PESTICIDE APPLICATOR TRAINING MANUAL

CATEGORY 10

DEMONSTRATION AND RESEARCH

INSTRUCTIONS FOR USING THIS TRAINING MANUAL

This training manual is intended to provide you with the information you will need to meet the standards of the U. S. Environmental Protection Agency for commercial certification as a pesticide applicator in the Demonstration and Research (Field) Pest Control category, and to prepare you to take an examination given by the pesticide regulatory agency based on this manual. It is not intended that this manual or training will provide you with all the information that you need for effective pest control. Up-to-date information regarding recommended materials and methods should be obtained from your Cooperative Extension office, your state extension publications, the label, and your pesticide manufacturer.

The manual is designed for use as a self-study manual by individuals, or it may be used in conjunction with other training materials at training schools. Your core manual (either the Northeast or EPA-USDA core training manual) is the basic information manual for all pesticide applicators. This manual begins where the core manual left off. Refer back to your core manual as necessary.

This manual was developed to be used in an open book exam since it contains resource information that is not intended for memorization. It will require careful study so that you are sufficiently familiar with its contents that needed information can be quickly found and used within the period allowed for examination.

You should place this manual in the same binder with your Northeast Core Manual or with the core manual you used for certification at the core level to qualify you for category certification.

PESTICIDE APPLICATOR TRAINING MANUAL

CATEGORY 10

DEMONSTRATION AND RESEARCH

A Training Program for the Certification
of Commercial Pesticide Applicators

Cooperative Extension
New York State College of Agriculture and Life Sciences
at
Cornell University, Ithaca, New York

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I. INTRODUCTION

All of us, whether we accept it or not, are a part of the total environment and more specifically the ecological system in which we live. Everyone, and our professional group more than most, must share the responsibility of preventing the destruction of the natural resources around us. Nowhere is this more true than in the use of thousands of pesticides and other agricultural chemicals available today. The safe and effective use of these chemicals can be assured by judicious regulation and by the users attention to the label instructions required on all pesticides.

It is very easy to point out the benefits from pesticide usage. Within the past three decades we have been able to reduce pest infestations in homes and agricultural production has climbed rapidly during this period (partially due to pesticides). Our food is more abundant and it costs less, life expectancy is greater, world food production has increased, millions of lives have been saved, etc., etc.

We must, however, recognize that there is another side to pesticide usage. Some of the pesticides when not properly handled, present an immediate danger to the user. Some of the pesticides are very persistent and remain for long periods of time in the environment. These can create some very complex problems if not used properly. They can interfere with certain wildlife reproduction and perhaps create residue hazards in our food supply if carelessly used.

Most of our professionals have agreed that we cannot afford to lose the advantages so painstakingly gained by the use of pesticides, and at the same time neither can we ignore the potential hazards and other problems created by their use. Obviously, the most logical thing to do is to derive the maximum benefits with the least amount of negative costs possible. It is generally believed that proper pesticide regulation, accompanied by research and educational efforts in improved pest management capabilities, can improve the quantity and quality of our production system in a manner safe to our society.

This manual is intended to provide the information that commercial applicators of restricted use pesticides need to meet the minimum standards for certification in Category 10, Demonstration and Research.

These standards are set by the U. S. Environmental Protection Agency as it has interpreted the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), amended by the Federal Environmental Pesticide Control Act (FEPCA) of 1972.

Those included in the Demonstration and Research category are:

1) people who demonstrate to the public the proper use and techniques of applying restricted use pesticides or supervise such demonstrations, and

2) people who conduct field research with pesticides and in doing so, use or supervise the use of restricted use pesticides.

The first group includes Cooperative Extension Service specialists and county agents, vocational agriculture instructors, state college and university instructors, industry representatives who demonstrate pesticide products, and others who demonstrate methods used in public programs.

The second group includes State, Federal, university, commercial, or industry research scientists and other persons conducting field research using pesticides.

People applying for certification in the Demonstration and Research Category will be responsible for the information contained in the Core Manual as well as for the information in this manual. In addition, each applicant for certification under Category 10 must pass the examinations in the category, categories or subcategories which represent at least 80 percent of his practice. These include:

Agricultural-Plant	Seed Treatment	Termite Control
Agricultural-Animal	Aquatic Pest Control	Fumigation (non-agricultural)
Forest Pest Control	Right-of-Way	Public Health
Ornamental & Turf	Structural & Rodent	Regulatory
		Aerial Application

All this information can help individuals to become responsible applicators but should not be considered all the training necessary to become a demonstration and research pest control expert.

Testing for certification is given by the New York State Department of Environmental Conservation, Bureau of Pesticides.

Individuals in field research and demonstration pest control not only provide and disseminate information on pest control but also serve as examples for other applicators. Therefore, they should be particularly knowledgeable in methods of pest control, and they should demonstrate competence in safe and effective use of pesticides.

They also must understand pesticide-organism interactions and recognize the importance of integrating pesticide use with other control measures in effective pest management programs. For example, cultivation often is needed to supplement the benefits of herbicides. And crop rotation helps to reduce the natural increase of many insects and disease-causing organisms, thereby decreasing the need for higher levels of pesticides.

II. REGULATIONS

Laws governing the use and users of pesticides are designed to protect man and the environment. Pesticide regulations, either state or federal, are not new. In 1898 New York State adopted the first pesticide law. It regulated the sale of Paris green, the most important insecticide in use at that time. Prior to this law, pesticides if regulated at all, were treated under the drug laws. Federal legislation to regulate insecticides and fungicides were not initiated until the early 1900's.

Early pesticide regulations were of two types -- those concerned with residues or adulteration of food by use of pesticides (first regulated federally in 1906 by the Pure Food and Drug Act), and those concerned with registration of pesticides to protect the purchaser from substandard and fraudulent products (first regulated federally in 1910). These early laws were replaced by the Federal Food, Drug and Cosmetic Act of 1938 (administered primarily by FDA of the Department of Health, Education and Welfare) and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1947 (administered by USDA prior to 1970). These laws have both been revised through amendment many times. Prior to 1972 and passage of the Federal Environmental Pesticide Control Act amending FIFRA, the user of pesticides, the hazard to other farm workers or protection of the environment were not regulated at the federal level.

The first laws regulating the user of pesticides were the state pesticide custom applicator laws pioneered by California in 1949. California also adopted in 1949 an "Injurious Materials List". It was probably the first attempt to place controls on the unlicensed individual's use of pesticides in a manner that would cause him to meet a certain level of competence.

California was also the first to recognize the hazard of pesticides to other farm workers with the adoption of regulations for reentry into treated areas in 1971.

The Federal Environmental Pesticide Control Act (Public Law 92-516), a major amendment of FIFRA, was enacted by Congress and signed into law on October

21, 1972. The Act included many new major provisions and became the responsibility of the Environmental Protection Agency (established in 1970 to control environmental matters). In addition to regulations concerning registrations and residues that may exist in our food, it made many new provisions. Those provisions of primary interest in affecting the use and the user of the pesticide are that for the first time pesticides and their uses are required to be classified for general or restricted use and all users of restricted pesticides must be certified either as private or commercial applicators or be under the supervision of a certified applicator; the use of any pesticide in a manner inconsistent with its labeling is prohibited; and cooperation with the states in training and certification of applicators is authorized. The act also regulated the use of all pesticides (some previously covered by state authority) and extended federal pesticide regulations within each state so that all had to meet the minimum standards set by federal regulations under the amendment. Reentry intervals to protect agricultural workers are a part of the regulations although not specifically mentioned in the act. Other provisions include the registration of all pesticides by EPA whether they move within or between states, thus controlling their distribution and sale; data requirements for registration, registration and inspection of establishments, experimental use permits, penalties, disposal and storage, and monitoring.

At the international level we still have no regulations but we do have some standards established and there is great interest in expanding these standards. This work is carried out by the Codex Alementarius Commission to develop International and Regional food standards and to publish them in a Codex Alementarious (food code). The Commission is sponsored by the United Nations through the World Health Organization (WHO) and the Food and Agricultural Organization (FAO). It was established in 1962. Although progress has been slow, some international tolerances have been established and many more are in the process.

Pesticide Registration

Registration of pesticides is designed to protect man and the environment from abuse of pesticide use. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1947 was primarily a labeling law and was originally administered

by the USDA. It was amended several times, most recently in 1972, to increase and expand the protection of the users of pesticides, our food, and the environment. The 1972 amendments require the classification of pesticides for general or restricted use. Commercial or private applicators of restricted use pesticides are required to be certified by their respective states. The Pesticide Amendment to the Federal Food, Drug, and Cosmetic Act requires the establishment of tolerances for residues of pesticides in food or feed. These tolerances provide consumer protection from potential contamination of food or feed with excess quantities of pesticides.

Data Requirements for Registration

As specified in the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) as amended, all pesticides must be registered. This will include all pesticides used in and around the home, swimming pools, businesses, public buildings, and in agriculture. Before any registration is issued, however, the manufacturer (applicant) must submit data to the Pesticide Registration Division (PRD) of EPA showing that the product when used as directed:

-- is effective against the pest listed on the label;

-- will not injure man, animals, crops or damage the environment;

-- and will not result in illegal residues on feed and food.

To establish these three requirements, the applicant must submit information on the following general requirements which will vary with the compound, its intended use, and the ever changing requirements to meet the regulations.

For Uses Requiring Negligible or No Tolerances

a. Chemical Specifications

Identity

Structure and composition

Chemical name

Common name

b. Physical-chemical Properties

Boiling point

Flash point

Vapor

Physical state

Density

Solubility

Stability

c. Efficacy Data

Effectiveness of control

Phytotoxicity

Translocation in plants or animals

Persistence in soil, water, plants, animals

Compatibility with other chemicals

d. Conditions of Use

Directions for use

Limitations

Restrictions

e. Analytical Methods

Validity

Accuracy and sensitivity

Practicability

Total toxic residue (including metabolites)

f. Residue Data

Conditions of use

Maximum number of applications

Geographical distribution

Reduction of residue in processing

g. Acute Toxicity

Oral

i. Several species - usually rats, dogs, rabbits, mice, cows, chickens

ii. Signs of toxicity - symptoms, chemical, histological

Dermal - usually 2 species

Subcutaneous - one species - usually mice

Eye

Inhalation

Synergism

Potentiation

h. Subacute Toxicity

Feeding studies - usually 2 species (rat and dog), 90 days duration at 3 dose levels with chemical and laboratory tests and gross and microscopic examination at end of 90 days.

Inhalation - rats or guinea pigs from 5 to 14 days.

Sensitization or dermal - rabbit - 21 days.

Wildlife studies

i. birds - 8 day feeding - pheasant, Pekin or mallard duck, and quail.

ii. fish - 96 hour exposure - bluegills, trout and catfish.

i. Effect on Bees

For Uses Requiring Temporary or Higher Tolerances (in addition to requirements under uses requiring negligible or no tolerances).

a. Chronic Toxicity

Feeding studies - usually 2 species - rats, dogs, or monkeys, 2 years duration at 3 dose levels with clinical and laboratory tests and with gross and microscopic examinations for changes including carcinogenicity.

b. Reproductive Tests

Feeding studies - usually 1 species - rats or mice, 2 or 3 generations at 3 dose levels with observations for teratogenic, mutagenic, and neurotoxic effects and with microscopic examination of the final litter.

c. Other tests when appropriate such as enzymatic, demyelinating, cataractongenic, etc.

The data which must be submitted to EPA at the time application for registration is made, is carefully analyzed by various scientists, each of which evaluates the information according to his own area of expertise. Some of the areas taken into account are: the pesticide's response in the environment including speed and type of pesticide decomposition following application; amount of movement and persistence in the soil, air or water; effect of light and rain on the pesticide as well as potential effect they (pesticides) will have on man, animal and plant life.

Establishing A Legal Residue Tolerance

One extremely important facet of pesticide usage is the potential for food contamination by excess amounts of pesticide residue. The Pesticide Amendment to the Federal Food, Drug, and Cosmetic Act authorizes EPA to establish a legal tolerance (amount of pesticide that is safe on the crop) for each pesticide on each food crop before registration for use on that crop.

To establish the tolerance level, EPA studies and analyzes the manufacturer's data to determine that the pesticide when used as directed will not result in residues over the safety level and that the established level for registration is safe for human consumption. Permissible tolerance levels are established well below any level that could possibly cause any harm. In most instances, the established tolerance is at approximately a 100 to 1 safety ratio on the raw product at harvest time. In other words, it would require 100 times the amount of residue tolerance allowed to create any potential harm to people who

consume the products. In some instances, the safety ratio is as much as 300 to 1 if the efficiency of the pesticide is not reduced by establishing the wide margin of safety.

All newly registered products bear an EPA registration number (some older products may still have a USDA number). The number is found on the label and is another safety feature of pesticide registration since the data pertaining to the pesticide must be reviewed and found acceptable before the registration number is granted.

State Registration Requirements (also see page 19).

Some states do not require state registration of EPA registered pesticides, while others including New York State require EPA registered products to be registered by the state. Such state registrations may regulate the sale or use of a pesticide and are permitted by federal law if and to the extent the state regulation does not permit any sale or use prohibited by FIFRA, or impose any requirements for labeling or packaging in addition to or different from those required by FIFRA.

A state may register a pesticide formulated for distribution and use within that state to meet special local needs if that state is certified by the EPA Administrator as capable of exercising adequate controls to be in accord with FIFRA and if registration for such use has not been previously denied, disapproved, or cancelled by the Administrator [24(c) - see page 19 for further discussion of these registrations].

Experimental Use Permits

Experimental use permits are required by amended FIFRA to accumulate information necessary to register a pesticide not registered by EPA or to register a new use for a previously registered pesticide. Most experimental use permits are obtained by the person wishing to register the pesticide. In most instances this is the company producing the pesticide. Experiment Station and Cooperative

Extension personnel who test unregistered pesticides generally do so under the experimental use permit of the company producing the pesticide.

No experimental use permit is required for a substance or mixture of substances being tested to determine its value for pesticidal purposes or to determine its toxicity or other properties, and from which the user does not expect to receive any benefit from pest control. In addition to laboratory and greenhouse trials, this also affects:

Land use where tests are conducted on a cumulative total of not more than 10 acres provided that any food or feed crop involved in or affected by such tests are destroyed or consumed by experimental animals unless a tolerance or exemption from a tolerance has been established.

Aquatic use where tests are conducted on a total of not more than one surface-acre of water provided the waters affected by such tests are not used for irrigation, drinking, water supplies, or body contact recreational purposes. No tests may be conducted in any waters where fish, shellfish, or other plants and animals are taken for recreation or commercial purposes and used for food or feed, unless a tolerance or exemption from a tolerance has been established.

Animal treatments conducted only on experimental animals. No animals can be tested if they may be used in food or feed, unless a tolerance or exemption from a tolerance has been established.

No experimental use permit is needed for substance or mixture of substances which under the Federal Food, Drug, and Cosmetic Act is defined as "new drug", a "new animal drug", or an "animal feed".

The Application for Permit

The application for an experimental use permit is made on forms provided by EPA and should be made as far as possible in advance of the intended date of use.

Each application for an experimental use permit must include:

(a) The purpose of the proposed tests; a detailed description of the testing program; a designation of the pest organism involved; the amount of pesticide proposed for use; the crops, fauna, flora, sites, modes, and situation of application on or in which the pesticide is to be used; the area (state(s)) in which the proposed program will be conducted; the number of acres to be treated or included in the area of experimental use; and the proposed dates or period(s) during which the testing program will be conducted.

(b) The name and address of the applicant.

(c) The name, address, and telephone number of the individual(s) in the employ of the applicant who will be responsible for the day-to-day administration of the experimental use program for which the permit is requested.

(d) The name, address, and telephone number of any participant in the program (whether or not in the employ of the applicant) if available at the time an application is submitted or as soon thereafter as available.

(e) All additions, deletions, or changes must be supplied promptly.

Chemical Information Required

(a) A complete statement of composition for the formulation of the product to be tested, giving the name and percentage by weight of each ingredient, active and inert.

(b) Chemical and physical properties for each ingredient and for the formulation to be tested, including but not limited to the manufacturing process and analytical methods suitable for the formulation.

(c) Appropriate data on rate of decline of residues on treated crop or environmental site.

Biological Information Required

(a) A description and specific results of any known prior testing of the product conducted to:

(1) Determine toxicity and effects on plants, animals, insects and other organisms at the site of application.

(2) Determine phytotoxicity, and other forms of toxicity or known adverse effects on non-target plants, animals, and insects surrounding the site of application and to determine adverse effects on the environment.

(b) Results of toxicity tests and other data relevant to the product's potential for causing injury to users or other persons who may be exposed including any available epidemiological information as to man.

Other Information Needed

If the experimental use pesticide is to be used in such a way that will be expected to result in residues on or in food or feed, the applicant must:

(a) submit evidence that a tolerance has been established for residues of the pesticide on or in any such food or feed or,

(b) submit a petition proposing establishment of a tolerance or exemption from the requirement of a tolerance or,

(c) certify that the food or feed derived from the experimental program will be destroyed or fed only to experimental laboratory animals for testing purposes, or otherwise disposed of in a manner that will not endanger man or the environment.

(d) describe the proposed method of storage and disposition of any unused experimental use pesticide and its container.

(e) submit a statement that the applicant and any participant in the experimental use program will permit, at any reasonable time, an authorized representative of the agency (EPA), upon presentation of official identification, entry to any premises involved in the testing program to inspect and to determine whether the provisions of the permit are being complied with as indicated.

(f) furnish any other additional pertinent information the Administrator may require.

The Permit

Issuance -- The Experimental Use Permit shall be issued when the Administrator determines the conditions and regulations of the Act have been met.

Duration -- Permits will be effective for a specified period of time, normally one year.

Limitations -- The quantity of pesticide allowed in the experimental programs is specified and may be less than that requested in the permit if data does not justify the quantity requested.

The testing program may be limited to certain states which are listed in the permit.

If no temporary or permanent tolerance or an exemption from a tolerance has been granted food or feed commodities must be destroyed.

Pesticides under an experimental use permit may be distributed or sold only to participants in an experimental program and are not for resale or other distribution.

Publication of Notice

At any time an experimental use permit is granted by EPA, a notice is printed in the Federal Register. EPA may publish notice of an application for an

experimental use permit in the Federal Register prior to the granting or denying of the permit, with opportunity for comment by interested persons.

Labeling Experimental Use Pesticides

All pesticides shipped under or used under an experimental use permit must be labeled with directions and conditions for use to be set by the Administrator. These labels and directions must include:

a. all the information prescribed for regular pesticide labels except that a registration number and previously registered use patterns will not appear.

b. the registration number of the establishment.

c. any limitations on entry of persons into treated areas.

d. prominently exposed statement "For experimental use only".

e. the statement "Not for resale".

Surveillance and Data Reporting

a. The permittee shall supervise the test program and evaluate the results of testing from each site of application. The permittee must also report any adverse effects from use or of exposure to the pesticide.

b. The following report must be submitted during the experimental programs.

   1. Name and address of the shipper and place or places from which shipped.

   2. Name and address of consignee, and amount of the shipment.

   3. Reports at three month intervals will be required unless otherwise directed. Reports to contain:

(a) quantity of pesticides shipped and used

(b) list of states into which shippings were made

(c) a summary of progress made and data obtained during the report period.

4. A final report shall be made within 90 days of the conclusion of the program. This report to include:

(a) all data gathered during the test program.

(b) disposition of any unused pesticides.

(c) disposition of treated food and/or feed.

(d) In case any animals or birds receive a direct treatment of an experimental pesticide, the name and location of the packing plant where they were processed should be sent to APHIS of USDA, Washington, DC, 20250 at least 10 days before they are to be shipped for slaughter.

Most experimental use permits are held by the company wishing to register the pesticide, so they will be responsible for making the reports to EPA. If Cooperative Extension and Experiment Station personnel or others are testing the experimental pesticide, they provide reports to the company holding the permit. The kinds of information they report generally are determined before they conduct the test.

State Issuance of Permits

a. The state of New York (Department of Environmental Conservation) or any other state may issue an experimental use permit for the purpose of accumulation of information necessary to register a pesticide formulated solely for the distribution and use within New York to meet special local needs of that state if:

1. The substance or mixture of substances has not been cancelled, suspended, or denied registration or the subject of a federal experimental use permit; and

2. A state permit for issuing such permits has been submitted and approved in accordance with regulations to be prescribed by the Administrator of EPA.

Registration for Minor or Specialty Crop Uses

The availability of registered pesticides for pest control of small acreage crops including ornamental trees, shrubs and flowers has always been a problem to growers, commercial applicators and homeowners. Without pesticides many specialty crops can't be produced economically or with the quality that markets demand. Developing pesticides for small acreage crops has long been burdensome to pesticide manufacturers and the problem shows no signs of improving. The basic reason for this problem is the increased regulation of the pesticide industry as a result of the 1972 amendments to the Federal Insecticide, Fungicide, and Rodenticide Act. Meeting more stringent standards increases the time required for developing a new product and obtaining the necessary information on tolerances and residues. As much as eight years and several million dollars may be invested in developing a pesticide before it can be registered for crop use. The relatively low financial return in proportion to effort and cost may cause a company to abandon plans for registering the product for a minor crop use and only to seek registration of the pesticide for large acreage crops.

Prior to the enactment of the 1972 amendments to FIFRA, pesticides sold, distributed, and used entirely within a state were not subject to federal regulations. Many minor or specialty crop uses of pesticides were taken care of by state registration. Now, however, all pesticides previously registered by states must be federally registered. Because of this requirement, many minor or specialty crop uses have become unavailable.

There are a few methods that have been established to help alleviate the minor or specialty crop use problems.

Interim Certification

Prior to the FEPCA amendment of FIFRA, several states had provisions for intrastate registrations which were accepted based on recommendations of extension services, or other state agencies but which lacked sponsorship of commercial registrants. When the FEPCA amendment passed these registrations were no longer legal. To help provide an orderly transition, the EPA registration regulations provided a procedure to ensure retention of these products or uses required for support of special local needs during the interim period between the effective date of Section 3 registration regulations and state registration under Section 24(c). The cut-off date for filing for registration of an intrastate product was October 4, 1975.

New York State has a large number of these interim certified uses. These are legal until final action can be taken under State 24(c) or federal Section 3 regulations.

State Registration to Meet Special Local Needs [24(c)]

Amended FIFRA permits a state to register pesticides formulated for distribution and use within that state to meet special local needs under Section 24(c) if that state is certified by EPA as capable of exercising adequate controls to assure that such a registration will be in accord with the purposes of FIFRA.

The purpose of special local needs registration is to give a state the opportunity to meet rapidly and efficiently with less cost and administrative burden (to the registrant) the problem of registering a pesticide for local use. The pesticide may be needed to treat a pest infestation which is a problem within a state, but which is not sufficiently widespread to warrant the expense and difficulties of federal registration.

When there is an existing or expected local or minor pest problem, the state agency responsible for registration will be permitted to register one or more pesticide products under the following situations:

a. There is no EPA-registered pesticide for the use in question.

b. There is an EPA-registered pesticide, but it is not available or cannot be obtained in sufficient quantity.

c. There is an EPA-registered pesticide which, nominally is suitable, but if used in accordance with the label, would not be safe or efficacious under the local conditions.

The New York State Department of Environmental Conservation has been granted the right of Interim Certification by EPA to register pesticide products for Special Local Needs. By this action, New York is now certified to register pesticide products which involve changed use patterns, such as from ground to aerial application, or added uses for a pesticide product.

Some Limitations -- The regulations are designed to facilitate state issuance of specified types of registrations. However, in accordance with the purposes of the legislation, several limitations were incorporated. States are not authorized to register:

a. pesticides on food crops that do not have an established tolerance on that crop.

b. pesticides containing active or inert ingredients not contained in any EPA-registered products.

c. any pesticide products or uses affected by suspension or cancellation action based on human health, environmental, or efficacy considerations.

d. pesticide products and/or uses previously denied registration by EPA.

EPA certification of a state will not be an all-or-nothing authorization. A state may be certified to issue one or more types of registration, depending on its scientific expertise, registration procedures, and legal authority.

If disapproved by the Administrator of EPA, a state registration cannot remain effective for more than 90 days. If not disapproved, it becomes a federal registration and is then subject to EPA actions such as suspension and cancellation procedures.

Special local needs registrations may be sought by commodity groups, Cooperative Extension Service personnel, and others. A pesticide manufacturer or formulator must, however, be willing to register or add the use in question to his product's label for use in the state. It is necessary for the people or groups making the request to work with the manufacturer or formulator in developing the necessary information to support the request for registration.

Interregional Research Project (IR-4)

The Interregional Research Project known as IR-4 was established by the USDA in 1963 to compile information generated through State and Federal Agriculture Experiment Stations and other sources that is required to obtain pesticide tolerances and to register labels for minor or specialty crop uses of pesticides. The IR-4 is financed with funds administered by the Federal Cooperative State Research Service (CSRS) of the USDA. The coordinating office of the project is located at Rutgers, the State University of New Jersey. Since the passage of the 1972 amendments to FIFRA, the IR-4 has taken on new importance in assisting to register minor or specialty crop uses of pesticides.

Each state has an IR-4 Liaison Representative who maintains contact with the several disciplines within the state that are concerned with usage of herbicides, insecticides, and fungicides. The State Liaison Representative identifies certain uses of pesticides that are needed in his state. Many of these uses may be related to specialty crops or to the protection of non-food items such as ornamentals. These clearance requests are sent to the IR-4 Coordinator's office.

The office of the IR-4 Coordinator determines:

a. whether there are effective pesticides already registered for the requested use.

b. the availability of data from the pesticide industry.

c. what interest industry has in obtaining tolerances, registrations and providing a labeled product for the requested use.

If industry will register the requested use, the IR-4 will encourage the development of the required data by the pesticide industry, state agricultural experiment stations, the USDA, and any appropriate segments of the agricultural community.

The IR-4 has established four laboratories, one for each experiment station region in the country, to perform the necessary residue analyses to assist in the establishment of tolerances and registrations for the pesticide requests.

The goal of the IR-4 project is to achieve pesticide clearances as efficiently and rapidly as possible. The success of this depends heavily on the assistance provided by the applicant or requestor and other cooperating persons and agencies in providing the necessary information and data. Without support data, IR-4 can do nothing.

Emergency Registration of Pesticides (Section 18 FIFRA)

Amended FIFRA makes it illegal to use a pesticide for any purpose unless it has been registered for that use or purpose. There may be situations where there is not a registered pesticide available for a certain use. An outbreak of a previously minor pest may occur on a crop for which no registered pesticide is available for use in that crop. If the crop is a food crop and no tolerance exists on that crop, a state 24(c) label cannot be obtained.

Amended FIFRA provides for emergency use of pesticides in these situations or others similar to it. A state may obtain permission to use an unregistered pesticide in the case of an emergency when there is not a registered pesticide available to control the pest problem. FIFRA provides for three types of exemptions.

a. Specific Exemption

When a pest outbreak has occurred or is about to occur and there is not a registered pesticide for that use or purpose, a request for an exemption to use a certain pesticide to control it may be made by the State Lead Agency. In New York, this is the State Department of Environmental Conservation. Information including the nature, scope, and the frequency of the problem, the pest involved, which pesticide or pesticides will be used and in what amounts, the economic benefits anticipated, and an analysis of possible adverse effects must be supplied. The U. S. EPA grants the exemptions. Reports must be filed when the treatment is over. A specific exemption is only good for a specified amount of time and for a designated area.

b. Quarantine or Public Health Exemption

This exemption may be granted to prevent the introduction or spread of a foreign pest into or throughout the United States or to prevent a public health problem. No pesticide that has been suspended by the Administrator of the U. S. EPA may be used. The procedure for requesting this exemption is the same as outlined for the specific exemption.

c. Crisis Exemption

A crisis exemption may be used if it is found that there is not a readily available pesticide registered to control or eradicate the pest and that there is not time to request and get approval for a specific exemption. No pesticide that has been suspended or cancelled may be used. The Administrator of EPA must be notified by telegram within 36 hours. Within 10 days of the use, the state must file information similar to that required for the specific exemption.

Cancellation, Suspension and Rebuttable Presumption (RPAR)

In recent years, we have seen several well known pesticides removed from use through the processes of suspension and cancellations. Most of the uses of DDT, aldrin, dieldrin, mercury compounds, and some predator poisons for coyote control have been cancelled. More recently, uses of chlordane, heptachlor, and Mirex have been suspended.

The Amended Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) gives the Administrator of EPA the power to remove the registrations of pesticides. The two ways specified in the FIFRA are cancellation and suspension.

Cancellation

The Administrator of EPA may issue a notice of intent to cancel all or part of the registrations of a pesticide, if:

-- the pesticide or its labeling or other material required to be submitted does not comply with the law, i.e., amended FIFRA.

-- the pesticide generally causes unreasonable adverse effects on the environment when it is used in accordance with widespread and commonly recognized practice.

The intent to cancel order becomes final 30 days after receipt by the company or companies holding the pesticide registration unless:

-- corrections can be made that will solve the problem, or

-- a request for hearing is made by a person adversely affected by the notice.

If a hearing is requested, it takes place before an Administrative Law Judge appointed to conduct the hearing. He makes a ruling on the cancellation issue based on evidence presented by both sides. The Administrator of EPA can accept or reject the findings of the Administrative Law Judge. The cancellation process can take as much as two years to complete.

Suspension

If the Administrator of EPA decides that action is necessary to prevent an imminent hazard during the time required for the cancellation issue to be settled, he may suspend the registrations of the pesticide immediately. A suspension order cannot be issued unless an intent to cancel the pesticide registration is filed at the same time or has been filed previously.

The Administrator must notify the registrant prior to issuing the suspension order. The notice must contain the findings pertaining to the imminent hazard. The registrant has five days in which to request a hearing. If no request is made, the suspension order takes effect and is not reviewable by a court. If a hearing is requested, it must begin within five days. Evidence pertaining to the imminent hazard issue is presented by both sides at the hearing. When the hearing is concluded, the Administrative Law Judge must present his findings to the Administrator within 10 days. The Administrator may accept or reject the opinion of the Administrative Law Judge.

Rebuttable Presumption Against Registration (RPAR)

A third process, affecting continued registration and use of pesticides has been established by EPA. Rebuttable presumption against registration (RPAR) is not a part of amended FIFRA, but is contained in regulations written by EPA to implement Section 3 of FIFRA, which deals with pesticide registration, and classification. Extension specialists and experiment station researchers have been asked to assist in providing information and data they have to support the continued registration of certain pesticides that are going through the RPAR process.

Rebuttable presumption against registration as defined by EPA, means that if a pesticide shows potentially dangerous characteristics, it is subjected to intensive scientific review and public comment before a decision is made on whether to allow continued use or begin the process of removing it from the market by cancellation or suspension.

One of the advantages claimed for rebuttable presumption is that it allows EPA to gather extensive scientific information about the effects of a chemical

before determining whether prolonged courtroom hearings on safety are necessary. It attempts to ensure that benefits and risks are given full consideration.

The rebuttable presumption against registration is not the same as banning a pesticide, even though it may be the first action leading to that decision. Whether banning occurs will depend upon the type of information accumulated by EPA and then a judgment as to whether benefits appear to outweigh risks or vice versa.

At the time of reregistration and/or classification, all pesticides are carefully examined. If no hazard to trigger RPAR is found it is registered or reregistered. If, on the other hand, a single study or incident is found that triggers the RPAR risk criteria, a detailed study is initiated including consultation with scientific and economic experts and an opportunity for further comment from the general public. Depending on the evidence found, a decision is made to either return the compound for registration/reregistration or to issue a rebuttable presumption against registration/reregistration which is published in the Federal Register. If the latter occurs the presumption may be rebutted by proving the studies upon which it is based are not scientifically valid or that actual exposure will not cause the effects described.

The hazardous criteria that trigger rebuttable presumptiom are: if the pesticide is highly toxic and may pose the threat of immediate poisoning to people or wildlife, if it may cause serious long-term health problems such as tumor formation or mutations in people or "non-target" animals, or if the pesticide lacks an emergency first-aid treatment, or occurs as excess residues on feeds.

If a pesticide ingredient meets one or more of the risk criteria mentioned above, the rebuttable presumption process comes into play as follows:

a. Manufacturers and users of the suspect pesticide and the general public are notified of the risk information and given 45 days to offer rebuttable evidence. This period for submitting views may be extended by 60 days.

b. At the conclusion of this period EPA announces whether or not all risks have been rebutted.

c. If they have, then EPA proposes to allow continued use of the pesticide. If they have not, an internal analysis of risks versus benefits is undertaken. Up to 180 days may have elapsed by this time and the pesticide in question may continue to be sold.

d. Depending on the outcome of the risk/benefit analysis, the pesticide is proposed for approval, or EPA begins formal consultation with the U. S. Department of Agriculture on the economic impact and sales. An independent Scientific Advisory Panel reviews the health and environmental effects information.

e. Approximately 60 days after the USDA and scientific consultation, EPA must again decide whether to propose continued use of the pesticide or issue a "notice of intent to cancel" further production and sale. Regardless of which way the decision goes, the opportunity for a public hearing exists.

A "notice of intent to cancel" represents EPA's finding that a pesticide generally causes unreasonable adverse effects upon the environment. It provides manufacturers and users of the pesticide and any other interested persons the chance to request hearings on risk and benefits. Depending on the complexity of the issues, these hearings may last a year or longer. If the registrant is able to convince EPA that when considered with proposed restrictions on use and widespread and commonly recognized practices of use, the pesticides will not cause the effects claimed by EPA the pesticide will be registered. The Administrator determines that the presumption (against registration) has been rebutted.

The registrant, at the time he submits evidence to rebut the presumption, may submit evidence as to whether the economic, social, and environmental benefits of the use of the pesticide outweigh the risks. The Administrator, in his discretion, may take into account staff recommendations resulting from preliminary analysis, if any, concerning the balance of risks versus benefits. The eventual outcome is a decision by the EPA on the pesticide's future.

During the cancellation hearings, the pesticide may continue to be sold.

"Suspension" may interrupt either the rebuttable presumption or the cancellation process at any point. It is based upon a finding of imminent hazard posed by the pesticide. A brief public hearing may be held. The purpose of a suspension is to decide whether to allow continued sale of a pesticide during the time it would take to hold more in-depth cancellation hearings. To date, Rebuttable Presumptions Against Registration have been issued for Kepone, chloroform, chlorobenzilate, and endrin.

Some Organizations and Agencies Concerned with Pesticides

Many persons unfamiliar with pesticides, and some that are familiar with them, are not aware that anyone other than EPA has an interest in them. Listed below are some of the different publicly supported groups which change their names and composition from time to time but seem to expand in numbers rather than contract.

International

a. United Nations

   1. Food and Agricultural Organization (FAO)

   2. World Health Organization (WHO)

   3. Codex Alementarius Commission, Committee on Pesticides

b. International Standards Organizations (ISO)

c. International Union of Pure and Applied Chemistry (IUPAC)

d. Collaborative International Pesticides Analytical Committee (CIPAC)

e. Organization for Economic Cooperation and Development (OECD)

f. European Economic Community (Common Market)

Federal

a. Departments and Agencies

1. Environmental Protection Agency

2. U. S. Department of Agriculture

Poultry and Meat Inspection

Plant Quarantines

Research Service

Forest Service

3. U. S. Department of Health, Education and Welfare

Food and Drug Administration

Public Health Service

4. U. S. Department of Interior

5. U. S. Department of Transportation

Regulations for transport of hazardous chemicals

6. U. S. Post Office Department

7. U. S. Department of Commerce

Patent Office

Interstate Commerce Committee

Division of Ecosystem Quality, National Marine Fisheries Service

8. White House Office of Science and Technology

9. U. S. Federal Trade Commission - advertising

10. U. S. Department of Defense

11. U. S. Department of Labor

Occupational Safety and Health Administration (OSHA)

b. Councils, Committees, Etc.

1. President's Council on Environmental Quality

2. President's Science Advisory Committee

3. President's Cabinet Committee on the Environment - Subcommittee on Pesticides

4. Federal Committee on Pesticide Control

5. Federal Working Group on Pest Management

6. Federal Air Quality Advisory Board

7. National Technical Advisory Committee on Water Quality

8. National Academy of Sciences

9. National Research Council

10. Various legislative committees and groups including the House and Senate Agricultural Committees

New York State

a. Department of Environmental Conservation

b. Department of Health

c. Department of Agriculture and Markets

d. Department of Education - Science Service

e. Department of Commerce

f. Department of Transportation

g. New York State College of Agriculture and Life Sciences

h. New York State Agricultural Experiment Station

i. New York State College of Environmental Science and Forestry (Syracuse)

III. PEST MANAGEMENT

The dilemma of producing adequate food for a rapidly expanding population while maintaining a clean, stable environment has become a major problem in recent years, and will become a critical one within this decade. Problems of pest control will become more varied and intense as attempts are made to increase yield and quality of food and fiber. If these problems are to be met successfully, there must be a change in the concept and practice of pest control.

Misuse of pesticides has been referred to as one of the major problems in the production of food and fiber in the United States today. One of the charges of misuse involves the application of pesticides to certain crops at specified growth stages regardless of whether damaging infestations of pests are present or not. A second misuse is the application of pesticides long before the economic threshold of infestation has been reached. A third major mistake is the application of pesticides to pest populations that are not economically significant. These use patterns which have become common practice in some areas, are almost always associated with the lack of precise information on pest populations. Producers with high investments in crop production may feel that they cannot afford the risk of heavy losses due to pest damage and will often make preventative applications of pesticides.

One of the most important contributions which we could make at this time would be a system devised to furnish the necessary information to farmers to allow them to make sound decisions relative to pesticide usage on the basis of need or as determined by accurate pest population assessment. If pest control is to contribute positively to a more productive environment, more attention must be focused on the management of pest populations, and with more concern for all the organisms in the environment.

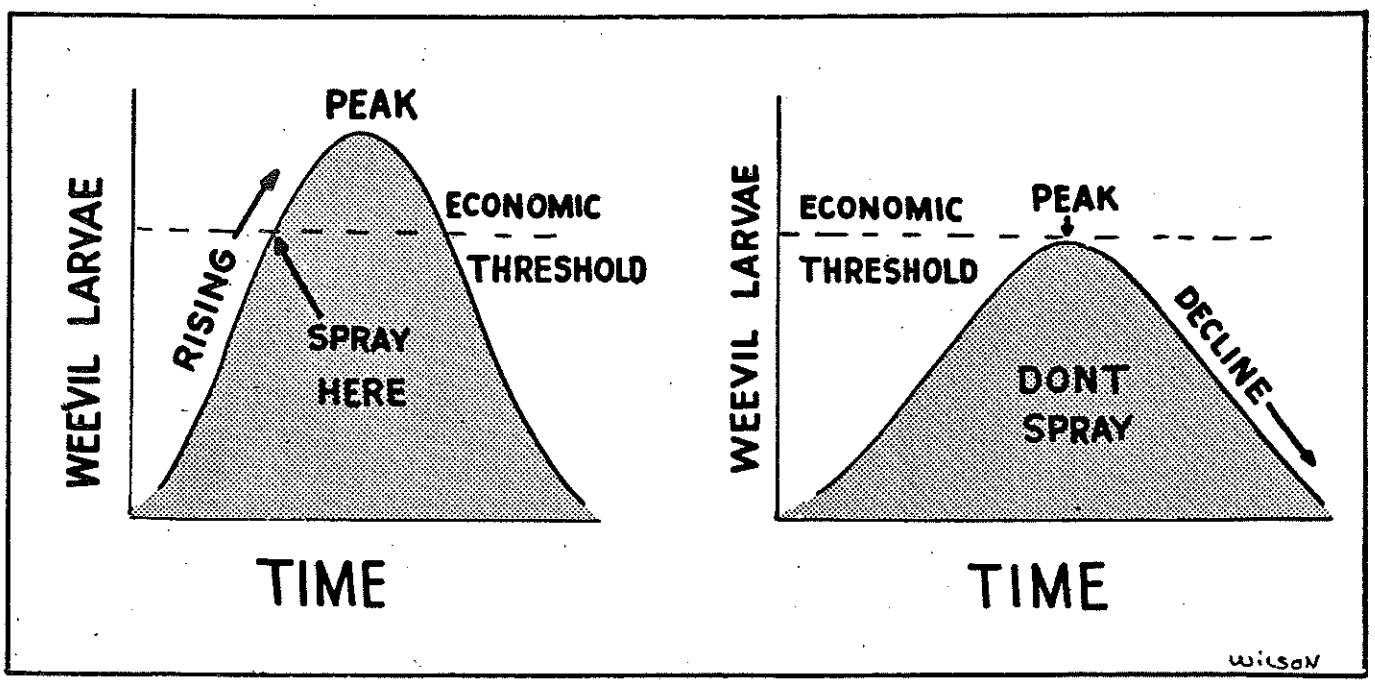
Pest management involves the integration of various chemical and non-chemical actions with those of the ecosystem to lower and regulate pest populations. Success depends largely on the degree to which the integration of

actions is guided by an understanding of the population dynamics of the pest and the general principles of ecology. The philosophy of pest management is to "manage" a pest population rather than to "eradicate" it. The objective is to combine chemical and non-chemical methods to maintain a pest population below the economic threshold established for that pest on a certain crop.

Economic Threshold

The concepts of "economic threshold" and "economic injury level" are the cornerstones of pest management. Establishing the economic threshold for a particular pest and crop is the decision of how large a pest population can be allowed to grow before a pesticide must be applied to control crop loss. The economic threshold is the density at which control measures should be applied to prevent a pest population from reaching the economic injury level.

The economic injury level is the lowest pest population that will cause economic damage to a crop. Sub-economic levels of a pest population not only do no measurable harm, but in some cases may have a beneficial effect. For example, low populations of alfalfa weevil apparently stimulate the alfalfa plant physiologically to produce more growth. This appears to continue until the weevil population gets so large the plant cannot tolerate it and loss occurs. The point between a sub-economic level that may benefit the host and a population that is causing economic loss is the economic injury level.



Pest populations can grow so rapidly that to wait for them to reach the economic injury level before applying control may be dangerous. Applying controls at the economic threshold is the best time.

Methods of Pest Control

Many methods are available for controlling pests. Each method can contribute some success in preventing or reducing kinds of pests and their numbers. Therefore, combining several of the most effective and practical methods, including pesticides, seems to be a logical approach to solving pest problems.

Some of the methods by which pests are kept in check which may be used in pest management are summarized below:

Natural Control

Natural control is any condition that slows down reproduction and growth of a pest organism and cannot be altered at will by man. The weather, especially temperature and moisture, is the major natural control force. It can encourage or discourage insect and plant disease outbreaks.

Cultural Control

Cultural control is any manipulation that tends to disrupt the normal association between a pest and its host. Examples are cultivation for weed control and control of planting dates. Planting wheat after the fly-free date has been a standard practice for many years to reduce Hessian fly damage.

Mechanical Control

Mechanical control is the use of special equipment. The results are immediate and positive. A classic example of this method is the fly swatter.

Legal (Quarantine) Control

Legal (quarantine) control uses procedures that resist the introduction or spread of a pest into an area; such as, active trapping, inspection, and

abatement such as the cooperative efforts between federal and state agencies in the gypsy-moth program.

Biological Control

Biological control is the direct or indirect use of living organisms to reduce the number of pests below a level of economic importance. Examples are hawks catching mice, lady beetles eating aphids, and one fungus antagonistic to another.

Chemical Control

Chemical control is the use of chemicals to suppress a pest population. We normally think of chemical control as toxic materials that kill weeds, insects, rodents, and plant-disease organisms; however, this is only part of the chemical arsenal. There are also chemical repellents, attractants, sex lures, hormones, growth regulators, etc.

Chemical pesticides usually provide only temporary reduction of pest numbers and involve certain risks to nonpests and beneficial organisms. Some pesticides can also be a potential hazard to the environment. However, chemical pesticides usually provide quick results, are easily manipulated, are usually readily available and are economical under most conditions.

Genetic Control

Genetic control is control through the use of resistant or tolerant varieties.

Integrated Control

Integrated control is the combination of cultural, mechanical, biological, and chemical control in a compatible relationship and forms the basis for a total pest management plan. An example would be the control of the alfalfa weevil on alfalfa. If weevil damage becomes serious, the field is sprayed with a selected pesticide that will bring the pest numbers back down to a tolerable

level, but in so doing will have minimal adverse effect on the weevil parasites.

Integrated Pest Management

Integrated pest management is the use of a number of effective control measures coordinated with production practices for overall crop or animal protection so as to reduce pest numbers to a low enough level where they cause little economic damage.

Properly planned and executed, integrated pest management practices can sometimes maintain pest populations at a level low enough to satisfy human needs with minimal adverse effects on nontarget organisms and on environmental quality. Integrated pest management can be more effectively accomplished if the agricultural crop or other site of a pest problem is considered in its entirety and not merely an arena in which to embattle a pest. Past, present, and future conditions or practices tremendously affect the level of pest populations, the choice of pest control methods, and the degree of pest control achieved.

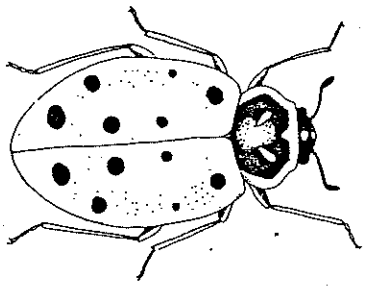
It should be recognized that any pest control practice, including the application of pesticides, will have effects other than the intended one. Such side effects may be good or bad, gross or slight, short-lived or long-lived, local or distant, obvious or nebulous. The demonstrator and researcher should be ever observant for these side effects and consider them in interpreting, reporting, demonstrating, and recommending pest control practices. Integrated pest management implies the selection of those pest control measures that will maximize beneficial effects and minimize harmful ones. Individual elements or control measures within the integrated pest management program should be selected, used in the proper sequence, and timed to be compatible with each other, with other cultural or maintenance practices, and with use of the item that is being

protected from pests. Neither pesticides nor any other individual control measure should be overused to the extent that it loses its effectiveness, interferes with the effectiveness of other control measures, or adversely affects man, other nontarget organisms or the environment.

Pesticides are probably more subject to being overused or misused than the other pest control methods. Such misuse or overuse may not only result in unnecessary harm or hazard to man and his environment but can result in poor pest control or even a higher incidence of pest attack.

Resurgence of target pest populations or population explosions among secondary pests or nontarget pests may follow pesticide applications because of the destruction of natural enemies.

Parasite and predator populations may survive a pesticide application but be decimated by starvation when the pests and other hosts are killed off.



In certain instances, an organism is not an important pest simply because of competition from another organism. Such an organism becomes a pest when its competition is removed. If broadleaf weeds are selectively killed by a herbicide, grassy weeds will usually thrive. Some pests that occur on crops late in the season are pests because the crop has been protected from competitors.

In some instances, a pest may be supporting another organism that becomes a pest when its host is controlled. Weeds and grasses may harbor insects such as stalk borers and armyworms that move to corn when the weeds are destroyed.

The certified applicator in demonstration and research pest control must be ever mindful of the extreme complexity of the usual environment in which pest control is practiced. Biological phenomena, climate, topography, various physical and chemical characteristics, maintenance or cultural practices, and use patterns are so interrelated that it is extremely difficult to adequately assay the effects that a pesticide may have on the ecosystem. One must be

constantly alert and thoughtful in developing, recommending, and demonstrating pest control practices.

IV. FIELD DEMONSTRATIONS AND RESEARCH EXPERIMENTS (TESTS)

Good tests and demonstrations can be of great value. Poor tests can be worthless or even misleading. Before conducting a test or demonstration, decide what your purpose is. Is it research to find answers to new questions? OR is it research to check the application of recommendations or ideas or to find clues to troubles and to show these to growers? OR is it to demonstrate or show growers new practices or comparisons which back up your recommendations? Usually the first two of these are for the purpose of taking data, are replicated and randomized, and are called experiments. Nonreplicated trials or trials without control plots are not experiments. They do not contain comparisons where the treatment was not used, nor do they sample the variation within the test area. Such trials are not acceptable for publication of data or sales promotion but may be valuable as demonstration plots. Demonstrations are usually for observation only and the plots should be arranged to best show the points you wish to demonstrate. In some instances however, test plots (experiments) may also serve as demonstrations.

Demonstrations

As indicated above, demonstrations have as their purpose the showing on a visible basis or comparison the usefulness of new, proved information to obtain grower acceptance. Demonstrations are usually one of two types or a combination of the two.

Method Demonstrations - on how to do something are usually an action project such as how to calibrate a sprayer or tank mixing of difficult mixtures, how to incorporate an herbicide properly in the soil, etc. These are appropriate for use with individuals or with groups, and may be the beginning of a result demonstration. Method demonstrations require study, ingenuity, and practice before actual demonstration.

Result Demonstrations - are to show what happens by example of the practical application of new information or to show principles or comparisons that support

a practice or your recommendations. Sometimes they are used to determine if a practice or product shows promise and is worthy of testing in an experiment. Usually result demonstrations are large plots, sometimes in the form of strips across a field. Use of a whole field for a treatment is not a good demonstration as you have nothing to compare it with and do not know what would have happened had other treatments been used. Yield data is seldom required but the farmer cooperator may obtain gross yield comparisons. Observations should be maintained through the season and notes taken, particularly on unexpected developments. Field meetings are generally held to show the results.

Good result demonstrations require:

-- A clear-cut and simple objective with differences that will be easy to see. Test only one response.

-- A good plan

-- A good cooperator. He should be really interested, not just agreeable. He should be known and respected in his area.

-- Good crop production practices

-- Good location with easy access so that results can be easily seen.

-- Good notes throughout the season on rainfall, diseases, insects, weeds, spray injury, hail and any other factors that may affect the response.

Site Selection

In addition to selection of a field easily accessible so that the results can be shown at a meeting or tour it is important to examine the field to be used before planting. If possible:

a. Avoid dead furrows, back furrows, wet spots, dry knolls, trees, anything that causes change in soil or environment.

b. Try for an area that is as uniform as possible.

c. Try for an area near a road for easy access and to permit use of the test as demonstration.

4. Stay away from the edge of the field to avoid compacted areas in headlands and other effects due to the edge of the field.

e. Steer clear of sites of old manure piles, haystacks, barn sites, or any other factor of this type. You can't always find these, but look for giveaways such as change in soil color, or other indications that there has been something different in some part of the test site.

Experiments or Tests

Experiments or tests are for the purpose of developing sound information whether the information sought is new, or whether the information is to solve practical problems. Experiments may be set up to determine if new information applies to the practical problems in your area, or to check your recommendations. Regardless of the purpose, experiments must be carefully planned to be successful.

Setting Up An Experiment

Before conducting a field experiment with pesticides, it is best to prepare a statement that answers the following questions:

a. What are the objectives? (What do you want to prove or demonstrate?)

b. What is the design? (How are the treatments and plots arranged?)

c. What variables exist within either the experiment or the plot area? (Are there soil or varietal differences?)

d. How many replications are needed? (Two, four, or more?)

e. What is the sampling procedure? (Number of weeds, insects or diseased plants per square foot or yields?)

f. How will the data be analyzed? (Analysis of variance statistically, or simple number comparison?)

g. How will the results of this experimental work be used? (Publication, sales, recommendations, or demonstration?)

The importance of the last question cannot be overemphasized. The intended use of the data collected in the experiment will greatly affect your answers to other questions. For example, an experiment designed to show that the yield increase was due to pesticide use will involve a different experimental plot design, greater numbers of replications and a different sampling procedure than an experiment designed to illustrate the possible use of a pesticide in combination with a new tillage practice.

Definitions

You should be familiar with these terms in setting up experimental or demonstration pest control work.

Bias -- A manipulation of the experiment so that results do not accurately reflect the effect of a treatment.

Block -- A group of experimental units or plots in which each treatment occurs the same number of times.

Check or Control -- The experimental units or plots to which treatments are not applied.

Experimental Error -- An inconsistency inherent in an experiment that may prejudice results.

Plot -- The experimental unit; e.g., the area of a field or a group of animals receiving a treatment.

Randomization -- A random arrangement of treatments by purely objective methods; e.g., drawing numbers out of a hat.

Replication -- The same treatment appears two or more times in an experiment.

Sample -- Representative unit(s) taken from a population; e.g., the number of velvet leaf plants or corn borers counted in each plot.

Result Demonstration Trial -- A nonreplicated trial used to demonstrate some established fact or principle.

Treatment -- The factor being tested in an experiment; e.g, type of herbicide or fungicide.

Trial -- An experiment. A group of plots to which treatments have been applied.

Experimental Design

Designing an experiment is an extremely important step because errors made in the design can invalidate the results of the entire experiment. The most able statistician cannot assist you in reaching valid conclusions from an improperly designed experiment. It is generally best to avoid complex experiments which involve elaborate designs. If you have trouble with a design or are in doubt about its validity, seek assistance before initiating the research.

The completely randomized design is the most simple design (see figure). It is set up by assigning treatments at random to a previously determined set of plots. Any number of treatments may be tested in this design. It is desirable to assign the same number of plots to each treatment, but it is not essential. This is not usually the most efficient design for research in field crops and may be better suited for trials with livestock.

The advantages of this design are that it is flexible and simple. The estimation of the experimental error with this design may be less precise than with other designs.

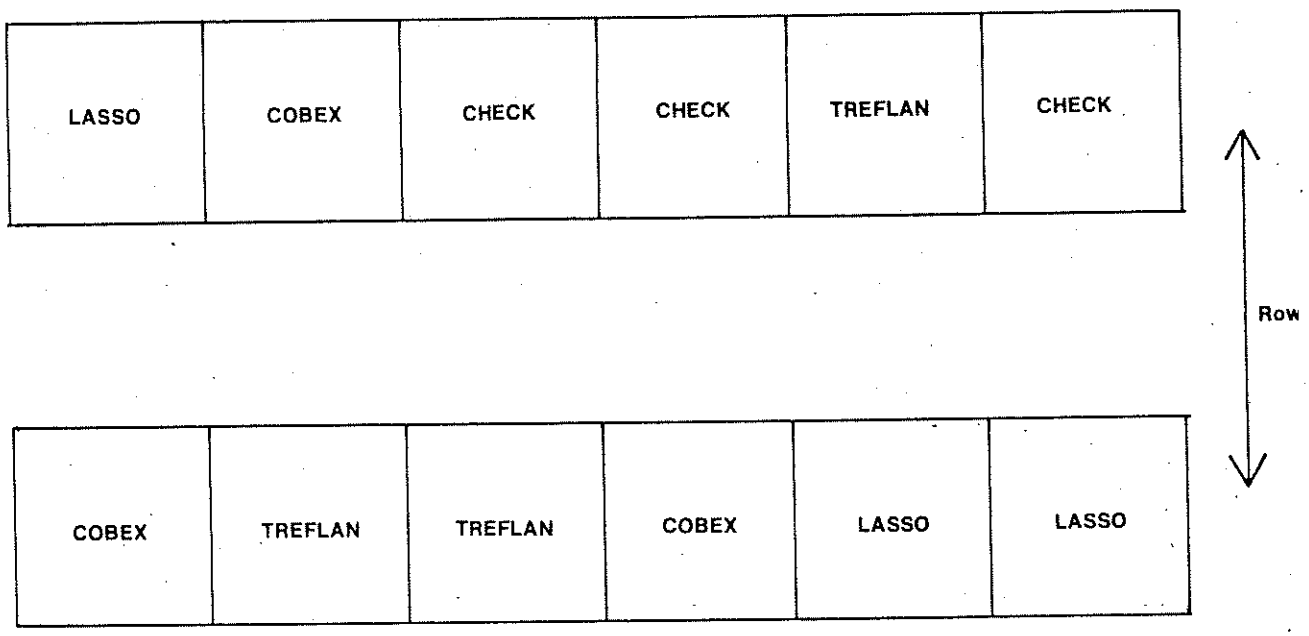


Figure 1. Completely randomized design with three herbicides -- Cobex, Lasso and Treflan, and control plots.

When the plots are laid out within a field, the number of plots is determined by multiplying the number of treatments by the number of replications of each treatment; e.g., 18 treatments of herbicides x 3 replications = 54 plots. The treatments are assigned to the plots at random.

The randomized complete block design is used to keep variability among plots in a block as small as possible (See figure). In this design, the treatments are assigned at random to a group of plots called a block. Because adjacent plots usually yield more alike or have more similar disease or pest infestations than those separated by some distance, the block is kept as compact as possible. This is accomplished by placing the plots, usually long and narrow in shape, close together. It is desirable to obtain a compact block. Thus, treatments should be as few as possible.

Plots can be laid out as strips through a field. This design will provide highly reliable data but will become cumbersome with a large number of treatments -- usually more than five to six. Note that each treatment occurs once in each block.

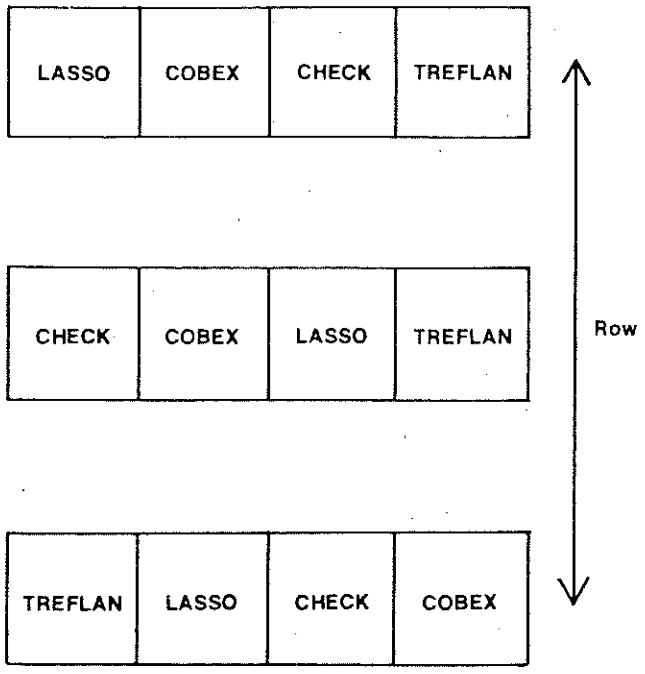


Figure 2. Randomized complete block design with three herbicides -- Cobex, Lasso and Treflan, and control plots.

The Latin square design groups treatments in two different ways -- by columns as well as rows (See Figure). Every treatment occurs once in each block (row) and once in each column. Variability across the experimental area is measured and removed in two directions. With the Latin square design, the number of treatments must equal the number of replications. With a large number of treatments this design becomes cumbersome. Usually, this design is used for experiments where there are from four to eight treatments.

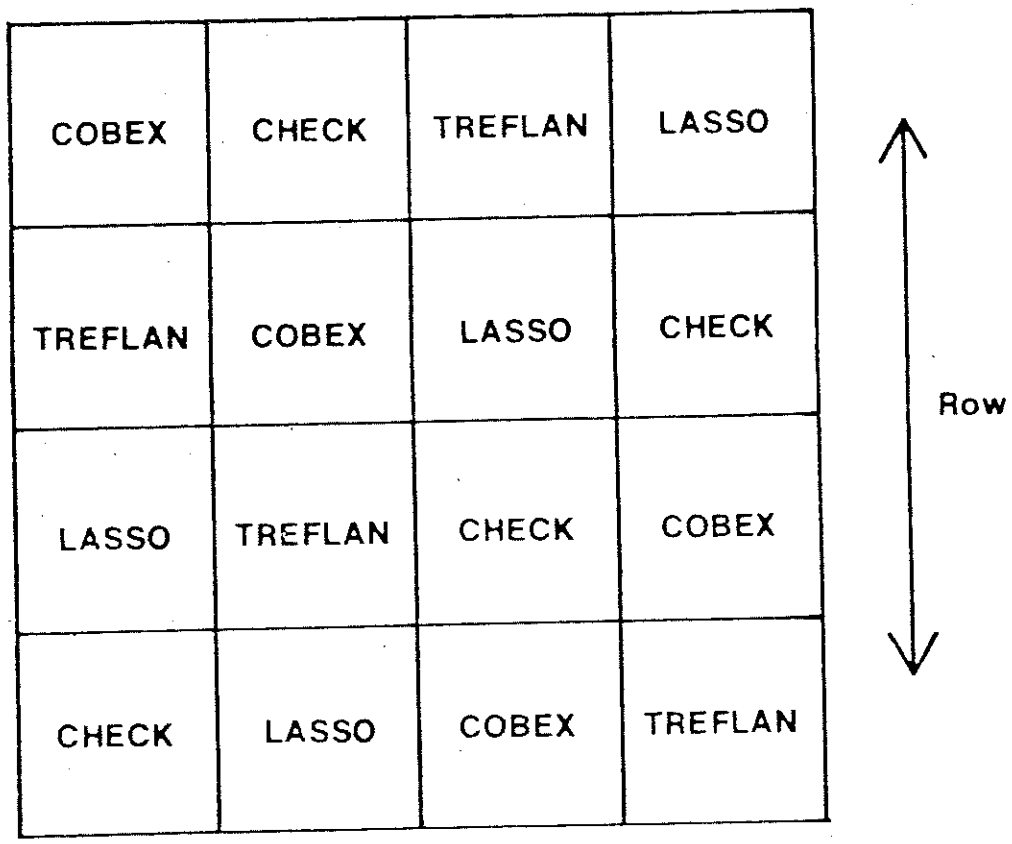


Figure 3. Latin square design with three herbicides -- Cobex, Lasso and Treflan, and control plots.

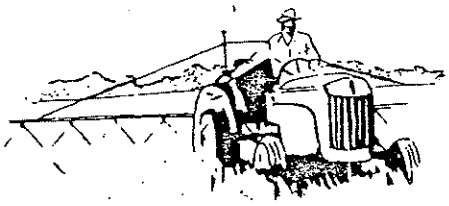
Randomization

Many factors might affect the outcome of experimental field work -- soil type, drainage, compaction, erosion, pest infestation, temperature variation, etc. Such factors may change with time and with location in a field. The researcher or individual involved in pest control demonstration work must be

constantly alert in selecting plots in order to avoid selecting ones that may differ from others. These sources of bias may be minimized by randomization. This is the process of determining which experimental plots or units are to receive a given treatment by a purely random fashion. This may be done by tossing a coin, casting a die, drawing cards or numbers, or using a table of random numbers. When randomizing plots, avoid systematic arrangements such as regularly alternating two treatments or repeating several treatments in the same order. Avoid selecting a group of numbers that "look as though they ought to be random."

Control or Check Plots

The experimental units or plots to which the treatment is not given are called the control or check. Inclusion of control plots is mandatory in all statistically sound experimental field work. Failure to include control plots or the incorporation of inadequate control plots provides only questionable results unacceptable for publication and sales promotion. The selection of check plots or units should be made with the same objectivity as that of other plot selection. The same variable factors that may affect treatment plots will affect control plots. Control plots should not be arbitrarily located near a fence row, lane, gate, or simply in the middle or side of the field.

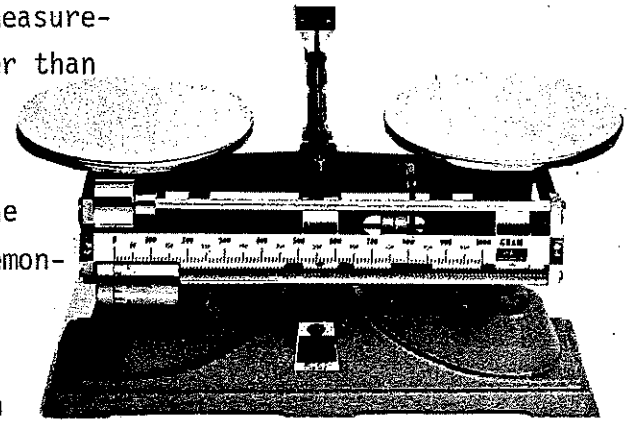


Calibration

Correct calibration and accurate measuring and mixing of pesticides are extremely important in research and demonstration pest control work. Although the hazards of application may be reduced and the chances of nontarget pollution minimized in small plot work, the chances of misapplying the correct rate of pesticide are generally increased. Small errors in measuring the candidate

material, for example, may cause over- or under-dosing of the treatment plot. Small errors in calculations are greatly magnified in small plot research. The addition of two fluid ounces of a candidate herbicide in a 100 gallon tank of water during mixing for general field application may not necessarily be significant. This small amount, however, added to two quarts of water in small plot research can result in highly inaccurate results.

Measuring of candidate pesticides for small plot or research work often demands the ability of the researcher to work comfortably with measurements of grams, milliliters, or ounces rather than pints or pounds.



Rough estimates or "rounding off" in the measurement of pesticides for research or demonstration is not an acceptable practice.

Liquid measurements should be made with graduated cylinders or pipettes. Safety pipette fillers or propipettes should be used with pipettes in order to avoid the inadvertent introduction of the pesticide into the mouth of the researcher.

Dry materials should be measured on properly adjusted scales that provide measurements in milligrams, grams, or ounces.

Application Techniques

A well-designed experiment can lose its value through careless techniques of treatment application and data sampling or collection.

-- Carefully label all plots or experimental units.

-- Avoid nonuniform applications.

-- Clean application equipment between treatments.

-- Avoid inadvertent factors such as unequal preparation, treatment, or maintenance of the check plots.

-- Require one individual to make all treatments.

-- Avoid terms such as "severe, moderate, slight."

-- Define indices clearly.

Sampling

Even though the experiment has been properly designed, high quality data can be obtained only through the use of an intelligently planned and uniform sampling method. If the sample taken, whether of pest population or for pesticide residues, is not representative the results will not be valid, and will be of little value to anyone. Furthermore such data may give rise to erroneous and misleading conclusions.

It is important to remember that the collection of a representative sample is influenced by a number of variables that must be taken into account before the sampling procedures can be planned. These include the source of the sample, the size and part of the commodity to be sampled, the method of application, and the purpose of the sampling.

For practical reasons, there is frequently a limit to the number of samples which can be taken from a particular plot. Therefore, certain fundamental sampling methods must be followed. In general, the sample should represent the situation in the plot, and if for pesticide residues, reflect the level of residue on the crop as it reaches the ultimate consumer. If the plots are small, it is desirable to avoid taking samples near the borders. Require one individual to take all samples. If more than one individual is involved, do not allow one person to sample all replications of one treatment. If possible, sample at the same time -- hour, day -- and do not pool or bulk samples initially.

Control plots are essential in any experiment. An alternate pesticide may be used when an absolute check (no treatment) is not possible. If sampling is

to be for residues, consult the residue analyst so that consideration will be given to posible contaminating or interfering substances. Borders of control plots should be avoided because of possible drift effects.

The following discussion of sampling will be as a guide for residue analysis since this is common to most pesticide demonstration or research. Specific sampling should be developed as required for the particular experiment and analyses.

Tree fruits should have fruit sampled from all four quadrants of each tree sampled. Care should also be taken to sample from the inner and outer portions of the tree. A minimum of 25 pounds and preferably 100 pounds gross sampled for residue analyses should be taken and then subsampled for a composite sample. If it is not convenient or desirable to reduce the size of the subsample, it may be possible to store the sample without freezing for several days prior to subsampling for analyses. Fruits which ripen or break down quickly should be subsampled and frozen soon after sampling.

Small fruits can be sampled by procedures similar to tree fruits. Samples are usually much smaller and if planted in rows should be sampled simultaneously by two persons on opposite sides of the row. Samples should be taken from 12 to 24 stations in the plot. Large samples cannot be taken because of the expense and depletion of the crop. One should remember that a small sample may be less representative than a large sample. Gross samples should be reduced as soon as possible by careful mixing and quartering to approximately six pounds which then should be divided into three equal portions, placed in containers, labeled with complete information as to plot identification and treatment history, frozen (if necessary) and kept unchanged until ready for analysis.

Leafy vegetables are sampled generally in much the same fashions as small fruits. About one-half pound of foliage is collected at each of the 12 to 24 sampling stations. In most cases only the foliage normally used for food is included in the samples. Yellow leaves or leaves lying on the ground are rejected. Since they are always washed before eating, composite samples are washed and drained or air dried before packing, labeling and freezing.

When sampling head crops (cabbage, head lettuce), 25 heads per plot are adequate. They should be trimmed to marketable condition and the trimmings discarded. Heads are quartered generally with alternate quarters combined to produce the gross sample. It is then reduced in size by cutting or chopping into pieces one-half to one inch in size, mixing and quartering to a six pound sample. This in turn is mixed and divided into three equal subsamples, placed in suitable containers, labeled with complete information, frozen and placed in storage.

Cucurbits or vine crops may or may not require analysis of rind (peel) and seeds. This must be decided before final sampling. If used for human food, each unit should be washed thoroughly, allowed to drain and air dried. Crops used for animal feed should not be washed. Twenty-four to 48 units, depending on their size, should be collected from each plot in such a manner that each row is represented. Subsampling and preparation is as for the previous crops.

Root and tuber crops are usually only sampled at harvest time and then exclusive of foliage. Sampling is as for the previous crops. Samples should be washed and dried before subsampling, quartering, etc. to avoid contamination of the sample from the soil.

Sometimes it is necessary to sample a crop being prepared for processing. This usually can best be obtained by random sampling at the point following final washing or just previous to packaging. If the same equipment is being used for both treated and untreated crops, it is essential that the untreated crop be processed first to avoid possible contamination from any residues that may be present on the treated crop. Care should be taken that the untreated crop is not contaminated by a previously processed crop that also may have been treated.

Legumes and green crops used for food are usually mechanically harvested and grab samples are taken from the harvester uniformly spacing them over the whole plot. If the plots are sampled by hand, two persons work together, and select pods (peas, beans, etc.) from opposite the same vine simultaneously. Pods should be selected from the inside and outside of the vine in proportion to their abundance on the vine. Peas and lima bean shells are not usually eaten

and should be shelled before subsampling. With the legumes used for food, the vines may be used for animal food after the human food has been harvested. The vines should be sampled if used for animal feed or for forage.

Legumes for forage are usually sampled as a "total sample" as the residue present may vary greatly from the protected and unprotected areas. Generally, sampling is to obtain an average rather than the maximum or minimum on or in the crop. Because the application is not uniform as large an area as possible is sampled -- 24 random sampling stations and one pound of sample taken from each station. Forage is cut to the normal height , usually two inches above the ground. The gross sample is then chopped into one inch lengths, combined, mixed, and reduced by quartering to a six pound sample divided into three equal subsamples, properly labeled and held in frozen storage. Care must be taken to avoid loss of leaves, or small branches in harvesting and storing the sample.

Storage and Shipment of Samples

Samples other than water should normally be stored in a freezer and below 0°F if possible. Sometimes it is convenient or desirable to store the gross sample before it is reduced to subsample size. The primary consideration of such temporary storage is the ability of the crop to withstand spoilage and shrinkage and of the pesticide to break down or decompose.

Frequently, samples collected for residue analyses are shipped to some other location for analysis. Whenever possible the shipment is made by air freight or air express. Frozen samples should be packed in a rigid insulated container with sufficient dry ice to keep the sample frozen for at least 48 hours. The amount of dry ice needed varies depending on the containers, the temperatures and distance. In warm weather two pounds of dry ice per pound of sample will keep the sample frozen for a couple of days if a multiwall corrugated paper container is used. Shipments should be made early in the week to avoid arrival over a weekend.

Finally, the full correct address of the recipient is given to avoid delay in routing or delivery. A delay of even a day sometimes leads to spoilage and loss of the sample. If the shipment is by air, it is important to notify the

addressee of the shipment before the sample arrives, giving the details of shipment; such as flight number and arrival time.

Extended storage in freezers can cause moisture to migrate to the surface of the sample and then to the freezer coils, slowly desiccating the sample. If water content affects the analysis or weight loss affects the calculated residue concentration, it may be important. Avoid plastic containers or plastic lined caps unless made of some inert plastic such as Teflon which does not interfere with the analysis. If polyethylene or other plastic bags or containers are used for storage, tests should be made to determine whether there is any interference. Some are capable of absorbing some pesticides. Bags should be checked for their PCB content. If cans are used, they should be checked first to demonstrate the absence of oil films, lacquers, resin from soldered joints, etc., that might interfere with the analysis.

Special precautions should always be taken in the storage or shipment to prevent the possibility of check samples being contaminated by mingling with treated samples, especially if it is necessary to pack both in the same outer container.

Guidelines for Cornell Agricultural Extension Field Staff Who Conduct Adaptive Research or Demonstrations with Pesticides

Most agricultural chemicals and particularly pesticides, being poisonous substances are classed as hazardous materials and are considered by law to be dangerous instrumentalities, and as such they require the highest degree of care in their use.

The policy of Cooperative Extension, N.Y.S. College of Agriculture and Life Sciences, is outlined below.

a. Only <u>fully registered</u> recommended materials may be used by the agricultural field staff for field demonstrations.

   1. Recommendations must originate with the college extension faculty. County recommendations should not differ from these.

2. If chemical company representatives contact the agricultural field staff and request them to conduct adaptive research or demonstrations with recommended materials, the appropriate extension faculty in the subject matter area should be consulted before starting the project.

b. Unregistered pesticide chemicals, feed, food, or color additives, and veterinary drugs will not be used in adaptive research or in demonstrations except on university-owned or controlled land, premises and animals. The use of all such unregistered drugs or chemicals, regardless of where or how used, must be under the direct supervision or cooperation of the appropriate faculty member of the college having knowledge of the nature of such drug or chemical. No portion of the treated commodity should enter trade channels unless it can be clearly established that no residue results from the treatments or that it is within a temporary tolerance, if one has been established.

c. Pesticide chemicals with an experimental label will not be used in demonstrations by the agricultural field staff. Adaptive research with these compounds may be undertaken, but must be conducted on a cooperative basis with the company representative or faculty member who shall be responsible for any liability resulting from harm to the crop or purchase of the crop if necessary to keep it out of market channels because of residues on the crop to be consumed. Field staff may help obtain farm cooperators and otherwise cooperate. Uses should be limited to those covered by the experimental label and in the manner specified. The appropriate college faculty should be consulted before starting the project.

d. Pesticide chemicals which have a temporary tolerance established may be used for adaptive research within the limits of the tolerance. Most such compounds will also have an experimental label and the procedures outlined above should be followed. Compounds with a temporary tolerance may be used on food crops and enter food channels providing the directions permit such use and are followed. Otherwise evidence will be necessary to show that the temporary tolerance

has not been exceeded by the experimental usage. The appropriate college faculty members should be consulted before starting the project.

e. Due precautions to protect personnel, property, the public, the environment, and other public interests shall be employed in all investigations wherein agricultural chemicals are used.

Not only must suitable safety measures be taken at all critical stages in the program, including storage and disposal, but also crops, dairy, poultry or other animals and their products that have been treated experimentally or otherwise with chemicals not cleared for use by the appropriate state or federal agencies must be handled or disposed of in such a way that there is no reasonable possibility of their being consumed by humans or animals. In no case shall they be marketed.

f. If pesticides are used that are on the restricted list or which have only experimental labels or which are numbered compounds as part of your research or demonstration program, a research permit is required.

All Cooperative Extension Specialists (employed by the College) are covered by the College blanket permit. To obtain the Permit Number, write the Associate Director of Research, 292 Roberts Hall, Cornell University, Ithaca, NY, 14853. You should submit with your request a list of the restricted materials you expect to use.

All County Extension Association personnel (employed by the County) should obtain individual permits. Requests for this permit with a list of restricted materials you expect to use should be directed to Mr. C. H. Frommer, Director, Bureau of Pesticide Control, Department of Environmental Conservation, 50 Wolf Road, Albany, NY, 12233.

Suggested Research and Demonstration Procedures

Prior to conducting adaptive research or demonstrations with chemicals, drugs, and pesticides on land, crops, and/or animals not owned or controlled by

the College, the following steps should be taken to ensure protection of the individual investigators, Research or Extension Division, and N.Y.S. College of Agriculture and Life Sciences.

a. Consult with the appropriate faculty member(s) of the College before making any commitments. Make certain that your plans conform with the policy outlined in the previous section.

b. Obtain necessary toxicological data so that you (the investigator) are satisfied that you will not jeopardize your health or that of others if the compound is used in the prescribed manner.

c. Obtain from the sponsor of the investigation or producer of the chemical, drug, or pesticide, information on the method (acceptable to EPA) by which animals or plants which are treated with these compounds must be disposed of. Also obtain a statement as to who will accept responsibility for disposing of the commodity and providing compensation for it.

d. Obtain sufficient instruction and research data from the company of origin on mode of action and use of compound to satisfy yourself that no untoward effects on soil, plants, or animals will result from its use.

e. Inform the owner of the commodity to which the compound will be applied of all possible dangers to himself, crop, or animals. Inform him of the method of disposal for the crop or animal.

f. Secure a simple written statement outlining contributions and responsibilities of each party. A copy of the agreement will be sent to the appropriate directors.

Liability of Government Employees

Personal

It is well settled in the law that Government, like other employees, are personally liable for their own acts of negligence, even if committed while they are acting in the scope of their employment. Employment is no cloak of immunity, and suits can be instituted against them as indicated in the case United States v. Gilam, 374 U. S. 507.

Negligence

If any Extension employee (area specialist) should put on a demonstration in cooperation with a local farmer to control a particular weed problem with a chemical that research indicates will be successful and the manufacturer has given assurance the product would be available when cleared for registration, what is the liability of the extension employees?

Regardless of whether the extension employer is demonstrating the use of the chemical, actually applies the material or gives advice as to their use, there may be grounds for negligence charges.

Negligence to be actionable, requires a breach of legal duty. This duty or standard of care, will vary in different situations. Weed and other pest control materials, being poisonous substances, require a very high degree of care in their use. As such they are considered to be dangerous instrumentalities. Chapman Chemical Co v. Taylor, 215 Ark. 630, 222 S.W. 2nd 820. Many states follow the doctrine of "absolute liability" or "liability without fault" where dangerous instrumentalities are concerned. A party responsible for a dangerous instrumentality, or for an operation likely to cause injury or damage to persons or property rightfully in its proximity, is charged with the duty of taking suitable precaution to avoid injury or damage, and his failure to take such precautions is negligence. All persons who deal with deadly poisons or noxious and dangerous substances are held to strict accountability, and the highest

degree of care must be used to prevent injury from their use. Rose v. Buffalo Air Service, 104 N.W. 2nd 431. Absolute liability will arise where dangerous chemicals are used for crop-dusting. Chapman Chemical Co. v. Taylor, supra.

Duty of Care

Included in the duty of care is the duty to warn those who may be injured by the use of weed and other pest controls, so that they may take precautions, if possible, to protect their property and themselves from damage or injury. This requires warning not only the farmer on whose land the tests are carried out, but neighboring farmers or other persons who may suffer damages. In some states once a person has been warned, his failure to take adequate steps to protect himself and his property will result, by statute, in his being contributarily negligent so as to prevent recovery for his damages. Regardless of whether there is a statute or not, the failure to warn of danger in use of untested materials would be an essential element in creating liability on the part of a government employee.

Liability

Liability for damages caused by use of poisonous chemicals will arise if the user has, or in the exercise of ordinary care should have knowledge of sufficient facts to have caused an ordinarily prudent person in the same or similar circumstances to believe that poisonous chemicals might reasonably be anticipated to cause damages. Such knowledge would presumably be imputed to a government employee using materials he knows not to have been approved for the particular purpose to which they are applied.

Landowner Responsibility

Except where provided by statutes, contributory negligence on the part of the farmer or landowner is not a defense where strict liability is the basis of negligence. However, assumption of the risk by the injured party will release liability. Where an activity is carried on in part or in full for the benefit of the injured party, assumption of the risk may be implied. However,

it is better if there is an express assumption of the risk. This will arise if the farmer or landowner gives approval after knowing all the facts and possibilities that might arise from the use of untested materials.

Negligent Misrepresentation

An Extension (or government) employee may merely advise the farmer or landowners how to apply and use untested materials. This too, may result in liability on the part of the employee. Such liability would be for negligent misrepresentations, and will arise when the person furnishing information owes a duty to give it with care and the person receiving it has a right to rely or act upon it, and does so to his damage. A representation made with an honest belief in its truth may still be negligent, because of lack of reasonable care in ascertaining the facts, or the manner of expression, or absence of the skill and competence required by a particular business or profession. The Restatement of the Law of Torts, Section 522, states that:

> "One who in the course of his business or profession supplies information for the guidance of others in their business transactions is subject to liability for harm caused to them by their reliance upon the information if (a) he fails to exercise that care and competence in obtaining and communicating the information which its recipient is justified in expecting, and (b) the harm is suffered by the person or one of a class of persons for whose guidance the information was supplied."

An action for negligent misrepresentations requires justifiable reliance upon material statements. This usually excludes actions based upon statements of opinion, for opinions are regarded as immaterial statements which do not justify reliance. However, where there are special circumstances such as disparity of knowledge between the parties, reliance upon an opinion may be justified. It would appear that such a disparity of knowledge would exist where government employees are advising farmers on new chemicals, therefore, statements made in the form of opinion may not be sufficient to avoid liability for a negligent misrepresentation.

Avoiding Liability

It would appear that a means of avoiding such liability would be to inform the farmers and landowners concerned of all factors involved: what the materials will do, what they will not do, what they might do, and the possible consequences that may arise from the use of these materials.

Summary

In summary -- the use of untested chemicals by Extension (government) employees can create liability on their part. This liability may be avoided by explaining to and warning the beneficiaries of field tests just what may happen, and thereby letting the beneficiaries assume the risk of injury and damage. Liability may still exist as to unwarned third parties who are injured as a result of the use of these materials.

If the Extension employees merely tell the beneficiaries how to apply these chemicals, they must communicate all possible consequences as well as benefits, which may arise from the negligent statements. This is the opinion from the U. S. Department of Agriculture, Office of the General Council, Washington, DC, Issued September 1, 1964.

Record Keeping

Accurate and complete records contribute to the success of an agricultural enterprise.

The use of a pesticide application record will provide a permanent record of purchase dates, application dates, types of equipment used, weather conditions and location of each pesticide application.

When considering the economic value of accurate, properly timed pesticide application, present regulations regarding residues and varying susceptibilities of different crops to certain pesticides and pesticide residues in soil, the importance of complete pesticide application records is obvious.

Maintain accurate records for safe and effective pesticide use in agricultural operations.

A pesticide record helps to:

-- Determine amounts of pesticides needed

-- Reduce inventory carry-over

-- Improve pest control practices and avoid pesticide misuse

-- Compare applications with results obtained

-- Establish proper use when residue affects marketing your crop

-- Establish where an error was made, if such occurs

-- Establish proof of use of recommended procedures if indemnity payments are involved and are to be collected

-- Plan cropping procedure for next year

Keep the following information:

-- Crop and variety or animals treated

-- Location and acreage treated

-- Crop history including planting date and developmental stage

-- Date and time of application

-- Pesticide used, including the name, percent active ingredient, type of formulation, manufacturer, purchase date and lot number

-- Amount of pesticide per gallon or 100 gallons of dilution

-- Amount of dilution applied per acre

-- Calibration of equipment including nozzle size, pressure, throttle setting and gear

-- Weather conditions including temperature, wind direction and velocity, soil moisture conditions and relative humidity

-- Estimated total cost of application

-- Application results

-- When animals are treated, average weight, age and target pest

How to Keep Records

Carry a pocket notebook with you and record information as it happens. Don't rely on your memory. Transfer this information to a permanent record sheet which is kept in a safe place.

V. GUIDELINES FOR MINIMIZING PESTICIDE POLLUTION

When Pesticides Become Pollutants

Pesticides, when properly used, are tools. When they move off target or are otherwise misused they become pollutants. They would not be much of a problem if they stayed where applied but the widespread distribution of DDT and similar compounds demonstrates that many pesticides do not remain where applied and do remain in the environment for relatively long periods of time.

Pesticides become particularly important as pollutants when they move into water and cause either immediate toxicity to organisms present or, more seriously, are of a persistent and accumulative nature and move into the food chain where they upset the normal life cycle of organisms; in such ways as destroying reproductive capacity, making the organism more vulnerable to predators by slowing the escape mechanism, or even by acutely poisoning the predator at the end of the food chain.

But areas other than water are also subject to pesticide contamination. When Sevin is sprayed on a field where bees are foraging on weed blossoms, the beekeeper considers it a pollutant. When 2,4-D drifts from the highway to injure or kill grapes it is a pollutant. And the lindane illegally used to treat dairy cows becomes a pollutant when it shows up in the milk.

How Pesticides Move Off Target

Pesticides may drift away from the target. Many factors contribute; some physical, some climatic. The smaller the spray droplet, the further it will drift. And, obviously, the stronger the wind, the greater the drift.

The choice of pesticides influences drift damage from toxicity, phytotoxicity, illegal residues, and volatilization. Choice of the proper formulation will reduce drift as will use of thickeners. And choosing the right machinery for a particular job is most important.

Pesticides adhere tightly to soil particles. Consequently any type of erosion -- runoff or sheet erosion, or wind erosion -- transports the pesticides along with the soil particles. Conversely, cultural practices that prevent soil erosion also prevent pesticide movement and pollution.

Because of the tight absorption to soil particles, leaching into ground water is not a particularly significant means of pesticide transport and contamination.

Pesticide residues on foods, both illegal and within tolerance limits, may be further distributed by humans and animals who consume the food and excrete the pesticide either directly or as a contaminant of meat, eggs, or milk.

Poor choice of a pesticide for a given problem increases pollution. In most cases a short-lived, biologically degradable, non-accumulative compound may be substituted for a persistent, accumulative, environmentally dangerous compound. The use of DDT for a mosquito larvicide over the highly active modern biodegradable larvicides would be a bad choice, even if it were not now illegal.

The careless operator hurts himself, his customers, and his environment through poor location of sprayer filling stations, slipshod tank filling procedures, insufficient mechanical safeguards against contamination, accidental spills, and poor disposal of left-over mixed spray, surplus pesticides, and used containers. Poor operational procedures and misuses are probably the greatest contributors to pesticide pollution.

Being aware of these sources of pollution one then should be able to come up with practical solutions based on existing methods and materials which will greatly minimize the contribution of agriculture, and other users, to pesticide pollution of our environment. The following are some practical considerations. Those presented are by no means complete, but are given as examples and to stimulate further preventative practices.

A Checklist for Practical Solutions to Pesticide Pollution

A. Is the Treatment Necessary? First make sure you have a control problem. Many urban or suburban applications are not necessary.

1. For example, oak leaf skeletonizer occurs in late summer when leaves are soon coming off anyway, so little is gained by spraying.

2. In agriculture is the pest numerous enough to cause economic damage? Will the increased production pay for the cost of treatment? What are the alternate methods of control? Maybe the application should not be made.

3. Will crop rotation or other cultural practices solve the problem?

B. If Treatment is Necessary

1. Consider other problems beside control -- sensitive crops, streams, people, houses, bees.

2. Consider public relations -- an informed public is more cooperative. Be as inconspicuous as possible.

C. Steps that Reduce Pesticide Pollution

1. Prevent Drift

The smaller the droplet and the greater the wind, the further the pesticide will drift.

a. Plan the farm or field layout.

i. Consider prevailing winds to minimize drift.

ii. Lengthen fields, lower hedgerows, remove obstructions.

-- Reduces turn arounds and overlapping of pesticides.

-- Allows agricultural aircraft to remain low, minimizing drift.

iii. Consider crop pesticide requirements.

-- Plant the crops which will require little or no pesticide use nearest sensitive areas -- houses and farm buildings, ponds and streams, bee yards, pastures and forage crops. Leave buffer areas such as crops not requiring treatment or requiring only safer materials, or leave hedgerows between crops and sensitive areas. The border rows of a crop can be treated with safer materials.

-- Where possible avoid planting crops with high pesticide requirements adjacent to or close upwind from crops that are sensitive either from phytotoxicity or residue standpoint. For example, if 2,4-D is to be used on corn, do not plant beans or tomatoes adjacent.

iv. Do not place pastures next to crops requiring several pesticide applications such as fresh market sweet corn or an orchard.

b. Choose equipment that will minimize drift.

i. Ground equipment -- slower, but less chance of drift than aerial equipment unless special equipment or formulations are used by air.

Boom equipment

--Use lower pressures and spray discs with larger orifices to increase droplet size.

-- Choose best type of nozzle. Hollow cone nozzles produce more fine droplets than flat fan nozzles.

-- Keep booms mounted as low as possible to reduce wind effects. Use closer nozzle spacing and wider fan angles.

-- Position boom to give larger droplets as ground speed increases.

    Tilted forward gives finer droplets.
    Tilted backward gives larger droplets.

-- Be sure machinery is properly calibrated -- not overdosing.

Airblast equipment -- more chance of drift than with boom equipment.

-- Determine effective swath width and calibrate. Lay out field accordingly.

-- Operate in little or no wind. Not only will wind cause drift, but it will distort the swath pattern.

-- Choose time to operate when drift is away from sensitive areas.

-- Position nozzles to give larger droplets.

    Facing into air blast gives finest droplets.
    Directed with air blast gives coarsest droplets.

-- Lower pump pressures give larger droplets.

-- When spraying near sensitive areas be sure airblast is directed away.

ii. Aerial equipment will get the job done quickly and economically, taking advantage of best weather conditions.

-- Use higher dosages per acre, larger droplets. Ultra low volume will increase chances of drift.

-- Mount nozzles away from wing tip so that spray is not sucked into vortices. Solid cone or fan nozzles form larger drops than hollow cones.

-- Position boom to give larger droplets.

Tilted slightly forward gives finest droplets.
Tilted backward 40 to 90° gives coarsest droplets.

-- Use lower pump pressures for larger droplets.

-- Be sure your shut-off is positive -- no dribbling in turns. Use positive shut-off nozzles.

-- Consider new machinery such as controlled droplet size booms, controlled porosity spray heads, foam forming nozzles.

-- Fly as low and slow as possible consistent with good spray technique.

-- Fly downwind from sensitive areas -- if you must fly upwind from sensitive areas, fly with the wind or into it. Arrange swaths at right angles, not parallel to streams.

c. Choose the right pesticide and formulation to minimize drift problems.

i. Use the safer chemical according to the circumstances. Examples:

-- if treating for alfalfa weevil:

Parathion is generally less toxic to fish than malathion, but much more toxic to humans. Does the alfalfa field border a stream or is it near a house?

Are fences tight? Will cattle break in? If there is a chance of this, don't use parathion.

If the alfalfa is weedy and dandelions are in bloom and attracting bees, Sevin is a poor choice.

-- If beans or tomatoes or other sensitive crops must be planted adjacent to corn use atrazine rather than 2,4-D. But remember, high doses of atrazine may injure sensitive crops planted the following year, i.e., oats, alfalfa, vegetables.

-- Federal and state restricted use laws will help you make the right choice. Unrestricted materials are usually safer to use than restricted materials.

ii. Choose the right formulation.

-- Sprays drift less than dusts.

-- Granules drift less than sprays.

-- Thickeners or additives may be needed and used under some conditions such as power line maintenance, roadside spraying, etc.

d. Do the job at the proper time.

i. When weather conditions are right.

-- Low wind, away from sensitive areas.

-- Rain not expected.

ii. Bees not foraging -- night or early morning.

iii. Allow for sufficient harvest intervals to avoid residues.

iv. Allow for sufficient interval between application and time workers have to be in the field.

2. Prevent Erosion

Pesticides ride along on eroding soil particles.

a. Cultivate with the contour, not across it.

b. Alternate cultivated crops such as corn with others such as oats, alfalfa. Leave sod buffer area, settling ponds, or dikes between cultivated crops and stream. Other things being equal, there is very little pesticide run-off from orchards with a sod floor.

c. Plan location of high pesticide requirement crops with topography in mind. Don't plant such crops where farm ponds, potable water supplies, etc., are further down the drainage system.

3. Prevent Transport of Pesticides as Illegal or Persistent Residues on Foods

a. Use all pesticides only as labeled paying attention to dosages, limitations, and making sure that the use intended is on the label.

4. Choose Safest Pesticide to be Used Under Circumstances

a. Points to consider:

i. Phytotoxicity -- will it hurt the target if overdosed? What is its compatibility with other pesticides used?

ii. Legal residues -- will the pesticide drift from target crop to cause illegal residue on adjoining crop, or in meat or milk?

iii. Persistence -- is the pesticide one which will persist in the environment, and either accumulate in wildlife or be damaging to following crops?

iv. Bee toxicity -- if bees are working a field, choose a pesticide of low bee toxicity and time application when bees are not present.

v. Fish toxicity -- if drainage or erosion threatens nearby waters, choose pesticides having low toxicity to fish.

vi. Human and domestic animal toxicity if located near houses or buildings or water supply.

vii. Effects of drift or volatility -- will it drift from the target crop to harm sensitive crops? Foul smelling pesticides may draw attention and criticism.

viii. Effect on wildlife from use of persistent, accumulative chemicals -- Cost should not be the most important factor. Don't use accumulative pesticides as aquatic larvicides. When there is a choice use the least persistent chemicals.

5. Use Good Operational and Disposal Procedures

a. Filling the tank -- poor procedure is a prime source of pesticide pollution.

i. Locate and construct filling station properly

-- Away from pond or creek bank so that surface drainage is not back into water source.

Or with established stations:

-- Regrade to change slope and drainage away from water source.

-- Construct an apron and sump to catch overflow and drainage for safe disposal.

ii. Use proper tank filling equipment.

-- Use separate pump for filling where possible.

-- Install check valves on intake hose to prevent back-siphoning from sprayer tank, particularly if the same pump is used for both spraying and filling.

-- Suspend filler hose from pump so that there is a space between end of hose and surface of spray mix in full tank to prevent back siphoning.

iii. Use good filling technique.

-- Stay with sprayer while filling. Don't let it run over while your back is turned.

-- Protect yourself with proper gear as instructed by the label.

-- Use minimum amount of pesticide necessary. The label will give you the range. Follow recommendations -- more won't work better and is illegal.

-- Before adding the pesticide, make a final check. Is the intended use specified on the label? Is the wind still down? Are other conditions still favorable?

-- Account for all empty pesticide containers and take them back to your storage. Don't leave them on the bank to fall in the water.

iv. Use good application techniques.

-- Use required protective gear (see label). Investigate filtered air equipment -- helmets, tractor cabs, agricultural aircraft cockpits. Have water and commercial handcleaner on the sprayer in case of accidental contact with spray.

-- Check constantly for drift, overdosing, unauthorized persons in treated area, other poor conditions. Stop spraying if necessary.

-- Have alternate areas available to treat in case you have spray left over. Do not leave puddles of spray mix or dump indiscriminately.

b. Cleanup and Disposal.

i. Maintain locked, safe, posted storage.

ii. Be aware of fire hazards -- water contamination possible from firefighting water.

iii. Construct safe machinery washing area -- water contamination may result if wash water is not trapped.

6. Use Good Common Sense in All Your Pesticide Applications

   Educating the pesticide applicator and equipment operator to be careful and conservative while maintaining an awareness of known principles will greatly reduce pesticide pollution.

Minimizing Bee, Fish and Wildlife Losses

From an ecological standpoint there is no "good time" or "right place" to introduce highly toxic compounds to the environment on a broad scale. It is nearly impossible to imagine using the pesticides without causing some negative environmental impact. The more persistent the pesticide, the greater the probability of harmful effects. Consequently when it is necessary to apply pesticides all precautionary measures possible should be adhered to.

The following recommendations will help in reducing environmental impact from pesticides and reduce the potential mortality of bees, fish and wildlife.

1. Study the label carefully to determine restrictions for use of the pesticide.

2. Restrict the use of the agricultural pesticides to those areas in crop production.

3. Treat only when the economic threshold of infestation will justify.

4. Use the pesticide least toxic to non-target organisms that will accomplish adequate pest control.

5. Use only the quantity of pesticide needed for the job. Do not over-treat.

6. Do not apply pesticides when wind velocity is great enough to carry them out of the target area.

19. Do not spray areas that harbor high populations of desirable wildlife species.

20. Avoid treating areas frequented by waterfowl.

21. Do not leave treated seed exposed where birds and animals have access to it.

22. When soil applications of pesticides are made, disk in as quickly as possible to avoid wasting the pesticide and to prevent possible wildlife losses.

23. Use only minimum dosage when applying pesticides to large areas and avoid the use of persistent pesticides when possible.

24. Use those pesticides that will do the job but are the least toxic to domestic animals and wildlife.

Some Effects of Pesticides on Wildlife

Research has demonstrated that persistent chemicals such as the chlorinated hydrocarbons are concentrated within wildlife food chains so that entire populations may lose their reproductive capacity. Information presently available indicates that pesticides may have reduced the reproductive capacity of the bald eagle, duck-hawk, some fishes and fish-eating birds such as loons, cormorants and pelicans.

Some pesticides are much less toxic to birds and fish than others. Careful selection and use of the pesticides may eliminate some of the hazards to fish and wildlife. Remember that contamination of even a short section of a stream or ditch may poison animals or fish for many miles downstream. Toxicity of pesticides varies greatly with fish species, the chemical, and the formulation of the chemical.

Toxicity of Some Pesticides to Birds[1/]

HIGHLY TOXIC

aldrin
carbofuran (Furadan)
*Ceresan
Co-Ral
demeton (Systox)
Diazinon
dieldrin
dioxathion (Delnav)
dimethoate
Dipterex (Dylox)
endosulfan (Thiodan)
endrin
EPN
fenthion (Baytex)
Methyl Parathion
parathion
Phosdrin
phosphamidon
sodium arsenite
thimet (Phorate)
toxaphene

MODERATELY TOXIC

azinphos methyl (Guthion)
BHC
carbaryl (Sevin)
chlordane
DDT
Di-Syston
Kelthane
Kepone
lindane
Mirex
naled (Dibrom)
TDE
Zectran

SLIGHTLY TOXIC TO RELATIVELY NONTOXIC

**amiben
**amitrole
**Amitrol-T
chlorobenzilate
Chlorthion
**Dacthal
**dalapon
dichlorvos (Vapona)
*Dyrene
**2,4-D
**2,4,5-T
heptachlor
methoxychlor
**MCPA
Perthane
rotenone
TEPP

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* Fungicide

** Herbicide

1/ This information is intended only as a rough guide for reference use where toxicity to birds is of concern. Information is based on chronic toxicity to bobwhite, pheasant and mallard ducks and fish. Wildlife Service publications.

Toxicity of Some Peticides to Fish[1/]

HIGHLY TOXIC

aldrin
*Antimycin A
azinphos methyl (Guthion)
chlordane
DDT
dieldrin
dioxathion (Delnav)
Di-Syston
endrin
ethion
heptachlor
Imidan
Kelthane
Kepone
lindane
methoxychlor
parathion
phorate (Thimet)
rotenone
Toxaphene
*Ziram

MODERATELY TOXIC

carbofuran (Furadan)
BHC
Chlorthion
Co-Ral
**2,4-D
**dalapon
demeton (Systox)
Diazinon
dichlorvos (Vapona)
EPN
fenthion (Baytex)
*ferbam (Fermate)
***Hyamine 1622
***Hyamine 3500
malathion
Methyl parathion
Methyl trithion
naled (Dibrom)
Ovex
Phosdrin
phosphamidon
**silvex
**2,4,5-T
TDE or DDD
Tedion
*Vancide 512
Zectran

MODERATE TO LOW (Believed Reasonably Safe to Use Around Ponds and Pools)

carbaryl (Sevin)
dimethoate
Dylox
Methyl parathion

SLIGHTLY TOXIC TO RELATIVELY NONTOXIC

**Amitrol-T
**Ammate
**Diquat
**endothall
**Eptam
**Fenac
**MCPA
Schradan

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* Fungicide
** Herbicide
*** Bactericide

1/ This information is intended only as a rough guide for reference use where fish toxicity is of particular concern. Information is based on toxicity studies to Bluegills and Rainbow Trout published by Cope and by George in Wildlife Service Circular 167, 1963 and by Tarzwell in "The Use and Effects of Pesticides" - A symposium sponsored by the N.Y.S. Joint Legislative Committee on Natural Resources. 1963.

Pesticides and Bees

In addition to the production of honey and its by-products, bees are very important as pollinators of tree fruits, pumpkins, clovers, alfalfa, cantaloupes, watermelons, cucumbers, squash and many other crops. The annual value of crops benefited by insect pollination, the majority of which is performed by honey bees, exceeds $10 billion. The farmer and the beekeeper are, therefore, dependent upon each other.

Honey bees may be killed when crops are treated with pesticides. When this occurs, both the farmer and the beekeeper suffer a loss. For this reason, they need to cooperate fully in protecting the bees from pesticide damage. Careful management of control programs and of bees can do much to reduce loss of bees by necessary pest control programs.

Beekeepers should be informed of intended pesticide applications. Advance warning of the intended use of pesticides should be of value to the beekeeper in protecting his colonies. In some areas organized effort is made to keep beekeepers forewarned of pesticide applications in their area.

Causes of Bee Poisoning

Most bee poisoning occurs when insecticides are applied to crops during the blooming period. Other hazards are:

-- Drift of toxic sprays or dusts onto adjoining crops that are in bloom.

-- Contamination of flowering cover crops when orchards are sprayed.

-- Bees coming into contact with insecticide residues on plants.

-- Bees collecting insecticidal dusts with pollen (Penncap-M and Sevin are especially dangerous because they may be stored with pollen in the hive and later fed to brood and newly emerged workers).

-- Bees drinking or touching contaminated water on foliage or flowers.

-- Bees collecting contaminated pollen or nectar.

Relative Toxicity of Pesticides to Honey Bees

The various pesticides differ greatly in their effect on honey bees. The formulation of the material plays an important role in its toxicity to bees. In general sprays are safer than dusts, and emulsifiable concentrates are less toxic than wettable powders. Granular materials are seldom used in such a way to be hazardous to bees.

Timing of pesticide applications, particularly insecticides, in respect to bee poisoning hazard can be drastically modified by abnormal weather conditions. If temperatures are unusually low following treatment, residues on the crop may remain toxic to bees up to 20 times longer as those during reasonably warm weather. Conversely, if abnormally high temperatures occur during late evening or early morning, bees may actively forage on the treated crop during these times when normally they would not.

The fungicides, acaricides (miticides), herbicides and blossom thinners are relatively nontoxic to bees. These materials as well as the insecticides can be placed in three groups in relation to their effects on bees -- those highly toxic, moderately toxic and those that are relatively nontoxic.

Pesticides Highly Toxic to Bees

This group includes materials that kill bees on contact during application and in many cases for one or more days after treatment. Bees should be moved from the area if highly toxic materials are used on plants the bees are visiting. This group includes:

acephate (Orthene)[a/]
aldicarb (Temik)
aldrin
aminocarb (Matacil)
arsenicals
azinphosethyl (Ethyl Guthion)
azinphosmethyl (Guthion)
Azodrin
Banol
Baygon
BHC
Bidrin
Bomyl
carbaryl (Sevin)
carbofuran (Furadan)
chlordane
chlorpyriphos (Dursban, Lorsban)
Ciodrin
Dasanit
Diazinon
dicapthon
dichlorvos (Vapona, DDVP)[a/]
dieldrin
dimethoate (Cygon)
dinitrobutylphenol (DNOSBP)[b/]
endothall [b/]
EPN
fenthion (Baytex)
heptachlor
Imidan
lindane
malathion[a/]
malathion ULV
Metacide
methomyl (Lannate)
methyl parathion
mevinphos (Phosdrin)[a/]
Mobam
naled (Dibrom)[a/]
parathion
Penncap-M
phorate (Thimet EC)[a/]
phosphamidon (Dimecron)
Pydrin (0.1 lb/A or less)[a/]
Pyramat
Zectran
Zinophos

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a/ Short residual activity. Can usually be applied safely when bees are not in flight. Do not apply over hives.

b/ herbicide

Insecticides Moderately Toxic

These materials can be used with limited damage to bees if not applied over bees in the field or at the hives. Correct dosage, timing, and method of application are essential. This group includes:

Abate
carbophenothion (Trithion)
Carzol
coumaphos (Co-Ral)
DDT
demeton (Systox)
Dimetilan
disulfoton (Di-Syston)
endosulfan (Thiodan)
endothion
endrin
ethoprop (Mocap)
Galecron (Fundal)
methyl demeton (Meta Systox)
Mirex
oxamyl (Vydate)
oxydemetonmyethyl (Meta-Systox-R)
Perthane
phorate (Thimet)
phosalone (Zolone)
Pyramat
ronnel
tartar emetic
terbuphos (Counter)

Pesticides Relatively Nontoxic

Materials in this group can be used around bees with few precautions and a minimum of injury to bees. This group includes:

Insecticides

Acarol
allethrin
Aramite
Bacillus thuringiensis
BAAM
binapacryl (Morocide)
Bordeaux mixture
Chlorbenside (Mitox)
chlorobenzilate
chloropropylate
dicofol (Kelthane)
Dimite (DMC)
dioxathion (Delnav)
ethion (Nialate)
fenson (Murvesco)
Kepone
Lethane
Lovozal
methoxychlor
Morestan
nicotine
Omite
oil sprays (superior type)
ovex
Pentac
Plictran
pyrethrum
rotenone
sabadilla
sulfur
Sulphenone
TDE (Rhothane)
tetradifon (Tedion)
toxaphene
trichlorfon (Dylox, Dipterex)

Fungicides

anilazine (Dyrene)
benomyl (Benlate)
Bordeaux mixture
captan
copper oxychloride sulfate
copper 8-quinolinolate
copper sulfate
copper oxide
Dexon
dichlone (Phygon)
dinocap (Karathane)
dodine (Cyprex)
Dyrene
ferbam (Fermate)
folcid (Difolatan)
folpet (Phaltan)
glyodin (Glyoxide)
maneb (Manzate)
Mylone
nabam (Parzate)
Polyram
sulfur
thiram (Arasan)
zineb (Parzate)
ziram (Zerlate)

Herbicides

alachlor (Lasso)
Ammate
amitrole
atrazine
CDAA (Randox)
CDEC (Vegedex)
dalapon
dicamba (Banvel-D)
diquat
diuron (Karmex)
EPTC (Eptam)
EXD (Herbisan)
IPC
MCPA
monuron
NPA
paraquat
Planavin
sesone
simazine
2,3,6-TBA (Trysben)
2,4-D
2,4,5-T

Defoliants

DEF
merphos (Folex)
PREP

Some Additional Points to Remember

1. Prevention of bee losses is the joint responsibility of the spray operator, the farmer, and the beekeeper. Before spraying is done, the beekeeper should be notified in ample time to allow him to arrange for protection or movement of his colonies.

2. Sprays generally are less hazardous to bees than are dusts.

3. Late evening and early morning spray treatments (after 9 p.m. DST and before dawn, 3 a.m.) will reduce bee death losses.

4. Aircraft applications of technical/ultra low volume malathion are HIGHLY poisonous to bees. This ultra LV treatment should be used chiefly on rangelands for grasshopper control.

5. Ground sprayer treatments usually are less severe on bees than are aircraft applications.

6. Spraying or dusting while bees are active in the fields will increase bee kills.

7. Treatment over hives when bees are clustered outside the hive during hot weather increases bee kill.

8. Drift to neighboring fields in blossom, or to adjacent blossoming weeds and wild flowers, may result in substantial bee poisoning.

Some Precautionary Steps the Beekeeper Can Take

1. Identify your colonies. Post your name, address, and telephone number in a conspicuous place in the apiary. In some states this is required. Let the farmers in the area know where the bees are located so they will not be unknowingly poisoned.

2. If practicable, do not place colonies near fields that are routinely treated with pesticides.

3. Know the pesticides commonly used in your area.

4. Be prepared to remove the bees from the area if you are notified that a hazardous material is likely to be applied. Pesticides are grouped according to their relative hazards to bees on pages 80 and 81.

5. If the colonies are likely to be repeatedly exposed to pesticides listed in group 1 on page 80, move the colonies to another site.

6. If the colonies must be moved, move them at night when all the bees are in the hive.

VI. PESTICIDE MONITORING

Almost every study group has stated that the use of pesticides must be continued if we are to maintain the advantages now resulting from the work of informed researchers, food producers, and others responsible for the control of the many pests affecting our potential food, feed, and fiber production. At the same time enough problems have been identified to emphasize that the proper usage of pesticides is not simple and that while they do destroy harmful plants, nematodes, weeds, insects or other harmful pests, they may also be toxic to beneficial plants and animals including man. The toxic effects of large doses of most of the pesticides have been well documented and the necessary precautions are being taken to see that humans and beneficial plants and animals are not needlessly exposed.

National Programs

Although sampling of crop and water residues had been carried on for a number of years, it was considered necessary in the early sixties to take measures to insure that continued exposure to minimal amounts of these toxins in our environment would not reach proportions that might be harmful over long periods of time. For this reason, the National Pesticide Monitoring Program came into being in the fall of 1965 as a cooperative effort of the Departments of Agriculture, Defense, HEW, and Interior. During the initial efforts of this Program, various segments of the environment, where determination of pesticide residues appeared desirable, became the direct responsibility of that Agency most vitally affected.

This type of a cooperative, multi-administered program was continued until the Environmental Protection Agency (EPA) assumed these monitoring activities in 1971. The program was finally given legislative status in 1972 when the Federal Environmental Pesticide Control Act was passed. Section 20 of this Act under Parts (b) and (c) specified:

(b) National Monitoring Plan - The Administrator shall formulate and periodically revise, in cooperation with other federal, state, or local agencies, a national plan for monitoring pesticides.

(c) Monitoring - The Administrator shall undertake such monitoring activities, including but not limited to monitoring in air, soil, water, man, plants, and animals, as may be necessary for the implementation of this Act and of the national pesticide monitoring plan. Such activities shall be carried out in cooperation with other federal, state, and local agencies.

In recent years, much of the monitoring of pesticides has been reported in the "Pesticides Monitoring Journal" published by EPA. Additional information is published by the governmental departments having some responsibilities in this area.

Residues in Food and Feed

The first residue studies were initiated by the Bureau of Chemistry of USDA in 1915 and published in 1922. Monitoring was on an irregular basis until 1955 when a regular surveillance program of crops and commodities was established by FDA. A consumer protection program was authorized for livestock and poultry in 1946 and 1957. An additional program to monitor residues in ready-to-eat food, called the "Market Basket Project" was initiated in 1964.

FDA Surveillance Program - The purpose of this program is to determine pesticide residue levels of individual commodities on a geographical basis at their origin.

Samples are taken by FDA in each of the 17 field districts. Each field district samples and examines food and feed within its area. Animal feed ready for consumption is included as part of the program. New York has two districts -- Buffalo and New York City.

Emphasis varies from year to year in types of sample or may vary with the use of a particular pesticide. Sampling may be biased toward those areas where the problem is believed to be the greatest.

Several thousand samples are taken annually, usually 10,000 to 12,000, encompassing an estimated 2.5 million carloads of raw agricultural products annually shipped in interstate commerce. Also sampled are milk, eggs, fish, and processed feed for a usual total of 10,000 - 12,000 annually. They are set up statistically to provide 95% confidence that the total percentage of samples exceeding guidelines will not be greater than 3.1% if the average is 2%. When sampling exceeds guides approaching 3% the sampling rate is increased.

Groups of foods are sampled throughout the year in the following broad categories:

leaf and stem vegetables
root vegetables
fruits
grains
hay and silage
fluid milk
fish and shellfish
eggs and egg products
manufactured dairy products

From 1955 to 1964 residues of 83 different pesticides were found by testing 111,296 samples of domestic foods. Almost all residues reported in these studies were at very low levels. The present pesticide surveillance program collects 10,000 to 12,000 samples annually and runs analyses on up to seventy pesticides.

Consumer protection program - This program was authorized by the U. S. Agricultural Marketing Act of 1946 and the U. S. Poultry Inspection Act of 1957 and gave the Consumers and Marketing Services of USDA the responsibility of monitoring meat, poultry and poultry products for pesticides.

Their primary responsibility is for sampling meats and poultry in about 1200 slaughtering plants. Sampling of carcasses in the plant and from different originating premises is carried out.

In 1972 this program inspected 123.7 million livestock and 3.2 billion poultry and collected 24,808 tissue samples for chemical residue analysis. Upon the disclosure of an objectionable residue much of the program capability may be temporarily diverted to exploring in depth any particular residue problem (such as DES in cattle, or PCB's in poultry).

The incidence of trace and measurable levels of most of the pesticides in the fat of meat has either not changed significantly or has declined in the past several years. Statistical tests indicate that residue levels for most of the pesticides in meat does not exceed 0.1 ppm (fat basis) in 97% of the samples of domestic and imported red meats analyzed.

Market Basket or Total Diet Studies - These studies are to determine pesticide residues in basic 2-week diet of a 16 to 19 year old male (the nation's largest eater) by FDA.

Sampling is done in 5 regions of U.S. - They are Northeast (Boston), Southeast (Baltimore), North Central (Minneapolis), Central (Kansas City), and Western (Los Angeles).

Sites are chosen within each region, one a standard metropolitan area and one an area of less than 50,000. Samples are collected 6 times making 30 samples annually.

A total of 117 items are now included in each Basket with regional variations recognized. Items normally consumed in process form are prepared in the kitchen under supervision of a dietitian as specified. Products consumed raw are not cooked. Chemical analyses are performed by methods prescribed in the FDA Pesticide Analytical Manual.

In reporting, the 117 food items are grouped into 12 food classes, i.e., dairy products, meats, vegetable, fish, fruits, oils, etc. The average and the range of each pesticide residue for each food class is reported in six annual reports covering the period from June 1964 through April 1970. Residue levels have shown some increase in percentage of occurrence while the daily expected intake of total chlorinated organics has declined and dropped 22% between the 1969 and 1970 reporting period.

The Market Basket Study has produced very encouraging information. The diet selected as the standard is one encompassing the greatest quantities of foods consumed by any age group. The ADI (Acceptable Daily Intake) of any

pesticide is that amount accepted by the Food and Agriculture Organization as, "the daily dosage of a chemical which, during an entire lifetime, appears to be without appreciable risks on the basis of all facts known at the time."

The last four reports state, "No Acceptable Daily Intake value has been exceeded in any of the tests during the six years of this study, and the calculated daily dietary intake for practically all pesticide chemicals is one order of magnitude of 1/10 or more below that considered as safe by the FAO-WHO scientist. The report states that the dietary intake of DDT compounds during the six year study showed a general decline to the point where they are now well below the six year average. The six year average daily intake of all chlorinated organic pesticide residues was only 0.0011 mg/kg of body weight."

Monitoring Pesticides in Water

The monitoring of pesticides in water predates the National Pesticide Monitoring Program by almost ten years. Water monitoring had its beginning as the National Water Quality Network and was under the supervision of the U. S. Public Health Service, which published annual reports.

A study entitled, "Pesticides in Selected Western Streams" was initiated in 1965 by the U. S. Geological Survey as an additional part of the National Program. There were eleven collection sites during the initial phase of this program which were increased to twenty in 1967, and this coverage has continued to the present. Samples were taken on a monthly basis until October of 1971 at which time a reduction to once each quarter of the year was effected. The collection of stream-bed samples was begun in October 1971 on a semi-annual basis. Sample size consists of one liter of rain water which is analyzed for pesticides in solution and on suspended silt and organic matter.

During the 1967-1968 period 62.5% of the "whole water" samples contained no detectable insecticides (minimum detectable level 0.01 ppb) and the remaining had individual pesticide levels only in fractions of a part per billion. The pesticides for which analysis have been conducted include DDT and its metabolites; aldrin; dieldrin; endrin; heptachlor and its epoxide; lindane;

chlordane; toxaphene; endosulfan; phosphorothioates; PCB's and three herbicides; 2,4-D, 2,4,5-T and silvex.

Monitoring Fish, Lakes and Rivers

This monitoring program had its beginning in 1967 and has undergone progressive change since that time. Initially fish were collected from 50 sampling stations located in the Great Lakes region and river basins throughout the United States. Samples consisted of five adult fish of each of three species collected in the spring and again in the fall of 1967 and 1968.

DDT and its metabolites were found in all of the 147 samples collected in 1969, with a median residue level of about 1.0 ppm. There appeared to be a decrease in total DDT values at some of the collecting sites between the fall of 1968 and fall of 1969. Residues of DDT in excess of FDA's "action level" (5.0 ppm) were found in four locations. Sampling has been increased and the species of fish have also grown to number 55 species in the 1970 collections. Samples have been taken through 1973 and sample analysis publication is planned.

Monitoring Estuarine Waters, Fish and Shellfish

The estuaries and bays along our coasts are often thought of as the final depositories of any persistent pesticides that may be used in any given drainage area. In 1965 the Bureau of Commercial Fisheries (Department of Commerce) undertook to organize and conduct a monitoring program for the chlorinated hydrocarbon insecticides reaching major estuaries on the Atlantic, Gulf and Pacific coasts.

During the seven year period of this study under contract, the U. S. Bureau of Commercial Fisheries collected monthly samples of 15 oysters (or other locally available mollusks), prepared and mailed samples to the laboratory for residue analysis. Samples were received from 169 estuarine sites in fifteen coastal states and a total of 8,095 samples were analyzed for the common chlorinated hydrocarbon insecticides. From 1969 on, Mirex and the PCB's were added to the list of residues being monitored. DDT and its metabolites were the most

common identified insecticides and they were detectable in 63% of the samples. However, in only 38 samples (0.5%) did the residue exceed 1.0 ppm. The single higher residue was 5.39 ppm. These studies indicated that in most estuaries monitored, detectable DDT residues have declined in both number and magnitude in the estuarine mollusks in recent years.

Monitoring Pesticides in Wildlife

The sponsoring agency involved in wildlife monitoring is the U. S. Department of the Interior Sport Fisheries and Wildlife at the Patuxent Wildlife Research Center at Laurel, Maryland.

This department accepts duck wings mailed in each year by hunters participating in a nationwide study of waterfowl productivity. It was in the 1965-1966 fall-winter season that the first full scale wildlife monitoring effort was accomplished.

The sample for residue analysis in wildlife consisted of a pool of 25 duck wings collected in a given state or sub-district. Wings from more than 24,000 ducks were included in the study.

DDT proved to be the predominant residue throughout this survey while dieldrin was detected in samples from 30 states; heptachlor epoxide was reported from two states, while endrin was not detected in this study. Nationwide DDT exceeded 0.50 ppm in only five sets of pooled tests.

Samples were taken for pesticide analysis in 1969 and again in the winter of 1972-1973, but a final report of the analysis was unavailable at the time of this writing. Earlier samples showed only low incidence of pesticide accumulation in wildlife sampled.

Starlings were also included as test animals in the wildlife studies and the sample consisted of ten starlings collected in the fall of even numbered years at approximately 130 sites. The data from the 1968 collection shows that DDT and its metabolites and dieldrin was found in all the samples tested. Of the 126 samples analyzed 60% (76 samples) had residue levels below 0.1 ppm.

Only 10% (13 samples) carried more than 3.0 ppm. The collection of pools of ten starlings in 1970 were from 125 sites and tests indicated that DDT and dieldrin levels were apparently declining from the baseline findings.

Monitoring Pesticides in Soils and Crops

The national soil monitoring program was initiated in 1964 by the U. S. Department of Agriculture, Animal Plant Inspection Service (now APHIS) and they have continued to play a major role even after the project's transfer to EPA in 1971.

Samples of soils, sediment, water, crops, livestock, and indicator species of land and aquatic animals are collected from one square mile study areas. In all areas collection of samples is backed by pesticide use history and available current-use records.

During the first year the USDA reported a total of 3,246 samples were collected; 2,186 of these consisted of soil, sediment and water. From tests run on these samples, there appeared to have been very little progressive buildup of any of the pesticides in soil, sediment or water in the study areas. Even so it can be demonstrated that detectable levels of the more slowly degrading pesticides were common whether referring to soils, sediments, crops or wildlife in the areas of high pesticide usage. However, the exact amount of the residue present generally was related to the annual application rate. During the study period there was no major change in overall residue levels in soils. The level determined was generally no higher than the annual application rate. From this it would seem that the accumulation of pesticide residues is related to rates of application of a specific pesticide, which may be further modified by geographic and climatic factors bearing on degradation and dissipation. Therefore this phase of the study was terminated and the new program evolved in two directions. One of these, on a one year basis searched for residues in approximately ten crops on which pesticides were important in production, and this included soil residue studies. These studies revealed few situations of any consequence with respect to pesticides in raw agricultural food products. Residue levels in crops were well below tolerance levels set by the U. S. Food and Drug Administration, a fact that they had been reporting for two decades.

This study initiated by USDA also included a pilot project in which soils at 51 nationwide locations were to be sampled for three years. The major feature of this project included three categories of pesticide use -- regular use sites 17 -- limited use sites, such as for forest insect control 16 sites, and no known use of pesticides 18 sites. From five to ten samples representing as many forms were collected at each of the 51 sites.

This study simply documented the expected. In the crop areas where pesticides were used regularly, some orchard soils showed the DDT complex had reached levels of 245.4 ppm. On the other hand, the average amount of DDT complex in the limited use area reached only 0.22 ppm in either of two years tested and DDT was detected only once in the no use areas, and that at only 0.001 ppm.

At this point (1967) the U. S. Department of Agriculture began a preliminary study in six states which resulted in residue findings in 242 cropland sites of 9,468 checked and in 117 non-cropland sites of 3,832 sampled. Records taken at the time of sampling indicated that 55 different pesticide chemicals had been applied to one or more of the sampling sites. Residue analysis was reported as DDT and its metabolites, dieldrin, toxaphene, chlordane, and arsenic. Even though an occasional sample showed residues as high as 89 ppm, the arithmetical means for each insecticide (excluding arsenic) did not exceed 0.38 ppm.

Monitoring Soils in Urban Areas

In 1969 a pilot study was conducted to determine pesticide residues in U. S. Cities. Eight cities were selected and 50 sampling sites were randomly selected within each city (400 sites). From a plot measuring 50 ft. square, 16 core samples (2 inches in diameter by three inches deep) were collected and blended into a single sample for the residue analysis study. These samples were then tested for organochlorines, some of the common organophosphates and arsenic. The DDT residues and its metabolites ranged from lows of 0.35 ppm at Houston, Texas, to 5.98 ppm in Miami, Florida. In all the samples the highest residues represented samples taken from lawns and backyard gardens while vacant lots or other unkept areas were far less contaminated. In the case of arsenic, the residue ranged from 2.0 ppm at Houston, Texas, to a high of 15.7 ppm at Salt Lake City, Utah.

This urban soil monitoring program became a regular part of the National Pesticide Monitoring program with samples being taken in 14 cities during 1971 and in only five cities during 1972 to 1974, for a total of 37 metropolitan areas studied to date.

It is of particular interest to note that residues of organochlorine insecticides in turf areas of cities are generally higher than those recorded for croplands in the surrounding state area.

Monitoring Pesticides in Air

Within the past two or three decades the practice of applying pesticides by use of the airplane in some areas of the United States has become common practice. This has caused the Public Health Service to become interested in perfecting equipment for air sampling of pesticides in both the particulate and the gaseous phases.

In 1969-1968, the Division of Pesticide Community Studies of HEW contracted to have Midwest Research Institute conduct a pilot study in nine localities for 19 pesticides and their metabolites in the atmosphere.

Midwest found that pesticide levels varied from day to day and from season to season. The levels of pesticides found in the ambient air "were almost entirely far below levels that might add to the total human intake of pesticides".

Monitoring Pesticides in Humans

The monitoring of pesticides in the human population had its inception in 1967 by the Pesticides Program, Communicable Disease Center of the Public Health Service. The study was designed to determine the levels of chlorinated hydrocarbon insecticides, DDT and its metabolites, dieldrin, heptachlor and isomers of BHC in the general populations of the United States.

Pathologists for these studies were recruited at random in selected states to take small samples of adipose tissue from postmortem examinations from specimens submitted for pathological examination during therapeutic surgery. A

special effort is made to exclude samples from any cases of known or suspected acute pesticide poisoning, or chronic debilitating illness.

From its early beginning in 1967, changes were made in sampling in 1972 in which the number of collecting centers were increased from 50 to 75 and the number of samples collected remained at approximately 2,000 annually.

This human monitoring program has operated continuously since 1967. Approximately 15,000 human adipose tissue samples were analyzed over the period 1967-1970.

State Programs

Many states conduct monitoring programs of their own, but range from no program to sampling pesticide packages for label integrity and residues in food, feed, air water, fish and wildlife. In New York State the following groups are regularly involved in pesticide monitoring or residue studies.

New York State Department of Agriculture and Markets

It has primary responsibility for food, livestock feed, and livestock and poultry products including milk. They work closely with FDA and USDA and annually run about 1500 samples.

New York State Department of Environmental Conservation

It has responsibility for product integrity, fish and wildlife. The Department becomes involved in special problems -- i.e., mercury, PCB's, as the situation demands.

New York State Department of Health

For many years this Department has routinely conducted pesticide analyses of water at 60 different stations. They may sample milk, but usually have not. They also may conduct special research projects as thought necessary or desirable.

New York State College of Agriculture and Life Sciences and Expriment Station

The College and Experiment Station regularly conduct research residue studies prior to recommending use of pesticides. Whenever possible, it may conduct special studies involving runoff, breakdown, etc. Monitoring, if done, usually is to check recommendations and possible long term effects.

VII. TOXICITY OF PESTICIDES

Certain chemicals predominately organic, are used as pesticides because they are toxic to various pests (insects, weeds and causal organisms of plant disease). Many of these chemicals are also toxic to nontarget organisms including man. Safe and, in fact, proper use depends in part on knowledge of toxic properties and a respect for the potential hazards associated with their use.

Toxicology is defined as the study of evaluating safety and injurious effects of chemicals and physical agents as observed in altering structure, function and response in living systems. A compound's toxicity is its inherent ability to injure living organisms. The ultimate toxic effect on a living organism is death, either due to a single dose or to continued administration of some lesser dose.

The accepted theory regarding the mode of action of organophosphorus and carbamate compounds relates to their function as cholinesterase inhibitors. Acetylcholine is a mediator of the transmission of nerve impulses at the junction of nerves and muscles, at sensory nerve endings and nerves that are involved in the regulation of vital body processes such as breathing, pulse rate and function of the gastrointestinal tract, for example. Following a nerve impulse, the acetycholine molecule is split (hydrolyzed) in the presence of an enzyme (acetylcholinesterase) and the nerve or junction thus is returned to the normal state again capable of carrying an impulse. The enzyme (acetylcholinesterase) functions to prevent persistent "activation" of the nerve junction. Certain chemicals including organophosphorus and many carbamate pesticides block the action of the enzyme (acetylcholinesterase) and acetylcholine accumulates causing a malfunction or overstimulation of the nerves or nerve junctions.

Manifestations of the failure of the nerves to function properly are (1) contraction of the pupil of the eye (miosis), (2) tightness of the chest, (3) increased bronchial (respiratory tract) secretions, (4) sweating, (5) tearing (lacrimation), (6) rapid pulse rate initially followed by a decrease in the

pulse rate, (7) nausea, vomiting, abdominal pain and diarrhea, (8) involuntary urination, (9) muscle twitching, (10) cramps and (11) increased salivation. A lethal dose of a cholinesterase inhibiting organophosphorus compound is reported to produce death due to respiratory failure (asphyxia). Symptoms of carbamate poisoning are essentially the same as those produced by the organophosphorus compounds.

Clinically, poisoning due to cholinesterase-inhibiting organophosphorus or carbamate pesticides is confirmed by measuring the cholinesterase activity of the blood plasma or of the red blood cells (erythrocytes). Special precautions are necessary in using the cholinesterase activity of blood plasma or of the red blood cells as a measure of carbamate poisoning since the blocking action by carbamates is readily reversed by certain procedures involved in many of the more commonly employed estimation methods. Persons working with organophosphorus or carbamate pesticides known to be inhibitors of the enzyme acetylcholinesterase should consult with a physician concerning the possibility of measurement of blood cholinesterase activity as an estimate of exposure. Atropine is known to be useful as an antidote for poisoning by organophosphorus and carbamate acetylcholinesterase inhibiting compounds. Atropine relieves many of the symptoms. The compound 2-PAM (2-Pyridine aldoxime methochloride) promotes the release of the enzyme (acetylcholinesterase) from the blocking action of organophosphorus acetylcholinesterase inhibiting compounds. In cases of organophosphorus poisoning, 2-PAM, used in conjunction with atropine, is often very effective. However, 2-PAM should not be used in treating poisoning due to carbamate acetylcholinesterase inhibiting compounds.

Although the symptom-producing effect of organophosphorus poisoning is a result of blocked activity of the enzyme at the nerve or nerve ending, the enzyme also exists in tissue and blood. The enzyme of tissue and blood may serve as a buffer or reserve "tying up" much of the toxic material although some will affect the enzyme at the nerve or junction. Thus, the reduction of blood and tissue enzyme by repeated exposure to the poison reduces the reserve, and the critical enzyme at the nerve and nerve junctions is more readily affected. Although repeated exposure to very small doses of organophosphorus insecticides is said to result in a "tolerance" to poisoning in rats and mice,

one should not assume a similar reaction in man. Exposure of a significant nature is likely to produce less severe poisoning if the reserve is not depleted. Thus, even in the absence of noticeable effects, one should always attempt to minimize exposure.

There are wide differences in toxicity to man and other warm-blooded animals within a given group of class of compounds, particularly those used as insecticides. For example, some organophosphorus insecticides are direct inhibitors of acetylcholinesterase, while others are inactive per se but are changed in a biological system to one or more secondary toxicants that are inhibitors. Therefore, the net toxic effect may depend on a combination of factors including the rates of activation and/or detoxification, penetration to the site of action and the affinity of the toxicant for acetylcholinesterase.

The principal effect of chlorinated hydrocarbon insecticides is on the central nervous system although the exact nature of the action is unknown. For a review of the mode of action of other pesticides, the reader is directed to either the "Clinical Handbook on Economic Poisons" (Public Health Service Publication No. 476) available through the U. S. Government Printing Office or "Recognition and Management of Pesticide Poisoning", EPA Publication 540/9-011.

There are numerous effects other than death that are very damaging to living systems. A familiar effect is that produced by the drug thalidomide. Congenital malformation or teratism can result from diverting the course of normal fetal development. Such toxicity attributed to a chemical is termed teratogenicity. Other commonly known expressions of toxicity are mutagenesis (mutation causing) and carcinogenesis (cancer causing). Less severe, yet equally important toxic effects are hemolytic (blood) reactions, allergy, photosensitization, disruption of normal organ function, etc. Recognition of the multitude of possible toxic effects is necessary if one is to accurately appraise the hazard of a given chemical use.

Acute toxicity usually implies overwhelming intoxication producing gross symptoms of death. Chronic toxicity is not as easily defined, but generally refers to an illness or undesirable effect resulting form long term, relatively low exposure. Toxicity, acute or chronic, may result from oral, dermal (through

intact skin), or respiratory exposure alone or in combination. A fourth route of entry of pesticides into the body is through cuts, abrasions or other skin disruptions.

One method of measuring acute toxicity is to determine the chemical dosage that will, upon administration to a group of animals, kill one-half of the group. Thus, the figure LD_{50} (lethal dose 50 percent) can be applied to oral and dermal exposure. Acute oral LD_{50} values are generally available on most pesticides. Acute dermal LD_{50} values are not as widely reported. The LD_{50} value is usually expressed on a weight to weight basis, i.e., milligrams of chemical per kilogram of body weight for a given test animal. Other information generally specified in reporting LD_{50} values includes species, strain, age and sex of the experimental animal, administration route, concentration of test material and vehicle used to administer the chemical.

LD_{50} values have become the universally accepted means of expressing toxicity. Acute oral LD_{50} values provide a means of comparing one chemical to another and thus a means of evaluating the relative toxicity of chemicals when administered orally. Many are and will be tempted to use the values in an absolute sense, i.e., direct extrapolation of LD_{50} to man even to the point of calculating the LD_{50} dose for man. The relevance of these animal values to man is questionable. Further assumption could lead to serious consequences. One should assume in the absence of information to the contrary, that the chemical is at least as toxic to man as it is to the most sensitive test animal. The following facts tend to support this conclusion as a guiding principle:

1. Variation exists between species.

2. Variation exists within species.

3. Variation exists between sexes.

4. The human population will include the very young, the old, the debilitated, the pregnant and those in varying degrees of diseased states.

5. Repeated exposure to chemicals may result in what might be termed a "conditioned" response.

A generally accepted uniform method for testing dermal toxicity is not evidenced in the available literature, although methods have been proposed. Considering the fact that such values (LD_{50}, LC_{50}) are valuable in a relative sense, testing uniformity may be as important as the precision of the method. Factors to be considered include:

1. Variation in dermal (skin) penetration rates between species.

2. Variation within species.

3. Skin condition.

4. Animal condition.

5. Environmental conditions (temperature and humidity).

6. Solvent in which the chemical is applied.

7. Time in contact with skin.

Toxicity vs. Hazard

A hazard of using a chemical is the danger it presents or possibility or probability that injury may result from using a substance. Hazard can be measured only in relation to practical conditions, although it can be predicted in part, at least, by the toxicity of the chemical in question. Estimating the degree of exposure is equally important in assessing or evaluating hazard.

Research has shown that dermal exposure to parathion, DDT, malathion, chlorthion and dinitro-ortho-cresol under practical conditions of agricultural or residual spraying is from two to 494 times as great as in respiratory exposure, even when only the face, neck and lower arms are exposed. The California

Community Studies (1968) show great differences also occur in the percent absorption of different compounds.

	% Absorbed
thiourea	1
Diquat	1
2,4-D	6
malathion	7
dieldrin	8
parathion	9
lindane	9
DDT	14
Baygon	20
carbaryl (Sevin)	75

It has been reported that the measured dermal exposure of spraymen is adequate to account for the majority of occupational poisoning by many newer pesticides.

Oral exposure to pesticides during ordinary spraying has not been measured, but the amount ingested in various ways, such as eating with unwashed hands, appears to be small in most instances. On the contrary, the poisoning incidence of children is usually associated with the ingestion of the pesticide resulting from improper storage of chemicals. Respiratory exposure can be very significant when spraying in closed areas with very small particulate spray such as a mist spray, dusts and materials that vaporize rapidly under normal conditions such as fumigants. Dermal exposure may also be a significant route of exposure of those working in treated fields (field workers, pest management scouts, etc.).

These comments generally are related to conditions in the sense of actual sign and symptom-producing exposures. Repeated small doses of certain pesticides, while possibly not producing immediate illness, can result in a slow progressive effect eventually reaching the point of producing an illness. In view of this, occupational exposure to any chemical should be minimized to the extent possible.

Summary

Information regarding the toxic effects of pesticides on humans is limited to that obtained through actual experiences (fortunately and notably few) and those extrapolations of animal data that can with proper knowledge of comparative toxicology, etc., be made by experienced and trained persons qualified to make such judgments.

Use LD_{50} - LC_{50} data as a guide to the relative toxicity of the pesticide. Within limits and under practical conditions there is very little distinction within the broad categories of toxicity in terms of estimating hazard. Information derived from acute toxicity studies is only an indication of the care necessary to protect the person who, occupationally or otherwise, will be exposed to the chemical. Used in proper perspective, such information can permit useful predictions of the comparative hazards of using a pesticide.

Dermal exposure is considered by many as the more common exposure route. Occupational poisoning by industrial and agricultural chemicals in California during 1960 involved absorption through the skin (percutaneous) as the probable exposure route in approximately 80 percent of the cases.

Reportedly, over 97 percent of the pesticide to which the body is subjected during most exposure situations and especially to applicators of liquid sprays is deposited on the skin. Pesticides may be more readily absorbed through the skin on certain parts of the body than on others.

	% absorption
forearm	9
palm of hand	12
abdomen	19
back of hand	21
back of ear	34
forehead	36
armpit	64
crotch	100

In studies of the absorption of parathion, absorption has been found to vary depending on the site of the body. Absorption through the skin of the head and neck area was found to be greater than other sites tested with the exception of the skin of the armpit, the ear canal and the scrotum. Absorption through cuts, abrasions or other disruptions of the skin may be as much as eight times that through intact skin.

VIII. EMERGENCY PROCEDURE FOR HANDLING ACCIDENTAL SPILLS OF CLASS B POISON PESTICIDE CHEMICALS

Pesticide Safety Team Network

The National Agricultural Chemicals Association has formed a Pesticide Safety Team Network to minimize the risk of injury from accidental spillage or leakage of Class B poison pesticides.

A central telephone number - (800) - 424-9300 - in Cincinnati, Ohio is monitored on a 24-hour basis. Nine association members -- Chevron, Shell, Stauffer, Chemagro, Diamond Shamrock, Velsicol, Niagara, Union Carbide and Monsanto -- are participating in the program by cooperatively furnishing personnel, equipment and expertise for the prompt and efficient clean-up and decontamination of Class B poison pesticides involved in a major accident. More than 40 safety teams currently make up the network.

Each participant has been assigned a specific area of the United States for which he acts as area coordinator. The area coordinator's responsibility is to receive from Telephone Central reports of any accident involving a Class B poison pesticide occurring in his area and act in one of several ways to make sure that the potential hazard to the public is reduced or eliminated.

Immediately following an emergency message from Telephone Central, the area coordinator communicates with the manufacturer or producer of the involved product and agrees on a procedure to follow. The person reporting the incident to Telephone Central is then contacted and given immediate steps to take. A safety team, if needed, is sent, either from the manufacturer or dispatched by the area coordinator from a roster of teams in his area.

What Are Class B Poisons?

Class B poisons are defined in the Code of Federal Regulations, Title 49-Transportation, parts 170-189, Section 173.343 as follows:

173.343 less dangerous poisons, class B. liquid or solid, poison label; definition.

"(a) For the purposes of parts 170-189 of this chapter and except as otherwise provided in this part, class B poisons are those substances, liquid or solid (including pastes and semisolids), other than class A or class C poisons, which are known to be so toxic to man as to afford a hazard to health during transportation; or which, in the absence of adequate data on human toxicity, are presumed to be toxic to man because they fall within any one of the following categories when tested on laboratory animals:

(1) Oral toxicity. Those which produce death within 48 hours in half or more than half of a group of 10 or more white laboratory rats weighing 200 to 300 grams at a single dose of 50 milligrams or less per kilogram of body weight, when administered orally.

(2) Toxicity on inhalation. Those which produce death within 48 hours in half or more than half of a group of 10 or more white laboratory rats weighing 200 to 300 grams, when inhaled continously for a period of one hour or less at a concentration of 2 milligrams or less per liter of vapor, mist, or dust, provided such concentration is likely to be encountered by man when the chemical product is used in any reasonable foreseeable manner.

(3) Toxicity by skin absorption. Those which produce death within 48 hours in half or more than half of a group of 10 or more rabbits tested at a dosage of 200 milligrams or less per kilogram body weight, when administered by continuous contact with the bare skin for 24 hours or less.

(b) The foregoing categories shall not apply if the physical characteristics or the probable hazards to humans as shown by experience indicate that the substances will not cause serious sickness or death. Neither the display of danger or warning labels pertaining to use nor the toxicity tests set forth above shall prejudice or prohibit the exemption of any substances from the provisions of parts 171-179 of this chapter."

Economic Poisons Highly Toxic to Man

Regulation under present federal law (The Federal Insecticide, Fungicide and Rodenticide Act) defines economic poisons highly toxic to man as follows:

362.8 Economic poisons highly toxic to man.

"(a) Economic poisons which fall within any of the following categories when tested on laboratory animals as specified in subparagraphs (1), (2) or (3) of this paragraph are highly toxic to man or contain substances or quantities of substances highly toxic to man within the meaning of the Act (such economic poisons being herinafter in this part referred to as economic poisons highly toxic to man): Provided however, that the Director may, upon application and after opportunity for hearing, exempt any economic poison which is in any of these categories, but which is not in fact highly toxic to man, from the requirements of the Act and the regulations in this part with respect to economic poisons highly toxic to man:

(1) Oral toxicity. An economic poison which has a single dose LD_{50} of 50 milligrams or less per kilogram of body weight when administered orally to both male and female rats which have been fasted for a period of 24 hours (or to other rodent or nonrodent species specified by the Director); or

(2) Toxicity on inhalation. An economic poison which has an LC_{50} of 2,000 micrograms or less of dust or mist per liter of air or 200 parts per million or less by volume of a gas or vapor, when administered by continuous inhalation for one hour to both male and female rats (or to other rodent or nonrodent species specified by the Director), if the Director finds that it is reasonably foreseeable that such concentration will be encountered by man; or

(3) Toxicity by skin absorption. An economic poison which has an LD_{50} of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours with the bare skin of rabbits (or other rodent or nonrodent species specified by the Director).

(b) Tests on other species. Tests on other specified rodent or nonrodent species may be required by the Director with respect to individual economic

poisons or to classes of economic poisons whenever he finds that tests on other species are necessary to determine whether an economic poison is highly toxic to man.

(c) Terms LD_{50} and LC_{50}. An LD_{50} as used in connection with oral toxicity and skin absorption toxicity tests specified in paragraph (a) (1) and (3) of this section is the dose and LC_{50} as used in connection with inhalation tests specified in paragraph (a) (2) of this section is the concentration which is expected to cause death within 14 days in 50 percent of the test animals so treated.

(d) Toxicity based on human experience. If the Director finds, after opportunity for hearing, that available data on human experience with any economic poison indicate a toxicity greater than that determined from the above described tests on animals, the human data shall take precedence and, if he finds that the protection of the public so requires, the Director shall declare such an economic poison to be highly toxic to man for the purposes of this act and the regulations thereunder."

Please note that the regulation established certain parameters under which the LD_{50} and LC_{50} values are to be determined. Thus, in attempting to fit an economic poison into one of the categories, the conditions under which the data were obtained must be known in order to make a valid judgment.

The label of every economic poison which is highly toxic to man as described by the preceding quoted regulation is required to bear the word "danger" along with the word "poison" in red on a contrasting background in immediate proximity to the skull and crossbones and an antidote statement, etc. Thus, the presence of the symbols and signal words identify economic poisons that probably fall within the Department of Transportation's description of a Class B poison.

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SOME U.S. AND METRIC COMMONLY USED WEIGHTS AND MEASURES

WEIGHT

Avoirdupois	Metric	Metric	Avoirdupois
1 ounce (oz)	28.35 grams (g)	1 gram	0.03527 ounces
1 pound (lb)	453.59 grams	1 kilogram	2.205 pounds

LIQUID MEASURE

U. S. Units	Metric	Metric	U. S. Units
1 fluid ounce (fl oz)	29.57 milliliters (ml)	1 milliliter	0.0338 fluid oun
1 pint (pt)	0.47 liter	1 liter	2.113 pints
1 quart (qt)	0.95 liter	1 liter	1.057 quarts
1 gallon (gal)	3.78 liters	1 liter	0.2642 gallons

LINEAR MEASURE

U. S. Units	Metric	Metric	U. S. Units
1 inch	25,400 microns (μ)	1 millimeter	0.03937 inches
1 inch	2.54 centimeters (cm)	1 centimeter	0.3937 inches
1 inch	25.4 millimeters (mm)		
1 foot	30.48 centimeters	1 meter	39.37 inches
1 yard	0.91 meter (m)	1 meter	3.281 feet
		1 kilometer	3281 feet
1 mile	1.61 kilometers (km)	1 kilometer	0.6214 mile

AREA MEASURE

U. S. Units	Metric	Metric	U. S. Units
1 square inch (in^2)	6.45 square centimers (cm^2)	1 square centimeter	0.155 square inches
1 square foot (ft^2)	929 square centimers	1 square meter	10.76 square feet
1 square yard (yd^2)	0.836 square meter	1 square meter	1.196 square yards
1 acre	4047 square meters	1 hectare	2.471 acres
1 square mile (mi^2)	2.59 square kilometers (km^2)	1 square kilometer	0.3861 square miles