual with respect to the underlying variable which the scale was intended to measure--knowledge or deliberateness. That is to say, if A has a higher score than B, it indicates that A knows more about pesticides than B. However, in social and psychological measurement, the units do not necessarily have the same quantitative meaning throughout the entire scale. Even though A's score may be higher than B's, it cannot be said how much more A knows than B. If A has a higher score than B, and B has a higher score than C, they can be ranked A, B, C. But it cannot be said that A is as much more knowledgeable than B as B is more knowledgeable than C.

It is desirable to have a scale which is unidimensional or measures one factor and one factor only. Therefore it would be ambiguous to have a single total score designed to measure prejudice against some racial group and also to test knowledge of chemistry in the same test. Guttman proposes the following criterion of unidimensionality of a scale: If a single quantitative score is to represent

¹Herman H. Remmers, Introduction to Opinion and Attitude Measurement (New York: Harper and Brothers, 1954), pp. 96-118.

the behavior of an individual on a group of items, then it is required that it be possible by knowing the individual's score to know his behavior on each and every item in the group. This is referred to as the principle of reproducibility. If this criterion is completely satisfied then a given score on a scale stands for only one pattern of responses to the items of that scale.

A naive illustration may show how this criterion insures unidimensionality. Suppose we wanted to measure the heights of people but a standard unit of measurement was not available. We might use as a measuring instrument, ten sticks of different lengths. The procedure would be to place each stick alongside each individual to record whether he is taller or shorter than each stick. The information could be recorded as a plus if he is taller and a minus if he is shorter. Therefore, the data for each individual would consist of ten marks, either a plus or minus.

Next the procedure would be to determine how many individuals received a plus on each of the measuring sticks. Then the sticks would be arranged in order from the one on which the greatest number of people received a plus down to the one on which the smallest number of people received a plus. Thus, it would be found that any individual who received a minus on stick number one would have received minuses on all the remaining sticks and an individual who received a plus on stick number one and a minus on stick number two would have received minuses on all the remaining sticks, and so on. A person

who received a plus on stick number ten would have received pluses on all the other sticks. Therefore, each individual would fall into one of eleven patterns of response. These patterns would, when arranged in order from tallest to shortest, form a scale for measuring height. It would have been impossible for an individual to receive a minus on stick number one and a plus on stick number two, therefore this instrument would be unidimensional.

When the patterns of response are arranged in order from tallest to shortest a quantitative scale variable can be obtained by assigning rank order numbers to each successive different pattern of response running from that pattern characterizing the shortest individuals to that pattern characterizing the tallest. The shortest pattern could be assigned the number 0, the next to the shortest 1, and so on.

This hypothetical example of a perfect scale illustrates how Guttman's criterion of unidimensionality will be fulfilled if the underlying variable is unidimensional. Thus it is known, without ambiguity, that an individual with a scale score of six received pluses on sticks one through six and received minuses on sticks seven through ten.

It would be evident that the underlying variable was unidimensional if a consistently reproducible pattern such as the one in the measuring stick example emerged and unambiguous meaning could be attached to the individual's score. However, a unique and clear-cut reproducible pattern usually does not emerge in practice. Usually

there will be individuals with responses that do not fit the patterns. Such responses are called error of reproducibility. Therefore, by counting the out of place responses and deducting them from the total number of responses, the in place responses can be expressed as a proportion of the total number of responses. This measurement is referred to as the coefficient of reproducibility.

APPENDIX E

PESTICIDE KNOWLEDGE

1. There are three types of residues that a producer must recognize. These are a legal residue, an excessive residue, and an illegal residue.
 - (a) What is meant by a legal residue? _____
 - (b) What is meant by an excessive residue? _____
 - (c) What is meant by an illegal residue? _____
2. How do you make sure that the residues on your vegetables stay within the legal tolerances? _____
3. What agency checks foods and feeds to see that no excessive or illegal residues are present? _____
4. What is the established tolerance of the vegetable that you produce for the following pesticides?
 - A) DDT _____
 - B) Ethyl Parathion _____
 - C) Sevin _____
 - D) Dieldrin _____
 - E) Malathion _____
 - F) Manzate _____
5. Which of the following are members of the overall classification of pesticides?
 - A) Insecticides _____
 - B) Miticides _____
 - C) Rodenticides _____
 - D) Fungicides _____
 - E) Herbicides _____
 - F) Aquaticides _____
6. DDT is a member of which of the following chemical groups?
 - A) Hydrocarbons _____
 - B) Organic Phosphates _____
 - C) Carbamates _____

7. Malathion is a member of which of the following chemical groups?

- A) Hydrocarbons _____
- B) Organic Phosphates _____
- C) Carbamates _____

8. Suppose you had a serious infestation of the corn ear worm; which of the following would control this insect?

- A) DDT _____
- B) Sevin _____
- C) Malathion _____
- D) Lindane _____

9. Suppose you had a serious infestation of aphids; which of the following would control this insect?

- A) DDT _____
- B) Malathion _____
- C) Sevin _____
- D) Parathion _____

10. One suggestion that we often hear in relation to using pesticides is to follow the recommendations and instructions on the label. Below are a few terms that have been taken from the labels of various pesticides; please explain briefly what these terms mean to you.

- A) Wettable powder: _____
- B) Antidote: _____
- C) Toxic poisoning: _____
- D) Diluted: _____
- E) Fungicide: _____
- F) Larvae: _____
- G) Agitate: _____
- H) Herbicide: _____
- I) Inert ingredients: _____

APPENDIX F

TABLE LVI

CORRELATION MATRIX, 23 VARIABLES, ^a 239 VEGETABLE PRODUCERS, TENNESSEE, 1965
(VARIABLES 1-10)

Variables	1	2	3	4	5	6	7	8	9	10
1	1.000	-.2014	-.2876	-.1793	-.0986	-.1751	.2676	.3127	.1213	-.2367
2		1.000	.7710	.3504	-.0423	.3824	.1304	.0082	-.0103	.3667
3			1.000	.6675	.0827	.5130	.1380	-.0778	-.0391	.5854
4				1.000	.3948	.4510	.0892	-.1652	.1789	.7304
5					1.000	.2383	-.0270	-.0790	.2124	.2963
6						1.000	.1699	-.0110	.0679	.5882
7							1.000	.8006	.0074	.1002
8								1.000	-.0043	-.1151
9									1.000	.1151
10										1.000

^aFor identification of specific variables, refer to page 163.

TABLE LVII
CORRELATION MATRIX, 23 VARIABLES, ^a 239 VEGETABLE PRODUCERS, TENNESSEE, 1965
(VARIABLES 11-20)

Variables	11	12	13	14	15	16	17	18	19	20
1	-.0611	-.1222	.0713	-.1893	.0135	.0390	.4202	.2609	-.2152	-.0776
2	-.0741	-.0599	.3195	.4277	.1131	.2868	-.1167	-.2156	.2740	.1269
3	-.1050	-.1294	.2608	.5094	.1673	.3243	-.1582	-.3663	.3406	.1854
4	-.0858	-.0952	.1391	.3550	.2272	.2458	-.2627	-.3552	.3102	.1755
5	-.0163	-.0097	.0205	.1922	.0815	.1166	-.5542	-.2209	.2726	.2061
6	-.1188	-.1389	.2721	.5732	.1958	.3692	-.2271	-.3467	.3823	.1900
7	-.0507	-.0274	.2734	.2330	.2254	.3346	.1354	.2412	.1382	-.0488
8	-.0379	-.0007	.1661	.0790	.1176	.1995	.2108	.4774	-.0892	-.0124
9	-.0694	.0153	.0348	.0816	.1219	-.0706	-.0971	-.0242	.1202	.1819
10	-.0885	-.1317	.2709	.4349	.2482	.3506	-.2424	-.3752	.4864	.2292
11	1.000	.7492	-.3064	-.0901	-.0557	-.2226	.0516	.0086	-.0945	.0112
12		1.000	-.2963	-.1382	-.0480	-.2554	.0603	.0576	-.0866	-.0098
13			1.000	.4121	.2532	.6453	.0383	-.1338	.2600	.1258
14				1.000	.2666	.5334	-.1833	-.3026	.3571	.2126
15					1.000	.3645	-.0286	-.1462	.2340	.0309
16						1.000	-.0065	-.1140	.2899	.1176
17							1.000	.2782	-.2235	-.1171
18								1.000	-.1889	-.1031
19									1.000	.3774
20										1.000

^aFor identification of specific variables, refer to page 163.

TABLE LVII

CORRELATION MATRIX, 23 VARIABLES,^a 239 VEGETABLE PRODUCERS,
TENNESSEE, 1965 (VARIABLES 21-23)

Variables	21	22	23
1	.1926	-.1045	-.1684
2	.1698	-.0451	-.0671
3	.2015	-.0323	-.0228
4	.2395	-.0147	.0391
5	.0817	-.0816	.0896
6	.2561	-.1466	-.1082
7	.2304	-.0238	-.0763
8	.1091	-.0762	-.0128
9	-.0044	-.1607	.1277
10	.2230	-.0890	-.0248
11	-.1234	-.0810	.0383
12	-.1482	-.0951	.0174
13	.2590	-.0752	-.2345
14	.3005	-.1468	-.1384
15	.1592	.0329	-.1875
16	.3547	-.0325	-.2254
17	.0164	-.1165	-.2023
18	-.0078	-.0326	.0877
19	.1321	-.1093	.0420
20	.1205	-.2794	-.0272
21	1.000	-.0750	-.1531
22		1.000	-.0638
23			1.000

^aFor identification of specific variables, refer to page 163.

Variable No.	Variable Identification
1	Area of State
2	Total Acres of Farm Unit
3	Acres of Cropland
4	Acres of Vegetables
5	Percent Income Vegetables Contributed to Total Income
6	Hours of Hired Labor
7	Type of Pesticide Application Equipment Owned
8	Application of Pesticide by Producer or Commercial Applicator
9	Distance to Source of Pesticides
10	Total Pesticide Expenditures
11	Years Farming Experience
12	Age of Operator
13	Education of Operator
14	Gross Farm Income
15	Deliberateness Score
16	Knowledgeability Score
17	Most Important Enterprise
18	Method of Pesticide Application
19	Degree of Use of Assistance of Chemical Company Representatives
20	Assistance from Dealers
21	Type of Tenure
22	Source of Pesticides
23	Source of Information About Pesticides