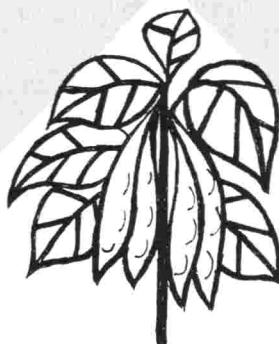


# Utilization OF Pesticides BY Tennessee Vegetable Growers

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## SUMMARY

The pesticide market in Tennessee is relatively large—consuming in 1965 over 17.3 million pounds of pesticide materials valued at more than \$16.6 million at the manufacturer's level. In 1965, pesticide sales in Tennessee represented 4.6% of total U. S. sales. Of total pesticide sales, 56% were for insecticides, 28% for herbicides, 7% for fungicides, and 9% for rodenticides and other pesticides. Fifty-eight percent of total pesticide sales were sold for commercial agricultural purposes.

Of all pesticides sold in Tennessee, 30% were sold through general farm supply stores, 18% through farmer cooperatives, 11% through feed and seed stores, and 8% through miscellaneous outlets. Drug, grocery, department, and discount stores, classified as nonagricultural retail outlets, accounted for a third of all sales.

Two hundred thirty-nine commercial vegetable producers were interviewed during the summer of 1965 to secure data on factors related to buying pesticides and their use. The producers interviewed averaged 52 acres in vegetables per farm and 38% of them had vegetable crops as their major farm enterprise. Thirty-five percent had gross farm incomes of over \$10,000.

This sample of Tennessee commercial vegetable growers spent an average of \$472 for pesticides in 1965. West Tennessee growers spent three and one-half times more money for pesticides than East Tennessee growers, and had more than four times the acreage in vegetable crops. The pesticide materials were purchased from local farmer cooperative associations by 51% of the growers, from general farm supply stores and feed and seed stores by 26% of the growers, and from miscellaneous sources by the remaining 23%.

Nearly three-fourths of the vegetable growers owned pesticide application equipment. Of these, 60% owned tractor sprayers or dusters, 34% hand sprayers or dusters, and 6% high clearance self-propelled sprayers.

Aerial spraying or dusting was the method used for applying pesticide materials by 20% of the vegetable growers with these methods being more commonly used in West Tennessee than elsewhere. Twenty-four percent of the growers used a tractor sprayer and 31% a tractor duster. Hand sprayers were used by 11% of the growers and hand dusters by 10%. Only 4% of the growers applied pesticides with high clearance self-propelled sprayers.

The sources of information about pesticides used by the vegetable growers were the Extension Service personnel (31%), dealers and salesmen (24%), neighbors and friends (15%), from radio and television programs, farm magazine articles, and information from processor's fieldmen (18%), and from university publications and university field days (12%).

Personal observation of the presence of damage to plants by pests was the deciding factor as to when pesticides should be applied by 64% of the growers. Another 23% followed a preventive schedule for dusting or spraying. Specifications in grower's contracts, advice received from processor's fieldmen, and advice received from Extension Service personnel were relatively unimportant as the bases for making this decision.

The decision on the type of pesticide to use was based upon past experience by 38% of the growers. Advice received from Extension personnel was followed by 13% of the growers, advice from pesticide dealers by 13%, and information received from materials published by the U. S. Department of Agriculture by another 13%. Very little attention was paid to information on the labels of the pesticide materials.

Forty-one percent of the growers followed instructions on the labels of the pesticide container in determining the amount to use. Advice received from commercial applicators was followed by 21% of the growers. Past experience was the basis for this decision by another 20%, and advice from processor's fieldmen, Extension personnel, and guesswork was followed by the remaining 18% of the growers.

Forty-two percent of the growers were nondeliberate in making decisions on pesticide purchases; that is, no attempt was made to secure information about the qualities of a particular pesticide or about its price. Over half the growers, 51%, were considered as moderately deliberate in buying. This group made only limited use of technical knowledge and of price and quality information. Only 7% of the growers were highly deliberate in making their purchasing decisions. This group made extensive use of technical, price, and quality information.

The most important factors associated with deliberativeness in pesticide buying decisions were the growers' knowledge about pesticides, their gross farm income, their education, and the amount of money spent for pesticides.

Twenty-two percent of the growers were considered highly knowledgeable about pesticides, 40% moderately knowledgeable, and 38% nonknowledgeable.

Two-thirds of the variation in the amount of pesticides used by the vegetable growers was associated with acres in vegetables, hours of hired labor employed in all farm operations, distance to the source of pesticides purchased, years of education of the grower, and the use of information supplied by representatives of pesticide companies.

# Utilization of Pesticides By Tennessee Vegetable Growers

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## INTRODUCTION

American farmers make wide use of chemical pesticides to control insects, nematodes, fungi, and weeds.<sup>1</sup> Pesticides are applied to crops before planting, during growth, and in storage. A 1964 survey of U. S. farmers whose sales represented 90% of total agricultural sales indicated that 94% of them used pesticides in some form, such as treating crop and other land, livestock and poultry, or for controlling rodents.<sup>2</sup> In the above study, it was estimated that American farmers in 1964 spent \$514 million for pesticide materials exclusive of application costs. Expenditures have been increased as evidenced by estimated expenditures of \$310 million in 1961. Eighty-five percent of pesticide expenditures were for treating crops, about 11% were for treating livestock and poultry, and 4% were for other uses.<sup>3</sup>

In 1964, farmers using pesticides spent an average of about \$300 on pesticides. There were variations in the amount spent in different sections of the country. Those in the specialized areas on the Pacific Coast had the largest average expenditures, \$882, while those in the Appalachian Region, which includes Tennessee, spent only \$237.<sup>4</sup>

In 1962, sale of pesticides at the user level, both farm and

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<sup>1</sup>In this report, pesticides include insecticides, herbicides, fungicides, miticides, nematocides, rodenticides, soil fumigants, defoliants, and desiccants. They do not include disinfectants, or any kind of medicine taken internally.

<sup>2</sup>Andrilenas, Paul, Theodore Eichers, and Austin Fox, **Farmers Expenditures for Pesticides in 1964**, USDA, ERS, Agr. Econ. Rep. 106, January, 1967, p. ii.

<sup>3</sup>Even on specialized livestock and dairy farms, expenditures for crop pesticides were about twice as great as for livestock pesticides.

<sup>4</sup>*Ibid.*, p. 9.

nonfarm, exceeded the one billion dollar mark for the first time. It is estimated that retail sales will reach \$2 billion by 1975.<sup>5</sup>

Rapid changes have occurred in the pesticide industry. This is true particularly since the introduction of new synthetic organic pesticides, including chlorinated hydrocarbons, organic phosphates, and carbamates.<sup>6</sup> For the U. S. in 1954, total pesticide production was 419 million pounds. By 1965, production had more than doubled to 877 million pounds. Sale of herbicides has increased more rapidly than sale of either insecticides or fungicides. In 1965, herbicides sales were 42% of total pesticide sales. It is expected that sale of herbicides will exceed that of insecticides by 1975.<sup>7</sup>

About 5% of the land area in the United States is treated with insecticides annually according to pesticide wildlife studies of the U. S. Department of Interior.<sup>8</sup> More than three-fourths of the treated area is cropland or cropland pasture, with nearly one-half of the treated cropland planted to grain. However, only 15% of the grain acreage is treated. This compares to 30% of the fruit and nut acreage, 75% of the cotton acreage, and 50% of the vegetable acreage which are treated (figures based on estimates made for 1962).

The land area treated with herbicides in 1962 was estimated at more than 85 million acres and represented a 60% increase over 1959. Since there is considerable overlap of land treated with insecticides and land treated with herbicides, it has been estimated that 1 acre in 12 of the nation's total land area receives one or more pesticide treatments each year.<sup>9</sup> Of all pesticides sold by

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<sup>5</sup>"Pesticides," *Chemical Week*, May 25, 1963, p. 118.

<sup>6</sup>Before 1800, simple compounds such as lye, lime, soap, turpentine, mineral oil, and arsenic were used as insecticides. The use of Paris green in 1867 to control the Colorado beetle marked the beginning of the use of commercial pesticides and led to the commercial use of lead and calcium arsenate. Before 1945 and the introduction of DDT, the use of agricultural insecticides was confined to fruits, vegetables, cotton, and a few other high-value crops. See Headley, J. C., and J. N. Lewis, *The Pesticide Problem: An Economic Approach to Public Policy*, Washington, Resources for the Future, Inc., 1967.

<sup>7</sup>U. S. Department of Agriculture, ASCS, *The Pesticide Review*, October, 1966.

<sup>8</sup>U. S. Department of Interior, *Pesticide-Wildlife Studies*, Fish and Wildlife Circular 167, June, 1963.

<sup>9</sup>Estimated average annual crop losses in the U. S. due to plant diseases, nematodes, insects, and weeds are \$10.2 billion. For livestock, the estimated average annual loss is \$2.8 billion. See U. S. Department of Agriculture, *Losses in Agriculture*, ARS, Agricultural Handbook No. 291, August, 1965.

United States firms in 1964, about 40% were sold to farmers. Industry, government, home owners, and exports accounted for the rest. If only sales for domestic use are considered, farmers accounted for a larger proportion of pesticide sales.<sup>10</sup>

In 1964, Tennessee farmers reported 344,195 acres of cropland treated for the control of insects and diseases and 554,723 acres treated for control of weeds, grass, or brush (Table 1). However, cotton farmers in Tennessee treated only 34% of their 1964 cotton acreage to control insects and diseases and 47% of this acreage to control weeds, grass, or brush. Corn producers treated 30% of the corn acreage harvested for grain to control weeds, grass, or brush.

Adverse effects from pesticide use, such as the killing of fish and other wildlife and the discovery of DDT and its metabolites in the fatty tissue of humans and other warm-blooded animals, have been responsible for controversy over the use of pesticides. These

<sup>10</sup>Headley, J. C., "Estimating the Productivity of Agricultural Pesticides," *Journal of Farm Economics*, 50:13-23, February, 1968. Exports accounted for about one-fourth of total pesticides sales.

**Table 1. Acres of cropland in Tennessee treated with pesticides, 1964**

|                               |  | Acreage treated for control of<br>insects and diseases   |
|-------------------------------|--|----------------------------------------------------------|
|                               |  | Acres                                                    |
| <b>Crop</b>                   |  | 50,600                                                   |
| Grain                         |  | 45,052                                                   |
| Alfalfa, clover and other hay |  | 170,302                                                  |
| Cotton                        |  | 20,578                                                   |
| Vegetables                    |  | 3,103                                                    |
| Fruit and nuts                |  | 54,560                                                   |
| Seed crops and other crops    |  | 344,195                                                  |
|                               |  | Acreage treated for control of<br>weeds, grass, or brush |
|                               |  | Acres                                                    |
| <b>Crop</b>                   |  | 239,772                                                  |
| Corn                          |  | 232,528                                                  |
| Cotton                        |  | 2,808                                                    |
| Small grain                   |  | 59,317                                                   |
| Other crops                   |  | 20,298                                                   |
| Pasture and range land        |  | 554,723                                                  |

Source: U. S. Department of Commerce, Bureau of the Census, U. S. Census of Agriculture, 1964, Tennessee.

controversies have led to increased regulations affecting pesticide production and sale.<sup>11</sup> Additional research needs to be directed toward reducing uncertainty about the harmful effects associated with pesticides and toward the development of policy at the national level.

## OBJECTIVES AND PROCEDURES

The objectives of this study are: 1) to estimate the volume and value of pesticides sold in Tennessee; 2) to examine the purchasing patterns of pesticides by vegetable producers in the State; and 3) to determine the factors that influence the use of pesticides by the vegetable producers.

Firms that manufacture or formulate pesticide products for sale in Tennessee are required by law to register their products annually with the Tennessee State Department of Agriculture. In 1965, 585 such firms were registered. Data to estimate the sales volume and value of pesticides were obtained through a mail questionnaire returned by 316, or 54% of these firms. Of these 316 firms, 158, or 50%, sold pesticides in Tennessee in 1965. Of these 158 firms, 121 supplied information that could be used to estimate sales volume and value.<sup>12</sup>

Data collected on buying insecticides and the factors that influence their use were limited to vegetable producers. This decision

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<sup>11</sup>The Federal Insecticide, Fungicide, and Rodenticide Act of 1947 which was amended in 1959 is one of the basic pesticide laws. See Ward, Justus C., "A Dynamic Statute for Pesticides," *The Yearbook of Agriculture* 1966, Washington: Government Printing Office, 1966, p. 272. The purpose of this Act 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 U. S. Department of Agriculture. By 1965, more than 57,000 different formulations were registered under this Act. See Sundquist, W. B., "Economic Research on Pesticide Use," *Minnesota Farm Business Notes*, No. 472, May, 1965, University of Minnesota, p. 1.

The Federal Food, Drug and Cosmetic Act of 1938 first provided for consumer protection against pesticides in food supplies. 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. See "Pesticides," *Chemical Week*, June 1, 1963, p. 56.

<sup>12</sup>After reviewing the data obtained and noting the distribution of the 121 firms that responded to the questions asked in the mail questionnaire, it was concluded that the sample was representative of the population. Thirty-seven firms indicated they could not supply the information wanted on a state basis or that company policy prohibited the release of such information.

was made because many vegetables grown for human consumption have been closely examined by state and federal officials for pesticide residues; also, because vegetables are normally susceptible to attack by pests and diseases that require the use of pesticides for their control.

Only those vegetables and one small fruit of commercial importance in the State were included in the study. The vegetables were considered as commercially important if there were at least 1,000 acres produced. Using this criterion, 13 crops were included: blackeye peas, cabbage, greens, irish potatoes, lima beans, melons, okra, snap beans, sweet corn, sweet pepper, sweet potatoes, tomatoes and strawberries (small fruit).

For purposes of sampling, the State was divided into three areas, the commonly delineated grand divisions of West, Middle, and East Tennessee. Those counties within each area with the greatest acreage in 1964 of each of the 13 crops were selected as sample counties. Since some of these counties had the largest acreage of more than one of these crops, only 17 counties were included (Figure 1). A list of commercial vegetable growers in each of the counties was obtained from county agricultural agents, representatives of marketing cooperatives, processors, and selected producers. From these lists, 239 growers were selected as a sample to be interviewed.<sup>13</sup>

Questions on the interview schedule were designed to obtain data on the commercial vegetable growers, the pesticide application equipment they owned, the methods that were used to apply pesticide materials, how much money the growers spent for pesticides, where they obtained pesticide information, and from whom the materials were purchased. A series of open end questions were asked to obtain the growers' bases for deciding when pesticides should be used, type to use, and rate of application. Procedures used to determine the influence of deliberateness and knowledge of pesticides on buying decisions, and to determine factors affecting the volume of pesticides used are indicated in a later section of this report.

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<sup>13</sup>The following procedure was followed. If the county list contained the names of 10 producers or less, then the sample included all the producers listed. If the list contained the names of more than 10 producers but less than 100, the sample included 10 producers selected at random from the list. If the list contained the names of more than 100 producers, the sample size was 10% of the number of names on the list drawn at random.

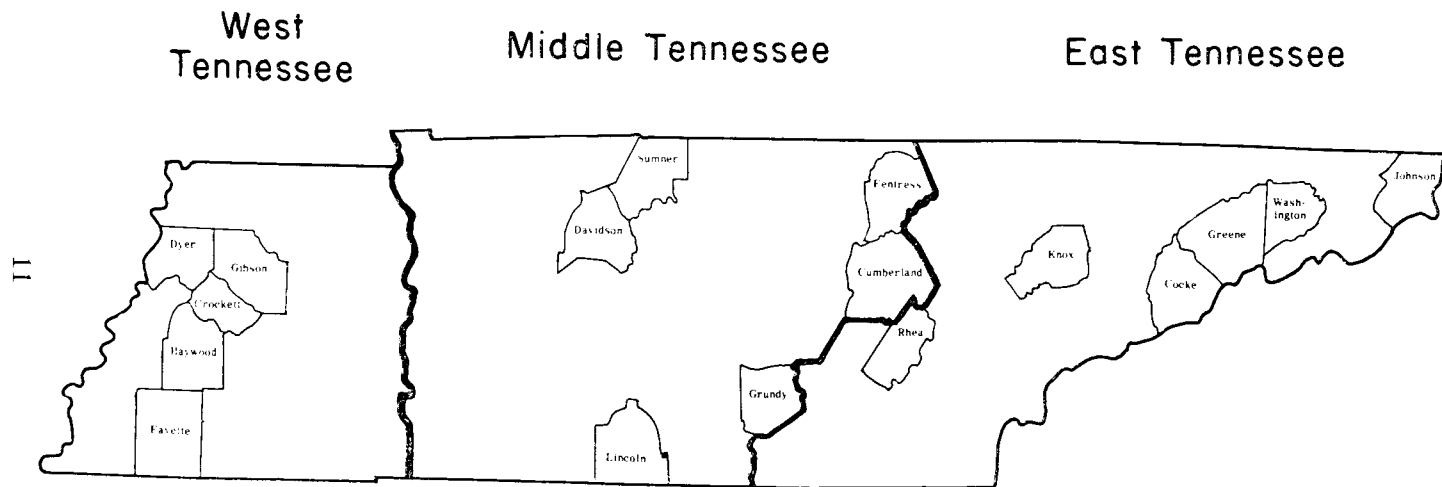


Figure 1. Geographic areas and counties included in the study.

## THE PESTICIDE MARKET IN TENNESSEE

The pesticide market in Tennessee is relatively large—consuming in 1965 over 17.3 million pounds of pesticide materials valued at more than \$16.6 million at the manufacturer's level (Table 2). The average price per pound of pesticide material was

**Table 2. Volume and value of pesticides sold in Tennessee, 1965**

| Type           | Estimated<br>volume<br>of<br>pesticides<br>sold | Standard<br>error <sup>a</sup> | Estimated<br>value<br>of<br>pesticides<br>sold <sup>b</sup> | Standard<br>error | Average<br>price<br>per<br>pound <sup>b</sup> |
|----------------|-------------------------------------------------|--------------------------------|-------------------------------------------------------------|-------------------|-----------------------------------------------|
|                | Pounds<br>(000)                                 |                                | Dollars<br>(000)                                            |                   | Dollars                                       |
| Insecticides   | 9,729                                           | 2,358                          | 7,935                                                       | 1,496             | .82                                           |
| Herbicides     | 4,919                                           | 1,512                          | 5,134                                                       | 1,699             | 1.04                                          |
| Fungicides     | 1,178                                           | 538                            | 959                                                         | 398               | .81                                           |
| Rodenticides   | 233                                             | 85                             | 394                                                         | 240               | .68                                           |
| Others         | 1,276                                           | 308                            | 2,482                                                       | 933               | 1.95                                          |
| All pesticides | 17,335                                          | 3,113                          | 16,669                                                      | 3,077             | .96                                           |

<sup>a</sup>The chances are 68 out of 100 that the volume of the different pesticides sold lies within 1 standard error of the sample mean. The range for all pesticides sold, for example, is from 14,222,000 to 20,448,000 pounds.

<sup>b</sup>Value is at the manufacturer's level.

96 cents. In 1965, pesticide sales in Tennessee represented 4.6% of total U. S. sales.

The volume of pesticides sold annually per firm was over 59,000 pounds. Of total pesticide sales, 56% was for insecticides, 28% for herbicides, 7% for fungicides, and 9% for rodenticides and other pesticides (Table 3). Fifty-eight percent of total pesti-

**Table 3. Average volume of pesticides sold annually per firm and proportion sold for agricultural purposes, 121 firms, Tennessee, 1965**

| Type           | Average<br>volume sold<br>per firm | Type of<br>pesticides<br>sold | Sold for<br>agricultural<br>purposes |
|----------------|------------------------------------|-------------------------------|--------------------------------------|
|                | Pounds                             | Percent                       | Percent                              |
| Insecticides   | 33,262                             | 56                            | 62                                   |
| Herbicides     | 16,816                             | 28                            | 50                                   |
| Fungicides     | 4,027                              | 7                             | 65                                   |
| Rodenticides   | 798                                | 1                             | 40                                   |
| Others         | 4,362                              | 8                             | 53                                   |
| All pesticides | 59,265                             | 100                           | 58                                   |

cide sales was for commercial agricultural purposes. Of total insecticides and herbicides sales, 62% and 50%, respectively, were for agricultural use.

Pesticides are sold through various retail outlets as indicated in Table 4. For insecticides sold for agricultural purposes, the principal outlet was the general supply stores. For herbicides, the principal outlet was the local farmer cooperative associations. Fungicides and rodenticides were sold primarily through nonagricultural outlets such as drug, grocery, department, and discount stores. One-third of all pesticide sales were made through non-agricultural retail outlets.

## THE COMMERCIAL VEGETABLE PRODUCERS

The 239 commercial vegetable producers surveyed in Tennessee averaged 52 acres in vegetables per farm in 1965. West Tennessee producers averaged 77 acres in vegetables per farm compared to 52 acres in Middle Tennessee and 18 acres in East Tennessee. Forty-two percent of the vegetable growers in West Tennessee averaged 15 acres or less of vegetables per farm and 15% averaged more than 100 acres. Eighty percent of the growers in East Tennessee averaged 15 acres or less in vegetable production. The farm units on which the vegetables were grown averaged 369 acres for the West Tennessee producers (24% averaged more than 500 acres per farm), 190 acres for producers in Middle Tennessee, and 220 acres per farm for producers in East Tennessee. Acres in cropland followed similar patterns, averaging 155 acres for the State as a whole (Table 5).

The vegetable growers averaged 50 years of age and had 25 years of farming experience. About one-third of the growers completed high school and 6% had a college degree; however, the number of years of education averaged 9 years. Forty-four percent of the growers owned their farms, 38% were part owners, and 18% were tenants. Tenancy rates were much higher among the growers in West Tennessee than in Middle and East Tennessee.

Thirty-five percent of the producers reported gross farm incomes exceeding \$10,000 per farm in 1965. In West Tennessee, 47% of the producers had gross incomes from farming in excess of \$10,000 per farm compared to 26% in Middle Tennessee and 22%

**Table 4. Distribution of pesticides through various retail outlets, 121 firms, Tennessee, 1965**

| Retail outlet                          | All<br>pesticides | Insecticides | Herbicides | Fungicides | Rodenticides | Others <sup>a</sup> |
|----------------------------------------|-------------------|--------------|------------|------------|--------------|---------------------|
|                                        | Percent           |              |            |            |              |                     |
| General farm supply stores             | 29.6              | 37.8         | 27.2       | 3.3        | 7.1          | 4.4                 |
| Farmer cooperatives                    | 18.1              | 9.0          | 37.6       | 4.5        | 10.0         | 26.4                |
| Feed and seed stores                   | 10.6              | 16.0         | 2.6        | 2.3        | 8.7          | 7.5                 |
| Direct sales to farmers                | 3.3               | 4.4          | 1.8        | .3         | .5           | 4.4                 |
| Implement dealers                      | 2.8               | 3.9          | 1.6        | .3         | .6           | 2.3                 |
| Direct sales to commercial applicators | 1.1               | 1.7          | .4         | .1         | 2.7          | —                   |
| Landscape and nursery firms            | .8                | .7           | 1.0        | .8         | —            | .2                  |
| Elevators                              | .2                | .2           | .3         | .3         | .8           | .1                  |
| Country general stores                 | .7                | 1.0          | .1         | .3         | .7           | 1.0                 |
| Other <sup>b</sup>                     | 32.8              | 25.3         | 27.4       | 87.8       | 68.9         | 53.7                |

<sup>a</sup>The pesticide classification of "others" includes such pesticides as miticides, nematocides, soil fumigants, and defoliants and desiccants.

<sup>b</sup>Other refers to nonagricultural type of outlets, such as drug stores, discount houses, grocery stores, and department stores.

**Table 5. Data on 239 commercial vegetable producers, Tennessee, 1965**

| Characteristics                                                            | West Tenn. | Middle Tenn. | East Tenn. | Tenn. |
|----------------------------------------------------------------------------|------------|--------------|------------|-------|
| Number of vegetable producers                                              | 104        | 76           | 59         | 239   |
| Size of farms, acres                                                       | 369        | 190          | 220        | 263   |
| Acres in cropland per farm                                                 | 224        | 134          | 91         | 155   |
| Acres in vegetables per farm                                               | 77         | 52           | 18         | 52    |
| Years of farming experience                                                | 26         | 24           | 24         | 25    |
| Age of vegetable producers, years                                          | 49         | 48           | 53         | 50    |
| Education of vegetable producers, years                                    | 9          | 9            | 10         | 9     |
| Tenure of vegetable producers, percent                                     |            |              |            |       |
| Owner                                                                      | 31         | 55           | 57         | 44    |
| Part owner                                                                 | 37         | 40           | 38         | 38    |
| Tenant                                                                     | 32         | 5            | 5          | 18    |
| Vegetable producers with gross farm income over \$10,000 per farm, percent | 47         | 26           | 22         | 35    |
| More than half of gross farm income from vegetables, percent               | 22         | 38           | 18         | 25    |
| Major farm enterprise being vegetables, percent                            | 39         | 58           | 20         | 38    |
| Amount of hired labor used in total farm operation, hours <sup>a</sup>     | 2,960      | 1,874        | 1,679      | 2,293 |

<sup>a</sup>Computed for producers that used hired labor: 90 in West Tennessee, 61 in Middle Tennessee, and 49 in East Tennessee. Sixteen percent of the vegetable producers did not use hired labor in their farm operation.

in East Tennessee. One-fourth of the producers indicated that more than half of their gross farm income came from vegetable enterprises. Vegetable production was the major farm enterprise on 38% of the producers' farms.

### Application Equipment and Application of Pesticides

Of the 173 vegetable growers who owned pesticide application equipment (72%), 60% owned tractor dusters or sprayers. An additional 34% owned hand sprayers or dusters. Six percent owned high clearance self-propelled sprayers. Hand sprayers and dusters were used to a greater extent by East Tennessee growers than others. High clearance self-propelled sprayers were owned by 10% of the growers in West Tennessee, 5% in Middle Tennessee, and by none of the growers in East Tennessee (Table 6).

**Table 6. Type of pesticide application equipment owned by 173 Tennessee vegetable producers, 1965<sup>a</sup>**

| Type                                  | West<br>Tennessee<br>(N=66) | Middle<br>Tennessee<br>(N=51) | East<br>Tennessee<br>(N=56) | Tennessee<br>(N=173) |
|---------------------------------------|-----------------------------|-------------------------------|-----------------------------|----------------------|
|                                       | Percent                     | Percent                       | Percent                     | Percent              |
| Tractor sprayer                       | 43                          | 27                            | 31                          | 36                   |
| Tractor duster                        | 29                          | 38                            | 9                           | 24                   |
| Hand sprayer                          | 9                           | 14                            | 44                          | 21                   |
| Hand duster                           | 9                           | 16                            | 16                          | 13                   |
| High clearance self-propelled sprayer | 10                          | 5                             | —                           | 6                    |

<sup>a</sup>Sixty-six, or 28%, of the 239 vegetable producers in the sample did not own pesticide application equipment. Of the vegetable producers in West Tennessee, 37% did not own application equipment; in Middle Tennessee, 33%; and in East Tennessee, 5%.

Aerial spraying or dusting was used for applying pesticide materials by about 20% of the 239 vegetable growers in the State and was more commonly used in West Tennessee. Twenty-four percent of the growers applied pesticides by using a tractor sprayer and 31% a tractor duster. Taken together, hand sprayers and dusters were used by over 43% of the growers in East Tennessee, 23% in Middle Tennessee, 9% in West Tennessee, and 21% for the State. Only 4% of the growers applied pesticides with high clearance self-propelled sprayers (Table 7).

**Table 7. Method used to apply pesticide materials, 239 vegetable producers, Tennessee, 1965**

| Method                                | West<br>Tennessee<br>(N=104) | Middle<br>Tennessee<br>(N=76) | East<br>Tennessee<br>(N=59) | Tennessee<br>(N=239) |
|---------------------------------------|------------------------------|-------------------------------|-----------------------------|----------------------|
|                                       | Percent                      | Percent                       | Percent                     | Percent              |
| Tractor dust                          | 33                           | 26                            | 32                          | 31                   |
| Tractor spray                         | 23                           | 32                            | 30                          | 24                   |
| Hand spray                            | 5                            | 10                            | 23                          | 11                   |
| Hand dust                             | 4                            | 13                            | 20                          | 10                   |
| Aerial spray                          | 15                           | 11                            | 3                           | 11                   |
| Aerial dust                           | 14                           | 6                             | 2                           | 9                    |
| High-clearance self-propelled sprayer | 6                            | 2                             | —                           | 4                    |

## PESTICIDE PURCHASES BY VEGETABLE GROWERS

The 239 commercial vegetable growers spent an average of \$472 for pesticides in 1965. West Tennessee growers spent three and one-half times more (\$723) for pesticides than East Tennessee

growers (\$198). However, they had more than four times the acreage in vegetable crops (Table 8).

**Table 8. Expenditures for pesticides, 239 vegetable producers, Tennessee, 1965**

| Dollars              | West<br>Tennessee<br>(N=104) | Middle<br>Tennessee<br>(N=76) | East<br>Tennessee<br>(N=59) | Tennessee<br>(N=239) |
|----------------------|------------------------------|-------------------------------|-----------------------------|----------------------|
|                      | Percent                      | Percent                       | Percent                     | Percent              |
| Less than 100        | 38                           | 48                            | 58                          | 45                   |
| 100-399              | 26                           | 27                            | 29                          | 27                   |
| 400-699              | 10                           | 10                            | 4                           | 9                    |
| 700-999              | 6                            | 5                             | 7                           | 6                    |
| 1,000 or more        | 20                           | 10                            | 2                           | 13                   |
| Average expenditures | \$723                        | \$339                         | \$198                       | \$472                |

Over half the growers purchased pesticide materials from local farmer cooperative associations. General farm supply stores and feed and seed stores were the major sources of pesticide purchases by another fourth of the growers (Table 9). Nearly three-fourths

**Table 9. Major sources of purchases of pesticides, 239 vegetable producers, Tennessee, 1965**

| Source                         | West<br>Tennessee<br>(N=104) | Middle<br>Tennessee<br>(N=76) | East<br>Tennessee<br>(N=59) | Tennessee<br>(N=239) |
|--------------------------------|------------------------------|-------------------------------|-----------------------------|----------------------|
|                                | Percent                      | Percent                       | Percent                     | Percent              |
| Tennessee Farmers' Cooperative | 58                           | 39                            | 52                          | 51                   |
| General farm supply stores     | 12                           | 19                            | 18                          | 15                   |
| Feed and seed stores           | 6                            | 18                            | 10                          | 11                   |
| Processor                      | 15                           | 8                             | 8                           | 11                   |
| County general stores          | 3                            | 8                             | 5                           | 5                    |
| Direct from manufacturer       | 3                            | 8                             | 7                           | 5                    |
| Commercial applicator          | 3                            | —                             | —                           | 2                    |

of the growers traveled less than 10 miles to purchase pesticides. Nearly two-thirds of all the growers purchased their supply from only one retail outlet. A third of the growers indicated that convenience was the major reason for buying from only one source. Other important reasons given were price (25%), credit (12%), and custom (10%). Of growers buying from more than one retail outlet, one-half indicated it was because purchases were made wherever it was the most convenient to do so. Other reasons given for buying pesticides from more than one dealer was because of

the desire to share purchases among different dealers (20%), because the particular material needed was not available (18%), and because of their desire to try different brands (12%).

### Source and Use of Information about Pesticides

Thirty-one percent of the vegetable growers indicated that Extension Service personnel was the most important source of information about pesticides and their use (Table 10). Thirty-four

**Table 10. Most important sources of information about pesticides and their use according to 239 vegetable producers, Tennessee, 1965**

| Source of information                  | West Tennessee (N=104) | Middle Tennessee (N=76) | East Tennessee (N=59) | Tennessee (N=239) |
|----------------------------------------|------------------------|-------------------------|-----------------------|-------------------|
|                                        | Percent                | Percent                 | Percent               | Percent           |
| Extension Service personnel            | 24                     | 40                      | 35                    | 31                |
| Dealers and salesmen                   | 27                     | 27                      | 15                    | 24                |
| Neighbors and friends                  | 21                     | 12                      | 9                     | 15                |
| University publications and field days | 8                      | 11                      | 20                    | 12                |
| Processor's fieldmen                   | 10                     | 2                       | 13                    | 9                 |
| Farm magazine articles                 | 8                      | 6                       | 5                     | 7                 |
| Radio and television                   | 2                      | 2                       | 3                     | 2                 |

percent of the growers indicated they used this source of information frequently, 30% now and then, and 36% seldom or never (Table 11). Dealers and salesmen of pesticide materials were the second most important information source (24%) about pesticides and 40% of the growers used this source frequently, 37% now and then, and 23% seldom or never. Information received through radio and television advertising and educational programs were not considered important sources; however, 5% of the growers used this source frequently, 30% now and then, and 54% seldom or never.

### Bases for Decisions on Use of Pesticides

Sixty-four percent of the growers indicated that personal observation of damage to plants by pests was the major factor determining when pesticides should be used. Another 23% followed

**Table 11. Use of different sources of information about pesticides and their use, 239 vegetable producers, Tennessee, 1965**

| Source of information                  | Frequently                   |               |               |       | Now and then  |               |               |       | Seldom or never |               |               |       |
|----------------------------------------|------------------------------|---------------|---------------|-------|---------------|---------------|---------------|-------|-----------------|---------------|---------------|-------|
|                                        | West<br>Tenn.                | Mid.<br>Tenn. | East<br>Tenn. | Tenn. | West<br>Tenn. | Mid.<br>Tenn. | East<br>Tenn. | Tenn. | West<br>Tenn.   | Mid.<br>Tenn. | East<br>Tenn. | Tenn. |
|                                        | - - - - - Percenta - - - - - |               |               |       |               |               |               |       |                 |               |               |       |
| Neighbors and friends                  | 51                           | 44            | 17            | 41    | 29            | 21            | 45            | 31    | 20              | 35            | 38            | 28    |
| Dealers and salesmen                   | 46                           | 37            | 30            | 40    | 33            | 44            | 37            | 37    | 21              | 19            | 33            | 23    |
| Extension Service personnel            | 31                           | 36            | 37            | 34    | 25            | 32            | 38            | 30    | 44              | 32            | 25            | 36    |
| Farm magazines                         | 32                           | 44            | 23            | 33    | 33            | 26            | 53            | 36    | 35              | 30            | 24            | 31    |
| University bulletins and<br>field days | 27                           | 29            | 27            | 28    | 26            | 40            | 38            | 33    | 47              | 31            | 35            | 39    |
| Pesticide company publications         | 23                           | 27            | 13            | 22    | 38            | 32            | 43            | 38    | 39              | 41            | 44            | 40    |
| Magazine ads                           | 23                           | 16            | 10            | 18    | 32            | 39            | 32            | 33    | 45              | 45            | 58            | 49    |
| Radio and television                   | 21                           | 16            | 5             | 16    | 35            | 27            | 22            | 30    | 44              | 57            | 73            | 54    |
| Processors' fieldmen                   | 17                           | 3             | 15            | 13    | 3             | 2             | 2             | 2     | 80              | 95            | 83            | 85    |

<sup>a</sup>Number of observations: West Tennessee, 104; Middle Tennessee, 76; East Tennessee, 59; and Tennessee, 239.

a preventive schedule of dusting or spraying. Specifications in growers' contracts and advice received from processors' fieldmen and Extension Service personnel were other factors given as bases for making such decisions (Table 12).

**Table 12. Bases for decisions by vegetable producers for determining when pesticides should be used, type to use, and rate of application, 239 producers, Tennessee, 1965**

| Bases for decision                      | West<br>Tennessee<br>(N=104) | Middle<br>Tennessee<br>(N=76) | East<br>Tennessee<br>(N=59) | Tennessee<br>(N=239) |
|-----------------------------------------|------------------------------|-------------------------------|-----------------------------|----------------------|
|                                         | Percent                      | Percent                       | Percent                     | Percent              |
| <b>When pesticides should be used</b>   |                              |                               |                             |                      |
| Personal observation of damage or pests | 65                           | 68                            | 60                          | 64                   |
| Preventive schedule                     | 14                           | 26                            | 33                          | 23                   |
| Contract specifications                 | 11                           | —                             | —                           | 5                    |
| Advice from processors' fieldmen        | 7                            | 3                             | 2                           | 4                    |
| Advice from Extension Service personnel | 3                            | 3                             | 5                           | 4                    |
| <b>What type to use</b>                 |                              |                               |                             |                      |
| Past experience                         | 20                           | 73                            | 40                          | 38                   |
| Advice from Extension Service personnel | 14                           | 5                             | 18                          | 13                   |
| Advice from pesticide dealer            | 15                           | 13                            | 8                           | 13                   |
| USDA recommendations                    | 15                           | 6                             | 13                          | 13                   |
| Advice from processors' fieldmen        | 10                           | 3                             | 12                          | 9                    |
| Contract specifications                 | 15                           | —                             | —                           | 7                    |
| Advice from commercial applicators      | 11                           | —                             | 1                           | 5                    |
| Information on labels                   | —                            | —                             | 8                           | 2                    |
| <b>Rate of application</b>              |                              |                               |                             |                      |
| Instructions on labels                  | 46                           | 44                            | 27                          | 41                   |
| Advice from commercial applicators      | 28                           | 15                            | 12                          | 21                   |
| Past experience                         | 13                           | 25                            | 28                          | 20                   |
| Advice from processors' fieldmen        | 9                            | 5                             | 8                           | 7                    |
| By guesswork—to completely cover plant  | 1                            | 5                             | 20                          | 7                    |
| Advice from Extension Service personnel | 3                            | 6                             | 5                           | 4                    |

The decision on what type of pesticide material to use is often difficult. In many situations different chemicals will adequately take care of a given pest. Also, the same basic chemicals are manufactured under different brand names. Irrespective of these diffi-

culties, the decision on what type of pesticide to use was based upon past experience by 38% of the vegetable growers. Advice from Extension Service personnel, from pesticide dealers, and recommendations in publications of the U. S. Department of Agriculture was given as the bases for decision by another 39% of the growers. Each of these sources of information was equal in importance. Little attention was given to information on the labels of the pesticide materials as to the type of material needed to control pests. On the other hand, 41% of the growers indicated they followed the instructions on the labels of the pesticide container in determining the amount to use. Advice from representatives of firms that apply pesticides was the basis for making the decision on how much pesticide to use by another 21% of the growers, and advice from Extension personnel and processors' fieldmen was followed by 11%.

Vegetable growers were not very brand conscious and had little loyalty to brands when it came to pesticide purchases (Table 13). Only 8% of the growers indicated they would change dealers in order to continue using the brand of pesticide they had been using if their dealer discontinued handling their regular brand. On the other hand, 60% of the growers indicated they would continue to trade with their dealer and buy a different brand of pesticide rather than change dealers in order to buy the pesticide they had been using. About one-fourth of the growers said dealers made on-the-farm calls to sell pesticide materials. About 40% of the dealers called on West Tennessee growers compared to only 7% that called on East Tennessee growers. Difference in kind and acreage of vegetables per farm probably accounts for this difference in the dealers' sales activity.

Representatives of chemical companies promote the sale of pesticide products through contacting growers and processors and supplying them with educational and promotional literature. Seventeen percent of the growers used the services provided by these representatives (Table 13). Such services were used more frequently by West Tennessee growers than by the growers in Middle or East Tennessee.

In general, vegetable growers did not check prices of pesticide materials before making purchases. Most of them believed there were no price differences among retail outlets. Short term credit was generally supplied to the growers by their pesticide dealers. Nearly a fourth of the growers reported they could obtain 30 days

**Table 13. Selected factors related to pesticide purchases, 239 vegetable growers, Tennessee, 1965**

| Selected factors                                            | West<br>Tenn.<br>(N=104)<br>Percent | Middle<br>Tenn.<br>(N=76)<br>Percent | East<br>Tenn.<br>(N=59)<br>Percent | Tenn.<br>(N=239)<br>Percent |
|-------------------------------------------------------------|-------------------------------------|--------------------------------------|------------------------------------|-----------------------------|
| <b>Dealer and brand loyalty</b>                             |                                     |                                      |                                    |                             |
| Stay with dealer and change brand                           | 59                                  | 47                                   | 75                                 | 60                          |
| Stay with dealer and try new brand                          | 31                                  | 44                                   | 22                                 | 32                          |
| Change dealer to obtain specific brand                      | 10                                  | 9                                    | 3                                  | 8                           |
| <b>Used services of chemical company representative</b>     |                                     |                                      |                                    |                             |
| None                                                        | 77                                  | 87                                   | 92                                 | 83                          |
| Little                                                      | 5                                   | 3                                    | 7                                  | 5                           |
| Much                                                        | 18                                  | 10                                   | 1                                  | 12                          |
| <b>Checking of pesticides price two months before study</b> |                                     |                                      |                                    |                             |
| Never                                                       | 88                                  | 85                                   | 80                                 | 85                          |
| Seldom                                                      | 8                                   | 15                                   | 15                                 | 11                          |
| Frequently                                                  | 4                                   | —                                    | 5                                  | 4                           |
| <b>Credit terms on pesticide purchases</b>                  |                                     |                                      |                                    |                             |
| None                                                        | 2                                   | 18                                   | 12                                 | 8                           |
| 30 days                                                     | 31                                  | 19                                   | 10                                 | 23                          |
| 60-120 days                                                 | 22                                  | 10                                   | 6                                  | 15                          |
| Any terms desired                                           | 45                                  | 53                                   | 72                                 | 54                          |

credit, 15%, 60 to 120 days credit, and 54% stated they could get credit extended on any reasonable terms desired. Only 8% of the growers indicated their dealers would not extend credit (Table 13).

## INFLUENCE OF DELIBERATENESS AND KNOWLEDGE OF PESTICIDES ON PURCHASING DECISIONS

### Influence of Deliberateness

Deliberate decisions are those based on choice processes in which alternatives are consciously identified and evaluated. These processes involve inquiry, reflective thinking, and some attempt to anticipate the consequences of alternatives.<sup>14</sup> To find out how deliberate vegetable growers were in making decisions about pesticide purchases, a series of open response questions were asked relative to the factors that influence such decisions. (See Appendix

<sup>14</sup>Smith, Eldon D., "The Deliberativeness of Economic Choices," *The Southern Economic Journal*, 29:39-43, No. 1, July, 1962. The decision-making

A for a list of the questions asked.) An attempt was made to scale the growers' responses to these questions according to Guttman scale procedures. (See Appendix B for comments on the Guttman scale.) The attempt failed because the results did not meet the minimum criterion for a Guttman scale. It was believed, however, that the pattern of responses showed sufficient consistency so that the scale that evolved could be considered a quasi scale. Admittedly, the procedure is crude. But if the variations in deliberativeness of farmers with respect to purchasing decisions importantly affect their pesticide purchasing behavior, omission of the deliberateness variable from the analysis could lead to erroneous inferences and erroneous practical judgments.

Based on the quasi scale score, the growers were divided into three groups: highly deliberate, moderately deliberate, and non-deliberate.<sup>12</sup> The distinction between deliberative and nondeliberative decision makers relates to the disposition or readiness to inquire and evaluate alternatives when and if the strategic elements become unsettled or changeable. The highly deliberate group included those growers who made maximum use of technical, price, and quality information, and who actively sought new knowledge about pesticides. The moderately deliberate group included the growers who made only limited use of technical, price, and quality information and who paid little attention to services supplied by the pesticide marketing agencies. The nondeliberate group was made up of those growers who made no attempt to secure information about the qualities of a particular pesticide or its price and usually did not consider information supplied by other people.

The resulting quasi scale scores for the vegetable growers ranged from 1 through 14 based on an increasing degree of de-

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process should be viewed as a continuum, one in which intermediate decisions are made which influence later decisions. Both terminal and intermediate decisions are shaped by: 1) existing predispositions (example: deliberativeness) resulting from prior experiences and training, 2) environmental circumstances (situational supports), and 3) knowledge of various kinds.

<sup>12</sup>In dealing with attitudes, the correctness or incorrectness of a response cannot be measured accurately 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. (See Morrison, D. E., and G. A. Kristjanson, *Personal Adjustment Among Older Persons* (Brookings, South Dakota: South Dakota Agricultural Experiment Station Technical Bulletin 21, 1958).

liberateness. Growers receiving quasi scale scores of 1 through 4 were arbitrarily placed in the nondeliberate group; those receiving quasi scale scores of 5 through 10 were placed in the moderately deliberate group; and those receiving scores of 11 through 14 were placed in the highly deliberate group.<sup>16</sup>

Generally speaking, the decisions with respect to pesticide purchases were relatively nondeliberate or only moderately deliberate in character. Forty-two percent of the growers were assigned in the nondeliberate group. Over half of the growers, 51%, were assigned in the moderately deliberate group. Only 7% of the growers were highly deliberate in their pesticide purchases—meaning that only 7 growers out of 100 made extensive use of technical, price, and quality information on pesticides before making their purchases (Figure 2).

<sup>16</sup>The procedure of arbitrarily placing individuals into deliberateness groups based on their quasi scale score is crude. However, later testing of the approach using different attributes thought to be related to the individuals decision on buying pesticides revealed high correlation coefficients.

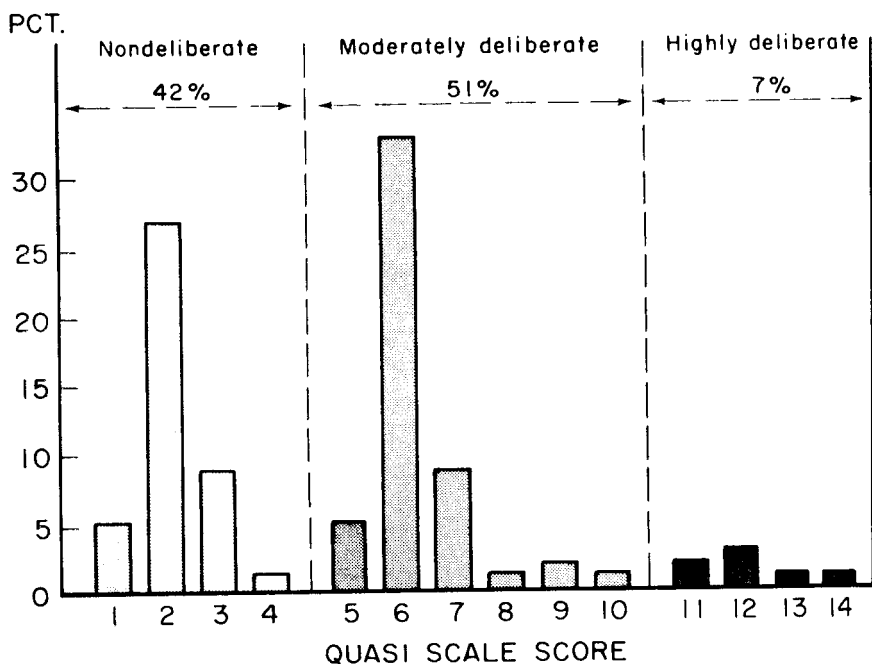


Figure 2. Distribution of quasi scale scores on deliberateness in making pesticide purchases, 239 vegetable producers, Tennessee, 1965.

Little difference was noted in the percent of growers falling in the three different deliberateness groups between West, Middle, and East Tennessee. The only appreciable difference was in the percent falling in the highly deliberate group in East Tennessee. In this case, only 3% of the growers in East Tennessee were classified as highly deliberate in their pesticide purchases compared to 8% in West Tennessee and 7% in Middle Tennessee. The number of cases in each group was small.

Statistically significant correlations were found between the deliberativeness of pesticide purchasing decisions as measured by the individual deliberativeness scores and the relevant variables that affect choice in buying pesticides (Table 14). The growers' knowledge about pesticides was the most important factor relating to deliberativeness in making purchases. Gross farm income, education of the grower, and the amount spent for pesticides were the next most important factors. The results also suggest that deliberativeness was not distributed randomly with respect to other characteristics that were not significant in determining the degree of deliberativeness. Examples of variables not significantly related were years of farming experience, age of the grower, distance to nearest retail outlet for pesticides, and the percent vegetables contribute to total gross farm income.

### Influence of Knowledge

The vegetable growers were also asked a series of questions about their general knowledge of pesticides. Similarly, the growers' responses to these questions were scaled according to the same Guttman scale procedures that were used in determining how de-

**Table 14. Correlation coefficients between deliberativeness score and relevant variables that affect choice in the purchasing of pesticides, 239 vegetable producers, Tennessee, 1965**

| Relevant factors <sup>a</sup> | Correlation coefficients |
|-------------------------------|--------------------------|
| Knowledge about pesticides    | .365                     |
| Gross farm income             | .267                     |
| Education of producer         | .253                     |
| Pesticide expenditures        | .248                     |
| Vegetables, acres per farm    | .229                     |
| Hours hired labor used        | .196                     |
| Cropland, acres per farm      | .167                     |

<sup>a</sup>Significant at the 0.05 level.

liberate growers were in making decisions on pesticide purchases. Again, this procedure failed to produce results that meet the minimum criterion for a Guttman scale.<sup>17</sup> The pattern of responses, like that of deliberateness, showed enough consistency so that the items could also be considered a quasi scale.

Based on the quasi scale knowledge score, the growers were divided into three groups: nonknowledgeable, moderately knowledgeable, and highly knowledgeable. The quasi scale scores ranged from 1 through 39 based on increasing degree of knowledge. Growers receiving scores of 1 through 12 were arbitrarily placed in the nonknowledgeable group; those receiving quasi scale scores of 13 through 27 were placed in the moderately knowledgeable group; and those receiving scores of 28 through 39 were placed in the highly knowledgeable group. In terms of this classification, 22% of the growers were highly knowledgeable about pesticides, 40% moderately knowledgeable, and 38% nonknowledgeable (Figure 3). Very little difference was noted in the percent of

<sup>17</sup>The coefficient of reproducibility of .778 was obtained with a minimal reproducibility of .599. The coefficient of reproducibility for individual questions ranged from .70 to .97.

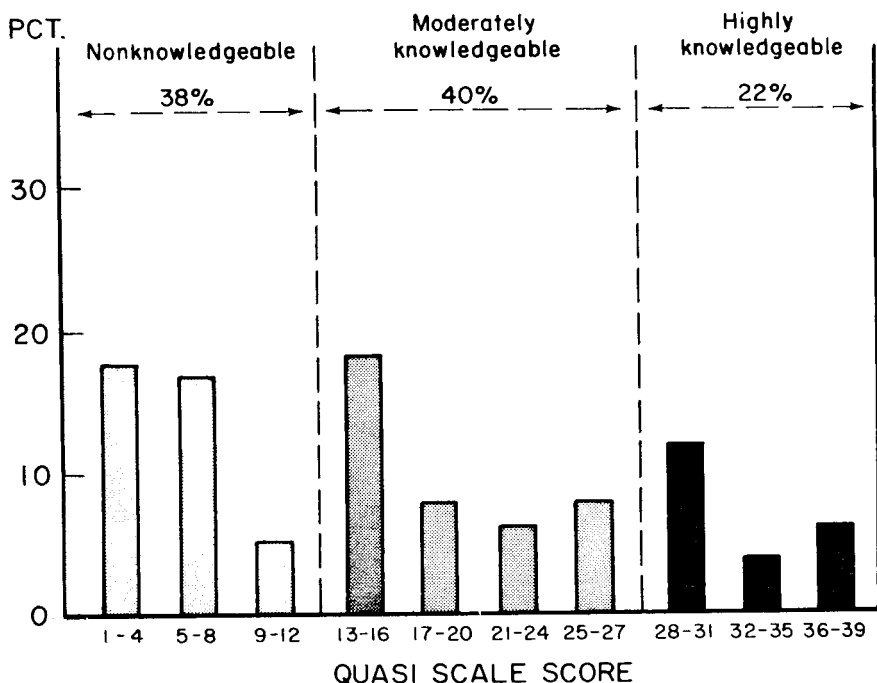


Figure 3. Distribution of quasi scale scores on knowledge about pesticides and their use, 239 vegetable growers, Tennessee, 1965.

growers falling in the knowledge groups based on the quasi scale scores between West, Middle, and East Tennessee. The quality of the answers given by the growers to questions concerning their knowledge about pesticides is shown in Table 15. In general, a higher percentage of the ratings assigned to the answers fell in the poor and fair categories when they were added together than in the good category.

Statistically significant correlations were found between the knowledge of producers about pesticides as measured by the individual knowledge scores and relevant variables that affect choice of pesticide purchases (Table 16). The relevant variables positively correlated were education of the producer, gross farm income, amount of hired labor used, pesticide expenditures, deliberateness in making purchasing decisions, and acres owned—in crops or in vegetables. Age of the producer and years of farming experience were negatively correlated with the knowledge score.

**Table 15. Quality of responses to questions related to knowledge about pesticides, 239 vegetable producers, Tennessee, 1965**

| Question                                                                                                                             | Quality of answers to questions about pesticides |      |      |
|--------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|------|------|
|                                                                                                                                      | Good                                             | Fair | Poor |
|                                                                                                                                      | -Percent-                                        |      |      |
| (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 feed and food 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, aquaticides? | 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   |
| (12) All of the following terms are found on pesticide labels. Define their meaning.                                                 |                                                  |      |      |
| Wettable powder                                                                                                                      | 69                                               | 10   | 21   |
| Antidote                                                                                                                             | 48                                               | 2    | 50   |
| Toxic poisoning                                                                                                                      | 4                                                | 43   | 53   |
| Diluted                                                                                                                              | 50                                               | 13   | 37   |
| Fungicide                                                                                                                            | 28                                               | 24   | 48   |
| Larvae                                                                                                                               | 23                                               | 28   | 49   |
| Agitate                                                                                                                              | 67                                               | 3    | 30   |
| Herbicide                                                                                                                            | 38                                               | 5    | 57   |
| Inert ingredients                                                                                                                    | 34                                               | 11   | 55   |

**Table 16. Significant correlation coefficients between knowledge score and relevant variables that affect choice in the purchasing of pesticides, 239 vegetable producers, Tennessee, 1965**

| Relevant factors <sup>a</sup>          | Correlation coefficients |
|----------------------------------------|--------------------------|
| Education of producers                 | .645                     |
| Gross farm income                      | .533                     |
| Hours hired labor                      | .369                     |
| Pesticide expenditures                 | .351                     |
| Acres in cropland                      | .324                     |
| Total acres owned                      | .287                     |
| Deliberateness in purchasing decisions | .265                     |
| Acres in vegetables                    | .246                     |
| Years farming experience               | -.223                    |
| Age of producers                       | -.255                    |

<sup>a</sup>Significant at the 0.05 level.

## FACTORS AFFECTING THE VOLUME OF PESTICIDES USED

In determining the relationship of factors that affect the volume of pesticide materials used, a stepwise regression model was used. Twenty-two variables were included.<sup>18</sup> These were variables thought to influence the volume of pesticides used. The volume of pesticides used (the dependent variable  $Y_i$ ) was measured by the actual expenditures for pesticides in 1965. The independent variables considered were:

- $X_1$  --- the location of the producer in terms of the grand divisions of the State
- $X_2$  --- total acres in the farm, 1965
- $X_3$  --- acres of cropland, 1965

<sup>18</sup>The Stepwise Regression Program used a sequence of multiple linear regression equations in a stepwise manner adding one variable to the regression equation at each step (see The University of Tennessee Computing Center, "BMD02R Stepwise Regression," The University of Tennessee, Knoxville, September 1, 1965). The variable added at each step was the one which made the greatest reduction in the error sum of squares. The statistical criteria used to determine the goodness of fit of the regression equations were the coefficient of determination ( $R^2$ ) and the student t-test of the estimated coefficients ( $t_{bi}$ ),  $b_i$  values being the regression coefficients that measure the effect on the dependent variable ( $Y_i$ ) per unit change in the independent variable ( $X_i$ ). The test of significance of the  $b_i$  values was obtained by  $t_{bi} = b_i/S_{b_i}$ , where  $S_{b_i}$  is equal to the standard error of the regression coefficient. The purpose of this test was to determine whether the  $b_i$  values were significantly different from zero at a given probability level.

- $X_1$  == acres of vegetables grown, 1965  
 $X_2$  == percent vegetable enterprises contributed to total gross farm income, 1965  
 $X_3$  == hours of hired labor employed, 1965  
 $X_4$  == type of pesticide application equipment owned  
 $X_5$  == application of pesticides by producer or commercial applicator  
 $X_6$  == distance to source of pesticides, nearest mile  
 $X_7$  == years of farming experience  
 $X_8$  == age of producer  
 $X_9$  == years of education  
 $X_{10}$  == gross farm income, 1965  
 $X_{11}$  == quasi scale deliberateness score  
 $X_{12}$  == quasi scale knowledge score  
 $X_{13}$  == most important farm enterprise in terms of income, 1965  
 $X_{14}$  == method of applying pesticides  
 $X_{15}$  == use of services of chemical company representative  
 $X_{16}$  == availability of assistance from pesticide dealers  
 $X_{17}$  == type of tenure  
 $X_{18}$  == source of pesticides  
 $X_{19}$  == source of information concerning pesticides  
 $X_{20}$

In terms of this analysis, two-thirds of the variation in the volume of pesticides used was associated with five variables. These in order of importance are: 1) acres in vegetables, 2) hours of hired labor employed in all farm operations in 1965, 3) distance to the source of pesticides purchased, 4) years of education of the grower, and 5) the use of information supplied by representatives of chemical companies.<sup>19</sup> When all 22 variables were included in the regression equation, the additional variation in pesticide expenditures accounted for was very little, the coefficient of determination being increased by .009, or about 1%.

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<sup>19</sup>The regression equation resulting from this analysis was as follows:  

$$Y = 130.83 + 4.41X_1 + .07X_2 - 6.24X_3 + 20.49X_4 + 347.67X_5$$
Standard error = (.338) (.013) (2.549) (10.738) (68.956)  
The multiple regression coefficient (R) for the above equation was .819.  
The coefficient of determination ( $R^2$ ) was .671.

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# APPENDIX A

## BUYER DELIBERATIVENESS

1. In general, how do you usually decide where to buy pesticides?  
Record verbatim: \_\_\_\_\_

2. Do you usually buy pesticides from the same place you buy feed, seed, and other supplies? Yes \_\_\_\_\_ No \_\_\_\_\_. Are there any particular reasons why you (buy, don't buy) pesticides at the same place?  
Verbatim: \_\_\_\_\_

3. Thinking about your most recent purchase of pesticides, did you buy the pesticides at the same place you usually buy pesticides? Yes \_\_\_\_\_ No \_\_\_\_\_. Did you have any particular reason for (changing, not changing)?  
Verbatim: \_\_\_\_\_

4. Did you buy the same brand of pesticides that you have been buying? Yes \_\_\_\_\_ No \_\_\_\_\_. Did you have any particular reason for (changing, not changing)?  
Verbatim: \_\_\_\_\_

5. Did you check to see where you might get the best price on 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 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 on the basis of a brand name rather than on the ingredients in the pesticide?  
Verbatim: \_\_\_\_\_

8. Do you buy on the basis of the ingredients in the pesticides or just buy from a dealer in whom you have confidence? Contents \_\_\_\_\_ Dealer \_\_\_\_\_  
Verbatim: \_\_\_\_\_

9. (If dealer) Is there any particular reason why you buy from this dealer?  
Verbatim: \_\_\_\_\_

## APPENDIX B

### THE GUTTMAN SCALE

The Guttman scale score when assigned to an individual indicates the rank order position of the particular individual with respect to the underlying variable the scale is intended to measure, in this study, the deliberateness of a pesticide purchasing decision. If Grower A has a score of 8 and Grower B a score of 4, then Grower A is more deliberate in making pesticide purchases than Grower B. However, in social and psychological measurement, the units do not necessarily have the same quantitative measurement throughout the scale. Even though Grower A's score may be higher than Grower B's, it cannot be said how much more Grower A deliberates than Grower B. If Grower A has a score of 8, Grower B, a score of 4, and Grower C, a score of 2, they can be ranked A, B, C. But it cannot be said that Grower A was twice as deliberate about making pesticide purchases as Grower B or that Grower B was twice as deliberate as Grower C. See Remmers, Hermann H., **Introduction to Opinion and Attitude Measurement** (New York: Harper and Brothers, 1954), pp. 96-118.

It is desirable to have a scale which is unidimensional or one that measures only one factor. Therefore, it would be ambiguous, for instance, to have a single score designed to measure a grower's appraisal of insect damage to a certain vegetable crop and also to measure a grower's knowledge of pesticides in the same test. Guttman proposed the following criterion of unidimensionality of scale: If a single quantitative score is to represent 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.

Reproducibility measures the proportion of instances in which any given individual's response to a particular question may be reproduced correctly from his scale score. A scale with 100% reproducibility means that each individual's score describes the exact pattern of his answers to all questions. 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. In practice, however, clear-cut reproducible patterns do not usually emerge. Deviations in responses from the pattern are referred to as error. By counting the out-of-place responses and subtracting them from the

total responses, the in-place responses can be expressed as a proportion of the total responses. This measurement is the coefficient of reproducibility.

To satisfy the suggested Guttman criterion for measuring deliberateness, the minimum coefficient of reproducibility should be .90. In this study, a coefficient of reproducibility of .829 was obtained with a minimal reproducibility of .594. The coefficient for individual questions ranged from .80 to .90. The problem is one of how far the distribution of the data can depart from the Guttman scale criterion and still be judged to "scale." Riley refers to the .90 coefficient of reproducibility suggested by Guttman as an "arbitrary decision" and a "practical rule of thumb." (See Riley, Matilda White, **Sociological Research: I. A Case Approach** (New York: Harcourt, Brace and Wald, Inc., 1963), p. 476.) It was decided, therefore, that the scale developed from this study could be considered a quasi scale since the pattern of responses showed sufficient consistency. Reproducibility of quasi scales may not be high, but the error of reproducibility is random. (See Stouffer, Samuel A., Louis Guttman, et al., "Studies in Social Psychology in World War II," Vol. IV, **Measurement and Prediction** (Princeton, New Jersey: Princeton University Press, 1950), p. 79.)

Decisions based on the processes of rational and planned behavior are deliberate decisions. If, therefore, much of behavior is not ruled by conscious motive, we do violence to our data if we force them into an analytical model which assumes equally rational, deliberate choices on the part of everyone. If other characteristics—such as knowledge of relevant kinds, or its converse, uncertainty—are intercorrelated with the deliberativeness characteristic, we may be deluding ourselves into thinking that we are observing rational responses to uncertainty (or other values) when, in fact, we are observing the effects of the inertia of habit or custom involving little or no deliberative evaluation of alternative line of activity and the utilities forthcoming therefrom. In effect, we prove what we have assumed to be true from the outset.

If differences in the rate of adjustments to new economic circumstances can be significantly explained by differences in the deliberativeness of individuals with respect to their decisions, then the use of the quasi scale developed in this study should help in understanding those relationships that explain why people vary in the extent to which they tend to base decisions on deliberate evaluations.

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