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SPECIAL REPORT NO. 49
Agricultural and Home Economics Experiment Station
Cooperative Extension Service
Iowa State University of Science and Technology
Ames, Iowa
December, 1966

AGRICULTURAL CHEMICALS AND IOWA FARMERS

- Purchase and Use Patterns
- Knowledge
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Behavior Studies Related to Pesticides

Agricultural Chemicals and Iowa Farmers

by

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This study was conducted by Cooperative Extension Service in Agriculture and Home Economics cooperating with the Federal Extension Service of the United States Department of Agriculture.

FOREWORD

Chemicals play significant roles in agriculture today. In the United States they contribute to the immense capability of farmers to produce food and fiber. They are viewed as promising steps in economic development in parts of the world where population grows faster than food production.

Agricultural chemicals add to the efficiency of production. They help improve products and maintain quality from the production phase through to ultimate consumption. As is true with many products of modern technology, such as electrical appliances, drugs and the automobile, chemicals can be harmful if improperly used.

Some aspects of the use of agricultural chemicals have been raised as public issues. Many different viewpoints have been expressed. One principal agreement has been that education on proper use of chemicals is in the public interest—to farmers, businessmen, householders and consumers alike.

The Cooperative Extension Service is the educational arm of the U. S. Department of Agriculture. Through its programs at local, state and federal levels, the Extension Service disseminates information on technical innovations in agriculture, marketing and other subjects of importance to both rural and urban residents. Its educational work helps farmers evaluate and decide whether to adopt new practices—including use of agricultural chemicals. It helps people—regardless of their place of residence—to understand and use practices that originate in agricultural research.

Cooperative Extension Service has been doing such work for many years. A tradition throughout its history has been the educational dictum, start where the people are.

Educational efforts to promote proper use of agricultural chemicals must begin "where the people are"—what do they know about chemicals and about proper use of chemicals?

This is a special report that presents some of the basic facts about "where the people are" in their knowledge, attitudes and use patterns with respect to agricultural chemicals. Research from which the data were drawn was conducted by Iowa State University social scientists with financial support provided by the Federal Extension Service.

The reader should recognize that this research touched only part of a large and complicated subject. There are many agricultural chemicals used for many different purposes by many different persons. Farmers are only one of several groups of users of agricultural chemicals. The general category of "farmers" represents wide and diverse uses of chemicals in food and fiber production—far broader than the Iowa farmers on whom this research focused.

This research applies to Iowa farmers. The findings may be of greatest relevance to educators and others who are interested in knowledge, attitudes and use patterns of *Iowa* farmers. The reader is reminded of that fact. He may find useful concepts and insights disclosed in the data. However, the data are not offered as generalizations concerning farmers in general nor any groups not specifically included in the statistical universe studied.

MARVIN A. ANDERSON, *Director*
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This report should be of interest to anyone whose job deals with providing information to farmers on how to use agricultural chemicals safely and effectively. It contains findings and summaries to help better understand farmer use and expenditure patterns, knowledge, attitudes and information sources concerning agricultural chemicals.

From the data presented, one should gain an understanding of what information needs to be communicated to farmers who use chemicals, how to present the information, and what sources will best convey the information to the farmers who need it.

Prior to this study, little was known about the use patterns, knowledge and attitudes of farmers concerning agricultural chemicals. With the rapid increase in the number of chemicals being used, the need for this information has become increasingly important.

Other similar studies are planned and information will be presented on other aspects related to farmers' use of chemicals.

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Agricultural Chemicals and Iowa Farmers

Millions of farmers are using agricultural chemicals to control weeds and insects in an effort to meet the increasing demands for food for a rapidly growing world population.

Still, the use of agricultural chemicals hasn't been accepted by everyone as an ideal way to increase farm production. Concern has been voiced about consequences of improper use of these chemicals on the user, wildlife, crops, livestock and the ultimate consumer of food products. In its extreme form, the concern has been expressed in proposals to abolish the use of agricultural chemicals. Other proposals call for strict control of chemical exposure to food produced for human consumption.

The subject is controversial. However, there has been little valid data on which to base discussion and interpretation of the problem. Little has been known about the patterns of chemical use and expenditure, knowledge and attitudes of farmers concerning chemical use, and sources of information relied on by users of chemicals.

Such data should be useful to people who establish and enforce public policies. They should have special value for those who conduct educational programs related to the proper use of agricultural chemicals.

Against this background, the Cooperative Extension Service in Iowa, cooperating with the Federal Extension Service, undertook a research project to gather these data. This report presents some of the findings of the study.

THE PROBLEM SETTING

TECHNOLOGY AND SOCIAL DECISIONS

Modern technology is usually accepted because people believe it will bring benefits to those who adopt it, to sectors of society or to society as a whole. However, there are usually some human and social costs inherent in the acceptance of almost any new technology. Decisions on acceptance of technology are usually made by weighing the probable benefits against the costs: How great are the benefits and for whom? How great are the costs and who bears them? In most cases, the cost-benefit ratio is subject to individual interpretation. In the case of agricultural chemicals, differences of opinion, further compounded by a lack of data, make it difficult for people to reach agreement.

THE ROLE OF AGRICULTURAL CHEMICALS

The use of agricultural chemicals is one of many technological innovations. In North America, cultivated crops are attacked by over 3,000 species of insects, by a comparable number of plant diseases and by unestimated numbers of nematodes, rodents and weeds. In 1954 the United States Department of Agriculture (USDA) estimated that losses in agricultural production from pests before harvest were equal to the production of 88 million acres. Losses after harvest equaled the production of an additional 32 million acres (1).[1] This is a total production loss of 120 million acres of United States cropland.

Estimates made independently by several agencies place the losses caused by agricultural pests at $8 to $15 billion annually (1). It is estimated that the current extensive use of agricultural chemicals can be credited with increasing our food supply by an amount sufficient to feed 60 million people (2).

Other estimates point out that without agricultural chemicals, the yields from fiber, cereal and forage crops would suffer a 10 to 25 percent drop and that prices would increase at least five times on many foodstuffs (3). It is further estimated that chemical feed additives give livestock and poultry producers 10 to 15 percent more productivity due to increased disease control, feed efficiency and rate of gain (4).

CONCERNS ABOUT THE USE OF AGRICULTURAL CHEMICALS

With the increased number and use of agricultural chemicals, concern has been expressed about the possible hazards of their improper use. There has also been concern about the effectiveness of present government regulations concerning use of these chemicals.

Specific assertions have been made in terms of danger from the cumulative effects of small amounts of pesticides in foods, the possibility of these chemicals causing diseases such as leukemia and cancer, and the danger of pesticides upsetting the balance of nature by killing birds and wildlife. It is also said by some that pesticides are not adequately tested before marketing. They add that chemical companies are negligent in not warning the public of potential hazards of chemical use. Some of these critics claim that food production can be maintained without chemical pesticides.

On the other hand, those who believe in the efficacy of agricultural chemicals cite statements from the American Medical Association. These statements show that there is not a single confirmed record of negative clinical effects on any person from eating food which has

[1]Numbers in parentheses refer to the list of references on page 24.

been treated with agricultural chemicals used according to approved recommendations. They further state that there has not been a clinically confirmed death from agricultural chemicals used properly. However, according to the best available records, the *improper* use of agricultural chemicals causes 100 to 150 deaths annually (5).

These are only a few of the arguments for and against agricultural chemicals. This controversy has found its way into the public dialogue through books, magazines, newspapers, radio, television, bulletins and organized education. These arguments form part of the basis for man's knowledge and attitudes about farm chemicals.

There is one point that critics and advocates of agricultural chemicals agree on: There is a need for increased educational efforts to inform the public and a special need to inform persons who use agricultural chemicals, about the proper and safe use of chemicals. One example of this concern was expressed by Congress when it appropriated $2,100,000 for expansion of educational programs on the safe and proper use of agricultural chemicals.

THE OBJECTIVES OF THIS RESEARCH PROJECT

The general objectives have already been pointed out. The specific objectives are as follows:

1. To determine the level of knowledge about agricultural chemicals and their uses.
2. To determine the level of concern about possible negative consequences from the use of agricultural chemicals.
3. To determine the perceptions regarding possible consequences of use or misuse of agricultural chemicals in terms of danger to humans.
4. To determine the sources of information used regarding agricultural chemicals and their use.
5. To determine the sources of supply for chemicals and the role played by these sources in providing the information about agricultural chemicals and their uses.
6. To determine the present use patterns of agricultural chemicals that have a potential danger to the user, his neighbors or the consumer of treated products.

Researchers and Extension Service specialists agreed that questions concerning seven functional categories of agricultural chemicals should be included in the study. These are: (1) broadleaf weed killers, (2) grass killers, (3) brush killers, (4) soil insecticides, (5) crop insecticides, (6) livestock insecticides and (7) animal health, animal medicinals and animal growth stimulators. In the last category, the pesticides were limited to those products administered by the farmer on the farm, not those products which were a part of feed purchased or administered by others.

THEORETICAL ORIENTATION

A basic assumption of this research study is that there is a need to understand, predict and—in some cases—modify human behavior related to the use of agricultural chemicals.

Understanding and predicting the behavior of man is difficult. Man is apparently unique from other forms of life in a number of ways. First, he can deal with abstractions—he can visualize and deal with phenomena that aren't physically present. Second, he develops word symbols to which he attaches meaning. Third, man is telic—he has the ability to project into the future and think and direct his behavior toward goals or outcomes he wishes to obtain. Fourth, he is an organizing being—he organizes the data he possesses in a manner that is meaningful to him. And, finally, he behaves within this constructed world of reality.

At a more specific level, one approach to understanding human behavior is the unit act. Any action consists of three stages: (1) receiving a stimulus, (2) interpreting this stimulus and the circumstances in which it is received and (3) responding to the stimulus in order to fulfill a goal.

However, it is easily observable that not everyone receives the same stimuli. Also, different interpretations are made from apparently identical stimuli and circumstances. And different responses to the same stimuli vary greatly. This implies that many variables become involved in what appears to be a relatively simple unit act—stimulus, interpretation and response.

In a simplified form, it may be said that man's behavior is based on several main conditions. These are: (a) an organized accretion of past experiences—these provide the basis for his knowledge and attitudes, (b) the stimuli he receives and the sources from which these stimuli come, (c) his perception of desirable outcomes or the goals he strives for, (d) his evaluation of acceptable means to achieve the chosen goals and (e) situational variables within which he receives or creates stimuli and within which he must act.

Four variables flowing from these conditions constitute the main emphasis of this report. These are: farmer use and expenditure patterns, knowledge, attitudes and sources of information concerning agricultural chemicals. Each of these variables will be discussed separately.

USE AND EXPENDITURE PATTERNS

An analysis of the use and expenditure patterns of farmers regarding agricultural chemicals appears to be one of the first steps toward understanding farmer behavior as related to agricultural chemicals.

These data will provide information about the existing behavior of farmers concerning agricultural chemicals. This existing behavior will provide a situational context in which to interpret the other variables—knowledge, attitudes and sources of information.

Use patterns of agricultural chemicals can be considered as a measure of the farmer's perception of his need for these chemicals. For example, if an educator knows what specific chemicals farmers are using, he may know what problems of improper use might exist.

Consider, for example, these three situations: (1) certain agricultural chemicals have a high potential danger if improperly used, but if no one is using them, then no problem actually exists; (2) if only a few farmers are using a particular chemical and it appears there won't be extensive use of the chemical, educational programs aimed at all farmers would be unnecessary; and (3) if some chemicals are used only in certain geographic areas or by certain types of farmers, efficient educational programs should be limited to those specific farmers. This report is aimed at showing which of these and other similar situations actually exist.

Another indicator of what chemicals and how many of them are being used is the amount of money spent for all agricultural chemicals, for the various categories of chemicals and for specific chemicals. If this study shows that farmers are using a large number of different agricultural chemicals, the biggest need may be for information about agricultural chemicals in general, including information about many specific chemicals.

The amount of money spent for chemicals in relation to other farm inputs may also give an indication of the amount of time and energy the farmer feels he can spend in gathering information about chemicals. For example, farmers who spend large amounts of money for agricultural chemicals may also spend more time gathering information and developing skills related to agricultural chemicals than the farmer who uses only a few chemicals. If this is found to be true, it might be used to determine the type of information and information sources to be used in getting information about agricultural chemicals to the farmers who need it most.

KNOWLEDGE

The second variable, knowledge, plays roles in both safe and effective use of agricultural chemicals. For chemicals to be used safely and effectively, the farmer must know that a problem exists and that chemicals are one alternative to help solve that problem. He must know or learn the nature of the problem and the chemical recommended to deal with it. A user must know when, how much, what method to use and under what conditions to apply the chemicals. He also needs to know what precautions to take and the consequences of improper use for the user, crops, livestock, aquatic life and wildlife, and the ultimate consumer. The farmer needs to know the expected outcomes from proper use of chemicals and the restrictions placed on the use of the product on which the chemical is used.

Farmers can accumulate knowledge from many different sources. They first learn from the institutional structures of family, church and school. The modern farmer is then exposed to many channels of communication, such as newspapers, farm magazines, radio, television, bulletins, pamphlets and books. County agents, extension specialists, company technicians, retail dealers and neighbors are additional sources of information. In the case of chemicals, the labels on containers also serve as a source of information. Personal experience plays a big part in knowledge too.

Since man is an organizing being, different individuals develop different meanings from their interpretation of the information they receive and from their past experiences. This, then, results in individual knowledge based on individual judgments.

Another approach to knowledge is from a scientific point of view. Scientifically validated knowledge is arrived at by a rigorous scientific method that rejects man's subjective approach to knowledge. Through careful testing processes and an accumulation of data over time, relationships between phenomena are accepted as to their degree of scientific validity.

The knowledge questions used in the study were those accepted as scientifically valid. A study of the data will show that farmer knowledge is sometimes consistent with the accepted scientific knowledge. In other cases, farmer knowledge is different from the accepted scientific knowledge. In still other cases the farmer doesn't possess knowledge about the specific question. Therefore, in understanding an individual behavior, it is necessary to recognize that it is often based on the farmer's own individually constructed base of knowledge that may or may not be scientifically valid.

Data on the present knowledge of farmers regarding agricultural chemicals and their use should aid in understanding their present agricultural chemical use behavior. In addition, the data should provide insights into crucial areas in which additional educational efforts are needed and the specific clienteles most in need of this information.

ATTITUDES

Attitudes are another variable that must be studied in order to understand, predict and modify human behavior in relation to the use of agricultural chemicals.

As stated in the orientation section, any action consists of three stages: (1) receiving a stimulus, (2) interpreting this stimulus under the circumstances in which it is received and (3) responding to the stimulus in order to fulfill a goal. Also, not everyone receives the same stimuli. Then, different interpretations are made from apparently identical stimuli and circumstances; therefore, responses may vary greatly.

As man builds his experience world, he makes judgments about experiences. These judgments about past experiences form man's value system. Values, then, can be defined as a subjective interpretation of the relationship which the individual thinks *ought* to exist between phenomena—what ought to be.

The individual's value system provides the basis for his tendencies to act in relation to the stimuli he receives. These tendencies to act are commonly referred

to as attitudes and can be described as a state of readiness to deal with an object or situation.

Attitudes also have dimensions that may help in understanding, predicting and modifying human behavior. Commonly accepted dimensions of attitudes are: (a) direction—for or against, positive or negative, agree or disagree, good or bad; (b) degree—the variation in direction; for example, very favorable or just favorable; (c) intensity—the degree of conviction with which an attitude is held; and (d) salience—the importance of a given attitude within the structure of attitudes. This study is primarily concerned with direction and degree of attitudes.

From an educational point of view, it is important to recognize that new experiences, including new information, may change existing values and attitudes. Also providing stimuli to reinterpret past experiences may lead to a change in attitudes.

It is relevant to understand attitudes as one of the important variables in attempting to understand and predict human behavior. Attitudes play a role at many points in human behavior. For example, they can affect what stimuli or messages are received, the interpretation of the stimuli received, the interpretation of experiences, the choice of goals and the choice of acceptable means to achieve these goals.

This part of the study shows which attitudes are held in common by most farmers and the attitudes upon which there is disagreement. It shows specific and general favorableness or unfavorableness toward agricultural chemicals and their use. And, depending upon the objectives of information and educational programs, the data should show which attitudes can be reinforced and the ones to which educational efforts need to be directed for change or modification. Knowledge of the attitudes of farmers should also aid the educator in choosing content, appeals and methods for effective and efficient educational programs.

FARMER INFORMATION SOURCES

At this point in the findings section, it is hoped the reader will have some insight into the type of information farmers need concerning agricultural chemicals. This is the purpose of the first three sections of this report concerning use and expenditure patterns, knowledge and attitudes.

The purpose of the final section is to determine which information sources are used most and perceived as most useful by farmers.

Communication is a functional process in which meaning is conveyed. It contains four basic elements: (1) a person who communicates—the sender; (2) the media by which he communicates—the channel; (3) the symbols by which he communicates—the message; and (4) a person who interprets the symbols—the receiver.

For the message to be interpreted correctly, the sender and receiver involved in communication must have a common network of shared symbols that have the same meaning for both participants. Meaningful communication is essential for the transmission of information and knowledge from the source through the channel to the farmer.

Mass and personal communications probably offer the greatest potential for changing the behavior of farmers related to the use of agricultural chemicals. If the level of knowledge is to be changed; if attitudes are to be supported, modified or changed—these communication media offer major channels through which messages may be sent.

A knowledge of what farmers perceive to be the most available and useful sources of information and the sources of information presently being used by farmers for various types of information should help educators plan where to place future information about agricultural chemicals to increase the possibilities of farmer exposure to it.

Knowledge of present sources of information used by farmers may point out the need to attempt to secure a higher degree of exposure and use of certain channels of communications, or for developing new channels.

The modern farmer has many types of mass media available to him: newspapers, farm magazines, radio, television, bulletins, pamphlets and books. He may attend meetings sponsored by private and public organizations where information on up-to-date research and agricultural technology is presented. He can also obtain information from extension specialists, county agents, company technicians, retail dealers and neighbors. He can often accumulate information by interpreting his own and other people's experiences with new technology. Finally, he can read information presented on the containers of products such as agricultural chemicals.

Many factors govern which sources of information the farmer will use. Probably the two most important factors are availability and credibility of the information sources. From the various sources of information available to him, man will select those sources that give information he feels is most credible for the fulfillment of his needs.

The credibility of an information source refers to how "believable" the information is. It is characterized by the perceived "expertness" of the information and the "trustworthiness" of the communicator. A source of information which proves to be most credible and available for certain information will probably also be used for other related information.

Information sources play many roles in the effective and proper use of agricultural chemicals. For chemicals to be used, the farmer must be aware that a problem exists and that chemicals are one of the solutions.

To make chemical use profitable, he must be informed of the precise nature of the problem, the chemicals that are recommended, when and how to apply, and under what conditions to apply the chemicals. He also needs to know what to expect from the proper use of chemicals.

For safe use of chemicals the farmer must know the consequence of improper use on the user, crops, livestock, aquatic and wildlife, and the ultimate consumer. He should know the restrictions placed on the use of products treated with chemicals.

Another source of information for the user of agricultural chemicals is the chemical dealer. Past research indicates that farmers expect the dealer not only to provide him with products and services, but also to be a source of information on agricultural chemicals and their use.

Retail dealers can become more valuable sources of information if they are made more aware of the best chemical to do the job, proper methods of application, correct handling and safety precautions, and hazards and possible consequences of misuse. However, if effective and efficient education efforts are to be achieved, the composition of the dealer audience must be known—"from whom does the farmer buy agricultural chemicals?"

Data in this study include the farmer's preception of the role the dealer plays as a source of information, his expectations of dealers and the adequacy with which he believes the dealer is providing information. These data should provide valuable insight into how effectively the dealer is playing his role. It should also suggest certain steps that might be taken to aid the dealer in playing his role more effectively.

The objective of this research project may be summarized as providing data to better understand farmer behavior related to agricultural chemicals and their use. Such an understanding should not only provide valuable insights into better understanding behavior, but also provide data for better predicting behavior, and perhaps modifying behavior toward proper and safe use of agricultural chemicals.

SAMPLING AND FIELD PROCEDURES

A stratified, random, area segment sample of Iowa farmers who are representative of the general farmer population of Iowa, was drawn for this study by the Iowa State University Statistical Laboratory. To qualify as a respondent, the farmer had to meet two criteria: (1) he must have farmed 70 or more acres in 1964 and (2) he must have made the major management decisions for his farming operation.

Using these sampling and screening procedures, it was found that there were 242 Iowa farmers in the statistical sample who were eligible to be interviewed. A total of 229 farmers completed the interview. The remainder are accounted for by: nine who refused to be interviewed, two who were not available and two whose questionnaires weren't used because of incomplete data. The personal interviews with each qualified farmer in the sample were completed during March and April of 1965.

The same farmers were interviewed for each of the four sections of this study.

ANALYSIS OF DATA

USE AND EXPENDITURE PATTERNS

Methodology

The methods used to obtain use and expenditure data were relatively straightforward. Sometimes the farmer was asked to respond to the questions using his own frame of reference. In other cases, a series of alternative answers were presented on a card and the farmer was asked to select a response.

Since the interviews took place in March and April, most of the data presented are based on the farmer's recall from the previous year. Some had difficulty recalling the specific names of chemicals used. In some cases, the specific chemical or brand wasn't given.

Expenditure patterns were also obtained mainly on a recall basis. In a few cases, the farmer went to his books or purchase slips to find them. The objective was to obtain as complete and accurate data as possible based on recall.

The data are presented as given by the farmer. For example, the chemical specified for a given functional purpose is recorded as given by the farmer. The reader may judge that the chemical is not the most effective for the purpose given or, in fact, may represent improper use. These qualifications should be kept in mind in interpreting the data.

Findings

The presentation will be made in two parts—use patterns and expenditure patterns.

Use Patterns. The widespread use of agricultural chemicals is reflected by the fact that 220 farmers or 96 percent of the sample used one or more of the seven categories of agricultural chemicals during 1964.

The number and percent of farmers using each functional category of agricultural chemicals are presented in table 1.

Table 1. Question—Of the categories of agricultural chemicals, which of these did YOU USE on your farm; either on your crops, livestock or for animal health and growth purposes during the past year (1964)?

Agricultural chemicals	Used in 1964	
	No. of farmers	Percent of 229*
Livestock insecticides	189	82.5
Broadleaf weed killers	166	72.5
Animal health products, animal medicinals and animal growth stimulators	159	69.4
Soil insecticides	115	50.2
Brush killers	46	20.1
Grass killers	25	10.9
Crop insecticides	17	7.4

*A total of 229 farmers were interviewed.

Livestock insecticides were the most-used chemicals, followed closely by broadleaf weed killers, animal health products and soil insecticides. The other three categories were little used compared to these.

Table 2 presents data on the number of categories of chemicals used by the farmers. The average number

Table 2. Number of categories of chemicals used by farmers.

Number of categories used	Number of farmers	Percent of 229
None	9	3.9
One	17	7.4
Two	48	21.0
Three	63	27.6
Four	55	24.0
Five	31	13.5
Six	6	2.6
Seven	0	0.0
TOTAL	229	100.0

of categories used was 3.1. However, no farmer used all seven categories of the chemicals.

Tables 3 through 11 present the specific chemicals reported being used within each functional category. The actual brand, trade or chemical name used in the tables isn't always the identical name given by the farmer. The actual name given by the respondent was recorded and is available. However, for clearer presentation, the names given by the farmers were sometimes checked with specialists and identified with a known name if possible.

It can be seen that 2,4-D is the agricultural chemical used by the greatest number of farmers.

Table 3. Broadleaf weed killers used by Iowa farmers in 1964.

Agricultural chemical	No.	Percent of 166†	Percent of 229
2,4-D	157	94.6	68.6
Amitrol compounds	22	13.3	9.6
Amitrol triazole	17		
Amitrol-T	2		
Cytrol	2		
Weedazol	1		
Atrazine	6	3.6	2.6
Randox-T	3	1.8	1.3
Sodium chlorate	2	1.2	0.9
Randox	1	0.6	0.4
Amiben	1	0.6	0.4
2,4,5-T	1	0.6	0.4
Aldrin	1	0.6	0.4
Used broadleaf weed killer, but did not know the name of chemical	2	1.2	0.9
TOTAL	196*		

*Some farmers used more than one broadleaf weed killer.
†Number of farmers using broadleaf weed killers.

Table 4. Grass killers used by Iowa farmers in 1964.

Agricultural chemical	No.	Percent of 25†	Percent of 229
Atrazine	11	44.0	4.8
Amiben	6	24.0	2.6
Amitrol compounds	5	20.0	2.2
Amino triazole	3		
Weedazol	1		
Cytrol	1		
Randox-T	3	12.0	1.3
Randox	1	4.0	0.4
2,4-D	1	4.0	0.4
Dalapon	1	4.0	0.4
Lorox	1	4.0	0.4
Ramrod	1	4.0	0.4
Philaden	1	4.0	0.4
TOTAL	31*		

*Some farmers used more than one grass killer.
†Number of farmers using grass killers.

Table 5. Brush killers used by Iowa farmers in 1964.

Agricultural chemical	No.	Percent of 46†	Percent of 229
2,4,5-T	23	50.0	10.0
2,4-D and 2,4,5-T mix	8	17.4	3.5
2,4-D	8	17.4	3.5
Amitrol compounds	2	4.3	0.9
Amino triazole			
Sodium chlorate	1	2.2	0.4
Dybar	1	2.2	0.4
Ureabor	1	2.2	0.4
Used brush killers but did not know name of chemical	6	13.0	2.6
TOTAL	50*		

*Some farmers used more than one brush killer.
†Number of farmers using brush killers.

Table 6. Soil insecticides used by Iowa farmers in 1964.

Agricultural chemical	No.	Percent of 115†	Percent of 229
Aldrin	83	72.2	36.2
Heptachlor	22	19.1	9.6
Diazinon	9	7.8	3.9
Thimet	2	1.7	0.9
Isotox	2	1.7	0.9
Lindane (BHC)	2	1.7	0.9
Lindane—Heptachlor	1	0.9	0.4
Stathion	1	0.9	0.4
Aldrex	1	0.9	0.4
Dieldrin	1	0.9	0.4
Used soil insecticide but did not know name of chemical	1	0.9	0.4
TOTAL	125*		

*Some farmers used more than one soil insecticide.
†Number of farmers using soil insecticides.

Table 7. Crop insecticides used by Iowa farmers in 1964.

Agricultural chemical	No.	Percent of 17†	Percent of 229
Toxaphene	4	23.5	1.7
Isotox	3	17.6	1.3
Aldrin	2	11.8	0.9
Heptachlor	2	11.8	0.9
Lindane (BHC)	1	5.9	0.4
DDT	1	5.9	0.4
2,4-D	1	5.9	0.4
Used crop insecticides but did not know name of chemical	4	23.5	1.7
TOTAL	18*		

*Some farmers used more than one crop insecticide.
†Number of farmers using crop insecticides.

Table 8. Livestock insecticides used by Iowa farmers in 1964.

Agricultural chemical	No.	Percent of 189†	Percent of 229
Lindane (BHC)	81	42.9	35.4
Dairy cattle fly spray	23	12.2	10.0
Toxaphene	21	11.1	9.2
DDVP (Vapona)	18	9.5	7.9
Malathion	14	7.4	6.1
Ronnel (Korlan, Trolene)	9	4.8	3.9
Chlordane	8	4.2	3.5
DDT	8	4.2	3.5
Lindane—Toxaphene	7	3.7	3.1
Oil	6	3.2	2.6
Ruelene	4	2.1	1.7
Methoxychlor	4	2.1	1.7
Pyrethrins	4	2.1	1.7
Rotenone	3	1.6	1.3
Cygon	2	1.1	0.9
Co-Ral	2	1.1	0.9
Nicotine sulfate	1	0.5	0.4
Methoxychlor—Pyrethrins	1	0.5	0.4
Used livestock insecticides but did not know name of chemical	42	22.2	18.3
TOTAL	258*		

*Some farmers used more than one livestock insecticide.
†Number of farmers using livestock insecticides.

Table 9. Self-administered antibiotics used by Iowa farmers in 1964.

Antibiotic	No.	Percent of 116†	Percent of 229
Combiotic	56	48.3	24.5
Penicillin	33	28.4	14.4
Terramycin	26	22.4	11.4
Aueromycin	14	12.1	6.1
Tylosin (Tylan)	8	6.9	3.5
Streptomycin	3	2.6	1.3
Bicillin	2	1.7	0.9
Liquomycin	2	1.7	0.9
Bacitracin	1	0.9	0.4
Hygromycin	1	0.9	0.4
Used self-administered antibiotic but did not know which specific antibiotic	16	13.8	7.0
TOTAL	162*		

*Some farmers used more than one antibiotic.
†Number of farmers using antibiotics.

Table 10. Self-administered sulfas used by Iowa farmers in 1964.

Sulfas	No.	Percent of 36†	Percent of 229
NF-180	11	30.6	4.8
Sulmet	9	25.0	3.9
Phenothiazine	7	19.4	3.1
Copper sulfate—blue vitriol	1	2.8	0.4
Furacin	1	2.8	0.4
Nitrofuracin	1	2.8	0.4
Sulfathiazol	1	2.8	0.4
Self-administered sulfas but did not know which specific sulfa	8	22.2	3.5
TOTAL	39*		

*Some farmers used more than one sulfa.
†Number of farmers using sulfas.

Table 11. Other self-administered animal health products, animal medicinal and animal growth stimulators used by Iowa farmers in 1964.

Animal health products	No.	Percent of 229
Iron compounds	31	13.5
Vaccines	26	11.4
Piperazine (wormer)	15	6.6
Arsenicals	15	6.6
Vitamins	11	4.8
Stilbestrol	9	3.9
Minerals	6	2.6
Coccidiostats	1	0.4
Cortisone	1	0.4
Organic iodide	1	0.4
Unidentifiable animal health products	2	0.9
TOTAL	118	

Table 12. Total amount of money spent by farmers for agricultural chemicals and animal health and growth products in 1964.

Categories of dollars spent	No.	Percent of 229
Under $25	25	10.9
$25 - 49	22	9.6
$50 - 99	42	18.4
$100 - 149	23	10.0
$150 - 199	17	7.4
$200 - 299	31	13.6
$300 - 399	24	10.5
$400 - 599	17	7.4
$600 - over	7	3.1
Used, but purchased chemical before 1964	12	5.2
Does not apply, did not use agricultural chemical	9	3.9
TOTAL	229	100.0

Chemical Expenditures. The distribution in chemical expenditures in 1964 is presented in table 12. The range was from zero to $1,200. The average expenditure for all farmers was $168, while the average for those who purchased chemicals in 1964 was $184.

The analysis of money spent by categories of chemicals is presented in table 13. These expenditures are based on the 210 farmers who purchased agricultural chemicals in 1964. Ten other farmers used chemicals purchased before 1964.

Table 13. Average dollar expenditure per category of agricultural chemicals.

Agricultural chemicals	Average dollar expended per category	Percent of total expenditure
Broadleaf weed killers	$ 53.42	22
Grass killers	108.68	6
Brush killers	16.83	2
Soil insecticides	90.22	25
Crop insecticides	69.12	9
Livestock insecticides	20.27	3
Animal health products, animal medicinals and animal growth stimulators	83.52	33
TOTAL		100.0

Approximately 22 percent of the total dollars spent for agricultural chemicals in 1964 was spent for broadleaf weed killers. Grass killers accounted for slightly more than 6 percent and brush killers for 2 percent. This shows that a total of 30 percent of all expenditures was for herbicides.

Soil insecticides received 25 percent of the farmers' total agricultural chemical expenditures that year. Crop insecticides accounted for 9 percent and livestock insecticides for 3 percent. The broad category of animal health products, animal medicinals and growth stimulators accounted for 33 percent of the total expenditures.

FARMER KNOWLEDGE

Methodology

Many factors complicate the development of an accurate test of farmer knowledge about proper use of agricultural chemicals. Two factors are the large number of chemicals available and the many uses for them. There is also a wide variation in the kind and number of chemicals used by farmers.

There may also be the problem of recall in this study. It may have been 8 to 10 months since the farmer had used a specific chemical. It is possible that he may have possessed the knowledge needed for proper use when he used the chemical, but might have forgotten it by the time he was interviewed. There is also the possibility of some people interpreting some of the questions differently than others.

Limitations had to be put on the amount of time spent on the study and number of items gathered. Therefore, an attempt was made to develop indicator questions to represent a cluster of relevant questions.

Extension specialists in entomology, plant pathology, botany and veterinary medicine developed a 44-item knowledge index to test farmer knowledge about agricultural chemicals. In developing questions to adequately test knowledge, the specialists considered the diversity of agricultural enterprises, agricultural chemical use patterns, a level of knowledge perceived to be needed and the results of pretest interviews with a sample of farmers.

The interview also obtained data on the farming enterprises and type of livestock and crops raised. This helps relate farmer knowledge about agricultural chemicals and their use to different categories of farmers.

The knowledge items were presented in statement form, and the farmer was asked to agree or disagree with each statement. Don't-know or no-opinion answers were also accepted and recorded.

Findings

This section of the knowledge study is divided into two parts. The first section, tables 14 through 18, presents the knowledge items grouped into logical categories—insecticides, herbicides, animal health, safety and general knowledge of agricultural chemicals.

Tables 19 through 22 compare selected knowledge item responses of those raising each of the types of livestock—dairy, beef, swine and poultry—with those who were not raising them. If a farmer had one or more of the specified types of livestock, he was classified as raising that type of livestock.

The reader is reminded of the difficulty present in developing a set of knowledge items that: (a) includes knowledge questions representative of the knowledge needed by farmers engaged in a number of different farming enterprises, who have many pests and who are using a wide variety of agricultural chemicals to combat those pests; and, at the same time, (b) does not include a large number of questions that might be judged not to apply to farmers who have a specialized farming operation, or to farmers who perceive they have few pest problems on which chemicals should be used and, in fact, are not using many agricultural chemicals.

Table 14. Knowledge of insecticides—soil, crop and livestock.

Question	Answered Correctly No.	Percent	Answered Incorrectly No.	Percent	Don't know or no opinion No.	Percent
1. 2,4-D is an effective insecticide for mosquito control. (Correct answer is DISAGREE)	122	53.2	40	17.5	67	29.3
2. DDT is a recommended chemical to be sprayed on milk cows for fly control. (Correct answer is DISAGREE)	161	70.3	31	13.5	37	16.2
3. The U. S. Dept. of Agriculture has the responsibility to enforce the proper use of insecticides. (Correct answer is DISAGREE)	47	20.5	160	69.9	22	9.6
4. Formulations of toxaphene for grasshopper and cutworm control should not be used on livestock. (Correct answer is AGREE)	172	75.1	22	9.6	35	15.3
5. For a fast knockdown of pests attacking livestock, one should use a "combination" spray made up of all recommended livestock insecticides (Correct answer is DISAGREE)	190	83.0	24	10.5	15	6.5
6. Pyrethrin sprays are the only type of insecticides that should be used on milk cows. (Correct answer is DISAGREE)	22	9.6	32	14.0	175	76.4
7. Alfalfa which has been sprayed with Diazinon should not be cut for hay until at least 7 days after treatment. (Correct answer is AGREE)	144	62.9	15	6.5	70	30.6
8. Corn treated with toxaphene should not be made into silage. (Correct answer is AGREE)	112	48.9	27	11.8	90	39.3
9. Two lbs. per acre of actual aldrin or heptachlor which is broadcast and disked in will control all major soil insects attacking corn on sod ground. (Correct answer is AGREE)	103	45.0	72	31.4	54	23.6
10. A 3% chlordane spray can be used to treat the inside surfaces of kitchen cupboards for roaches and ants if the dishes are not replaced in the cupboard until after it is completely dry. (Correct answer is AGREE)	65	28.4	26	11.3	138	60.3
11. Feeder cattle treated with ruelene for grubs can be slaughtered 14 days after treatment. (Correct answer is AGREE)	87	38.0	29	12.6	113	49.4
12. Chlordane is not a recommended residual fly control which can be sprayed on the walls in a dairy barn. (Correct answer is AGREE)	63	27.5	34	14.9	132	57.6
13. Methoxychlor is recommended for lice control on feeder cattle and can be used up to the time of slaughter. (Correct answer is AGREE)	47	20.5	54	23.6	128	55.9
14. Toxaphene is a recommended mange control treatment for hogs if it is applied no later than 28 days before marketing. (Correct answer is AGREE)	81	35.4	30	13.1	118	51.5
15. Lindane is not recommended for direct application to poultry as an insect control. (Correct answer is AGREE)	95	41.5	43	18.8	91	39.7
16. Malathion is recommended for controlling insects on poultry. (Correct answer is AGREE)	61	26.6	26	11.4	142	62.0

Range in percentage of correct answers ..... 83 - 10 percent
Average percentage of correct answers ..... 42.9 percent
Range in percentage of incorrect answers ..... 7 - 70 percent
Average percentage of incorrect answers ..... 18.2 percent
Range in percentage of don't-know or no-opinion answers ..... 10 - 76 percent
Average percentage of don't-know or no-opinion answers ..... 38.9 percent

Table 15. Knowledge of herbicides—weed, grass and brush killers.

Question	Answered Correctly No.	Percent	Answered Incorrectly No.	Percent	Don't know or no opinion No.	Percent
1. The amine form of 2,4-D is the best form to use for the control of broadleaf lawn weeds. (Correct answer is AGREE)	140	61.1	28	12.2	61	26.7
2. For weed control in soybeans Atrazine is a recommended pre-emergence spray. (Correct answer is DISAGREE)	84	36.7	66	28.8	79	34.5
3. Randox-T, 2,4-D and Atrazine are all weed control chemicals which can **safely** be used in corn as pre-emergents. (Correct answer is AGREE)	144	62.9	29	12.6	56	24.5
4. The recommended dosage for spraying 2,4-D on corn at lay-by time using a drop-extension nozzle is ½ lb. or one pint of ester per acre. (Correct answer is DISAGREE)	64	27.9	109	47.6	56	24.5
5. Randox-T is a chemical weed killer which may carry over in the soil and injure the next year's crop. (Correct answer is DISAGREE)	52	22.7	69	30.1	108	47.2
6. Aminotriazole will kill only broadleaf weeds. (Correct answer is DISAGREE)	104	45.4	40	17.5	85	37.1
7. Randox-T kills both annual grassy and broadleaf weeds. (Correct answer is AGREE)	129	56.3	11	4.8	89	38.9
8. Randox should not be applied to corn until it is 6 inches tall. (Correct answer is DISAGREE)	106	46.3	33	14.4	90	39.3
9. As soon as corn starts to silk, it can be sprayed with 2,4-D without risk of reducing yield. (Correct answer is AGREE)	159	69.5	39	17.0	31	13.5
10. Dosage recommendations of weed control chemicals are most accurate when given in in terms of pounds of active ingredients per acre. (Correct answer is AGREE)	166	72.5	37	16.2	26	11.3
11. When corn plants are 18-24 inches in height, they are least likely to be injured from direct application of 2,4-D. (Correct answer is DISAGREE)	139	60.7	74	32.3	16	7.0
12. After spraying a cornfield with 2,4-D ester, it is recommended that you wait 60 days before making silage. (Correct answer is AGREE)	144	62.9	30	13.1	55	24.0
13. When Amino triazole is applied to thistle patches in a pasture, it is recommended that livestock not be allowed on the treated area for 8 months. (Correct answer is AGREE)	67	29.3	93	40.6	69	30.1
14. Amiben is an effective perennial weed killer in soybeans. (Correct answer is DISAGREE)	22	9.6	93	40.6	114	49.8

Range in percentage of correct answers ..... 73 - 10 percent
Average percentage of correct answers ..... 47.4 percent
Range in percentage of incorrect answers ..... 5 - 48 percent
Average percentage of incorrect answers ..... 23.4 percent
Range in percentage of don't-know or no-opinion answers ..... 7 - 50 percent
Average percentage of don't-know or no-opinion answers ..... 29.2 percent

Table 16. Knowledge of animal health, animal medicinals and animal growth stimulators.

Question	Answered Correctly No.	Percent	Answered Incorrectly No.	Percent	Don't know or no opinion No.	Percent
1. Stilbestrol should be withdrawn from the ration 48 hours before marketing the cattle. (Correct answer is AGREE)	173	75.6	29	12.6	27	11.8
2. When arsenic is used in hog feed, it should be withdrawn from the ration 5 days before marketing. (Correct answer is AGREE)	169	73.8	15	6.5	45	19.7
3. No milk from a cow treated with antibiotics for mastitis may be sold until 96 hours after treatment. (Correct answer is AGREE)	141	61.6	53	23.1	35	15.3

Range in percentage of correct answers ..... 76 - 62 percent
Average percentage of correct answers ..... 70.3 percent
Range in percentage of incorrect answers ..... 7 - 23 percent
Average percentage of incorrect answers ..... 14.1 percent
Range in percentage of don't-know or no-opinion answers ..... 12 - 20 percent
Average percentage of don't-know or no-opinion answers ..... 15.6 percent

Table 17. Knowledge about proper safety precautions in using agricultural chemicals.

Question	Answered Correctly No.	Percent	Answered Incorrectly No.	Percent	Don't know or no opinion No.	Percent
1. If a person is doing a lot of spraying, it is a good idea for him to wear the same clothes day after day so as not to contaminate his other clothing. (Correct answer is DISAGREE)	208	90.8	20	8.8	1	0.4
2. An agricultural chemical container may be used after washing it out using a detergent in the water. (Correct answer is DISAGREE)	169	73.8	51	22.3	9	3.9
3. An individual should wash or take a bath immediately after doing any type of spraying. (Correct answer is AGREE)	226	98.7	3	1.3	0	0.0
4. The most effective method for disposing of aerosol cans when they are empty is to put them in the trash and burn them. (Correct answer is DISAGREE)	150	65.5	70	30.6	9	3.9
5. Farmers should never apply any agricultural chemical in such a way that these chemicals can ever get into lakes, ponds or streams. (Correct answer is AGREE)	218	95.2	9	3.9	2	0.9

Range in percentage of correct answers ..... 99 - 66 percent
Average percentage of correct answers ..... 84.8 percent
Range in percentage of incorrect answers ..... 1 - 31 percent
Average percentage of incorrect answers ..... 13.4 percent
Range in percentage of don't-know or no-opinion answers ..... 0 - 4 percent
Average percentage of don't-know or no-opinion answers ..... 1.8 percent

The wide range in the percentages of correct, incorrect and don't-know or no-opinion answers is evident. Ninety percent of the farmers answered four items correctly. All four items dealt with aspects directly concerned with safety. The three items that were answered by the highest percentage include two items of a general nature and one item on a commonly used chemical.

The respondents perceived incorrectly that the U. S. Department of Agriculture had the responsibility to enforce the proper use of insecticides when, in reality, the major enforcement responsibility rests with the Food and Drug Administration.

They also believed that when pests become resistant to present chemicals, new chemicals have to be made more poisonous to kill them. This leaves out the alternative of developing a new chemical that will kill the pest, but actually be less or no more poisonous.

Finally, nearly half the respondents answered incorrectly a question dealing with the recommended dosage of 2,4-D on corn. Remember that 2,4-D is by far the most used weed killer.

The highest percentage of don't-know or no-opinion answers occurred in relation to questions dealing with specific name chemicals and usually for specific uses.

Several knowledge questions dealt with restrictions placed on the use of crops or produce after being treated with agricultural chemicals. A wide range of correct answers appeared here also. For example, 76 percent answered correctly a question dealing with the withdrawal of stilbestrol before marketing. However, in the case of the use of Amino triazole on thistles and the recommended time period before livestock should be allowed on the pasture, only 30 percent gave correct answers.

Another approach to analyzing all the knowledge data is to aggregate all knowledge items for all people answering the items and compute averages. These averages will "cover up" the wide distribution apparent in the data. Such an analysis shows that 54.7 percent of the answers were *correct,* 18.9 percent were *incorrect* and 26.4 percent were *no-opinion* or *don't-know* answers. If one uses the five categories of knowledge items, it is found that the percentage of correct, incorrect and no-opinion or don't-know answers were distributed as follows:

	Correct	Incorrect	No opinion
Proper safety precautions	84.8	13.4	1.8
General knowledge	70.6	17.5	11.0
Animal health, medicinals and growth stimulators	70.3	14.1	15.6
Herbicides	47.4	23.4	29.2
Insecticides	42.9	18.2	38.9

Table 18. General knowledge about agricultural chemicals and their use.

Question	Answered Correctly No.	Percent	Incorrectly No.	Percent	Don't know or no opinion No.	Percent
1. Milk is not legally saleable if it contains any trace of agricultural chemicals. (Correct answer is AGREE)	201	87.8	15	6.5	13	5.7
2. The only two ways in which agricultural chemicals may be taken into the human body are through the nose and the mouth. (Correct answer is DISAGREE)	183	79.9	39	17.0	7	3.1
3. In order to kill pests which have become resistant to present chemicals, new chemicals have to be made more poisonous. (Correct answer is DISAGREE)	106	46.3	98	42.8	25	10.9
4. Pesticides in milk and other foods are detrimental because they may produce cancer. (Correct answer is AGREE)	85	37.1	48	21.0	96	41.9
5. It is necessary to pass a comprehensive test and receive a license before anyone can apply an agricultural chemical as a commercial or custom application. (Correct answer is AGREE)	174	76.0	38	16.6	17	7.4
6. The skull and crossbones on a label indicates that the pesticide is highly toxic to humans. (Correct answer is AGREE)	220	96.1	3	1.3	6	2.6

Range in percentage of correct answers	96 - 37 percent
Average percentage of correct answers	70.6 percent
Range in percentage of incorrect answers	1 - 43 percent
Average percentage of incorrect answers	17.5 percent
Range in percentage of don't-know or no-opinion answers	3 - 42 percent
Average percentage of don't-know or no-opinion answers	11.9 percent

Comparisons were made on questions dealing with agricultural chemical use on specific types of livestock —swine, beef cattle, dairy cattle and poultry. There again was a wide range of responses on individual knowledge items. In general, a higher percentage of those who did not raise the specific type of livestock gave don't-know or no-opinion answers. However, in no category of livestock was the difference more than 20 percent.

If one analyzes tables 19 through 22, which include the don't-know or no-opinion answers, it may be observed that in all but two questions a higher percentage of those raising the specific type of livestock gave correct answers. However, the difference may not be as large as might be expected.

Using this same procedure, however, it may be noted that on the majority of questions, those raising the specific type of livestock also gave a higher percentage of incorrect answers. This is possible due to the inclusion of the don't-know or no-opinion answers in the computations. Another way to compare these is to eliminate the don't-know or no-opinion answers from the computations.

Table 19. Knowledge test responses of farmers who have dairy cattle compared with those who do not have dairy cattle.

Question	Have dairy cattle (N=114) Correct No.	%	Incorrect No.	%	No opinion No.	%	Total	Do not have dairy cattle (N=115) Correct No.	%	Incorrect No.	%	No opinion No.	%	Total
1. DDT is a recommended chemical to be sprayed on milk cows for fly control. (Correct answer is DISAGREE)	85	74.5	15	13.2	14	12.3	114	76	66.1	16	13.9	23	20.0	115
2. Pyrethrin sprays are the only type of insecticides that should be used on milk cows. (Correct answer is DISAGREE)	13	11.4	22	19.3	79	69.3	114	9	7.8	10	8.7	96	83.5	115
3. No milk from a cow treated with antibiotics for mastitis may be sold until 96 hours after treatment. (Correct answer is AGREE)	68	59.7	39	34.2	7	6.1	114	73	63.5	14	12.2	28	24.3	115
4. Chlordane is not a recommended residual fly control which can be sprayed on the walls in a dairy barn. (Correct answer is AGREE)	33	28.9	18	15.8	63	55.3	114	30	26.1	16	13.9	69	60.0	115
Average Percentage		43.6		20.6		35.8			40.9		12.2		46.9	

Table 20. Knowledge test responses of farmers who have beef cattle compared with those who do not have beef cattle.

Question	Have beef cattle (N=167) Correct No.	%	Incorrect No.	%	No opinion No.	%	Total	Do not have beef cattle (N=62) Correct No.	%	Incorrect No.	%	No opinion No.	%	Total
1. Stilbestrol should be withdrawn from the ration 48 hours before marketing the cattle. (Correct answer is AGREE)	132	79.0	20	12.0	15	9.0	167	41	66.1	9	14.5	12	19.4	62
2. Feeder cattle treated with Ruelene for grubs can be slaughtered 14 days after treatment. (Correct answer is AGREE)	69	41.3	25	15.0	73	43.7	167	18	29.0	4	6.5	40	64.5	62
3. Methoxychlor is recommended for lice control on feeder cattle and can be used up to the time of slaughter. (Correct answer is AGREE)	33	19.8	46	27.5	88	52.7	167	14	22.6	8	12.9	40	64.5	62
Average Percentage		46.7		18.2		35.1			39.2		11.3		49.5	

Table 21. Knowledge test responses of farmers who have swine compared with those who do not have swine.

Question	Have swine (N=189) Correct No.	%	Incorrect No.	%	No opinion No.	%	Total	Do not have swine (N=40) Correct No.	%	Incorrect No.	%	No opinion No.	%	Total
1. When arsenic is used in hog feed, it should be withdrawn from the ration 5 days before marketing. Correct answer is AGREE)	145	76.7	13	6.9	31	16.4	189	24	60.0	2	5.0	14	35.0	40
2. Toxaphene is a recommended mange control treatment for hogs if it is applied no later than 28 days before marketing. (Correct answer is AGREE)	71	37.6	28	14.8	90	47.6	189	10	25.0	2	5.0	28	70.0	40
Average Percentage		57.1		10.9		30.0			42.5		5.0		52.5	

Table 22. Knowledge test responses of farmers who have poultry compared with those who do not have poultry.

Question	Have Poultry (N=137) Correct No.	%	Incorrect No.	%	No opinion No.	%	Total	Do not have poultry (N=92) Correct No.	%	Incorrect No.	%	No opinion No.	%	Total
1. Lindane is not recommended for direct application to poultry as an insect control. (Correct answer is AGREE)	68	49.6	27	19.7	42	30.7	137	27	29.3	16	17.4	49	53.3	92
2. Malathion is recommended for controlling insects on poultry. (Correct answer is AGREE)	39	28.5	15	10.9	83	60.6	137	22	23.9	11	12.0	59	64.1	92
Average Percentage		39.1		15.3		45.6			26.6		14.7		58.7	

Additional summary statistics may be presented as follows:

Number of respondents 229
Number of knowledge statements 44
Range of knowledge scores (correct responses) 10-40
Median knowledge score (correct responses) 24
Mean score (average number correct responses) 24.07
Standard deviation 5.14

The bar graph (fig. 1) presents the distribution of the *correct* responses to the 44-item knowledge test. The incorrect and don't-know or no-opinion answers aren't included in the graph. The distribution approximates a normal distribution of *correct* answers.

FARMER ATTITUDES

Methodology

Attitudes have been defined as a set of tendencies to act in relation to stimuli received. In order to measure attitudes, stimuli were interjected into the interview situation by reading statements about agricultural chemicals to the respondents. The respondents were then asked to agree or disagree with the statements. No-opinion answers were also accepted.

The 33 attitude statements in the study were taken from bulletins, speeches and publications of individuals and groups who have varying opinions about the efficacy of the use of agricultural chemicals. The ques-

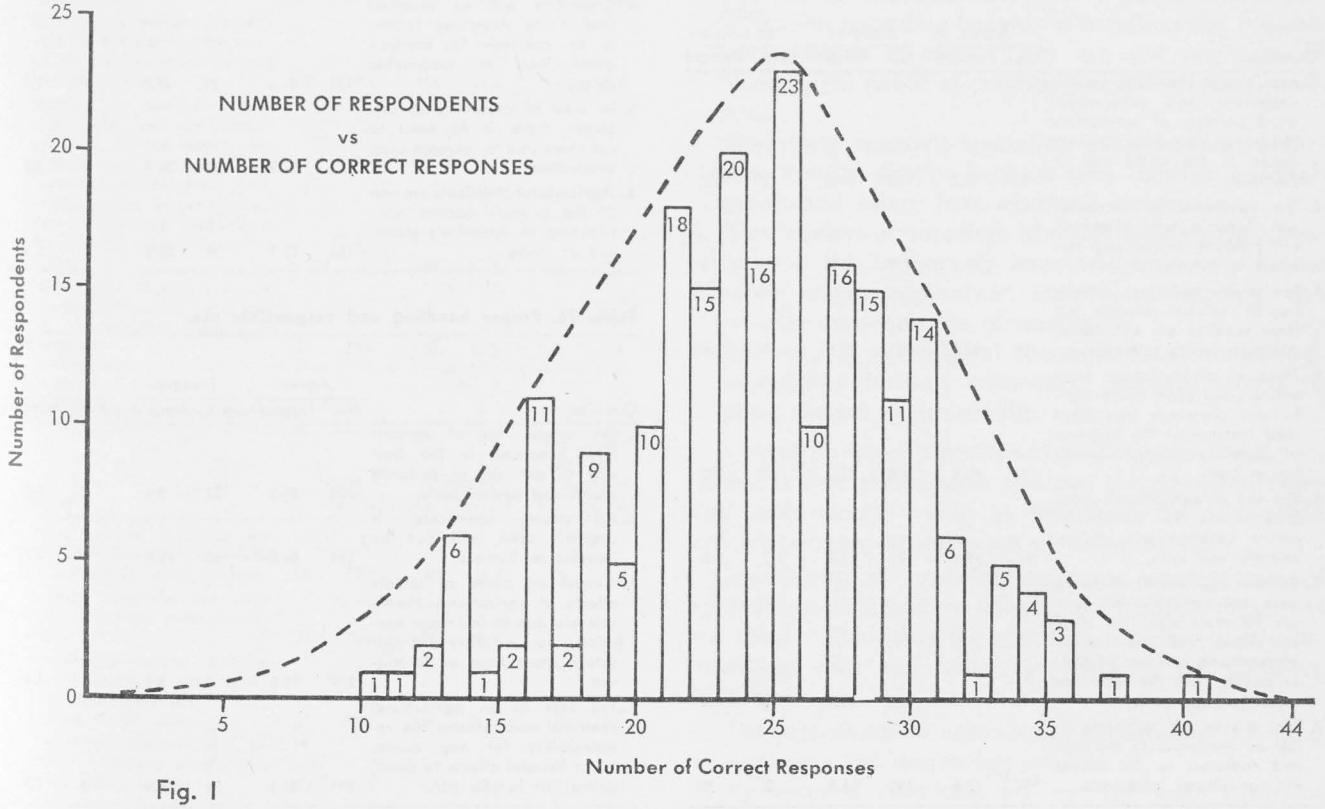

Fig. 1

tions were pretested with a sample of farmers before being used in the study.

No judgments were made by the authors about the actual validity of any of the statements. The assumption was that farmers in this study had been exposed or would be exposed to similar statements. The objective in this study, then, was to attempt to assess some of the attitudes of farmers toward agricultural chemicals by using these statements as a methodological tool.

Table 23. Harmful effects to wildlife, crops and plants.

Question	Agree		Disagree		No answer and/or no opinion	
	No.	Percent	No.	Percent	No.	Percent
1. Present use of agricultural chemicals is polluting our rivers and destroying wildlife.	167	72.9	61	26.7	1	0.4
2. Roadside weed sprays kill great numbers of wildlife.	104	45.4	122	53.3	3	1.3
3. Agricultural chemicals are the main cause of water pollution which kills fish.	83	36.2	141	61.6	5	2.2
4. Insecticides, even when used at recommended rates, build up in the soil to kill life other than the insects they are supposed to kill.	105	45.8	116	50.7	8	3.5
5. Continued spraying will exterminate the robins.	67	29.3	153	66.8	9	3.9
6. There has been a steady decline in all wildlife numbers since the use of agricultural chemicals began.	88	38.4	132	57.7	9	3.9

Table 24. Potential harmful consequences to humans—balance of nature.

Question	Agree		Disagree		No answer and/or no opinion	
	No.	Percent	No.	Percent	No.	Percent
1. Agricultural chemicals are the dangerous and little-recognized partners of radioactive fallout in changing the very nature of the world and of life itself.	80	35.0	137	59.8	12	5.2
2. The continued or increased use of agricultural chemicals will produce cancer and leukemia in humans.	76	33.2	136	59.4	17	7.4
3. Few if any foods are entirely free of chemical residues, but these residues are well below minimum health tolerances.	189	82.5	31	13.6	9	3.9
4. There is great danger from eating food upon which agricultural chemicals have been used because of the build-up of chemical residue in the human body	114	49.8	108	47.2	7	3.0
5. The use of agricultural chemicals upsets the balance of nature between soil, plants, animals and man.	101	44.1	123	53.7	5	2.2
6. Because agricultural chemicals were not available for farm use 50 years ago, the meat and food had less foreign contaminants and was of higher quality than the food and meat we buy today.	73	31.9	146	63.7	10	4.4
7. The misuse of fertilizers is just as dangerous to the user and consumer as the misuse of agricultural chemicals.	97	42.3	130	56.8	2	.9

Findings

The attitude statements have been classified into meaningful categories in tables 23-28. Table 29 presents additional data regarding the farmers' perceptions of how concerned the general public is about possible detrimental or harmful effects from the use of agricultural chemicals.

The detailed analysis and interpretation of the statements and findings is left to the reader. However, a brief summary of the attitude findings is also included.

It is difficult and possibly misleading to combine the responses to individual attitude statements into statements that may be generalized to apply to the majority of farmers.

However, if one assumes that individual attitudes can be aggregated and combined; if he assumes that attitudes within individuals are consistent; and if he assumes that if positive statements had been given as

Table 25. Productive capacity, economic returns.

Question	Agree		Disagree		No answer and/or no opinion	
	No.	Percent	No.	Percent	No.	Percent
1. Through the wide use of agricultural chemicals, man has managed to stave off starvation and disease in many parts of the world.	184	80.4	41	17.9	4	1.7
2 The use of agricultural chemicals is a profitable input in the farmer's operation.	214	93.5	12	5.2	3	1.3
3. The use of agricultural chemicals is essential to provide the food and fiber necessary to our way of life.	153	66.8	71	31.0	5	2.2
4. Chemicals are an essential tool if the American farmer is to continue to produce good food at reasonable prices.	186	81.3	39	17.0	4	1.7
5. In view of present crop surpluses, there is no need to use chemicals to increase crop production.	52	22.8	173	75.5	4	1.7
6. Agricultural chemicals are one of the primary factors contributing to America's standard of living.	165	72.1	58	25.3	6	2.6

Table 26. Proper handling and responsible use.

Question	Agree		Disagree		No answer and/or no opinion	
	No.	Percent	No.	Percent	No.	Percent
1. The proper use of agricultural chemicals is the best way to get rid of nuisance plants and control pests.	205	89.5	22	9.6	2	0.9
2. Agricultural chemicals, if properly used, will not be harmful to humans.	194	84.8	31	13.5	4	1.7
3. Almost all cases of deadly effects of agricultural chemicals are due to improper handling, to a disregard for safety precautions or to misuse.	219	95.6	7	3.1	3	1.3
4. The user of an agricultural chemical must assume the responsibility for any consequent harmful effects to plant, animal or human life.	193	84.3	33	14.4	3	1.3

negative statements instead, the same conclusion about attitudes would be drawn; then the following summary statements appear warranted:

A majority of the farmers appear to have these *favorable* attitudes toward *the role of agricultural chemicals:*

1. The proper use of agricultural chemicals is the best way to get rid of nuisance plants and control pests. Through their use man has managed to stave off disease and starvation in many parts of the world.
2. Agricultural chemicals are one of the primary factors contributing to the U. S. standard of living and way of life. They are an essential tool if the American farmer is to continue to produce good food at reasonable prices. Food and meat produced before the introduction of agricultural chemicals *did not* have less foreign contaminants and was *not* of higher quality. Even if one assumes present crop surpluses, there is still need for chemicals to increase crop production.
3. The use of agricultural chemicals is a profitable input in the farmer's operation.

Table 27. Responsibility for adequate and factual information about use.

Question	Agree		Disagree		No answer and/or no opinion	
	No.	Percent	No.	Percent	No.	Percent
1. The agricultural chemical companies are producing and selling many chemicals before they have adequate information regarding hazards of handling and possible consequences of use.	92	40.2	135	58.9	2	0.9
2. One of the main reasons that university research specialists report favorable results from the use of agricultural chemicals is **because** they receive research grants and salary from the chemical companies.	46	20.1	173	75.5	10	4.4
3. Governmental agencies should be spending more time and energy than they are now spending in an effort to determine the immediate and long-range consequences of chemical use.	171	74.7	55	24.0	3	1.3
4. Chemical companies are negligent in not warning the public of the potential hazards of their products.	70	30.6	158	69.0	1	0.4
5. Most of the dealers or suppliers who sell agricultural chemicals to the farmer are selling them without adequate information about proper application, about the hazards of handling, and about the possible consequences of misuse.	81	35.4	143	62.4	5	2.2
6. Agricultural chemicals should be labeled "poison" and sold only by persons licensed to do so.	120	52.4	106	46.3	3	1.3

Table 28. Pest control methods.

Question	Agree		Disagree		No answer and/or no opinion	
	No.	Percent	No.	Percent	No.	Percent
1. Good cultural practices are more effective than chemicals in controlling weed growth.	144	62.9	80	34.9	5	2.2
2. Sprayed roadsides are much more ugly than mowed roadsides.	174	76.0	54	23.6	1	0.4
3. Introducing natural enemies of the insects is more effective than chemicals in controlling insect pests.	59	25.8	164	71.6	6	2.6
4. People have become lazy. Instead of pulling weeds, they spray, spray, spray.	137	59.8	89	38.9	3	1.3

When considering the *possible danger of agricultural chemicals to humans* a majority of the farmers agreed that:

1. Agricultural chemicals, if properly used, will not be harmful to humans.
2. Almost all deadly effects of agricultural chemicals are due to improper handling, a disregard for safety precautions or improper use.
3. While few, if any, foods are entirely free of chemical residues, these residues are well below the minimum health tolerances.
4. Agricultural chemicals are *not* "dangerous and little recognized partners of radioactive fallout in changing the very nature of the world and life itself." The continued or increased use of agricultural chemicals will *not* produce cancer and leukemia in humans.

In terms of responsibility for testing, marketing, education and use related to agricultural chemicals the following generalizations appear to apply to the attitudes of a *majority* of farmers.

1. Agricultural chemical companies are *not* producing and selling chemicals before they have adequate information regarding hazards of handling and possible consequences of use. They are *not* negligent in warning the public of potential hazards of their products.
2. University research specialists *do not* report favorable results simply because they receive research grants and salary from chemical companies.
3. Most dealers or suppliers who sell agricultural chemicals to the farmer *do* have adequate information about proper application, hazards of handling and possible consequences of misuse.
4. The user of agricultural chemicals must assume responsibility for any consequent harmful effects to plant, animal or human life.

A point on which three-fourths of the sample farmers agreed is that government agencies should spend more time and energy trying to determine the immediate and long-range consequences of chemical use.

Considering the possible negative consequences of agricultural chemicals to wildlife, the attitude pattern is not clear. The following attitudes, not necessarily inconsistent with each other, are held by the majority of farmers:

1. The present use of agricultural chemicals is polluting our rivers and destroying wildlife.
2. Agricultural chemicals are not the main cause of

water pollution that kills fish. And continued spraying will not exterminate the robins.

There is a high degree of agreement that agricultural chemicals are the best way to get rid of pests. Still, the majority believe that good cultural practices are more effective than chemicals in controlling weeds. On the other hand, most farmers don't believe that introducing natural enemies of the insects is an effective control for these pests.

There were also a number of attitude statements where there was little agreement—the agree and disagree response distribution was within the range of 40 to 60 percent. Among these response areas were:

1. The use of agricultural chemicals upsets the balance of nature.
2. There is great danger from eating food treated with agricultural chemicals because of the build-up of chemical residues in the human body.
3. Insecticides used at recommended rates build up in the soil to kill life other than the insects they are supposed to kill.
4. There has been a steady decline in all wildlife numbers since the use of agricultural chemicals began. And, more specifically, roadside weed spraying kills great numbers of wildlife.
5. Agricultural chemicals should be labeled "poison" and sold only by persons licensed to do so.

As pointed out in the introduction to this section, the difficulty of aggregating attitudes derived from the specific attitude statements is recognized. The reader may wish to refer to the exact wording of the statement and the exact percentage figures for his own more detailed analysis.

Perceptions of Public Concern

The final attitude question dealt with the farmer's perceptions of the general public's concern about the use of agricultural chemicals. This perception could affect the farmer's attitudes and behavior concerning the use of agricultural chemicals. For example, if the farmer is influenced by the general public or if he is concerned about the possible market or price for his product, his attitudes and behavior in relation to agricultural chemicals might be changed by the public's concern.

The farmers were asked to indicate their opinion of how concerned the general public is about possible detrimental or harmful effects from the use of agricultural chemicals. Table 29 shows these results.

Table 29. Indicate your opinion of how concerned the general public is about possible detrimental or harmful effects from the use of agricultural chemicals.

Response	Number	Percent
Not concerned	30	13.1
A little concerned	121	52.8
Quite concerned	66	28.8
Very greatly concerned	10	4.4
No answer	2	0.9
TOTAL	229	100.0

Slightly over half of the sample farmers perceive the general public to be only "a little concerned" about the possible detrimental or harmful effects from the use of agricultural chemicals. Approximately 29 percent perceived the general public to be "quite concerned."

INFORMATION SOURCES

Methodology

In order to know how to reach farmers with chemical information, the respondents were asked what information sources they use to learn about agricultural chemicals. Each respondent was given a list of types of information sources. This list included companies and dealers, USDA-Extension, community organizations, mass media, personal sources and product containers. The validity of the various types of information sources listed was based on past agricultural chemical research with farmers and field testing prior to the actual survey.

The farmers were first asked which of the sources of information they were presently using. Then they were asked five questions about the most useful source to them. These questions were: "Which source is most useful: (1) in helping you select the best chemical to do the job properly, (2) in providing information regarding the methods and rate of application of agricultural chemicals, (3) regarding what safety precautions should be used in handling and applying agricultural chemicals, (4) in informing you about any hazards or possible harmful consequences as a result of the misuse of agricultural chemicals and (5) informing you about any new agricultural chemicals?"

A second part of the information sources analysis deals with an evaluation of the dealer as an information source. Each respondent was given a card listing the types of agricultural chemical dealers who make their services as a supplier readily available to the farmer. The farmer was then asked from which source he bought his supply of chemicals for each of the seven functional categories of agricultural chemicals—broadleaf weed killers, grass killers, brush killers, soil insecticides, crop insecticides, livestock insecticides and animal health products.

One role the agricultural chemical dealer may play in his service to the farmer is to provide information about the use of the product he sells. The research team, in consultation with the extension specialists, developed 20 types of information they believed the dealer might provide to farmers when they buy an agricultural chemical product. The farmer was given a card listing these types of information. He was then asked to indicate those types of information, if any, which his supplier or dealer provided. Then, the farmer was asked to rank in order the three types of information most important to him. Finally, the farmer was asked to indicate his opinion as to whether this information was adequate or inadequate.

Continuing the evaluation of the agricultural chemical dealer as a source of information, the farmer was asked to evaluate his dealer as: a highly qualified source of information on all aspects of agricultural chemicals and their use; a qualified source of information; a poorly qualified source; or just a source of supply for the agricultural chemicals, but not qualified to give information.

Finally, if the farmer responded that his supplier or dealer was more than just a source of supply, he was asked if he expected him to make recommendations about agricultural chemicals and their use.

Findings

The sources of information mentioned as presently being used have been placed in categories. Table 30 shows the number of times each source was mentioned. The respondents were asked to indicate all the sources they were presently using, and the percentage figures are computed on the basis of the percent of the 229 respondents.

The most frequently named source of information was farm magazines and papers, named by 94 percent. Ninety percent of the farmers indicated they obtained information from the product container. Other frequently named sources of information were: other farmers in the community, 68 percent; local agricultural chemical dealers, 61 percent; radio, 49 percent; county extension personnel, 48 percent; veterinarians, 44 percent; and agricultural chemical company publications, 42 percent.

The farmers who reported that they were using farm magazines and papers were asked to specify the magazines and papers they were using. These responses are listed in table 31. Many other magazines and papers were named only once.

Most useful sources

Five additional questions were asked to attempt to determine the *most useful source* of information related to five specific aspects of agricultural chemical use. Data related to these questions are presented in table 32.

It should be noted that the question specified that agricultural chemicals for animal health, medicinals and growth stimulators were to be excluded in answering these questions. This was done because a pretest of the questions showed a sharp difference in sources used for these chemicals compared with the other categories.

The detailed analysis of the table is left to the reader. However, certain summary statements can be made.

The local agricultural chemical dealer and farm magazines and papers were regarded as the most useful sources in helping select the best chemical to do the job—each named by approximately one-fifth of the sample.

Almost 70 percent stated that the product container was the most useful source for methods and rates of application; 62 percent said it was the most useful for

Table 30. Sources of information presently being used (categories).

Source of information	Presently using No.	Percent of 229
Company-Dealer		
Clinics and short courses sponsored by agricultural chemical companies	57	24.9
Clinics and short courses sponsored by local agricultural chemical dealers	58	25.3
Agricultural chemical company publications	95	41.5
Local agricultural chemical dealers	139	60.7
Salesmen for agricultural chemical manufacturers or wholesalers	41	17.9
USDA-Extension		
Clinics and short courses sponsored by Iowa State University and the Agricultural Extension Service	38	16.6
United States Department of Agriculture publications	47	20.5
Agricultural Extension publications	80	34.9
County Extension personnel	109	47.6
Iowa State University specialists	32	14.0
Mass Media		
Farm magazines and farm papers	216	94.3
Newspapers	82	35.8
Iowa Farm Science	23	10.0
Television	97	42.4
Radio	112	48.9
Other publications	4	1.7
Organizations		
Iowa Institute for Agricultural Medicine	3	1.3
Community organization	7	3.1
Farm Bureau	19	8.3
A.S.C. meetings	1	0.4
Acquaintances		
A member of my family (such as father, son or brother)	58	25.3
Other farmers in the community	155	67.7
Landlord	13	5.7
Vocational agriculture teacher	33	14.4
Banker	7	3.1
Farm manager	4	1.7
Veterinarian	100	43.7
Container in which product comes, such as bag, box, etc.	207	90.4
Other		
Past experiences	1	0.4

Table 31. Farm magazines and farm papers named as source of information about agricultural chemicals.

Farm magazines and farm papers	No.	Percent of 229
Farm Journal	160	69.9
Wallaces Farmer	152	66.4
Successful Farming	130	56.8
Farm Quarterly	10	4.4
Hoard's Dairyman	8	3.5
Cappers Weekly	6	2.6
Big Farmer	4	1.7
Iowa Farm Science	3	1.3
Farm Bureau Spokesman	3	1.3
The Farmer	3	1.3
Doane's Agriculture Newsletter	2	0.9
Journal Minnesota Farmer	2	0.9

Table 32. We would like to ask you where you are getting your information concerning agricultural chemicals we have been discussing, with the exception of animal health, animal medicinals and animal growth stimulators.

Source of information	Col. 1: Most useful regarding which chemical to use to do the job properly		Col. 2: Most useful regarding methods of application and rates of application		Col. 3: Most useful regarding handling and safety precautions to use		Col. 4: Most useful regarding hazards and possible harmful consequences of misuse of agricultural chemicals		Col. 5: Most useful in gaining information regarding new agricultural chemicals	
	No.	% of 229	No.	% of 229	No.	% of 229	No.	% of 229	No.	% of 229
Company-Dealer										
Clinics and short courses sponsored by agricultural chemical companies	3	1.3	3	1.3	2	0.9	9	3.9	7	3.1
Clinics and short courses sponsored by local agricultural chemical dealers	5	2.2	4	1.7	3	1.3	4	1.7	3	1.3
Agricultural chemical company publications	3	1.3	0	0.0	0	0.0	0	0.0	3	1.3
Local agricultural chemical dealers	49	21.5	17	7.4	16	7.0	15	6.6	18	7.9
Salesmen for agricultural chemical manufacturers or wholesalers	6	2.6	3	1.3	4	1.7	2	0.9	6	2.6
Total	66	28.9	27	11.8	25	10.9	30	13.1	37	16.2
USDA-Extension										
Clinics and short courses sponsored by Iowa State University and the Agricultural Extension Service	10	4.4	2	0.9	7	3.1	7	3.1	13	5.7
Agricultural Extension publications	5	2.2	4	1.7	2	0.9	4	1.7	4	1.7
United States Department of Agriculture publications	4	1.7	0	0.0	2	0.9	3	1.3	2	0.9
County Extension personnel	25	10.9	6	2.6	6	2.6	9	3.9	22	9.6
Iowa State University specialists	3	1.3	1	0.4	1	0.4	2	0.9	4	1.7
Total	47	20.5	13	5.6	18	7.9	25	10.9	45	19.6
Mass Media										
Farm magazines and farm papers	47	20.5	13	5.7	21	9.3	53	23.1	118	51.5
Newspapers	2	0.9	0	0.0	1	0.4	7	3.1	3	1.3
Iowa Farm Science	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4
Television	0	0.0	0	0.0	1	0.4	1	0.4	2	0.9
Radio	3	1.3	0	0.0	3	1.3	6	2.6	6	2.6
Other publications	0	0.0	1	0.4	0	0.0	1	0.4	0	0.0
Total	52	22.7	14	6.1	26	11.4	68	29.6	130	56.7
Organizations										
Iowa Institute for Agricultural Medicine	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Community organization	1	0.4	0	0.0	1	0.4	1	0.4	1	0.4
Farm Bureau	0	0.0	0	0.0	0	0.0	1	0.4	1	0.4
A.S.C. meetings	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	1	0.4	0	0.0	1	0.4	2	0.8	2	0.8
Acquaintances										
A member of my family (such as father, son or brother)	1	0.4	4	1.7	2	0.9	2	0.9	0	0.0
Other farmers in the community	13	5.8	9	3.9	9	3.9	14	6.1	6	2.6
Landlord	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Vocational agriculture teacher	4	1.7	1	0.4	1	0.4	1	0.4	3	1.3
Banker	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0
Farm manager	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0
Veterinarian	3	1.3	0	0.0	0	0.0	0	0.0	0	0.0
Total	23	10.0	14	6.0	12	5.2	17	7.4	9	3.9
Container in which product comes; such as bag, box, etc.	33	14.4	158	69.0	143	62.4	81	35.5	1	0.4
Other										
Past experiences	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0
No answer	6	2.6	3	1.3	4	1.7	6	2.6	5	2.2
Total	7	3.1	3	1.3	4	1.7	6	2.6	5	2.2

safety precautions. The container was also named as a useful source regarding hazards and possible harmful consequences as a result of misuse. Slightly over half the farmers questioned named farm magazines and papers as the most useful source of information about *new* chemicals.

Local agricultural chemical suppliers

One source of information readily available to the farmer is the agricultural chemical dealer. This study found that 61 percent of the farmers said they use the dealer as a source of information. Dealers were ranked particularly high as a source of information on the best chemical to do the job properly.

To better evaluate the supplier's role, it is relevant to determine the types of suppliers farmers purchase their chemicals from. Also it is helpful to know what type of suppliers the farmers are referring to when they report the type of information and evaluate the adequacy of the information they receive from their supplier.

Suppliers from whom farmers purchase chemicals

The farmer was handed a card listing the different sources of supply where a farmer might purchase agricultural chemicals. He was asked to indicate from which of these, if any, he purchased the specified categories of chemicals. The data given in response to these questions are presented in table 33. The source of supply was asked of only those farmers who had previously stated that they used the specified category of chemicals.

The most frequently named source of supply was feed and seed stores, followed by farmers' cooperative elevators. Veterinarians were named by the largest number of users of livestock insecticides and animal health products. Cooperative elevators were named by the

Table 33. **Question: Listed below are sources of supply where a farmer might purchase agricultural chemicals. From which of these, if any, did you buy your .....?**

	Col. 1		Col. 2		Col. 3		Col. 4		Col. 5		Col. 6		Col. 7		Col. 8	
	Broadleaf weed killers		Grass killers		Brush killers		Soil Insecticides		Crop Insecticides		Livestock Insecticides		Animal Health Products		Total	
Source of supply	No.	% of 166*	No.	% of 25*	No.	% of 46*	No.	% of 110*	No.	% of 15*	No.	% of 187*	No.	% of 157*	No.	% of 229*
Farmers' co-op elevator	51	30.7	6	24.0	14	30.4	30	27.3	4	26.7	23	12.3	11	7.0	**139**	**60.7**
Private or corporation elevator	12	7.2	5	20.0	4	8.7	12	10.9	0	0.0	5	2.7	7	4.5	45	19.7
Feed and seed store	36	21.7	3	12.0	4	8.7	22	20.0	2	13.3	37	19.8	38	24.2	142	62.0
Farm service companies (Farm Bureau)	14	8.4	4	16.0	6	13.0	6	5.5	1	6.7	10	5.3	10	6.4	51	22.3
Petroleum dealers	13	7.8	2	8.0	4	8.7	7	6.4	2	13.3	5	2.7	0	0.0	33	14.4
Implement dealers	7	4.2	1	4.0	2	4.3	3	2.7	0	0.0	1	0.5	0	0.0	14	6.1
Veterinarian	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	45	24.1	76	48.4	121	**52.8**
Drug stores	2	1.2	0	0.0	0	0.0	0	0.0	2	13.3	17	9.1	34	21.7	55	24.0
Farmer-dealer	4	2.4	0	0.0	0	0.0	3	2.7	1	6.7	5	2.7	9	5.7	22	9.6
On-the-farm chemical salesman	2	1.2	0	0.0	1	2.2	1	0.9	1	6.7	26	13.9	5	3.2	36	15.7
Grocery stores	1	0.6	0	0.0	0	0.0	1	0.9	0	0.0	1	0.5	3	1.9	6	2.6
Seed corn dealer	0	0.0	1	4.0	2	4.3	10	9.1	2	13.3	0	0.0	0	0.0	15	6.6
Hardware store	4	2.4	0	0.0	0	0.0	0	0.0	0	0.0	4	2.1	0	0.0	8	3.5
General farm supply store	23	13.9	0	0.0	3	6.5	9	8.2	0	0.0	15	8.0	14	8.9	64	27.9
Produce station	1	0.6	0	0.0	0	0.0	2	1.8	1	6.7	7	3.7	11	7.0	22	9.6
Mail order company	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.5	0	0.0	1	0.4
Garden supply store	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.4
Jobbers and wholesale distributors of agricultural chemicals	6	3.6	3	12.0	5	10.9	8	7.3	0	0.0	2	1.1	3	1.9	27	11.8
Fertilizer and chemical dealer	0	0.0	0	0.0	0	0.0	3	2.7	1	6.7	3	1.6	0	0.0	7	3.1
Commercial applicator	5	3.0	0	0.0	0	0.0	0	0.0	0	0.0	3	1.6	0	0.0	8	3.5
Livestock dealer	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	1	0.4
Neighbor and/or relative	1	0.6	0	0.0	2	4.3	0	0.0	0	0.0	1	0.5	0	0.0	4	1.7
Creamery	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	4	2.1	0	0.0	4	1.7
Total number sources named	183†		25†		47†		117†		17†		215†		222†		826†	
Used this category of chemicals in 1964	166		25		46		110		15		187		157		706	
No answer (Used, did not purchase in 1964)	0		0		0		5		2		2		2		11	
Did not use chemicals in this category	63		204		183		114		212		40		70		**886**	

*Percentage is figured as proportion of farmers who **purchased** this category of agricultural chemicals in 1964.
†Some farmers purchased a particular category of agricultural chemicals from **more than one** source of supply.

Table 34. Statement: One source of information about agricultural chemicals is the local supplier or dealer of agricultural chemicals. Indicate those types of information, if any, which your supplier or dealer provides to you. From the types of information you have just indicated that you are receiving from your dealer, rank the three most important to you in 1, 2, 3 order.

	Col. 1		Col. 2		Col. 3		Col. 4		Col. 5		Col. 6	
	Rank 1		Rank 2		Rank 3		Mentioned not ranked		Total mentions		Not mentioned	
Type of information	No.	% of 229	No.	% of 229	No.	% of 229	No.	% of 229	No.	% of 229	No.	% of 229*
What to use												
Which brand of chemical is the best quality	11	4.8	11	4.8	11	4.8	105	45.9	138	60.3	89	38.9
The chemical which is best to use for a specific purpose	37	16.2	28	12.2	17	7.4	89	38.9	171	74.7	56	24.4
Research results on the effectiveness of agricultural chemicals	8	3.5	5	2.2	3	1.3	76	33.2	92	40.2	135	59.0
Average Percentage										58.3		40.8
Application												
Methods of applying agricultural chemicals	17	7.4	20	8.7	23	10.0	93	40.6	153	66.8	74	32.3
Specific rates or dosages of application	24	10.5	23	10.0	13	5.7	79	34.5	139	60.7	88	38.4
When to apply agricultural chemicals	13	5.7	23	10.0	20	8.7	100	43.7	156	68.1	71	31.0
Average Percentage										65.2		33.9
Misuse and Consequences												
Possible consequences of misuse of agricultural chemicals	6	2.6	6	2.6	5	2.2	78	34.1	95	41.5	132	57.6
The hazards in applying agricultural chemicals	6	2.6	7	3.1	11	4.8	90	39.3	114	49.8	113	49.3
Unintended consequences of use of agricultural chemicals resulting in possible danger to humans	0	0.0	2	0.9	1	0.4	73	31.9	76	33.2	151	65.9
Purpose for which the chemicals should not be used	2	0.9	4	1.7	3	1.3	84	36.7	93	40.6	134	58.5
The hazards resulting from excessive application of chemicals	2	0.9	3	1.3	2	0.9	86	37.6	93	40.6	134	58.5
The danger of overexposure to the person applying the chemical	6	2.6	3	1.3	3	1.3	76	33.2	88	38.4	139	60.7
Unintended consequences of use of agricultural chemicals resulting in danger to livestock and crops	3	1.3	1	0.4	3	1.3	51	22.3	58	25.3	169	73.8
The danger of residues in the marketable product (milk, meat, etc.)	10	4.4	2	0.9	8	3.5	69	30.1	89	38.9	138	60.2
Average Percentage										38.5		60.6
Economic Information												
Price	42	18.3	19	8.3	26	11.4	129	56.3	216	94.3	11	4.8
Economic returns from use of agricultural chemicals	10	4.4	10	4.4	26	11.4	84	36.7	130	56.7	97	42.4
Average Percentage										75.5		23.6
Safety Precautions												
Safety measures to be taken in handling and applying agricultural chemicals	11	4.8	23	10.0	10	4.4	77	33.6	121	52.8	106	46.3
The disposal of empty agricultural chemical containers	0	0.0	0	0.0	2	0.9	42	18.3	44	19.2	183	79.9
Proper safety precautions in storage	1	0.4	1	0.4	0	0.0	66	28.8	68	29.7	159	69.4
Average Percentage										33.9		65.2
No information												
Gives no information at all	1	0.4	0	0.0	0	0.0	7	3.1	8	3.5	219	95.6
Average Percentage										3.5		95.6

*Two farmers did not answer this question because they said they had no supplier or dealers. Thus the percentages do not add to 100.

largest number of users of the other five categories of chemicals.

Many farmers purchase their chemicals from more than one source of supply. Additional analysis shows the following distribution of the number of places of purchase: No place of purchase, 4 percent; one place of purchase, 17 percent; two, 31 percent; three, 27 percent; four, 17 percent; and five, 4 percent.

Type and importance of dealer information

The farmer was given a card listing the types of information suppliers might provide farmers about agricultural chemicals. He was asked to indicate which types of information, if any, his supplier or dealer provided him. In addition, the farmer was asked to rank in 1, 2, 3 order the three types of information provided by the supplier that were most important to him. These are presented in table 34.

It may be observed that price was the most frequently mentioned type of information provided by the supplier —mentioned by 94 percent of the farmers (column 5, table 34). Other frequently mentioned types of information were: best chemical for specific purpose—75 percent; when to apply—68 percent; and methods of application—67 percent.

It may be of equal importance to note the types of information the farmers perceived were not being provided. These can be observed in table 34, column 6. For example, 80 percent of the farmers perceived their suppliers as not providing information on the disposal of empty agricultural chemical containers.

Column 1, table 34, shows that 18 percent of the farmers said price was the most important type of information provided by the dealers. The best chemical for a specified purpose was mentioned by 16 percent and specific rates and dosages by 10.5 percent as the most important information dealers provided. The same pattern of importance is found if one aggregates the three most important types of information (columns 1, 2 and 3).

Adequacy of information provided by suppliers

The farmer was read the types of information he had said were provided by his supplier. He was then asked to indicate his opinion as to whether the information received was adequate or inadequate. The data from this question are presented in table 35. It may be noted that since the question was asked only if the farmer stated that his supplier provided the specific information, the numbers in the total column vary and the percentages relate to these totals.

On the basis of these data it may be generalized that at least three-fourths of the farmers who perceive their

Table 35. You have indicated the following types of information are received by you from a supplier or dealer. Indicate your opinion as to whether the information received was ADEQUATE or INADEQUATE. (Categorized)

Type of information	Adequate		Inadequate		No Answer	Percent*	Total Mentions
	No.	Percent*	No.	Percent*			
What to use							
Which brand of chemical is the best quality	112	81.1	23	16.7	3	2.2	138
The chemical which is best to use for a specific purpose	146	85.4	23	13.4	2	1.2	171
Research results on the effectiveness of agricultural chemicals	71	77.2	20	21.7	1	1.1	92
Application							
Methods of applying agricultural chemicals	130	85.0	19	12.4	4	2.6	153
Specific rates or dosages of application	125	90.0	12	8.6	2	1.4	139
When to apply agricultural chemicals	138	88.5	17	10.9	1	0.6	156
Misuse and consequences							
Possible consequences of misuse of agricultural chemicals	77	81.1	17	17.9	1	1.0	95
The hazards in applying agricultural chemicals	87	76.3	25	21.9	2	1.8	114
Unintended consequences of use of agricultural chemicals resulting in possible danger to humans	60	79.0	14	18.4	2	2.6	76
Purposes for which the chemicals should **not** be used	76	81.7	17	18.3	0	0.0	93
The hazards resulting from excessive applications of chemicals	72	77.4	21	22.6	0	0.0	93
The danger of overexposure to the person applying the chemical	66	75.0	22	25.0	0	0.0	88
Unintended consequences of use of agricultural chemicals resulting in danger to livestock and crops	44	75.9	14	24.1	0	0.0	58
The danger of residues in the marketable product (milk, meat, etc.)	69	77.6	19	21.3	1	1.1	89
Economic information							
Price	208	96.3	4	1.8	4	1.8	216
Economic returns from use of agricultural chemicals	116	89.2	14	10.8	0	0.0	133
Safety precautions							
Safety measures to be taken in handling and applying agricultural chemicals	101	83.5	19	15.7	1	0.8	121
The disposal of empty agricultural chemical containers	37	84.1	6	13.6	1	2.3	44
Proper safety precautions in storage	55	80.9	13	19.1	0	0.0	68
No information							
Gives no information	1	12.5	4	50.0	3	37.5	8

*Percentage is figured as proportion of total mentions.

suppliers as providing specified types of information evaluate the information provided as adequate. The largest number of farmers evaluated the information on price as adequate. The lowest evaluation of adequacy was on the danger of overexposure to the person applying the chemical.

Suppliers' qualifications as an information source

The respondents were handed a card containing four statements concerning dealer's qualifications as an information source about agricultural chemicals. The farmer was asked to indicate which statement best described his supplier or dealer. The statements and responses are presented in table 36.

Table 36. Farmer perception of his supplier's qualifications as an information source.

	No.	Percent of 229
Just a source of supply for the agricultural chemicals I need, . . . not qualified to give information	20	8.7
A **poorly qualified** source of information on agricultural chemicals and their use	16	7.0
A **qualified** source of information on some aspects of agricultural chemicals and their use	126	55.0
A **highly qualified** source of information on **all** aspects of agricultural chemicals and their use	62	27.1
No answer	5	2.2
TOTAL	229	100.0

Table 37. Farmer expectations of supplier's role in providing information and making recommendations.

	No.	Percent of 229
Provide information only	29	12.7
Provide information and make recommendations	172	75.1
Does not apply—dealer **not** qualified to give information, just a source of supply	20	8.7
No answer	8	3.5
TOTAL	229	100.0

Farmer expectations of their suppliers

The farmer was asked if he expected his supplier to provide information only, or if he expected him to make recommendations about agricultural chemicals and their use. This question was not asked of those farmers who had stated in the previous question that their supplier was not qualified to give information. These data are presented in table 37.

A FINAL NOTE

At the beginning of this report, it was stated that little valid data has been available on which to base discussion and interpretation of the controversial subject of agricultural chemicals. Now, at least part of this information for Iowa is available in this report. More will be presented in later reports.

Need for these data has been expressed for some time. As chemicals become more and more important to agriculture, adapting this information to practical use should result in the best use of agricultural chemicals for top agricultural production.

The usefulness of this report will be determined by the people who use it. It should be helpful to those who establish and enforce public policies, to manufacturers and distributors of chemicals and to those who conduct educational programs on the proper and safe use of agricultural chemicals.

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