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TRAINING PROGRAM FOR PESTICIDE USERS

TRAINER'S MANUAL

by

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PREFACE

The TRAINING PROGRAM FOR PESTICIDE USERS is a practical, nonformal, education program designed for field use in developing countries. This program has been developed for use by individuals who work directly with small farmers, vendors, pesticide applicators and other persons who use or regularly handle pesticides. In particular, extension agents, health officials, school teachers and other persons who work in agricultural and rural development projects will find the training program and the accompanying materials to be directly applicable to their work.

This Training Program uses a didactic approach that combines information and knowledge with practical skills. Anyone who completes the program will be better informed and skilled to teach a variety of topics related to pest control, pesticides and pesticide safety. Furthermore, graduates of this program will be able to utilize this knowledge and adapt these skills to develop practical educational training programs on these same topics for anyone who regularly uses pesticides.

That is the intent of this program: to train those individuals responsible for educating, training or advising others on the safe and wise use of chemical pesticides.

The TRAINING PROGRAM FOR PESTICIDE USERS consists of 15 units requiring approximately 40 hours to complete. Unit I (Introduction) sets the stage for the next 13 units of subject matter. Unit XV (Evaluation) provides a means and method for practically evaluating what has been learned. Unit XVI contains various teaching aids and resource materials, such as posters, charts, and illustrations, that are to be used with the appropriate Units (a list appears on page xvi). Each Unit includes a list of materials provided, as well as materials you must provide.

This Manual was prepared with the expectation that all Units would be taught. However, it is recognized that there may be situations in which not all of the 13 subject-matter Units need to be taught. Thus, each Unit was developed so that it could be taught separately. It is not necessary for the trainers to attempt to use the Units intact when training small farmers or anyone else. Rather, the contents of the Manual should be adapted to the specifics of the situation.

CREDITS

This TRAINING PROGRAM FOR PESTICIDE USERS was developed by the Consortium for International Crop Protection (CICP) under contract to the United States Agency for International Development (USAID). The principal authors are Dr. Theodore A. Granovsky; Harry N. Howell, Jr, M.Sc.; Cindy L. Heep, and Dr. James I. Grieshop. The first three authors are affiliated with the Department of Entomology, Texas A&M University, College Station, Texas while Dr. Grieshop is a staff member at the University of California Cooperative Extension, Davis, California. Ms. Heep enthusiastically did the key developmental work for Units II to XIV (with the exception of Unit XII) and prepared the preliminary drawings. Final illustrations were drawn by Carolyn Tibbetts, Department of Entomology and Parasitology, and Frank Murillo, Department of Molecular Plant Biology, University of California, Berkeley, California. Myron Shenk, International Plant Protection Center, Oregon State University, Corvallis, Oregon prepared the information on calibration procedures presented in Unit XII. Dr. Grieshop provided technical assistance related to all the training units and developed Units I and XV. Dr. Granovsky, General Coordinator, was in charge of project development and the initial evaluation conducted in cooperation with the

Paraguayan National Extension Service, Ministry of Agriculture, CREDICOOP and USAID.

The original English program was translated into Spanish by Irene R. Tenney, M.A., with editorial assistance on the English version by Patricia Grieshop.

INSTRUCTIONS TO THE TRAINER

The following 11 pages outline and briefly discuss various components and features of the TRAINING PROGRAM FOR PESTICIDE USERS. Before you attempt to use the Manual, READ THESE PAGES.

Topics addressed are:

- Overview
- Content
- Suggested Organization by Day
- Training Principles
- Methods
- Audiences
- Format
- List of Accompanying Training Materials
- A Final Comment

OVERVIEW OF THE MANUAL

This Manual is a complete guide for organizing and delivering the TRAINING PROGRAM FOR PESTICIDE USERS to extension agents, pesticide vendors, health workers, school teachers and others who, in turn, would adapt this program for presentation to small farmers and their families, pesticide applicators and other persons who use or regularly handle pesticides.

The Trainer's Manual is composed of sixteen units. Each Unit is a subset of the total package, yet each Unit is complete within itself. One or more of the Units may be taught separately or in combination with other Units. The full program can be offered in approximately 40 hours in one intensive period or it may be offered over a period of several weeks to the same audience. Alternately, a less complete program of specific combinations of Units may be presented, directed toward specific audiences of other trainers.

CONTENTS

There are 13 distinct subject matter Units in this Manual. The various Units can be grouped into four general themes, as follows:

Theme 1. IDENTIFICATION AND ANALYSIS OF PEST PROBLEMS (Units II-IV). This theme includes such topics as types of pests and insects (Unit II), identification of pest problems and some principles of Integrated Pest Management (IPM) (Unit III), and methods of pest control (Unit IV).

Theme 2. PESTICIDES, LABELING, AND INHERENT DANGERS TO PEOPLE (Units V-VII). This theme stresses the basic dangers of pesticides (Unit V), the need for proper labels (Unit VI), and how formulation of the pesticide can make important differences in inherent danger of the pesticides (Unit VII).

Theme 3. BASIC WORKER SAFETY, MIXING, DISPOSAL, AND STORAGE (Units VIII-XI). Basic and practical aspects of pesticide use are covered in these 4 units. Emphasis is placed on prevention of problems through the proper handling (Unit VIII), mixing (Unit IX), disposal (Unit X) and storage of pesticides (Unit XI).

Theme 4. PROPER PESTICIDE APPLICATION AND ENVIRONMENTAL CONSIDERATIONS (Units XII-XIV). This theme presents topics on the use and calibration of pesticide application equipment (Unit XII), correct ground and aerial application procedures (Unit XIII), and the fate of pesticides following application (Unit XIV).

Training efforts with this training package should try to cover all of the 13 Units. Since this is about 40 hours of training, the Units may need to be presented over a period of a few weeks.

SUGGESTED ORGANIZATION BY DAY

If possible, offer the 40 hours of training within a 5 day period. The suggested organization for these 5 days is presented below:

DAY	TIME OF DAY	
	MORNING	AFTERNOON
1	Units I and II	Units III and IV
2	Unit V	Units VI and VII
3	Units VIII and IX	Units X and XI
4	Unit XII	Units XIII and XIV
5	Unit XV	Group Reports and Closure

TRAINING PRINCIPLES

This training program is based on two important principles:

1. An approach that stresses:
   a. Lectures or Demonstrations - First, the trainer demonstrates a skill or behavior, and
   b. Second, the learners, with the help and guidance of the trainer, jointly perform the skill or behavior. This last element usually will occur in the Evaluation.
2. A conviction that this training material should be taught to the trainers as it would be taught to the ultimate learners (the users of pesticides). Emphasis is on practice and skill development in pesticide safety.

METHODS

The teaching activities in this Manual emphasize learning by doing. A variety of teaching methods is used, all aimed at involving the learners (be they other trainers or users of pesticides) in the instruction. The principal methods used are:

LECTURES: Specific information is often best delivered through a lecture. Each Unit contains material to be delivered in a relatively brief period of time--usually no more than 20 minutes. Lecture portions are usually entitled PRESENTATION. NOTE: TRY TO KEEP EACH LECTURE UNDER 20 MINUTES!

DEMONSTRATIONS: In the pesticide safety area, many lessons are best delivered and learned when demonstrated. The suggested DEMONSTRATIONS involve the learners as active participants. The majority of Units include at least one DEMONSTRATION.

DISCUSSIONS: Learners must have the opportunity to discuss what they have heard or experienced. Therefore, every Unit includes specific, structured DISCUSSIONS. Often, you will be the discussion leader. Organize the Unit Summary as a period for discussion. Don't teach the Unit Summary as a simple question and answer exercise.

SIMULATIONS: In addition to DEMONSTRATIONS and DISCUSSIONS, several Units include SIMULATIONS. For example, one Unit creates a situation with a pesticide poisoning in which learners must deal with this poisoning while another Unit deals with a pesticide spill. Simulations can be very effective in making learners apply what they have heard and experi-

enced. Unit XV is organized around Simulations and Applications.

Develop and maintain an informal, relaxed atmosphere for the workshop. The adult learners should respond well to such a setting and approach. Include time for breaks, informal discussions and learning from each other. It will be up to you, as the trainer, to provide the leadership for an informal but productive workshop. However, remember that since the safe use of pesticides is a matter of life and death, the content material should not be treated lightly. Pesticides can and do kill. This message must be communicated . . . . but not at the expense of the learning atmosphere.

AUDIENCES

When the trainees have finished this course, they should use the same material to teach other individuals and groups who utilize pesticides. Remember that this material should not be taught in a rigid manner, rather the material should be adapted for the audience which will receive the instruction. It will be evident that a large part of the teaching materials and content can be adapted to a variety of groups.

There are two audiences for this Program. The First Audience (or Trainers) is composed of Agricultural Extension Agents, Health Personnel, School Teachers, U. S. Peace Corps Volunteers, personnel of other Private Voluntary Organizations and others who work in the field and are in contact with the Second Audience (or Pesticide Users) which includes the following:

- Farmers who use pesticides
- Applicators of pesticides
- Mixers of pesticides
- Vendors of pesticides
- Warehouse and dock workers who handle pesticides
- School children
- Truck drivers and other deliverers of pesticides
- Families of small farmers who use pesticides (especially school-aged children)

FORMAT

Each Unit begins with an OVERVIEW that summarizes the Unit's theme. The OVERVIEW lists the PURPOSE and OBJECTIVES of the Unit as well as the specific TOPICS to be taught. The number of hours needed to teach the Unit is also listed as well as TEACHING MATERIALS PROVIDED and TEACHING MATERIALS YOU MUST PROVIDE.

Each specific TOPIC in an Unit includes the title of the topic and its Purposes and Objectives. Development of each topic involves a small number of STEPS, numbered sequentially, which signify the specific activity to be undertaken. There are 5 types of STEPS:

1. PRESENTATION: signifies a "lecture" activity.
2. DEMONSTRATIONS: signifies the trainer is to demonstrate a particular item or idea.
3. DISCUSSION: signifies the trainer is to lead or organize a specific discussion.
4. SIMULATION: signifies the trainer is to organize and carry out a specific participatory activity (e.g., a role play of a poisoning.)
5. SUMMARY: signifies the trainer is to summarize a specific topic or the total unit.

In addition to these STEPS, every Unit will have notes "TO THE TRAINER," intended to aid you in your teaching effort. These notes are instructions for a specific activity and are set off by a box. Many of these "TO THE TRAINER" notes call for the use of teaching materials or arrangements which you are responsible for setting up.

Each Unit, with the exception of Unit I, contains a final QUESTION and ANSWER section. The intent of this section is not to give an examination, but to serve as a guide for a review of the material presented.

Illustrations. Many Units contain illustrations and graphics. These are to be used as teaching aids and as stimuli for questions, discussions and demonstrations.

TRAINING MATERIALS

1. Series of 11 drawings: "Safe Use of Pesticides"

2. Handouts

   a. LD_{50} List

   b. Relative Toxicity of Insecticides

   c. Plans for Pesticide Storage Chest

   d. Illustration for Pesticide Storage Facility

TO THE TRAINER: A FINAL COMMENT

This manual, TRAINING PROGRAM FOR PESTICIDE USERS, has been developed to serve as the basis of a program in pesticide safety. It is useful as a tool for this purpose, but since it is only a tool, there should be no hesitation on your part to substitute other training material or to develop additional material of your own. If you remember that the manual is only a tool designed for a particular purpose and use it in the manner intended, it will work for you. You, as the trainer, are the most important element. If you learn the material, plan your training and work to motivate the learners, you will be successful.

UNIT I: INTRODUCTION

UNIT OVERVIEW

The primary purpose of this training program is to assist the trainees to become more aware of the need for safety when pesticides are used. A second important purpose is to train the trainers to select and handle pesticides safely.

The format for this training program involves three approaches: (1) communicating information to the learners; (2) involving learners in discussions on specific topics and problems; and (3) actively and directly involving learners in activities. The success of the training program will depend partly on your ability to quickly involve the trainees.

Unit I is organized to permit you to communicate the main ideas of the total workshop, to begin to actively involve the learners with the subject material and to make sure that your expectations and the expectations of the trainees are clearly understood.

The TOPICS in this Unit are:

A. BEFORE BEGINNING.

B. GETTING ACQUAINTED WITH EACH OTHER AND THE WORKSHOP.

C. EXPECTATIONS OF THE TRAINEES.

D. WORKSHOP EXPECTATIONS.

OBJECTIVES:

By the end of Unit I, the learners will:

1. Understand the purposes and format for the TRAINING PROGRAM FOR PESTICIDE USERS.
2. Know what topics or Units will be taught.

3. Know your expectations.
4. Have had the opportunity to state their own expectations for the workshop.
5. Have become acquainted with the members of the training group, including yourself.

Unit I will take approximately 1 hour to complete. Materials needed to teach this Unit are:

TEACHING MATERIALS PROVIDED	TEACHING MATERIALS YOU MUST PROVIDE
A handout that lists all the topics or Units to be taught.	A list of specific Units to be taught.
	A blackboard or large chart paper with marking pens and tape.
	Name tags.
	Refreshments.
	Note cards for trainees to list their objectives.

TOPIC A. BEFORE BEGINNING

Purpose: To ask yourself several important questions before you begin the training:

1. Do you have all the teaching materials you need for the training?
2. Do you have the training facilities set up as you need them?
3. Do you know what Units will be taught and when?

These are only a few of the general questions you must address before beginning. Take time to list other general questions and to answer them. Base your preparations on these answers and your experience.

TOPIC B. GETTING ACQUAINTED WITH EACH OTHER AND THE WORKSHOP

Purpose: To ensure that all the program participants have a first opportunity to meet one another and to begin to understand how the workshop will operate, what procedures will be used, how long it will take and when they will be finished. At the end of Activity B, all the participants will:

1. Have at least heard everyone's name, job responsibilities and location.
2. Understand what they can expect to hear and experience as part of the training.

STEP 1. GETTING STARTED

Since you and the trainees may be together for up to five days and since this training stresses active involvement, you should immediately start to get to know one another and to work together.

Before you formally begin the workshop, have the room prepared for the trainees. Dependent on local custom, consider having coffee, soft drinks or fruit available for the trainees on their arrival. Encourage the trainees to introduce themselves to one another. Introduce yourself to the trainees as well. If appropriate, use name tags.

Allow from 15 to 30 minutes for this step. (This time is not included in the 1 hour suggested as time needed.)

STEP 2. WHO ARE WE?

As the trainer, it is up to you to start the program. Introduce yourself and provide a welcome to all the trainees. Indicate the formal name of the

training, who is sponsoring it and who will benefit. If there are invited guests or special persons, introduce them to the others.

Indicate to the trainees that without them, there would be no training program. Ask them to stand to introduce themselves by listing their name, their position or work responsibilities, where they are from and any other specific information you think is important.

> TO THE TRAINER: Be sure to limit the amount of time persons spend introducing themselves. If the group is composed of people previously unknown to one another, write the trainees' names on the blackboard or the tablet as they introduce themselves. (The purpose is to provide an opportunity to associate names and faces. Keep this process moving briskly.)

To avoid a monotonous repetition, ask participants at random to introduce themselves. Circulate freely in the room and direct this operation in a rapid, yet efficient, manner.

STEP 3. PRESENTATION--WHAT IS THIS TRAINING PROGRAM?

You should take time to present information on the total training program. Present information on the following aspects:

1. Purpose: To provide an opportunity to learn more about pesticide safety, how to safely select, use, and handle pesticides and how to use this program for training others.
2. Format: It includes PRESENTATIONS, DEMONSTRATIONS, DISCUSSIONS, and SIMULATIONS. The format stresses the active involvement of

all the trainees. Without their involvement, we can only be partially successful.

3. Content: The workshop is divided into 15 units. These include the Introduction (Unit I), the Evaluation (Unit XV) and 13 subject matter Units. If you teach the full program, hand out a list of all the Units. Briefly discuss (5-10 minutes) these Units. If the training includes only some of the Units, prepare a handout (or list on the blackboard or tablet) with a list of Units to be taught.

4. Time Required: If the total workshop package is taught, it will require approximately 40 hours. If fewer Units are to be taught, then fewer hours will be required.

5. Examinations: No formal examinations are included. However, the last 4 hours are to be used as a period to apply and evaluate what has been learned. In Unit XV, you will be presented with practical, true-to-life problems in the areas of pesticide use and pesticide safety and will be asked to respond with true-to-life procedures for dealing with these problems.

STEP 4. SUMMARY

Remind the trainees that the workshop involves discussion and participation and that each of them is an important member of the group. Point out that the purpose of the workshop is to become knowledgeable about pesticide use. Tell them that you will appreciate hearing what they want to learn about and that you will make an effort to address these topics during the workshop. Also, encourage any questions that the trainees may have at any point in the program.

TOPIC C. EXPECTATIONS OF TRAINEES

Purpose: To understand and consider the trainees' expectations before proceeding with the workshop. Not only must the trainer understand these expectations, but the trainees or learners should also understand and consider what expectations they have.

Topic C is aimed at meeting two objectives:

1. To permit the trainees to state their workshop expectations; and
2. Through the process of communication, to get to know each other.

STEP 1. SMALL GROUP DISCUSSIONS

As trainer, divide the large group into small groups of 4 or 5 individuals. You can create the small groups by having the learners "count off"--with all number one's in Group 1, all number two's in Group 2 and so on. Consider using some novel way to create these small groups.

Tell the groups they will meet for up to 30 minutes and that they have to accomplish either three or four tasks:

1. To re-introduce themselves to one another.
2. For each person to list and describe for the others what he or she expects to learn from the training. After listing the expectations, discussion should follow with an attempt to determine group expectation (for example--we expect to be the best group of the training workshop).
3. Time permitting, each person should describe one pesticide related problem they have experienced and how they dealt with it.
4. A spokesperson should be selected within each group who will be

responsible for reporting the group expectation and the common individual expectations.

STEP 2. REASSEMBLING THE SMALL GROUPS

Before reassembling the small groups into the large training group, tell them to take a short break. If it is locally appropriate, have coffee or fruit available. Encourage trainees to mingle and meet one another. You, as trainer, should do likewise.

STEP 3. SMALL GROUP REPORTS

After the large group has reassembled, ask the spokesperson from each small group to report the group expectation and the common individual expectations. As trainer, make sure that you write these expectations down on large chart paper or the blackboard, for everyone to see. Write them down for each group, clearly listing the groups. (Record these expectations for later use--particularly in Unit XV.)

After the groups have reported, encourage discussion, interaction, questions, and answers.

STEP 4. SUMMARY

It is extremely important that you, as trainer, summarize your interpretation or understanding of the expectations. Consider using such statements as: "It is my understanding that the groups expect to learn ..."; "I believe most trainees expect to learn ..." Use these statements as means to verify and clarify expectations. Refer to the small group reports as you summarize.

TOPIC D. WORKSHOP EXPECTATIONS

Purpose: To clearly state your expectations for the workshop. Your expectations should take into consideration that previously expressed by the trainees.

The objectives of this step are:

1. To ensure that you and the trainees are working toward common goals and expectations; and
2. To state workshop procedures.

STEP 1. YOUR EXPECTATIONS

Clearly state what you expect from the trainees during the workshop. Since you expect them to actively participate, state that. Since you expect them to attend every session, state that. In addition, if you have determined through the listing of trainees' expectations that specific topics are of no interest and use to the trainees, eliminate these topics from the program.

STEP 2. SUMMARY

Summarize and conclude Unit I. Remind the trainees that the workshop will involve discussion and participation and that each of them is an important member of the group. Point out that the purpose of the workshop is to become knowledgeable about pesticide use and to know how to use pesticides effectively and safely. Thank them for expressing their interests and concerns and say that you will make an effort to address these topics during the workshop. Also encourage any questions that the trainees may have at any point in the program.

Indicate that you hope everyone's goals will be met and that the time spent will be worthwhile.

STEP 3. A BREAK BEFORE BEGINNING

Before starting with Unit II, suggest a 15-minute break. Use this time to:

1. Organize the classroom,
2. Get materials ready, and
3. Permit everyone a chance to relax.

UNIT II: INTRODUCTION TO PESTS

UNIT OVERVIEW

Before the learners can effectively and safely deal with any pest problem, they must be able to recognize pests. They must know what a pest is, what pests look like, where they live, what they eat and what pest damage is. This Unit provides basic information to answer these questions. Special emphasis is placed on insect pests since they are the group of pests with which the authors are most familiar.

A primary purpose of this Unit is to provide information and skills for the identification of pests and the identification of beneficial insects.

Another objective of this Unit is to demonstrate that not all animals and insects are harmful or cause damage. This Unit provides information to distinguish between harmful (or bad) and beneficial (or good) animals and insects and includes the following TOPICS:

A. A LITTLE BIT ABOUT PESTS.

B. A LITTLE BIT ABOUT INSECTS.

C. GOOD AND BAD INSECTS.

OBJECTIVES:

1. To recognize the signs of a pest problem,
2. To identify, by their common names, the more common pests and insects, and
3. To distinguish between good and harmful insects.

Unit II will take approximately three hours to complete and includes activities that require teaching materials.

TEACHING MATERIALS PROVIDED	TEACHING MATERIALS YOU MUST PROVIDE
Illustrations	Samples of: Things that insects and other pests eat. Leaf or plant parts damaged by insects. Plant affected by a disease. Weeds from local area.

TOPIC A. A LITTLE BIT ABOUT PESTS

Purpose: To introduce to the learners pests they should be aware of and know about. By the end of this activity, learners will be able:

1. To recognize the signs of a pest problem.
2. To name several pests, besides insects, that cause damage to crops.
3. To list several characteristics of these pests such as where they live, what they look like, and what they like to eat.

STEP 1. PRESENTATION: PESTS

Harmful insects are one of the most common groups of pests, but they certainly are not the only organisms which cause damage to crops. There are several other common pest groups and causes of plant damage: plant pathogens which cause diseases, weeds, rodents, and birds.

Plant Pathogens and Diseases

Plant pathogens are microorganisms which cause a plant to be different in some way from a normal plant. They can harm or destroy a plant by disease. A disease is the set of symptoms that make a plant different from a normal plant. Plant diseases are divided into two groups.

A. Non-parasitic Plant Diseases. These diseases are caused by non-living things. Just as people and animals need food, water, and other things to live, so do plants. Extreme heat or cold, poisonous chemicals, too little or too much water, or a mineral imbalance are things which can harm plants.

B. Parasitic Plant Diseases. Members of the other group of plant diseases are called parasitic plant diseases. These are caused by

living things called pathogens that live on or inside plants and destroy them. These pathogens cause diseases which can be passed from one plant to another.

There are several different microorganisms which cause parasitic plant diseases. Let's look at some of them . . .

1. Fungi. Fungi are plants that cannot make their own food. Because they cannot make their own food, they must rely on other plants for food. They are not green plants. Like insects, not all fungi are harmful. There are different kinds of fungi. Many fungi are actually helpful to man, but some feed on crops. They can attack a plant both above and below the ground.
2. Bacteria. Bacteria can cause parasitic plant disease. They are too small to be seen. They can grow and spread very quickly, causing damage to plants.
3. Viruses. Viruses are other plant pathogens which are too small to be seen. They are easily spread from sick plants to healthy plants.
4. Nematodes. Nematodes are very small roundworms. Many are harmless but some attack plants both above and below ground. They usually do not kill the plant but can cause damage and yield loss.

Different kinds of plant pathogens often cause similar injury to plants. For this reason, it is hard to tell one disease from another. Only someone who is highly trained can usually tell which plant pathogen is at work.

Although some pathogens themselves cannot be seen since they are too small, the effects of plant pathogens can be seen. Sometimes, diseased plants

turn brown, wilt or droop. They may swell or have bumps or knots on their leaves and stems. Anytime a plant looks different from a normal plant, plant pathogens may be the cause.

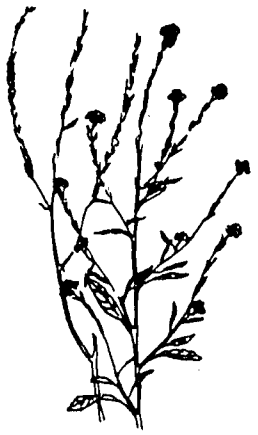
> TO THE TRAINER: Bring samples of plants which have been affected by pathogens and clearly show the evidence. Show the samples to the learners, explaining that this is a sign that plants are affected. Have learners examine damaged plants. For the next class meeting, have each learner bring at least one plant damaged by a pathogen.

Weeds

Weeds are another category of pest which may harm crops. A weed is any plant that is "out of place." Weeds are a problem because they take up water, light, nutrients, space or other factors that planted crops need to live. They also may harbor plant pathogens or insects which are of economic importance. Weeds may reduce the amount and quality of our crops.

Weeds have life cycles that vary from one to several years. They are divided into three groups depending on how many years they live.

A. Annuals. Annuals have one year cycles. Annuals may be grass-like or broadleaved. They may sprout in the spring or winter.



B. Biennials. Weeds that live two years are called biennials. Biennials grow from seed and develop a fleshy root and a leaf cluster.

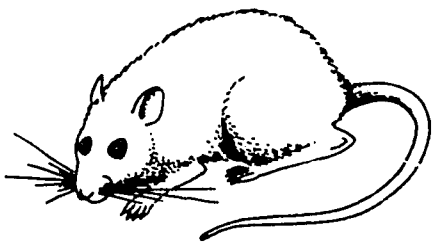
C. Perennials. Perennials live several years. They lose their leaves in the winter. Perennials come in many shapes and sizes.

TO THE TRAINER: Bring samples of weeds to show the learners. Try to have examples of each of the groups: annuals, biennials and perennials.

Higher Animals

Some higher animals are pests also, e.g., birds and rodents are frequently pests which eat and destroy crops in the field. They may also eat the crop after it is harvested.

A. Rodents. Rodents, such as rats and mice, eat grain in the field and in storage. Since rodents dirty or contaminate grain, humans often get sick from eating or even handling grain that has been exposed to rodents. Rats and mice are rodents. They are small with long tails and hair covering their bodies.

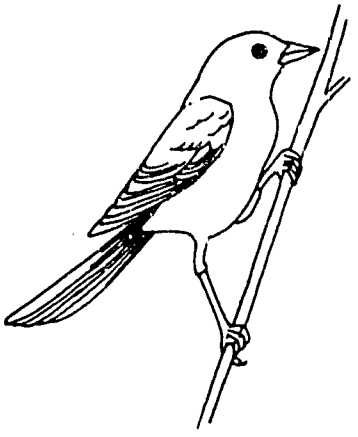


Rodents can climb and swim. Rats like to live near drains and water since they must be able to drink water each day. Mice do not need to drink water daily. Both rats and mice have teeth that they use to chew and bite.

Signs of rodents include paths through grass and dirt; tiny footprint and tail marks; tiny, dark, shiny, wet looking droppings; damage and gnaw marks from their teeth; and a bad odor in and around grain. Rodents are dangerous pests!

B. Birds. There are many different kinds of birds. Some birds eat stored grain and crops in the field. Like rodents, they contaminate our food and decrease the amount of food that is safe to eat.

Birds may cause severe damage to growing crops, especially grains, fruits, and vegetables. Birds also spread many diseases. They live in nests that they make out of twigs, leaves and other suitable materials. Birds are creatures of habit. They like to do the same things in the same place every day.



Signs of their damage or presence include holes or peck marks, feathers, and droppings.

STEP 2. SUMMARY

Conclude Activity A with a summary. The key points are:

1. Insects are one of the most common, but not the only group of pests that damage crops.
2. Other pests include:
   a. Plant Pathogens
      (1) Non-parasitic plant diseases
         (a) Extreme temperatures
         (b) Poisonous chemicals
         (c) Too much/too little water
         (d) Mineral deficiencies
      (2) Parasitic Plant Diseases
         (a) Fungi
         (b) Bacteria
         (c) Viruses
         (d) Nematodes

b. Weeds

(1) Annuals

(2) Biennials

(3) Perennials

c. Rodents and Birds

TOPIC B. A LITTLE BIT ABOUT INSECTS

Purpose: To present information about what insects look like, where they live, and what they eat. By the end of Activity B, learners should know:

1. Two things which all insects have in common.
2. Ways in which insects grow.
3. What insects eat.
4. The meaning of these words:

   chitin, larvae, metamorphosis, and molting.

STEP 1. PRESENTATION: INSECTS

There are so many different kinds of insects in the world that it is almost impossible to count them. Some insects have four wings, some have two wings, and some have no wings at all. Some insects are several inches long and some are so small they they can only be seen with a magnifying glass. Some insects have slender bodies and others are short and round. Insect colors vary greatly.

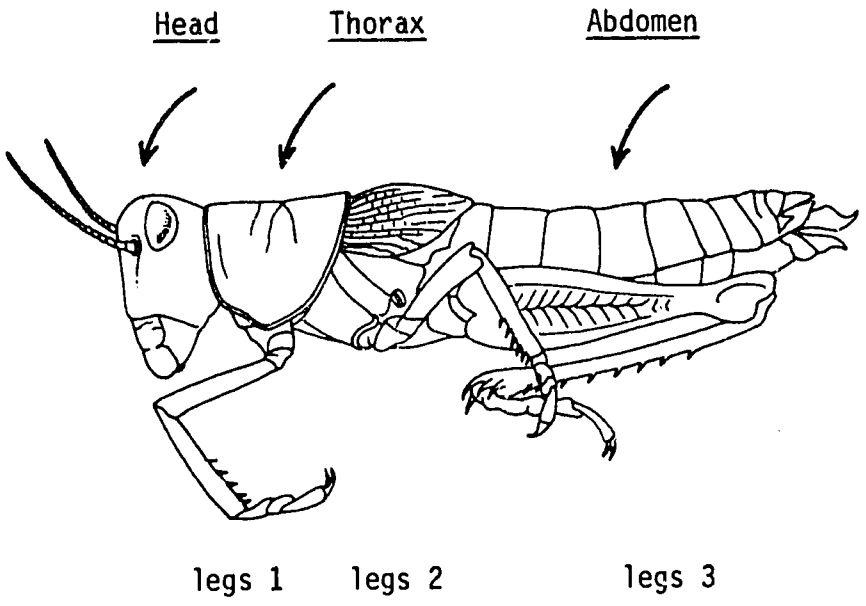
But, even though there are many different types of insects, they all have the same basic body structure. All insects have:

- three basic divisions in their bodies, and
- three pairs of legs

The word insect means "cut into." An insect is "cut into" three parts--the head, the thorax, and the abdomen.

Illustration 1: Insect Body Parts

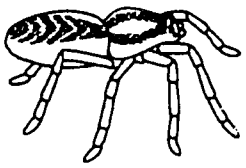
These are the parts of an insect:



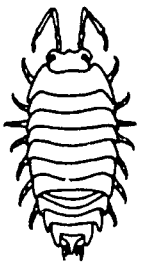
TO THE TRAINER: Draw the insect illustrated above, or one that is similar, on a large piece of paper which the learners will easily be able to see.

Some bugs look like insects but they are not.

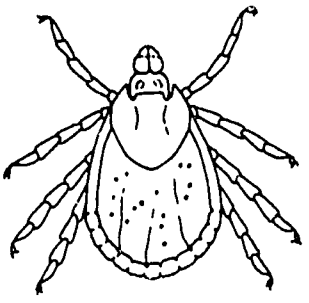
Illustration 2: Non-insects



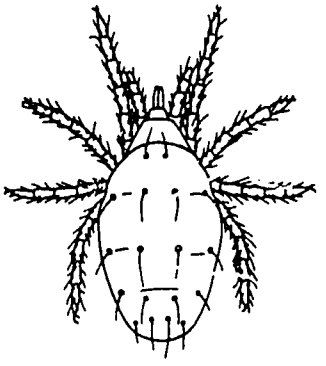
Spiders look like insects, but their bodies only have two divisions. They also have eight legs or four pairs, instead of three pairs.



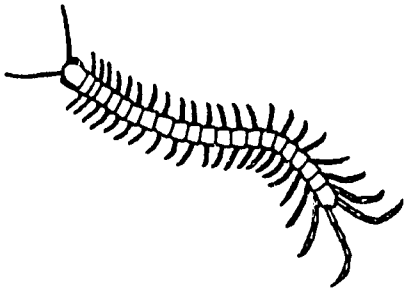
Pillbugs have five or more body segments and a pair of legs per each segment.



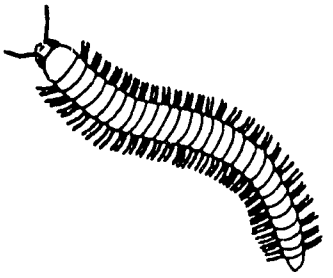
Ticks also have only two body segments and as adults, have four pairs of legs. These insects use their mouthparts to hook onto animals or people, feeding on their blood and spreading disease.



Mites are very much like ticks; they have two body segments with four pairs of legs.



Bugs like centipedes are often mistaken for insects. A centipede has many rings on its body, and a large number of legs, 1 pair/segment.



Millipedes are similar to centipedes. The difference is that they have more legs, 2 pair/segment.

STEP 2. PRESENTATION: LIFE STAGES OF INSECTS

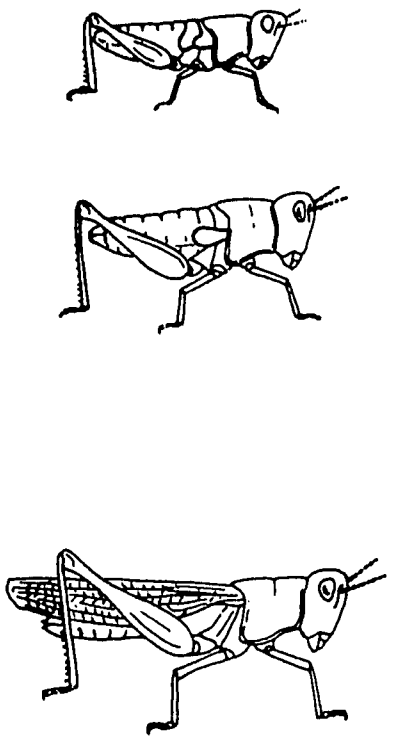
Insects do not look exactly the same throughout their entire lifespans. Insects grow and change just as people do. But children's bones and other parts of their bodies grow inside their skins. Their skin simply stretches to let their bodies get bigger.

Insects have no room to grow inside their skins. Their skin is made of a hard substance called chitin. It does not stretch. So, as they grow, young insects, called nymphs or larvae, have to throw off their skins to get bigger. They have a new skin underneath the old one. The old skin splits and the insect climbs out of it with his new skin, which is at first soft but rapidly hardens upon exposure to air. The change an insect goes through as it gets older is called metamorphosis. When the nymphs or larvae shed their old skin, it is called molting.

Different insects go through different changes. Some, such as the grasshopper, shed their skins many times, becoming bigger and bigger each

time, but looking about the same from birth to adulthood. When insects grow in this way the young are called nymphs.

Illustration 3: Grasshopper Life Stages

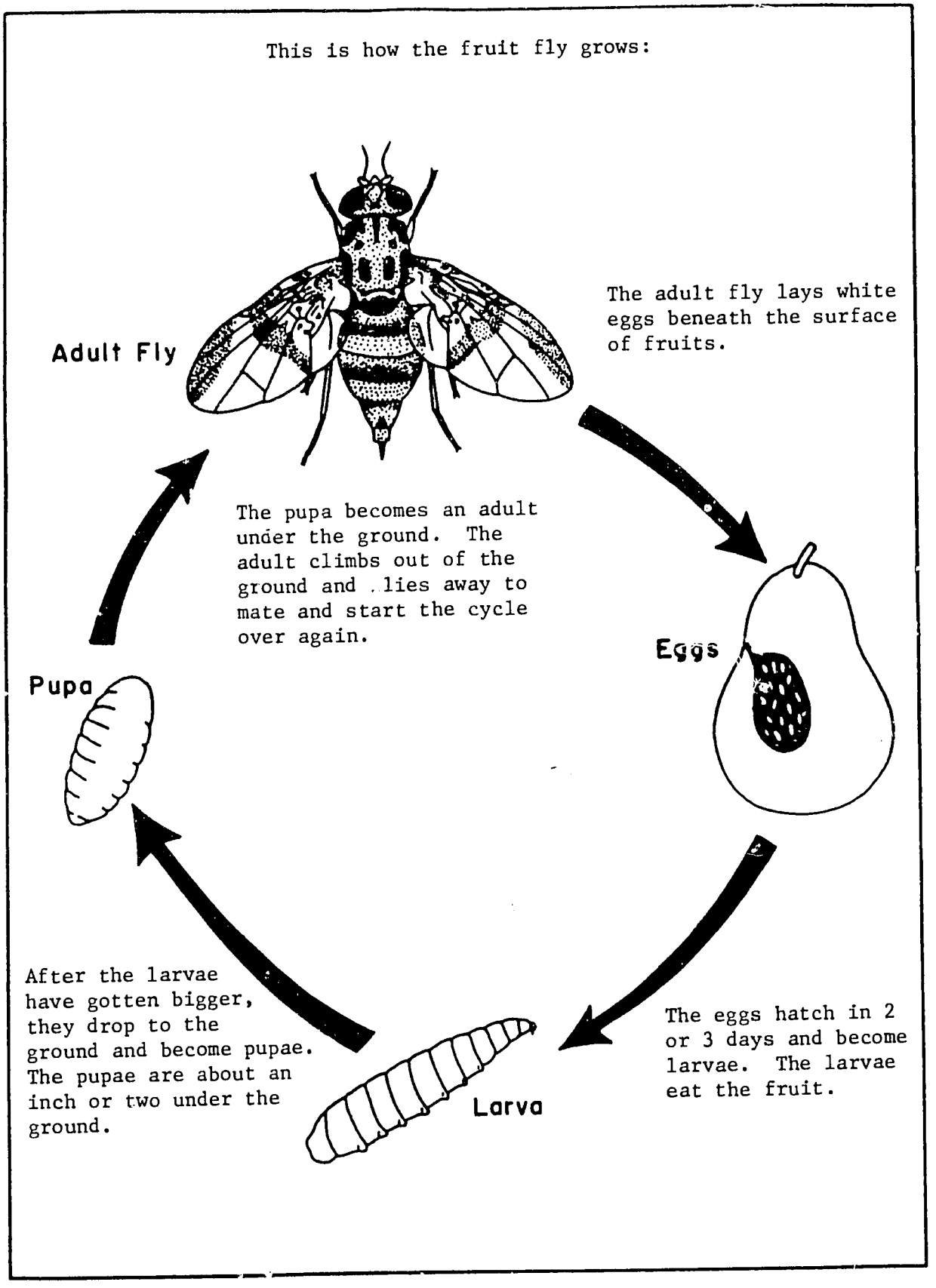


Nymphs

Adult

But other insects look completely different as adults. The fruit fly is a good example.

Illustration 4: Fruit Fly Life Cycle



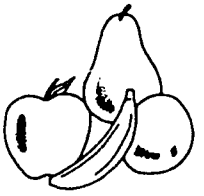
STEP 3. PRESENTATION: WHAT INSECTS EAT

What and how do insects eat? Some insects eat cork, tobacco, clothes and wood. Some feed on leaves, stems, stalks, branches, seeds, fruits and nuts. Some suck sap from leaves, stems, roots, fruits, and flowers. Some also carry disease agents and feed on man, animals and plants.

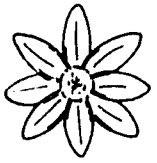
Illustration 5: Some things insects eat

Wood

Leaves



Fruit



Flowers

Other Insects

Clothing

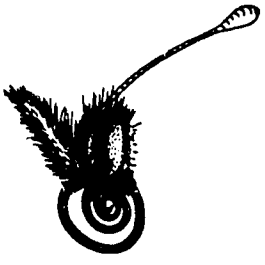
TO THE TRAINER: You may want to bring some examples of things that insects eat: wood, plant parts, flowers, cloth. You may know of some others. Ask the learners what they know in terms of what insects eat. Try to get an idea from each learner.

Since different insects have different kinds of mouthparts, they eat in distinct ways. Some chew and some suck or lick.

Illustration 6: This is how some insects eat

Chewing mouthparts

Sucking mouthparts



A butterfly has a very long tube-like tongue for sucking the nectar of flowers. When a butterfly is not feeding, the tongue is coiled on the underside of its head.

A praying mantid catches other insects and eats them with its strong chewing jaws.

A bee has a short tube-like tongue which has short hairs on it. The bee half-licks, half-sucks the nectar in flowers. When the bee is not feeding, the tongue is folded under its head.

STEP 4. SUMMARY

Conclude this activity with a summary. The key points are:

1. All insects have three body divisions and three pairs of legs.
2. Insects change and grow in different ways by shedding their old skins.
3. Insects eat many different things including plants, wood and cloth.
4. They have different mouthparts suited for the various things insects eat.

TOPIC C. GOOD AND BAD INSECTS

Purpose: To emphasize the fact that some, but not all, insects are harmful to us, or to our food supply. By the end of Activity C, learners should know:

1. The three groups of insects as related to their effects on man.
2. Examples of insects which belong in each group.
3. What damage from an insect looks like.

STEP 1. PRESENTATION: WHAT'S A PEST?

When man grows a crop of grain, vegetables or fruit, and an insect feeds on his crop, he calls that insect a pest. Other insects, like honeybees, are useful to man. They make honey and also help to fertilize flowers and plants. There are also many kinds of insects in the ground that help keep the soil healthy, while yet other insects attack and eat pest insects.

Insects are commonly put into three groups depending on whether they are good or bad for man. These three groups are:

1. Not Economically Important Insects
2. Beneficial Insects
3. Economically Important Insects

Not Economically Important Insects

The majority of insects (90%) belong to this group. These insects do not really help or hurt us. In fact, they are useful to other biota since they provide food for fish, birds, reptiles and other animals; but, as they do not bother man or his crops, they are not considered economically important. Some insects belong in this group, yet when conditions are right

they may become pests, e.g., termites, some white grubs, various butterflies, moths, and flies.

The total number of insect species known in the world from selected insect orders will provide a good reference point regarding numbers of insects.

Order	Common Name	Approximate Number of Species
Coleoptera	Beetles	280,000
Dermaptera	Earwigs	1,200
Diptera	Flies	85,000
Hemiptera	True Bugs	55,000
Hymenoptera	Ants, Bees, & Wasps	108,000
Isoptera	Termites	2,000
Lepidoptera	Butterflies & Moths	114,000
Phthiraptera	Biting & Sucking Lice	3,000
Thysanoptera	Thrips	4,000

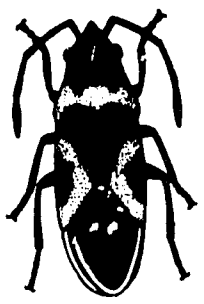
Most of the trainees will only know a few of the beetles, flies, butterflies and moths, yet the total number of species in such groups is impressive.

Diversity of insects, the total number of different kinds, has been studied in a number of different locations. Over 1,400 insect types have been found in one year in a backyard city garden. Many of these insects were beneficial and a few were pests. Most were active in turning the soil, breaking down organic matter, feeding on weeds, etc. In another study, of the 70 species of butterflies found in England, 21 (30%) were found in a 658 m^2 garden. Again, not all were pests nor beneficial.

Abundance or total numbers of some insects in nature is also truly phenomenal. In such places as forest soils, the number of total insects per acre may range from 4,000,000 to 34,000,000 with an average of 15,000,000. Many of these are small insects known as Collembola which are important in the breakdown of organic material. In pasture lands, the total number of insects is less, having been estimated at between 2,474,000 to 7,727,000 per acre. Many of these insects are not economically important pests and do not feed on other insects, so they fall into the group of non-economic insects.

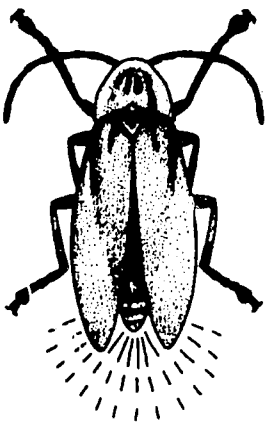
Illustration 7: Not Economically Important Insects

MILKWEED BUGS



Milkweed bugs are of no economic importance. Milkweed bugs look very much like the destructive chinch bugs. But milkweed bugs are not harmful to man's crops like chinch bugs. They eat milkweed.

FIREFLIES



Fireflies are unusual insects. Their bodies give off a glowing light that can be seen when it is dark outside. Fireflies eat other insects when they are in the larval stage.

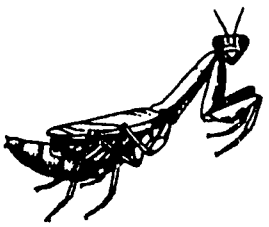
AMBUSH BUGS

Ambush bugs are not economically important. Ambush bugs are oddly shaped bugs. They eat other small insects. They are not common enough to control destructive insects or to harm the population of beneficial insects.

Beneficial Insects

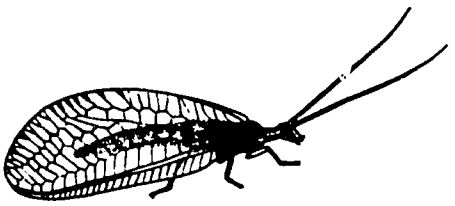
The second largest group of insects is the beneficials (7%). Since they eat insects that are harmful to man, they are beneficial. Without these insects, we would not be able to control many pest problems! Other good insects, such as the honeybee, make products that are useful. Since these insects are good to have around, do not destroy them! Also, honeybees, certain flies, and some moths are necessary for seed production in certain plants. Common plants such as oranges, lemons, watermelons, and cucumbers depend on these insects for seed and fruit production.

Illustration 8: Some Beneficial Insects



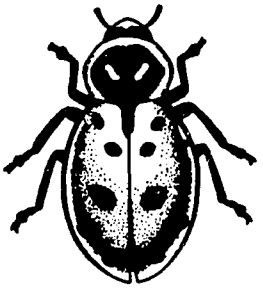
MANTIDS

Mantids, because of the way they hold their front pair of legs, are sometimes called praying mantids. Mantids eat many insect pests, which helps man control the number of destructive insects.



LACEWINGS

Lacewings are insects that are helpful in two ways: they provide food for birds and they also eat destructive insects that harm man's crops.



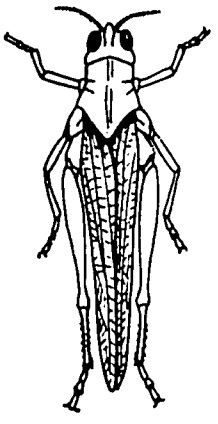
LADYBIRD BEETLES

Ladybird beetles are an important group of beneficials and are among the best known. Ladybird beetles eat destructive pests and are often used to control the number of bad insects.

Economically Important Insects

The insects that damage man's crops and carry diseases which can make man sick are small in number. Only 3% of all insects are harmful and are pests. These pests compete for man's food supply since they eat the same things man eats. Some of them spread illnesses that can kill!

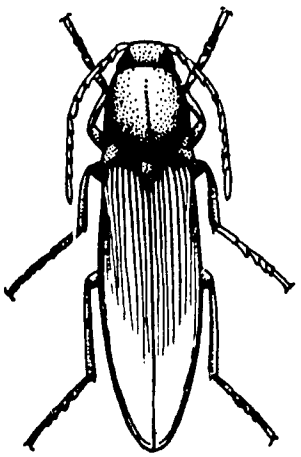
Illustration 9: Some Economically Important Insects



GRASSHOPPERS AND LOCUSTS

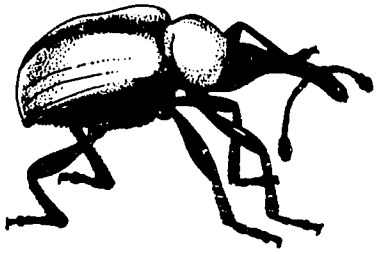
These insects are usually harmless. They mostly eat grass. But some kinds of grasshoppers also eat cereal crops such as wheat, barley, and oats. Locusts are this kind of grasshopper. Locusts fly together in very large groups called swarms. A swarm can destroy an entire crop, eating everything in its path and leaving nothing but bare land behind.

BEETLES



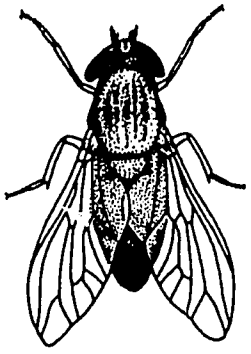
These insects have chewing mouthparts and feed on a very large diversity of flowers, fruits, vegetables and other plants. The CLICK BEETLE is one example. The click beetle larvae feed on roots, injuring potatoes and other crops.

WEEVILS

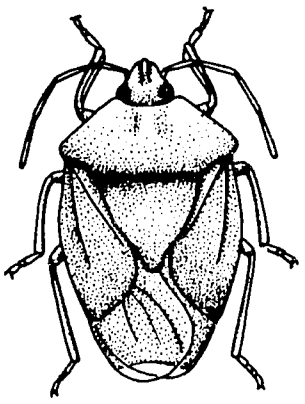


Weevils are small beetles with curved beaks. They damage grain, cotton, fruits, vegetables and nuts.

FLIES

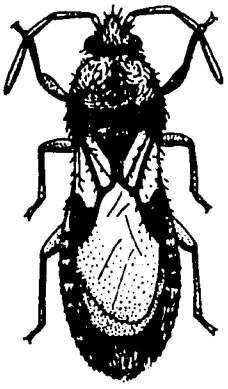


Although most flies are harmless and a few are even beneficial, there are some FLIES that cause serious damage to plants and illness to animals and people. Flies bite animals and people and spread disease.



TRUE BUGS

There are several kinds of True Bugs: STINK BUGS and SHIELD BUGS have flattened, shield-shaped bodies. They suck plant juices and this damages or kills the plant. Shield bugs and stink bugs are destructive to garden crops such as squash.

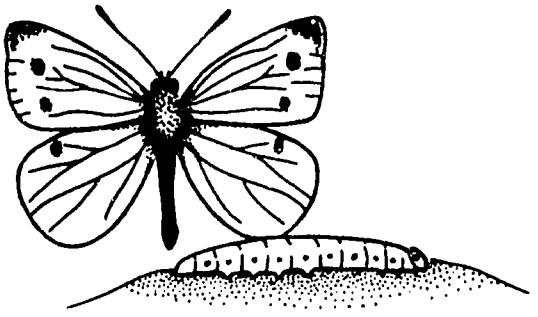


CHINCH BUGS

These insects reproduce so rapidly that that they can overrun grain fields, destroying the crops as they feed on plant juices. Chinch bugs cause many millions of dollars worth of damage.

MOTHS AND BUTTERFLIES

These are the largest and most beautiful insects. Moths and butterflies have sucking mouthparts as adults. But as larvae, they have chewing mouthparts and can severely damage crops. The adult moth or butterfly lays eggs on leaves. When the larva hatches out, it eats the leaf.

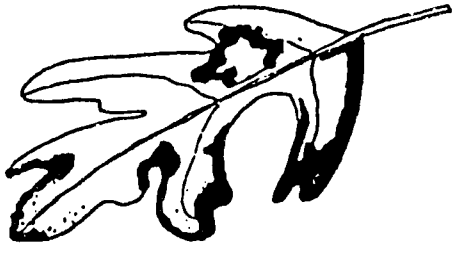


Adult

Larva

STEP 2. PRESENTATION: INSECT DAMAGE

The insects mentioned leave signs that indicate they damage crops. Their tiny eggs can be seen on fruit and plant leaves. When these eggs hatch, the larvae begin to eat the leaves and fruit and holes and marks are made on the plants. These holes and marks are often very apparent and may reduce yield or quality of the product produced.



Leaf damaged by insects

TO THE TRAINER: Bring leaves or plant parts that show evidence of insects. Find samples with variety if possible, perhaps some with eggs or larvae on them and some with holes or chew marks. Ask learners to find examples of insect damage to bring for the next meeting and to share with others.

When there is plenty for pests to eat and environmental conditions are favorable, their numbers increase. When this happens, it soon becomes easy to notice many insects in the crop area. A farmer should carefully look over his crops every week to check for evidence of harmful insects.

STEP 3. SUMMARY

Conclude this activity with a summary of the points covered. The key points are:

1. Not all insects are pests. In fact, only a small number (3%) harm people or crops.
2. Insects are divided into three groups depending on how they affect man. The three groups are:
   a. Not Economically Important Insects (90% of all insects)
   b. Beneficial Insects (7% of all insects)
   c. Economically Important Insects (3% of all insects)
3. Insects leave signs that they are living in the crop area. Signs are: egg deposits on plants, holes and chew marks, and the presence of insects themselves.

UNIT II SUMMARY

The major points covered in this Unit's activities were:

A. While there are many different kinds of insects, they all have three body parts and three pairs of legs. Since their hard skins are made of chitin and do not stretch, insects must grow by molting, or losing their old, smaller skins to expose a new softer skin underneath which can stretch and grow for a short period. This growth produces many different changes in some insects. The process of these changes is called metamorphosis.

B. Insects are distinguished by several different kinds of mouth-parts, so they eat many different things. Some insects like to eat many of the same crops which people eat. When insects eat the crops that man grows to feed himself and his family, the insects are called pests. Not all insects are pests. Some insects are helpful to man.

The different kinds of insects are divided into three groups:

1. Not economically important, about 90% of all known insects.
2. Beneficial insects, about 7% of all known insects.
3. Economically important, about 3% of all known insects.

C. There are other pests besides insects which damage our crops. Plant pathogens cause plant diseases that can damage or destroy our crops. Weeds are plants that grow where they are not wanted. They reduce the amount and quality of our crops. Weeds live from one to several years and are divided into three groups, depending on how long they live. Rodents and birds are two kinds of ani-

mals that are also pests. They contaminate crops with dirt and disease. Signs of these animals (such as droppings, hair and feathers) should be watched for.

TO THE TRAINER: Conclude this Unit with a question and answer session. First, ask the learners if they have any questions about the topics discussed in this Unit. After their questions have been addressed, ask the learners the following questions to test their understanding of the material that has been presented.

QUESTIONS

UNIT II: "Introduction to Pests"

1. What two things do all insects have in common?
2. How do insects grow?
3. Name five things that insects eat.
4. Name the three groups of insects relating to how they affect people.
5. Name several insects that are common pests and describe how they can be bad, or "economically important."
6. Name three other pests besides insects.
7. Name three things that can cause plant disease.
8. Weeds are put into three groups. What are these groups?
9. Name examples of rodents.
10. What do birds and rodents do to our food that makes it dangerous for us to eat or handle?
11. Name three signs that you should watch for in your crops that will tell you if the plants are diseased.
12. Name three signs that would indicate rodents or birds were a problem.

UNIT III: INTEGRATED PEST MANAGEMENT AND DECISION MAKING

UNIT OVERVIEW

Before the learners can begin to deal with pest situations, they must first know whether they have a pest problem or not. In the case of insect pests they must realize there are good or beneficial insects and that there are bad or harmful insects. Many insects help man when they eat or destroy other pests, whereas when they eat man's crops, they are not helpful and become pests.

This Unit provides basic information to help distinguish between good (or beneficial) insects and pest (or harmful) insects. Harmful pests are included in the "economically important group." This group is the smallest of the three groups of insects, animals and other organisms cited in Unit II. A serious question to be considered in this Unit is: How do you control economically important or harmful pests without destroying insects that are helpful or good for man? Integrated Pest Management (IPM) is central to the consideration of this question.

The purpose of this Unit is to aid trainees answer such questions as: How do I decide what to do about a pest problem? What issues do I consider? How serious is the pest problem? What choices do I have to deal with the problem? Can I effectively use IPM?

Three primary topic areas are included in Unit III. The TOPICS are:

A. GROUPS AND NUMBERS OF PESTS.

B. WHY CONTROL ECONOMIC PESTS?

C. INTEGRATED PEST MANAGEMENT AND "WEIGHING" THE DECISION.

OBJECTIVES:

By the end of Unit III, learners will know:

1. What percentage of all insects are destructive pests.
2. Why, even though the number of pests is small, pests need to be controlled.
3. What the concepts of "Integrated Pest Management", "economic injury level" and "economic threshold" mean.

Unit III requires approximately 2 hours to complete and includes activities that require teaching materials.

TEACHING MATERIALS PROVIDED	TEACHING MATERIALS YOU MUST PROVIDE
None.	100 small objects like wheat, corn or bottle caps. Sling balance. Coins equal in weight to the wheat or corn or caps. Flip chart paper.

TOPIC A. GROUPS AND NUMBERS OF PESTS

Purpose: To present information on the number of beneficial insects compared to those that are harmful as well as to recognize that a large majority of the animals man lives with on earth are not harmful to him--or his food supply. By the end of Activity A, learners will:

1. Know approximate percentages of the number of insects that fall into each of the three catagories: "not economically important"; "beneficial"; and "economically important" or harmful.
2. Understand why the "beneficials" and "not economically important" insects should not be destroyed.

STEP 1. PRESENTATION: GROUPS OF INSECTS

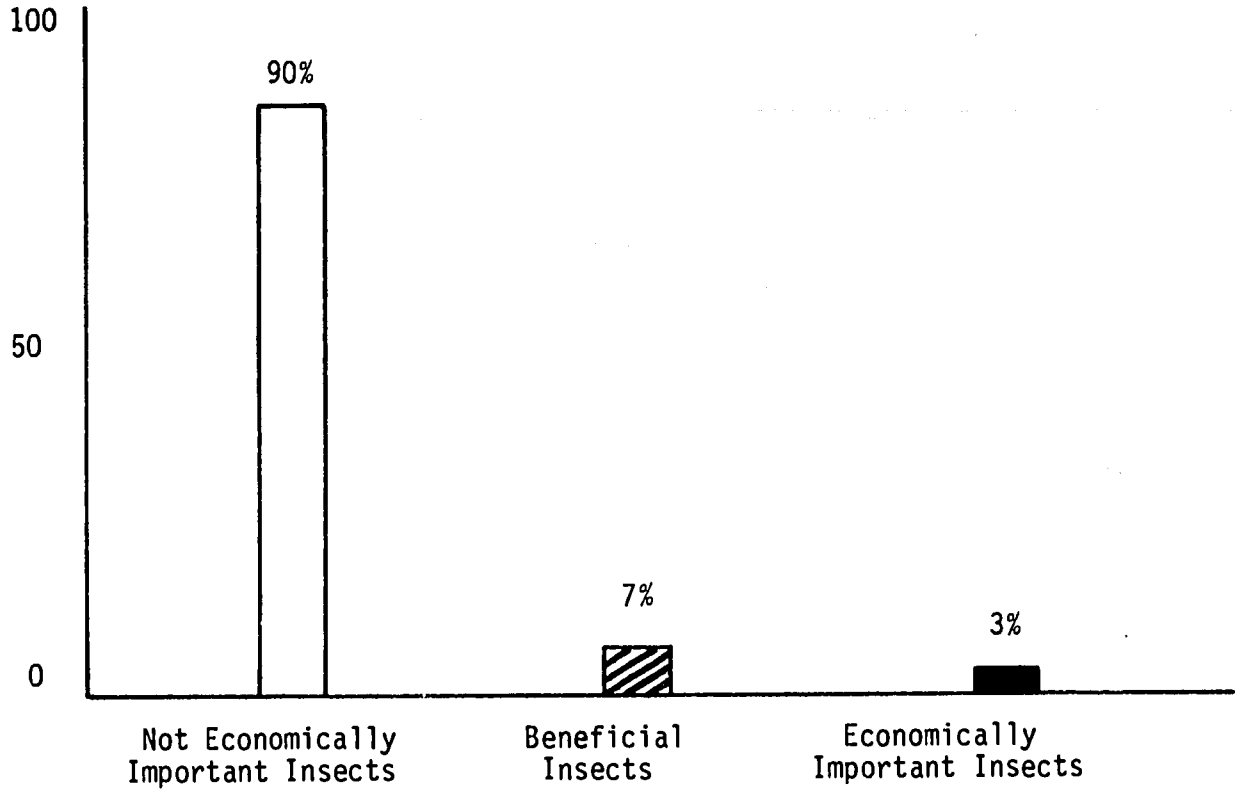
There are three groups of pests and insects:

1. Not economically important
2. Beneficial
3. Economically important

The "not economically important" group has the most members; "beneficials" are the second largest group and "economically important" are the smallest group.

Let's take a close look at the three groups of pests and the numbers of insects that belong in each group. The following chart illustrates the number of pests and insects that fall into each of the three groups.

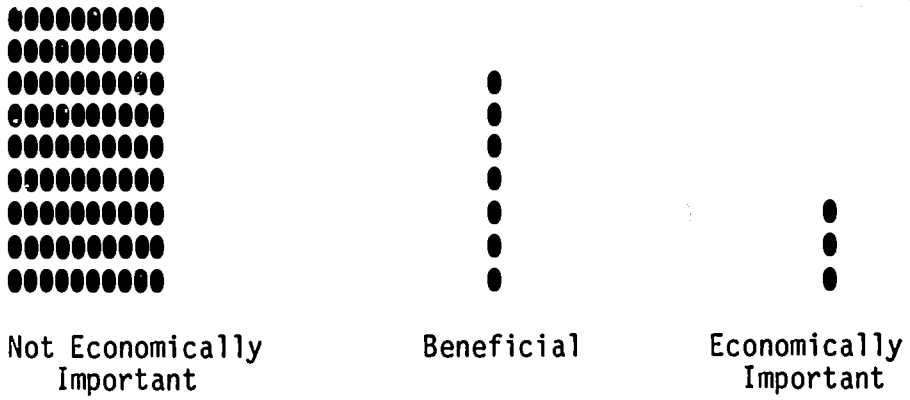
Three Groups of Insects



TO THE TRAINER: As you explain the chart, emphasize the percentages and the contrast between the large number of "not economically important" insects and the small number of "economically important" insects. Answer any questions.

STEP 2. DEMONSTRATION: NUMBER OF PESTS

Use a demonstration to illustrate these percentages. Use any small object (bottle caps, grains of corn, etc.). Tell the learners that these objects represent insects. Have three separate piles: one for "not economically important" insects; one for "beneficials"; and one for "economically important" insects.



TO THE TRAINER: This is what each of your piles should look like. In the "not economically important" group, count out 90 bottle caps (or whatever you decide to use). In the "beneficial" group, count out 7. And in the "economically important" group, only 3.

STEP 3. PRESENTATION: GOOD VS. BAD INSECTS

The number of destructive or harmful pests is small. If it were higher, man would be in a constant struggle to control them. But the larger number of nonpest insects compared to the smaller number of pests does present one problem: as man tries to control the few harmful insects he often kills many of the non-harmful or beneficial insects. Man destroys the very insects that can help him.

STEP 4. SUMMARY

Conclude this activity with a summary of the key points covered:

1. All insects can be placed in one of three groups:
   a. Not economically important
   b. Beneficial
   c. Economically important
2. The most numerous group is the "not economically important" group with 90 percent of all insects.
3. "Beneficials" include 7 percent of all insects and are the second most common group.
4. The "economically important" group has the fewest in number, only 3 percent of all insects belong to it.
5. It is easy to destroy helpful insects while trying to destroy pests.

TOPIC B. WHY CONTROL ECONOMIC PESTS?

Purpose: To understand why it is important to control the harmful or "economically important" pests, even though there are only a relatively small quantity (3%) of them. By the end of this topic, the question "Why Control Economically Important Pests?" will be answered. Learners will know:

1. Two main reasons why pest control is necessary.

STEP 1. PRESENTATION: PEST INSECTS

Only a very small percentage of all insects are destructive to man's crops. If the number is so small, and non-harmful insects are more common than harmful ones, do we need to control the number of harmful insects?

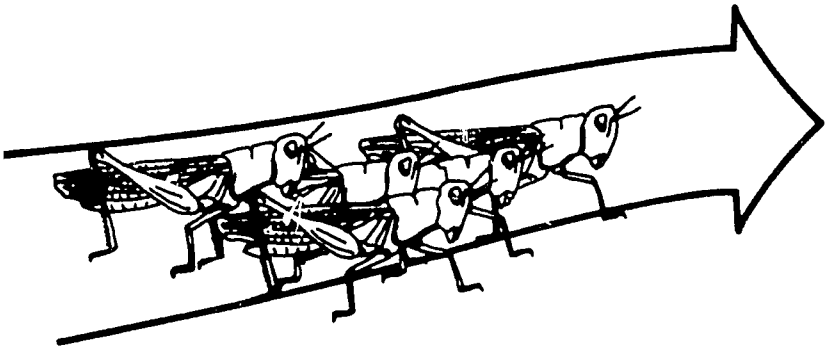
Let's go back and talk about this third and smallest group of insects - the "economically important" insects. Remember, economically important insects compete for man's food. They are the ones you should control.

Consider the story on the next two pages . . .

The crop is a good one.

There will be much to eat.

The insects think that the crop looks good to eat too.



The insects have eaten well.

The crop is no longer a good one.

There will not be enough to eat.

How will I feed my family?

STEP 2. DISCUSSION: THE MEANING OF THE STORY

> TO THE TRAINER: Give the learners several minutes to look over the previous series of pictures; then ask a volunteer to briefly explain the story. Encourage a short discussion concerning what has happened to the character in the series. Ask the learners if any of them have ever had a similar experience with their crops. Discuss briefly their experiences.

STEP 3. PRESENTATION: CROP LOSSES

Insects do eat crops. But how often do they cause crop losses? How much of our food is eaten by insects?

Here are the facts: Even when control measures are practiced, insect pests eat about one tenth of all food crops. This is a lot when you stop to think that even if insects did NOT eat any of our food crops, there would still be many people who would go hungry. With so many people in the world and only a limited amount of land available on which to grow crops to feed them, every bit of food that man can grow is important! Consequently, if the number of insect and other pests is allowed to grow with no control, it is obvious that more than 10% of our food crops would be lost to these pests. Keeping this in mind, would it be wise to let the pest population in the world grow too large? Surely not!

STEP 4. PRESENTATION: WHY CONTROL PESTS

Harmful pests are called "economically important" because of the monetary loss they cause. Each year, billions of dollars are lost when insects and other pests damage crops.

Keep two reasons in mind when you answer the question "Why control economic pests?":

1. To prevent hunger.
2. To prevent money loss to you.

STEP 5. SUMMARY

Conclude this activity with a summary. The key points are:

1. Insects and other pests may destroy one-third of our food supply, a loss that causes many people to go hungry.
2. Insects cause billions of dollars of damage each year.
3. There are two main reasons why pests need to be controlled:
   a. to prevent people from going hungry
   b. to prevent economic losses

TOPIC C. IPM AND "WEIGHING" THE DECISION

Purpose: To consider the various factors that are weighed before a decision is made to control a pest. There are a number of ways to control pests. One important way is through Integrated Pest Management (IPM). Decisions must be made on how and when to use chemical pesticides and when not to use them. At the end of Activity C, learners should know:

1. What IPM means.
2. The meaning of economic injury level and economic threshold.
3. How to use the idea of economic threshold to make pest control decisions.

STEP 1. PRESENTATION: A SHORT REVIEW

Two major points to remember are:

1. The majority of all living things are not harmful to man. By destroying some living animals, man actually hurts himself because many of these animals and insects can be helpful to man.
2. The small number of animals and insects that are harmful cause great damage. Their numbers need to be controlled.

But wait a minute! Aren't we saying two completely different things: If we destroy those insects that are economic pests, how can we keep from destroying too many of the helpful animals that we want to protect?

The answer is easy! . . . By making our pest control decisions very carefully and acting very carefully when these decisions are carried out.

The decision to use pest control is a very serious one. Let's explore ways to make pest control decisions carefully.

STEP 2. PRESENTATION: WORMS IN A FIELD

Suppose for a moment that you own one acre of land and that on half of this land you have planted a crop of maize. Let's further suppose that you have discovered there are worms feeding on the ears of the maize in your field and that you estimate these worms, if left uncontrolled, would cause five dollars worth of damage to your crop. Control costs to kill these worms in your field would cost eight dollars (this amount includes purchase price of chemicals, application equipment costs and labor). Would it be worth your while and worth your money to try to control these worms?

> TO THE TRAINER: Use the blackboard or sheet of paper to list the two sets of costs: potential dollar losses vs. cost of control. Do the same for the following situation.

But suppose that the next generation of worms is even larger than the first and would cause ten dollars worth of damage to your maize field. The cost to control these worms is still eight dollars. Ask yourself again, would it be worth your while and worth your money to try to control this pest?

STEP 3. DISCUSSION: MEANING OF THE STORY

> TO THE TRAINER: Ask the learners to discuss this example. Examine closely the reasoning involved in deciding whether or not it would be worthwhile to attempt control measures to rid the maize field of worms. Encourage discussion. Ask specific questions. Ask the learners if they have had similar experiences in pest control decisionmaking.

STEP 4. PRESENTATION: MAKING A PEST CONTROL DECISION

The same thing that is true in the story of the worms attacking the maize field is also true in man's relationship with other pests. We can and should expect to lose a certain amount of crops to pests. Some plants will be affected by insects. Some will become diseased by plant pathogens. Some will be eaten by animals such as rats and birds. A certain amount of loss has to be expected when growing crops.

When making pest control decisions, it is important to keep this point in mind--some loss will occur regardless of what we do.

But before deciding to use some form of pest control (such as chemical pesticides), you must be sure that the loss of crop is greater than expected and greater than an acceptable level. Like getting rid of the worms in the maize field, pest control will cost you money and it involves your time and your effort!

> TO THE TRAINER: Additional pest and loss situations should be presented at this point. Such situations have not been included since they will vary greatly from country to country, depending on pests, crop, climate, value of crop, cost of pesticides, etc. Use local examples.

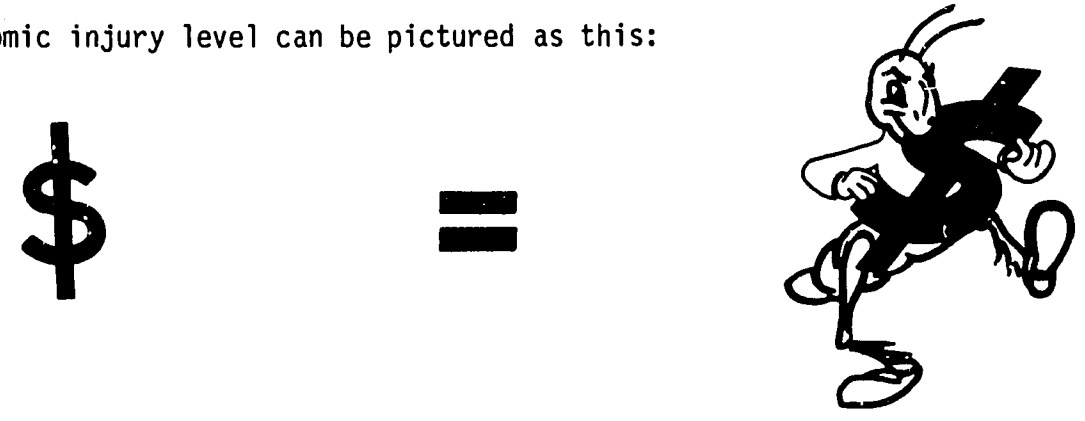
STEP 5. PRESENTATION: IPM AND ECONOMIC INJURY LEVELS

The letters "IPM" stand for Integrated Pest Management. Integrated Pest Management is a philosophy of pest control that promotes the use of a variety of control techniques and methods in a compatible manner in order to reduce pest populations to a level where they do not cause economic

damage. The application of these various control methods is based on a knowledge of expected economic, environmental and sociological consequences and on the recognition that a certain amount of loss is to be expected when crops are grown. Two concepts have been developed by pest control specialists to assist farmers and other decision makers to determine when control measures need to be applied. The first of these is the economic injury level (EIL) which may be defined as the lowest pest population density that will cause economic damage. The second concept is known as the economic threshold level. This may be defined as the pest population density at which control measures are employed to prevent an increasing population from exceeding the economic injury level.

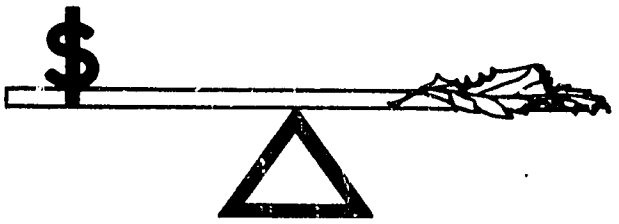
However, when the pest population has reached the economic injury level the crop has already sustained damage and loss in yield. As the population increases further, it becomes necessary to apply control procedures to avoid additional losses. Since it is desirable to prevent a pest population from reaching or exceeding the economic injury level, control measures are generally applied at a level below the EIL. This level is called the economic threshold.

Economic injury level can be pictured as this:

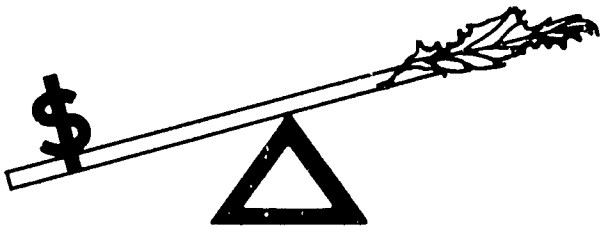


Money spent to kill pest Money lost to pest's damage

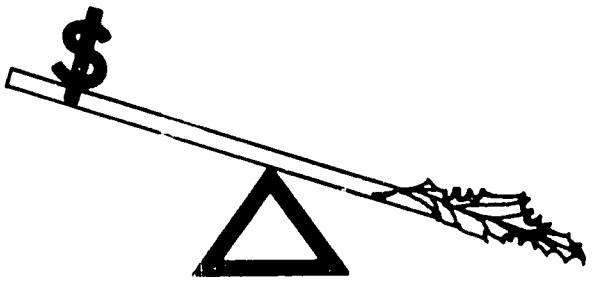
Using a balance beam system, the economic injury level looks like this:



Before the economic injury level is reached, a farmer would lose money if he tried to control a pest, i.e., the money he would spend to apply a pesticide would be more than the amount of money he would lose from the damage the pest might cause if no control measures were taken.

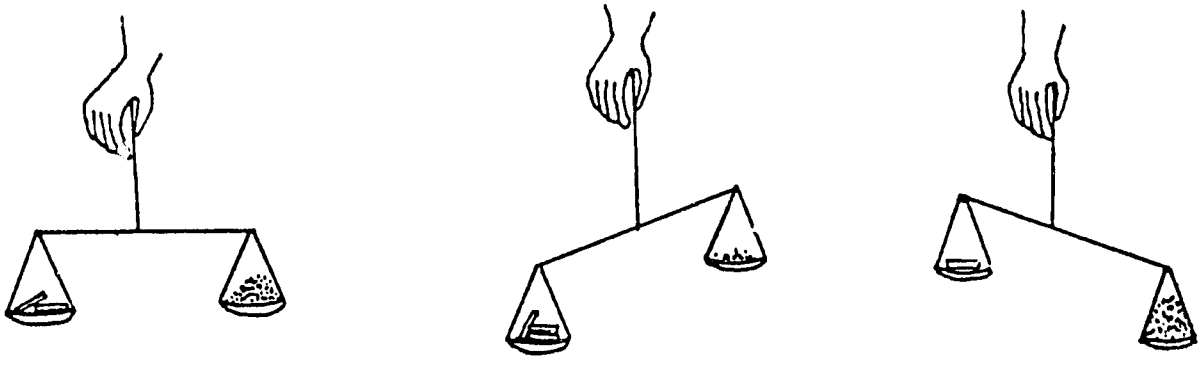


In the illustration below, the economic injury level has been passed. The farmer is losing his crop and money and needs to take action to get rid of the pest.



STEP 6. DEMONSTRATION: ECONOMIC INJURY LEVEL

TO THE TRAINER: Use a balance, such as a sling balance, with money on one side and grain on the other. Use the balance to demonstrate each of the possible economic injury level situations mentioned above. Whatever type of balance is used, make sure that a perfect balance can be achieved.



Economic Injury Level | Before Level Is Reached | After Level Has Been Exceeded

STEP 7. SIMULATION: DECIDING ON ECONOMIC INJURY LEVEL

TO THE TRAINER: You will need to describe 2 to 4 different situations--using numbers and pests in which learners analyze the situations to decide what the economic injury level is and whether it is passed or not. These situations should be based on realistic assumptions of conditions in the country where this training is being conducted. For example, the situation described in Step 2 is the type needed. These situations should be put on cards which learners can review in small groups of 4-6 persons.

STEP 8. SUMMARY

Conclude this activity with a summary. The key points are:

1. In order to control economic pests without destroying too many beneficial organisms, it is important to make pest control decisions carefully.
2. You can expect to lose some of your crops to economic pests. As long as the amount of crops lost is within an "acceptable level," accept the loss without spending your time, energy and money on pest control.
3. IPM or Integrated Pest Management is a program of control methods with the goal of reducing pest populations <u>to an acceptable level</u> through the use of diverse, yet compatible, pest control techniques.
4. <u>Economic injury level</u> is the point at which the money spent to control an insect pest is equal to the money loss that the insect could cause in damage to crops.

UNIT III SUMMARY

The major points covered in this Unit were:

A. Ninety-seven percent of all insects are not economically destructive to man's crops. This means that only a very small percentage of insects are pests that compete directly with man for food.

B. Although the number of economically destructive pests is small, these pests can and do create much damage. They eat one tenth of all of man's food. They cause billions of dollars worth of damage each year by destroying crops. There are two major reasons why economic pests need to be controlled: to keep people from going hungry and to prevent money loss.

C. Some crop loss is to be expected. As long as this loss is below an economically acceptable level, you need not exercise any pest control. Integrated Pest Management or IPM is concerned with controlling insects when this acceptable level of crop loss is passed. Another way to think of the acceptable level is expressed by the idea of <u>economic injury level</u>. Economic injury level is the point at which the money, time, and energy spent to control pests is equal to the money loss that pests could cause in damage to crops. The <u>economic threshold</u>, on the other hand, is the level of pest population abundance at which a decision to apply control measures is taken in order to prevent the pest population from reaching the economic injury level.

TO THE TRAINER: Conclude Unit III with a question and answer period. Ask the learners if they have any questions about the Unit and address them. Then ask the learners the following questions to make sure that they understand the concepts presented.

QUESTIONS

UNIT III: "Integrated Pest Management and Decision Making"

1. Which is the largest of the three insect groups?
   a. the not economically important?
   b. the beneficials?
   c. the economically important?
2. What is one reason for being careful when controlling pests?
3. If the number of destructive pests is small, why do we need to control economic pests at all? List two reasons.
4. What do the letters "IPM" stand for? What does IPM mean?
5. What is meant by "acceptable level" or "economic threshold"?

UNIT IV: PEST CONTROL

UNIT OVERVIEW

Once you have identified a pest problem and decided that it is economically serious, what do you do? Ask yourself a number of questions to help guide you in making your decision. These questions include: What is the best, safest and most economical way to handle this pest problem? What actions can I take? Do I apply pesticides? Can I use some other method of pest control?

This Unit provides information on a variety of pest control methods. This information should help the farmer to decide what method of control, or what combination of methods, to use to deal with a particular pest problem. The primary purpose of this Unit is to develop the farmer's ability to make safe and economically wise decisions related to pest control methods.

This Unit includes 3 primary topics. The topic titles are:

A. PEST CONTROL METHODS.

B. IPM AND USE OF PEST CONTROL METHODS.

C. THE CONTINUED NEED FOR PESTICIDES.

OBJECTIVES:

By the end of this Unit, the learners will know:

1. At least 8 suitable pest control methods.
2. Why to use these methods alone, or in combination with other methods, to get the best results from a pest control program.

3. What the term IPM means in relation to pest control methods.

4. Why there is continued need for pesticides.

Unit IV requires approximately 2 hours and 30 minutes to complete and includes exercises that require specific teaching materials.

TEACHING MATERIALS PROVIDED	TEACHING MATERIALS YOU MUST PROVIDE
None.	Pest traps and barriers, e.g., fly paper, cockroach trap, screen, etc. Flip chart paper.

TOPIC A. PEST CONTROL METHODS

Purpose: To present different methods of controlling pests. By the end of Topic A, learners should know:

1. Methods to prevent a pest problem from occurring.
2. Methods for treating a pest problem after one has developed.

STEP 1. PRESENTATION: CONTROLLING PESTS

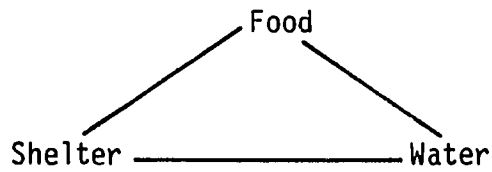
> TO THE TRAINER: Ask the learners the following question: "Which would be better, to put out a fire if your house were burning, or to prevent a fire from ever starting in your home?" Why? A similar example with sickness could also be used. Is it easier to prevent or cure one or another type of disease?

The following points should be made: surely, it is better to never have a fire start. To put out the fire takes work, time and money. Even more important, fighting a fire can be dangerous. (After these points have been made, tell the trainees that the same is true for a pest problem once it develops.)

Pest control involves money, time, work and, sometimes, the risk of injury or illness. How much better it would be then to do everything possible to prevent a pest problem from occurring in the first place!

For a fire to ignite, a certain set of circumstances must be present--a flame or a spark, an explosive chemical, or intense heat. Similarly, for a pest problem to grow, a set of conditions must also occur. There must be food for the pest to eat and live on. The environment of the crop area must be pleasant for the pest to live in and grow. The pest must have the

right amount of light, moisture and warmth. If these conditions are not right for the pest, such as an insect or rat, it is less likely that it will choose to make its home in the area. This set of conditions is frequently call the triangle of life.



TO THE TRAINER: List on the blackboard or flip chart various pests and their sources of food, water and shelter. As trainer, list additional local examples.

Pest	Food	Water	Shelter
Rats	Grain & Fruit	Drink water each day	Weeds, trash, burrows
Aphids	Plant juices	From plant	Under leaf
Leafcutting ants	Cut leaves to serve as media for fungi	From dew drops, plant tissue, soil	Nest in ground
Sorghum midge	Sorghum seeds in formation	From plant	Inside forming seeds
Stored grain insects	Grain	From grain	Grain kernels, spilled grain
Termites	Wood & grass	From soil & food	In ground & wood

It's easy to see that you can prevent a pest problem if you pay attention to the crop environment. If you alter the crop environment to make conditions poor for pests to live in, they won't live there. There are several ways to do this . . . .

STEP 2. PRESENTATION: PREVENTATIVE METHODS OF PEST CONTROL

There are 8 methods that can be used to control, or suppress, a pest problem.

1. Sanitation
2. Natural Control
3. Biological Control
4. Mechanical Control
5. Resistant Varieties
6. Cultural Control
7. Physical Control
8. Chemical Control

1. Sanitation

Remember: One of the conditions that must be present for a pest problem to occur is plenty of food. Some pests, such as rats, eat food wastes that we should throw away. They feed on filth and debris. If you are careful and remove these sources of food for rats you have greatly reduced the chances for a rat problem to develop. The method of removing filth and wastes that are the food of some pests is called sanitation. Sanitation involves proper disposal of wastes. It involves keeping areas as clean as possible. This is an easy and inexpensive way to prevent many pest problems!

2. Natural Control

Many animals and diseases are enemies of pests. If too many of these enemies are present in an area, the area is not a good environment for the pest to live in. For example, ladybugs are enemies of aphids. If

ladybugs are present in your crop area, they will likely control aphids. If these beneficial insects are present in a crop, they should be conserved.

Other elements of the environment, such as winter cold or summer heat, rain, frost or some other physical weather factor, also contribute to reducing the abundance of a pest and, together with the action of natural enemies and disease, achieve what is known as natural control. Thus, natural control involves the combined actions of the whole environment to maintain the population of a species at a characteristic density.

3. Biological Control

Biological Control is a result of the action of parasites, predators and pathogens in reducing the abundance of a species and maintaining its population at a level lower than it would have obtained in the absence of this action. It is also the name of the pest control method that involves releasing a pest's natural enemies in an area. The enemy controls the number of pests . . . so you don't have to! Releasing ladybugs in an area to control aphids is one example of biological control.

4. Mechanical Control

There are other methods to prevent pest problems that are just as (or more) effective as biological control. These methods are called Mechanical Control. Mechanical control includes setting up traps and barriers which discourage pests in a particular area.

TO THE TRAINER: Bring some sample traps and barriers to show the learners. Include window screening as a barrier. Ask the learners for any examples of mechanical control they use.

5. Resistant Varieties

Some crops resist the attack of pests better than other crops. They do not become as damaged and are not as easily destroyed by pests. These crops are called Resistant Varieties. Since they resist the pest's attack, planting resistant plant varieties makes the chance of a pest problem less likely. This method can be useful for reducing problems with aphids, sorghum midge, some stored grain insects, and others.

6. Cultural Control

The way in which you plant, grow, and harvest your crops affects the pests that live in the crop area. Planting, growing and harvesting practices which harm these pests are methods of pest control called Cultural Control. Practices such as crop-rotation, time of planting, fertilization, and weed control are all types of cultural control methods.

7. Physical Control

Changing the availability of water, relative humidity, temperature, or light conditions can make living conditions unpleasant for pests. Cool and dry grain will have fewer pest problems than warm and moist grain. Such Physical Control directly impacts on the environment around the pest.

8. Chemical Control

Although there are other methods, we will discuss one final method of pest control . . . the use of pesticides. Pesticides are chemicals that are applied to crops. A chemical pesticide is a poison. As soon as the pest tries to eat the crop sprayed with a pesticide, it comes into direct contact with the chemical or it may ingest it or breathe it in. This typically causes the pest to become sick and die.

Pesticides can be used to fight a pest problem when other methods fail. Pesticide chemicals are the strongest and fastest form of pest control but not always the cheapest or safest. Some pesticides are so strong that the insect only has to touch the chemical to die instantly.

Because of this, pesticides can also be dangerous to man and the environment. Very special care must be taken when using them!

STEP 3. DISCUSSION: WHAT METHODS DO LEARNERS USE

List the 8 methods on the blackboard. Ask learners to list specific examples that they use. Also, ask which ones they would like to use.

STEP 4. SUMMARY

Conclude this activity with a summary of the pest control methods. Review the following key points:

1. Just as it is not always possible to prevent accidents (such as a house fire), it is not always possible to prevent a pest problem from occurring and growing. There are a number of methods of pest control.
2. Sanitation, or removing food wastes, debris and filth can prevent and control a pest problem.
3. Natural Control uses beneficial insects already present in the crop together with physical elements of the environment.
4. Biological Control, or releasing a pest's natural enemies, can control the number of pests in a crop area.
5. Mechanical Control involves setting traps or barriers to trap or discourage pests.
6. Resistant Varieties are crops that are not easily destroyed or damaged by pests. They can be planted to reduce the possibility of a pest problem.
7. Physical Control involves changing the environment in the crop or storage area to make it unfavorable for pests to live in.
8. Cultural Control involves methods in which we plant, grow and harvest our crops. These affect pests and can control pest populations.
9. Pesticide Use can be dangerous to man and the environment. Care should be taken when using this method!

TOPIC B. INTEGRATED PEST MANAGEMENT AND USE OF PEST CONTROL METHODS

Purpose: To explain how pest control methods can be combined to create an effective pest management program. By the end of this activity, learners will know:

1. What the term IPM stands for.
2. How the concept of Integrated Pest Management relates to pest control methods.

STEP 1. PRESENTATION: COMBINING CONTROL METHODS

Let us return for a moment to the story of the house fire. In struggling to put the growing fire out, would you rely on just throwing water on the flame if there were other methods which you could use to extinguish the blaze? Certainly not, you would use every available method to fight the fire!

If you apply the same thought to pest control, you can ask yourself: "Why use only one of the eight pest control methods? Wouldn't two or three combined be much more effective?"

The answer is YES!

Sanitation, natural control, biological control, mechanical control, resistant varieties, cultural control, physical control, and pesticide use are all methods of control that can be selected and used. The combination of methods you use depends on the kind and amount of control you need and the kind, amount and value of crops you are growing.

STEP 2. PRESENTATION: IPM

Combination of pest control methods to create an effective pest management program is part of IPM. IPM stands for Integrated Pest Management. The goal of IPM is to reduce pest populations to an acceptable level through the use of suitable pest control methods.

An IPM procedure involves the following principles:

1. Identification: The pest problem must be correctly identified. That is why you must have some knowledge of pests and the decision making procedure talked about in the last unit.
2. Combination: All available control alternatives should be determined. Remember, at least 8 methods are available to you.
3. Economic Threshold: The safest, most economical and efficient solution should be selected. Remember: this is the most important principle of pest control--use a pest control method only when that method will prevent the pest from causing more damage than is reasonable to expect--or when the cost for that control method is not greater than the damage that the pest would cause if not controlled.
4. Timing: To use the IPM procedure is to time the control methods to achieve maximum good results.

STEP 3. PRESENTATION: IPM EXAMPLES

Let's look at several examples of IPM programs to develop a better understanding of the IPM concept.

TO THE TRAINER: Have learners refer to the following chart while you talk through the example of IPM programs for flies and mosquitos.

METHOD	FLIES	MOSQUITOS
Sanitation	Breeding source reduction Cleaning waste containers Good housekeeping	Remove standing water when possible
Natural and Biological Control	Predatory mites and certain other flies	Predatory fish Fungi Nematodes
Mechanical Control	Screening Trapping with sticky traps and attractants Fly swatters	Remove containers providing breeding sites Use of screening on doors and windows
Cultural Control	N/A	Lowering and raising of water levels
Pesticides	Insecticides Baits	Repellents Residual insecticides Biodegradeable oils

STEP 4. SIMULATION: CONTROLLING OTHER PESTS

Ask learners to list other pests (rats, weeds, and insects), then "brain-storm" various methods which can be used to control them. Place the name of pest type on the board and ask learners to suggest various methods to be used. Then discuss the methods. Use the same chart form.

STEP 5. SUMMARY

Conclude Topic B with a summary. The key points are:

1. There are 8 pest control methods: sanitation, natural control, biological control, mechanical control, resistant varieties, cultural control, physical control, and chemical control.
2. A combination of methods is more effective than any one method used alone.
3. IPM (Integrated Pest Management) is aimed at reducing any pest population to an acceptable level through the use of a suitable combination of pest control methods.

TOPIC C. THE CONTINUED NEED FOR PESTICIDES

Purpose: To explain why a farmer must sometimes resort to the use of pesticides even though he is relying on one of, or a combination of, the other control methods.

By the end of this activity, learners will be able to:

1. List several reasons why pesticides are sometimes necessary.

STEP 1. PRESENTATION: WHY PESTICIDES?

There are many different ways to control pests. Remember, the last method--the use of pesticides, can be dangerous to both man and the environment. But, if this last method is so dangerous and there are so many other methods that we can use instead, why not do away with pesticides completely and rely on the other methods to fight pest problems?

This is a good question!

But . . . there are excellent reasons why pesticides are sometimes preferred alone. There are also excellent reasons why it is sometimes necessary to combine the use of pesticides with the other methods. Either way, chemical pesticides as a pest control method sometimes cannot be avoided. The necessity for the continued use of pesticides is related to food production.

Recall for a minute the reason for the need to control pests in the first place: as living beings in the world, people compete for food with all other living things. In order for people to have enough to eat, the number of other living things that reduce food production must be controlled.

If we didn't control pests, there would not be adequate food for people. Some people would go hungry or die. And many people do go hungry and die.

STEP 2. PRESENTATION: ADVANTAGES OF PESTICIDES

What are some of the advantages of pesticides?

1. Rapidity of action. Pesticides are useful when other control measures have failed and an emergency situation has occurred as a result. When a pest population grows large enough to exceed the economic threshold, pesticides can act more rapidly than any other method. Pesticides can act within a few hours to a day or two to kill pests!
2. Flexibility of application. Another advantage of pesticides is that they include a wide variety of formulations. This means that they can be used and be effective in many different situations. Thus, pesticides are flexible and adaptable.
3. Inexpensive. Finally, pesticides usually are low in cost--especially when compared to the money gained by saving crops from destruction. However, cost of application will be greater than amount of crop lost if the economic threshold has not been reached.

But, the most important reason for the continued use of pesticides is: sometimes pesticides are the only method of pest control that can succeed in controlling certain pest populations. In some cases, pesticides are the only control measure that will protect people from going hungry!

STEP 3. DISCUSSION: EXPERIENCES WITH PESTICIDES

> TO THE TRAINER: This discussion should relate to learners' experiences with pesticides. Why did they use pesticides? What types did they use? For what purposes? Make sure you focus the discussion on these questions. Limit discussion to 10 to 15 minutes and summarize the major points.

STEP 4. SUMMARY

Complete Activity C by summarizing the main reasons for the continued use of pesticides. The key points are:

1. Pesticides can be useful in emergency situations.
2. Pesticides can be highly effective.
3. Pesticides can act very quickly.
4. Pesticides are flexible and adaptable to many situations.
5. Pesticides are usually low in cost with a high rate of money return.
6. Pesticides are sometimes the only successful method for pest control.

UNIT IV SUMMARY

The major points covered in Unit IV are:

A. There are eigh basic methods of pest control that can be used to control pest populations:

1. Sanitation
2. Natural Control
3. Biological Control
4. Mechanical Control
5. Resistant Varieties
6. Cultural Control
7. Physical Control
8. Chemical Control: the strongest and most dangerous of all the control methods. Used carelessly, they harm people, animals, and the environment.

B. A combination of two or more of the pest control methods is usually much more effective than one method used alone. The coordination of combined pest control methods is part of Integrated Pest Management (or IPM).

C. In spite of the fact that pesticides can be very dangerous, they are a necessary element of most pest control programs and sometimes they are the only method that will be successful. Pesticides are fast acting and dependable in emergency situations. They are flexible and have many forms so that they can adapt to many different pest problem situations. They are relatively low in cost while being highly effective in protecting crops from damage and destruction.

TO THE TRAINER: Conclude Unit IV with a question and answer period. Ask the learners if they have any questions about the Unit and answer them. Ask the learners the following questions to make sure that they understand the concepts presented.

QUESTIONS

UNIT IV: "Pest Control"

1. Define the term sanitation.
2. What does natural control mean?
3. List three types of mechanical control?
4. Plants that are not as easily damaged by certain pests are called _____?
5. Name two other methods of pest control besides sanitation, natural control, mechanical control.
6. What is the most dangerous form of pest control?
7. What is IPM?
8. Use a pest control method only when that method will prevent the pest from causing more damage than _____ _____.
9. Name four reasons why pesticides are used.

UNIT V: PESTICIDES AND THEIR EFFECTS ON PEOPLE

UNIT OVERVIEW

When you use pesticides often, it is easy to forget to be careful. Pesticide safety must be an important part of every pesticide training program. Even when you are careful, accidents can happen. It is important that workers and their families be familiar with pesticide poisoning incidents and know how to handle them. Severe illness and, in serious cases, death can be prevented by knowing and practicing a few rules.

Unit V stresses the importance of knowing how to recognize and deal with pesticide poisonings. The Unit relates how pesticide poisonings occur so that you can recognize when you, a family member, or someone else has been poisoned. Learners will also learn what to do to help a poisoning victim.

Four primary topic areas are included in Unit V. The topic titles are:

A. THE DANGER OF PESTICIDES.

B. HOW POISONING OCCURS.

C. SIGNS AND SYMPTOMS.

D. FIRST AID.

OBJECTIVES:

By the end of this Unit, the learners will know:

1. The worldwide dangers to humans associated with pesticide use.
2. The levels of toxicity for the 4 classes of pesticides.
3. How pesticide poisoning can occur.
4. Signs and symptoms of pesticide poisoning.
5. Basic first aid for pesticide poisoning.

Unit V will require approximately 2 1/2 hours to complete and includes activities that require teaching materials.

TEACHING MATERIALS PROVIDED	TEACHING MATERIALS YOU MUST PROVIDE
None.	Information on local pesticide deaths, intoxications, etc.
	LD_{50} chart for Activity A.
	Examples (containers) of the 4 classes of pesticides.
	Flip chart paper.
	Bucket of water.
	Soap.
	2 blankets.
	Glass of milk.
	Respirator.

TOPIC A. THE DANGER OF PESTICIDES

Purpose: Pesticides are useful because they help people kill insects that damage their crops. But just as pesticides can kill insects, they can also kill people. Tell the learners that by the end of Activity A, they should:

1. Realize why pesticides are dangerous.
2. Understand the term LD_{50} and be able to apply it.

STEP 1. PRESENTATION: PESTICIDE POISONINGS

> TO THE TRAINER: The following data from various countries are factual (Weir and Schapiro, 1981). You may have access to other current statistics which you can use instead of the facts listed here. The point to be made is: pesticides can and do kill people. Death and poisoning data from the particular part of the country where you are teaching will be especially relevant and useful.

WORLDWIDE

According to the World Health Organization, one person is poisoned by pesticides every minute in underdeveloped countries. This totals 500,000 poisoned people every year. Even more startling is the fact that a pesticide-caused death occurs about every hour and 45 minutes, totaling at least 5,000 deaths each year. The sale of pesticides has skyrocketed. The pesticide industry now produces four billion pounds of pesticides each

year--more than one pound for every person on earth! The problem is that many pesticides are greatly overused and used incorrectly.

CENTRAL AMERICA

More than 14,000 poisonings and 40 deaths from pesticides were reported between 1972 and 1975 in the cotton-growing Pacific coastal plains of Central America. A local newspaper reported that 30 to 40 people are treated daily in the nearby government clinic at the height of pesticide spraying in one area alone.

CULIACAN, MEXICO

Government doctors report two to three pesticide poisonings per week. Every two or three weeks, a federal hospital in Culiacán treats a farm-worker for chronic organochlorine poisoning. About half of these victims die.

PAKISTAN

In 1976, at least five persons died and 2,900 became ill from malathion.

PAPUA, NEW GUINEA

At least 18 people were killed by pesticides during a four year period in Papua, New Guinea.

A pastor conducted a religious service at Tega Village where he accidentally gave the pesticide Gramoxone instead of wine for communion to four people. They all died within seven days.

In 1979, a young father asked his son to go and get him a drink. He accidentally brought back a bottle in which the father had stored

pesticide. After a gulp, the father realized it was not water in the bottle but it was too late. He died.

STEP 2. DISCUSSION: EXPERIENCES WITH PESTICIDES

Ask the learners if any of them have been poisoned or if anyone they know has ever been poisoned. Ask them to share the story. Encourage group discussion.

> TO THE TRAINER: As the learners discuss poisoning incidents, try to determine whether the people involved did not know that a poisoning had taken place until after it was too late, or if they knew poisoning had occurred but did not know what to do about it.

STEP 3. PRESENTATION: LD_{50}

Although all pesticides will kill people at a great enough dose, some pesticides are more dangerous than others. Scientists have a way to rate pesticides according to how poisonous, or toxic, they are. Scientists apply the pesticide to test animals (usually rats or rabbits). The chemical is applied to the skin, fed to, or breathed by the animal. Scientists then determine how much pesticide is needed to kill one-half (or 50%) of the animals tested. This amount is called the "lethal dose to 50%," or LD_{50}. The LD_{50} is lower for pesticides that are more poisonous because it takes less amount of the pesticide to kill the animals. Therefore, the lower the LD_{50} value or number, the more toxic or poisonous the pesticide. LD_{50} is the amount of chemical needed to kill half of the animals tested.

Chart V-1 rates LD_{50}'s according to how dangerous they are to man. The LD_{50} is expressed in milligrams of chemical per kilogram of body weight.

Chart V-1: LD_{50}

LD_{50} Lethal Dose to 50%	Categories	Probable Oral Lethal Dose for a 150 lb. man
less than 50 mg/kg	I Highly Toxic	A few drops to a teaspoon
50-500 mg/kg	II Moderately Toxic	Over one teaspoon to an ounce
500-5000 mg/kg	III Slightly Toxic	Over one ounce to one pint or one pound.
more than 5000 mg/kg	IV Relatively Non-Toxic	Over one pint or one pound

STEP 4. SUMMARY

Summarize Topic A with these general conclusions:

1. Pesticide poisoning can cause death.
2. Some pesticides are more dangerous than others--the LD_{50} indicates how dangerous a pesticide is.

TOPIC B. HOW POISONING OCCURS

Purpose: To learn four ways by which pesticides enter a body and make people sick. By the end of this activity, the learners should be able to:

1. Name the four ways pesticides enter the body.
2. Name several examples of how each of these four cases could happen.
3. What the term degree of absorption means.

STEP 1. PRESENTATION: HOW PESTICIDES ENTER THE BODY

There are four ways in which pesticides can enter the body and make you sick:

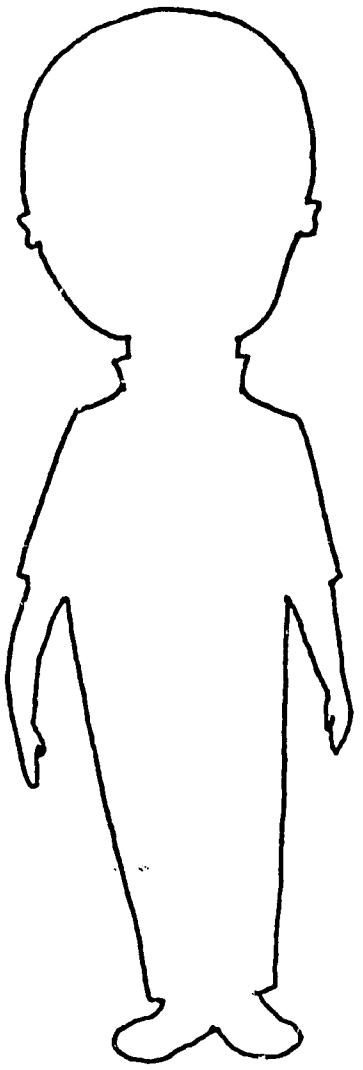
1. Through the skin
2. Through the mouth
3. Through the nose
4. Through the eyes

THROUGH THE SKIN

This is the most common way for pesticides to enter the body. A pesticide may be splashed or spilled on the skin during mixing, loading or disposing of containers.

Certain parts of the body allow a pesticide to enter the body more rapidly than others. We say that the degree of absorption is high.

The illustration points out different degrees of absorption for parts of the body.



Degree of Absorption

35% Scalp

40% Forehead

50% Ear Canal

20% Abdomen

8% Forearm

10% Palm

9% Scrotum

15% Foot

THROUGH THE MOUTH

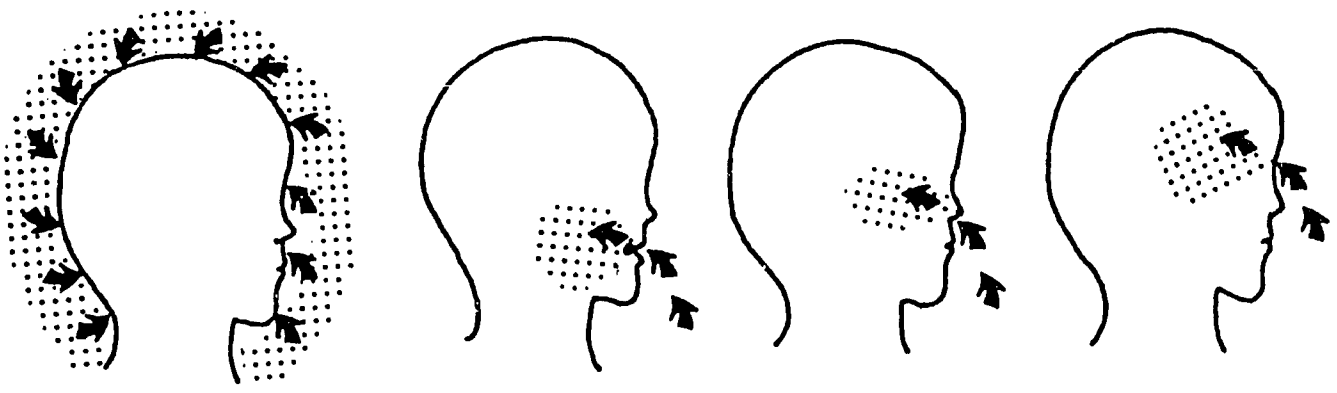
Another way that pesticides enter the body is through the mouth. Persons who want to kill themselves sometimes swallow pesticides. But pesticides may also be swallowed by accident. This can make people very sick and kill them. Many times a pesticide is taken out of its labeled container and put into another bottle or container. People may forget and drink the pesticide thinking it is water, coke or liquor. Pesticides can also enter the mouth when a worker eats, drinks or smokes after he has handled pesticides.

THROUGH THE NOSE

A third way that people can be poisoned is if they breathe pesticide vapors or dusts, or when pesticides enter the body through the nose, throat and lungs. When workers do not use the proper safety equipment, they may breathe pesticides. Working with pesticides in poorly ventilated areas inside buildings also increases this type of exposure. Individuals who sell pesticides must be very careful.

THROUGH THE EYES

A fourth way that a person can be poisoned by pesticides is when a pesticide enters the eyes. Pesticides that enter the eyes can make a person sick or cause blindness or death. Workers can easily get pesticide in their eyes if they do not cover or protect their eyes during pouring operations. If a worker rubs his eyes with his hands after he has handled pesticides, he risks this type of pesticide poisoning.



STEP 2. DISCUSSION: PERSONAL EXPERIENCES

Ask the learners in your group if any of them have ever gotten pesticide in their eyes, on their arms, or breathed it into their lungs. Ask them if they saw a doctor and, if so, what treatment did they receive. Encourage discussion!

STEP 3. SUMMARY

Conclude with a summary. The key points are:

1. There are four ways in which pesticides enter the body:
   a. Through the skin.
   b. Through the mouth.
   c. Through the nose.
   d. Through the eyes.
2. Pesticide poisoning can make you sick or kill you.

TOPIC C. SIGNS AND SYMPTOMS

Purpose: To learn signs and symptoms that indicate pesticide poisoning.

By the end of Topic C, the learners should know:

1. What are the symptoms of pesticide poisoning.
2. What signs of poisoning to look for in co-workers and others who may have been exposed.
3. The difference between chronic and acute poisoning.
4. The difference in signs and symptoms between two chemical groups of pesticide: organophosphates and organochlorines.

STEP 1. PRESENTATION: SIGNS AND SYMPTOMS

There are two types of clues to a pesticide poisoning: symptoms and signs. Symptoms are feelings that only the person who has been poisoned can notice, such as a stomachache or a headache. Signs, such as fainting or vomiting, are visible to someone else.

> TO THE TRAINER: The following incident can be used to illustrate the difference between signs and symptoms.

A little boy, who had been playing in a shed used to store pesticides, came to his mother, crying. He was sweating (a sign) profusely even though the temperature outside was cool. When his mother asked the boy why he was crying, he told her that his head hurt and his stomach ached (symptoms). The mother put the boy in bed and noticed that he appeared very tired. A little while later, the boy began vomiting (a sign). He said that his chest hurt (a symptom). His mother noticed that his muscles twitched (a sign) and that his eyes had unusually small pupils (a sign). The woman

recognized these signs and symptoms as pesticide poisoning and took the boy to the doctor.

TO THE TRAINER: On the blackboard or on a large paper that will be visible to all of the learners, make two columns: Signs and Symptoms. Go through this story and talk about each of the boy's physical reactions. Have the learners decide which of these were signs and which were symptoms. The list, when completed, should look like this:

Signs	Symptoms
sweating	headache
vomiting	stomachache
muscle twitches	chest discomfort
pinpoint pupils	

STEP 2. PRESENTATION: ACUTE AND CHRONIC POISONINGS

A person may be poisoned after just a single contact with a pesticide. This is called acute poisoning. But a person may also be poisoned if he or she is exposed again and again to only small amounts of a pesticide. These small amounts are not harmful at first, but later they add up in the body's system and cause sickness. This is called chronic poisoning.

For example, suppose that a field worker who frequently handles pesticides one day becomes sick. He may not even have been mixing or spraying the chemicals at the time of his illness. Perhaps he simply walked into a storeroom where the pesticides are stored. Pesticide fumes may also be present in the room. These vapors may not be enough to make anyone else sick, but since the worker had built up enough of the poison in his body

over a long period of time in working with pesticides, he could become very sick. This is an example of chronic poisoning.

STEP 3. PRESENTATION: TYPES OF POISONINGS

Every pesticide user should know what kinds of sickness are caused by each kind of pesticide used. All pesticides in the same chemical group cause the same signs and symptoms. Pesticides in a different chemical group cause different signs and symptoms. The sickness may be mild or severe, depending on the pesticide and the amount absorbed.

There are four agricultural chemical groups that commonly poison people:

1. THE ORGANOCHLORINES
2. THE ORGANOPHOSPHATES
3. THE CARBAMATES
4. THE SYNTHETIC PYRETHROIDS

The ORGANOCHLORINES tend to build up in fatty tissues of the body over a long period of time. They are commonly the cause of chronic poisonings. Common organochlorines include:

aldrin	dieldrin
BHC	endrin
chlordane	heptachlor
DDT	

The ORGANOPHOSPHATES and the CARBAMATES are more commonly involved in acute poisoning cases. They are fast acting and are considered more dangerous than the organochlorines. Common examples of these two groups are:

Organophosphates	Carbamates
diazinon	aldicarb
malathion	carbaryl
parathion	propoxur

The SYNTHETIC PYRETHROIDS are a new group of pesticides. They are fast acting and of relatively low human toxicity. No symptoms nor signs of human intoxication are known. Common synthetic pyrethroids are:

allethrin	fenvalerate
cypermethrin	permethrin
decamethrin	resmethrin

STEP 4. PRESENTATION: ORGANOCHLORINE POISONINGS

Early symptoms and signs of organochlorine poisoning include:

SYMPTOMS:

- general discomfort
- headache
- dizziness

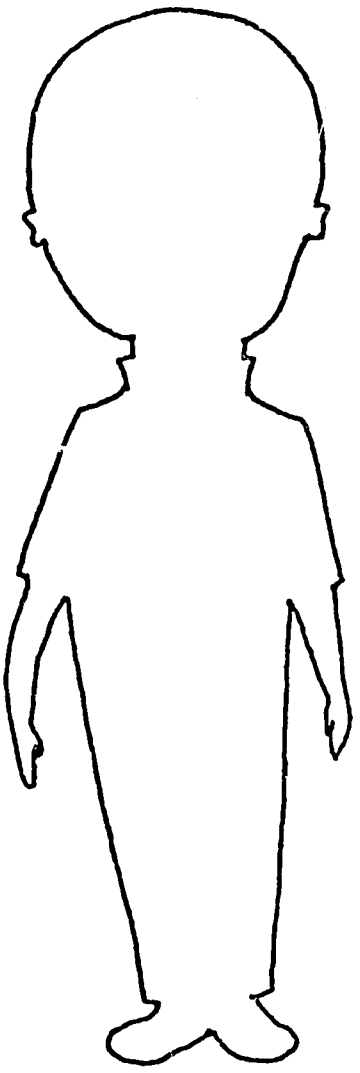
SIGNS

- nausea
- vomiting

Later, a victim of organochlorine poisoning may suffer:

- breathing problems
- convulsions and trembling
- coma

These are the signs and symptoms of organochlorine poisoning.



General discomfort

Headache

Dizziness

Vomiting

Nausea

Tremors

Convulsions

Coma

Respiratory failure

STEP 5. PRESENTATION: ORGANOPHOSPHATE POISONINGS

Different signs and symptoms are produced by organophosphate pesticides. These include, during the early stages:

SYMPTOMS:

- headaches
- dizziness
- fatigue
- blurred vision

SIGNS:

- sweating
- salivation
- nausea and vomiting
- stomach cramps or diarrhea

In later stages, the organophosphate poisoning victim may suffer:

- weakness
- inability to walk
- chest discomfort
- muscle twitches
- very small, non-reactive pupils

The late stage of organophosphate poisoning includes these signs and symptoms:

- unconsciousness
- loss of reflexes
- breathing difficulty
- loss of sphincter control
- death, if not treated

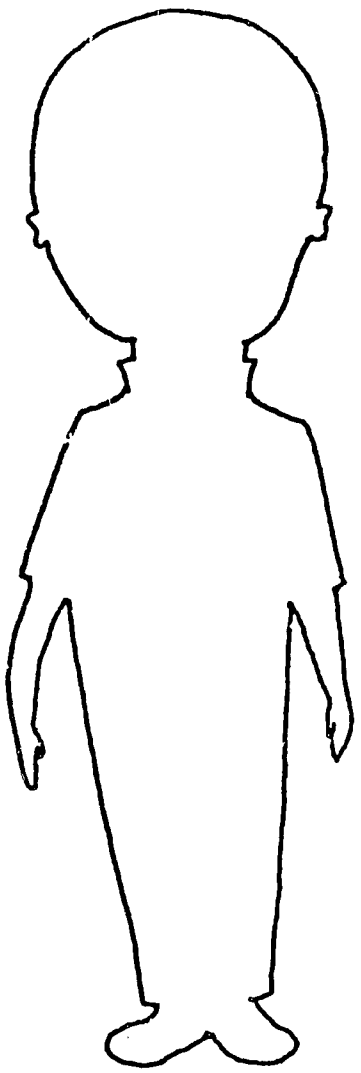
TO THE TRAINER: The figure on this page (as well as the others that appear in this Unit) is a helpful teaching tool. Enlarge and display these figures where the group can see the signs and symptoms as you talk.

The symptoms and signs of organophosphate poisoning are:

Headache

Dizziness

Blurred vision



Pinpoint and non-reactive pupils

Salivation

Breathing Difficulty

Chest Discomfort

Vomiting

Nausea

Stomach Cramps

Sweating

Tremors

Diarrhea

Weakness

Convulsions

Coma

Signs and symptoms of pesticide illness may not occur until a few hours after contact with the poison. But, if signs or symptoms start more than 12 hours after a worker is exposed to a pesticide, he or she probably has some other illness. Check with a doctor to be sure.

STEP 6. SUMMARY

Summarize the activity by briefly recalling signs and symptoms of ORGANOCHLORINE and ORGANOPHOSPHATE poisoning:

1. Headache, dizziness, nausea and vomiting, breathing difficulty, tremors and convulsions are signs and symptoms of organochlorine poisoning.
2. Headache, dizziness, blurred vision, small pupils, salivation, sweating, breathing difficulty and chest pain, nausea and vomiting, stomach cramps and diarrhea, weakness, convulsions, and coma are signs and symptoms of organophosphate poisoning.
3. Symptoms can only be reported by the person who has been poisoned. Signs can be seen or observed by others. It is important for you to know both what your own feelings might mean and what the behavior of others might mean.
4. A person may be suffering from pesticide poisoning even if he or she has not recently been exposed to a large amount of pesticide. Over a long period of time, pesticides can add up in the body. This is called chronic exposure.
5. Organochlorines are often involved in chronic poisoning cases. They include the pesticides aldrin, BHC, chlordane, dieldrin, endrin, heptachlor.
6. Organophosphates more commonly produce acute poisonings. Common pesticides in this group are diazinon, malathion, and parathion.

TOPIC D. FIRST AID

Purpose: To learn what to do when someone has been poisoned.

By the end of Topic D, the learners should know:

1. The general steps to take in treating any poisoned victim.
2. How to treat someone who has splashed or spilled pesticide on his skin or in his eyes.
3. What to do if someone has swallowed pesticide.
4. What to do if the victim has breathed pesticide into his nose, throat and lungs.

STEP 1. PRESENTATION: IMPORTANCE OF FIRST AID

Once the signs and symptoms of pesticide poisoning have been recognized, you must act quickly. Knowing what to do can mean the difference between life and death! (Stress that the treatments in this Topic are not a substitute for medical care.) First Aid is only to relieve the patient until medical help is available! Pay very close attention to these steps because at the end of each step you will practice First Aid measures on each other.

TO THE TRAINER: Have the materials needed for these First Aid measures on hand. These include:

1. Soap and clean water (running water if possible)
2. Blankets
3. Milk
4. Pesticide container with proper label (for safety purposes, the pesticide should be removed and the container rinsed well)
5. Respiratory protective equipment. These will be used when the trainees participate in practice First Aid sessions.

STEP 2. PRESENTATION: FIRST AID: FIRST STEP

The immediate, general steps to take for all kinds of pesticide poisoning are:

1. Stop contact with the poison right away. Move the victim away from pesticide. Wash it off his or her skin and wash it out of the eyes.
2. If possible, notify a doctor, hospital or clinic at once in all cases of suspected poisoning.
3. Read the pesticide label of the pesticide involved in the poisoning. If properly labeled, it should include a "Statement of Practical Treatment" that will tell you what to do.
4. Save the pesticide container and any material left. Take it to the doctor or clinic. If the poison is not known, save a sample of the material vomited and take it to the doctor.

STEP 3. PRESENTATION: PESTICIDE ON THE SKIN

In the case of pesticide on the skin, the chemical should be washed off at once. Soap should be used if possible. Remember, wash the hair and fingernails. Speed is important! Any clothing contaminated with pesticide should be removed.

Do not use detergents or commercial cleansers to wash the victim's skin as this may enhance absorption of the pesticide through the skin.

After washing well, the victim should be dried, wrapped in a blanket and taken to a doctor. A pesticide poisoning victim should never be left to go to a doctor alone, even if he or she seems O.K.!

STEP 4. SIMULATION: FIRST AID

TO THE TRAINER: Ask for two volunteers from the group and explain that they are going to practice First Aid for victims of pesticide poisoning. Encourage all of the learners to add comments and suggestions to help their classmates who are doing the simulation.

Tell them that they will all practice the first aid. Make each practice session a group effort so everyone can add their contributions to the activity! Make sure that the materials needed, such as water, soap and blankets, are available.

To begin the activity, announce to the group that one of the volunteers will approach the other and will tell him or her that he has spilled pesticide on his skin. The

other volunteer should then react according to the First Aid measures discussed for "Pesticide on the Skin". Have volunteers act the scene out.

After the group has acted out the First Aid scenario to your satisfaction, summarize what has taken place and move on to the next poisoning situation.

STEP 5. PRESENTATION: POISON IN THE MOUTH

In case of poison in the mouth, follow these procedures:

1. RINSE THE VICTIM'S MOUTH WITH WATER AND HAVE HIM OR HER SPIT IT OUT. READ THE PESTICIDE LABEL TO FIND OUT IF VOMITING SHOULD BE INDUCED.
2. DO NOT TRY TO MAKE THE VICTIM VOMIT, IF THE VICTIM:
   a. IS UNCONSCIOUS, OR
   b. IS IN CONVULSIONS, OR
   c. HAS SWALLOWED PETROLEUM PRODUCTS (KEROSENE OR GASOLINE), AND
   d. WHEN THE PESTICIDE SWALLOWED CAUSES SEVERE PAIN AND BURNING SENSATIONS IN THE MOUTH AND THROAT.
   e. IF AN ACID OR ALKALINE PRODUCT HAS BEEN SWALLOWED, GIVE THE VICTIM MILK OR WATER. DO NOT INDUCE VOMITING.
3. INDUCE VOMITING IN THE VICTIM ONLY IF THE VICTIM:
   a. IS CONSCIOUS, AND
   b. IS NOT IN CONVULSIONS, AND
   c. HAS NOT SWALLOWED PETROLEUM PRODUCTS (KEROSENE AND GASOLINE), AND
   d. THE PESTICIDE SWALLOWED DOES NOT CAUSE SEVERE PAIN AND BURNING IN THE MOUTH OR THROAT, AND

e. THE PRODUCT SWALLOWED IS NOT STRONG ACID OR ALKALINE. FIRST, GIVE THE PATIENT MILK OR WATER TO DRINK. INDUCE VOMITING BY PLACING A FINGER AT THE BACK OF THE VICTIM'S THROAT. THE PATIENT SHOULD BE PLACED FACE DOWN WITH HIS HEAD LOWERED TO PREVENT VOMITUS FROM ENTERING THE LUNGS. COLLECT SOME OF THE VOMITUS TO TAKE TO THE DOCTOR.

STEP 6. SIMULATION

TO THE TRAINER: Ask for volunteers to act out the following situations. A worker arrives on the scene and finds that several people apparently drank a pesticide from a bottle they thought contained water. One victim is unconscious and one complains of severe burning in his throat and chest. What should the worker do? Encourage other learners to offer suggestions and discuss the situation.

In a second situation, a worker has swallowed pesticide that is known to be acidic. What should be done? Repeat with an alkaline pesticide. Finally, stage a situation where none of the above is indicated. In this scene, do not have the learners induce vomiting! He or she should simply indicate verbally that this is what should be done when it is time for this step.

When the trainees seem to be able to accurately act out and talk through each situation, move on to the next step.

STEP 7. PRESENTATION: POISON BREATHED THROUGH THE NOSE AND MOUTH

As indicated in the general First Aid instructions, victims who experience breathing difficulty or any of the signs or symptoms of poisoning, should first be removed from the pesticide source. The victim should be rescued only by someone with proper respiratory equipment. Victims who have breathed pesticides should be treated according to the following steps:

1. The victim should be placed in an open area with fresh air.
2. Any tight clothing worn by the victim should be loosened.
3. The victim should be wrapped in blankets to prevent chilling, but not to the point of causing over-heating.
4. The victim should lie down and be kept quiet. His or her neck should be extended with chin up to keep airways open for breathing. Do not give alcohol of any kind. Call for a doctor at once.

STEP 8. DEMONSTRATION: RESPIRATORY EQUIPMENT

At this point, show the respiratory equipment to the learners. Demonstrate how to put it on by putting it on yourself. Tell them that this equipment will be talked about in a later Unit.

STEP 9. SIMULATION

Have two volunteers act out the above procedures. Again ask for volunteers to act the part of a poison victim. Describe to the others how the victim was poisoned. Ask the rescuer to treat the victim.

STEP 10. PRESENTATION: POISON IN THE EYES

If a person is poisoned in the eyes, follow these steps:

1. Hold the eyelids open. Wash eyes at once with a gentle stream of running water for 15 minutes or more. Stress speed! Do not add anything else to eyes or water.
2. Take the victim for medical treatment.

STEP 11. SIMULATION

Ask for volunteers to simulate a poison victim with pesticide in the eyes and the person treating the victim. In this simulation, do not have learners pour water in a classmate's eyes. Simply have the trainees talk through this one.

Encourage questions, comments, and suggestions. Once you feel that all learners are comfortable with each situation, end this practice session. Review any situation in which there are questions.

STEP 12. SUMMARY

Summarize the key points:

1. Stress speed of action in removing the victim from contact with the pesticide.
2. Poison on the Skin: Wash skin immediately; remove clothing; watch for signs and reported symptoms.
3. Poison in the Mouth: Rinse out; induce vomiting or give counteractant, depending on what is indicated on pesticide label.

4. Poison breathed through nose or mouth: Remove victim from pesticide source; wear respiratory equipment when entering contaminated areas.

5. Poison in the eyes: Rinse eyes; Take victim to doctor.

UNIT V SUMMARY

Briefly summarize all the major points covered in Unit V:

A. Pesticides can and do kill. Statistics tell us that the number of illnesses and deaths caused by pesticides each year is alarming. All pesticides are dangerous, but some are more poisonous than others. The LD_{50} indicates how poisonous or toxic a pesticide is. The LD_{50} is the amount of pesticide needed to kill one half of the animals tested.

B. Pesticides can enter the body in one of four ways:

1. Through the skin
2. Through the mouth
3. Through the nose
4. Through the eyes

When pesticides touch the skin, certain parts of the body let more poison inside than other parts of the body. The parts that let the poison in faster are said to have a high <u>degree of absorption</u>.

C. Pesticide poisoning produces <u>signs</u> of sickness (anyone else can see these), and <u>symptoms</u> of sickness (only the person who has been poisoned can report these).

Pesticide poisoning may produce signs and symptoms after only one exposure: this is called <u>acute poisoning</u>. Poisoning can also happen after a person has been repeatedly exposed to the pesticide over a period of time: this is <u>chronic poisoning</u>.

Four chemical groups of poison are the organochlorines, organophosphates, carbamates, and pyrethroids.

The common signs and symptoms for organochlorine poisoning include: general discomfort, headache, dizziness, vomiting, nausea, breathing difficulty, trembling and convulsions, and coma. Organophosphates produce all of the same signs and symptoms as organochlorine poisoning plus: sweating, salivation, secretions from the mouth and nose, weakness, chest discomfort, and pin-point pupils.

D. The steps for First Aid were summarized in Step 12 of Topic D. Go over these one more time.

TO THE TRAINER: Conclude this Unit with a question and answer period. Ask the learners if they have any questions about the topics discussed in this Unit. After any questions have been addressed, ask the learners the following questions to test their understanding of the material that has been presented.

QUESTIONS

UNIT V: "Pesticides and their effects on people"

1. What do the letters "LD_{50}" mean?
2. Name four ways that pesticides can enter the body.
3. What is the most common way that pesticides enter the body?
4. What is meant by degree of absorption?
5. What is the difference between a sign and a symptom?
6. What is the difference between acute and chronic poisoning?
7. Name three chemical groups of insecticides commonly involved in poisoning incidents.
8. Name five signs and/or symptoms of organochlorine poisoning.
9. Name three signs and/or symptoms of organophosphate poisoning that are NOT signs and/or symptoms of organochlorine poisoning.
10. What is the first thing to do in any poisoning situation?
11. What should be done for someone who has:
    (a) spilled pesticide on his or her skin?
    (b) splashed pesticide in his or her eyes?
    (c) accidentally drunk an acid or alkaline pesticide?
    (d) drunk a pesticide that does not cause a burning sensation in the mouth and throat?
12. When should you NOT induce vomiting?

UNIT VI: PESTICIDE LABELS

UNIT OVERVIEW

Often, the questions a user has about a pesticide can be answered simply by reading the label on the pesticide container. The problem is labels often do not have all of the information they should. Labels should contain a standard set of information. By reading the label, the user should obtain the answer to many of the questions he has concerning the particular pesticide he intends to use. Unfortunately, however, labels may be missing entirely from a pesticide container or may provide only very limited information.

This Unit will explore labeling procedures. The primary purpose of this Unit is to stress how to use a label and what to look for on a label.

Three primary topics are included in Unit VI:

A. WHY ARE LABELS IMPORTANT?

B. PARTS OF A LABEL.

C. HOW TO USE A LABEL.

OBJECTIVES:

By the end of Unit VI, learners will know:

1. How reading the information on the label can help to avoid problems.
2. What a good label looks like.
3. How to use the label for their benefit and protection.

Unit VI will require approximately 2 hours to complete and includes activities which require the following materials.

TEACHING MATERIALS PROVIDED	TEACHING MATERIALS YOU MUST PROVIDE
Sample of stylized label (to be used only if copies of local labels cannot be obtained for class use).	Samples of at least 6 pesticide labels: 2 inadequate, 2 marginally adequate; and 2 fully adequate.
	2 cola, rum or whisky bottles with and without pesticide labels.
	Some examples of brochures or fliers which form part of the label information.
	Enlargement of sample label.
	Enlargement of table on toxicity.

TOPIC A. WHY ARE LABELS IMPORTANT?

Purpose: To demonstrate the reasons why good labels are important. By the end of Topic A, learners will:

1. Know the definitions and difference between labels and labeling;
2. Know some of the things that labels can tell us;
3. Know why good labels are important.

STEP 1. PRESENTATION: LABELS & LABELING

When you buy a pesticide, instructions that tell you how to use that particular pesticide should be on the container or attached to it; however, they may be in the form of brochures or fliers. All of these things are called labeling. Only the instructions that are attached to the pesticide container are called a label.

> TO THE TRAINER: Use the sample labels and brochures to illustrate the differences between these two types of instructions. Distribute the labels and brochures or fliers to the participants so that they can learn these differences.

STEP 2. PRESENTATION: HOW LABELS HELP

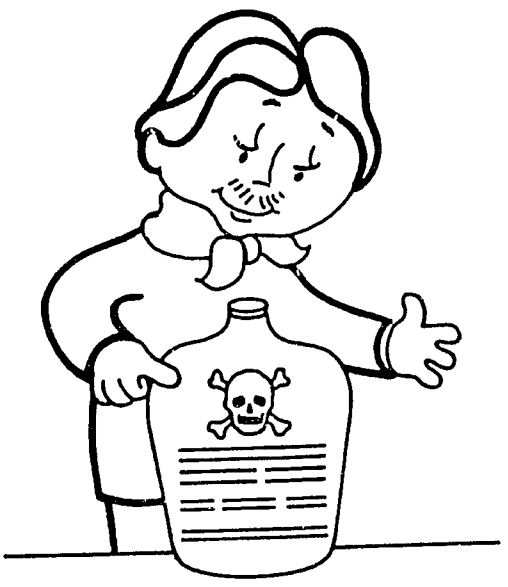
When a farmer decides to use a pesticide to control a pest problem, he will find that this is only the first of many decisions he must make to protect his crop., e.g., he must also decide which particular pesticide to use for each particular pest problem. Without help, choosing the appropriate pesticide to use is not an easy decision to make! Remember: with regard to their toxicity and hazard, all pesticides are NOT the same.

There are many questions a label can answer. It can tell you which pesticide to use for the particular crop you are trying to protect. It can also tell you how to correctly use the product.

Not all pesticides are alike, some are more poisonous than others. A complete label will tell you how poisonous a particular pesticide is.

The label can also tell you what to do if someone has been poisoned by that particular pesticide.

A proper pesticide label should tell you all these things and more.



STEP 3. DISCUSSION: LOCAL LABELS

> TO THE TRAINER: Divide the trainees into groups. Give each group copies of at least 6 local labels. Each group should have the same labels as every other group. Have trainees study these labels and answer the following questions. These questions should be written on a blackboard so all can easily read them.

1. Which products can be used on aphids?
2. Which products can be used on lepidopteran pests?
3. Which product is most toxic?
4. Which product is least toxic?
5. Which product can be used on cattle?
6. Which product can be used on tomatoes?
7. Rank products from least toxic to most toxic.

This activity should take 20 minutes of group work followed by 10-15 min. of discussion.

During the discussion, ask each question and obtain a group consensus on answers. You will probably note some degree of disagreement since some of the labels do not have all the information needed. Write group answers on blackboard.

To answer Question 7, you, as trainer, should have the LD_{50} values for each product (see Unit XVI). Do not give this information to trainees, but first have them rank the products. Again, disagreement will be encountered since the labels probably do not have the information needed.

Once the whole group has more or less agreed as to the order of toxicity (these should be listed so all can see), ask for discussion from the group on why they were not able to all agree on order of toxicity.

Now reveal the LD_{50} value for each product. Based on these values, rank (1, 2, 3, etc.) the products again, from least to most toxic. Discuss differences between group results and LD_{50} results.

STEP 4. SUMMARY

Conclude Topic A by reviewing the key points:

1. Labeling is all of the information which you receive about the pesticide when you buy it. A label is the information on, or attached to, the pesticide container.
2. All pesticides are NOT the same and care should be taken when deciding which pesticide to use.
3. Labels can help you decide which pesticide to use as well as answer many questions which you may have about using a particular pesticide. The label should tell you:
    - how to correctly use the pesticide.
    - how poisonous it is.
    - how to care for someone who has been poisoned.

TOPIC B. PARTS OF A LABEL

Purpose: To study and review the contents of a pesticide label.

By the end of this activity, learners should know:

1. What items of information a label should contain.
2. The four categories of pesticide toxicity and their key signal words.
3. The meaning of the terms active ingredient, formulation, and field reentry time.

STEP 1. PRESENTATION: SAMPLE LABEL

> TO THE TRAINER: The following diagram should be enlarged and displayed. Make sure the trainees can see it. As you talk about each part of the label, point the part out on the label diagram. (Also, bring at least two clean pesticide containers - one with a correct and another with an incorrect label - to show the class.)

The first important part of the label is the name of the pesticide.

Each company has product names for each of its products. This is the most identifiable name such as _____ ., _____, and _____, (trainers should supply local examples). It is the one used when the product is advertised. The same chemical may be made by many companies and each company may give this same chemical a different name.

The common name (such as parathion, carbaryl, and malathion) remains the same for the same chemical - no matter how many different brand names may

be used. Some pesticides have very long chemical names that have been shortened to make them easier to read. This is why they are called "common names".

PRECAUTIONARY STATEMENTS

Hazards to humans (and domestic animals) - _____

Environmental Hazards - _____

Physical or Chemical Hazards - _____

Directions for use - _____

Re-entry statement (if applicable) - _____

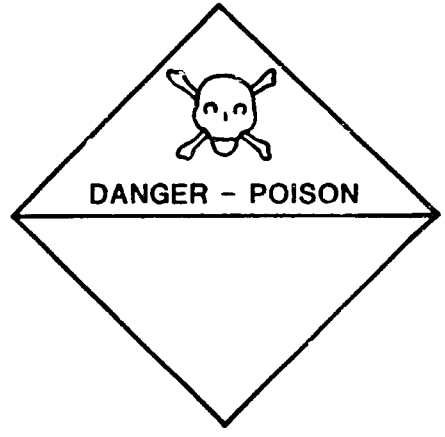
Storage and Disposal - _____

Statement of Practical Treatment - _____

DESTROY THIS CONTAINER AFTER USE OF PESTICIDE

PRODUCT NAME

Active ingredient	_____	%
Related compounds	_____	%
Inert ingredients	_____	%
Total	100%	



Keep out of reach of children

Manufactured by _____

Address _____

Net contents _____

CROP AND PEST INFORMATION

Crop 1

Dosage _____

Pests controlled _____

Use directions _____

Use restrictions _____

Crop 2

Dosage _____

Pests controlled _____

Use directions _____

Use restrictions _____

Crop 3

Dosage _____

Pests controlled _____

Use directions _____

Use restrictions _____

Warranty Statement _____

DESTROY THIS CONTAINER AFTER USE OF PESTICIDE

STEP 2. PRESENTATION: LABEL INGREDIENTS

Pesticide labels should also list the ingredients of a pesticide (or what the pesticide is made of). These are divided into active ingredients (or active ingredient and related compounds), and inactive, or inert ingredients. Active ingredients are the ones that do the work. Active and inactive ingredients are listed on a percent basis and add up to 100%. Therefore, the label tells you exactly what is in the pesticide as well as how much of the ingredient is in it. The net contents reveals how much is in the container by weight.

STEP 3. PRESENTATION: LABEL SIGNAL WORDS AND SYMBOLS

All pesticides are NOT alike. Some are effective in treating a particular crop while others are not. Some are more poisonous than others. The label should tell how poisonous a pesticide is. It does so by using signal words and symbols. These may appear on the label inside a square or circle. A signal word means: Be Careful! A symbol is a picture or illustration that warns you that a particular pesticide product is very dangerous. Signal words and symbols are used together to create four different categories of pesticides as related to their toxicity (or how dangerous they are) to man.

The four categories are:

CATEGORY I - Highly Toxic

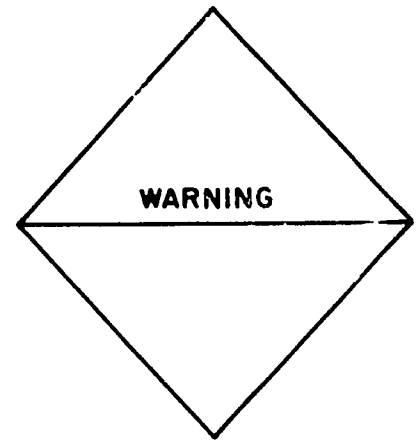
Pesticides with this symbol are the most dangerous. They are marked with the signal words "DANGER-POISON!" and have a picture of a skull and cross-bones to show how deadly these chemicals can be. The probable lethal dose (LD_{50}), or the amount of this product that would probably be needed to kill a man weighing 65 kilograms, is only a few drops to a teaspoon!

CATEGORY I PESTICIDE

Highly Toxic

CATEGORY II - Moderately Toxic

Pesticides in this category are considered "moderately toxic." They are marked with the signal word "WARNING!" It would take between one teaspoon to 10 grams of a Category II pesticide to kill a man weighing 65 kilograms.

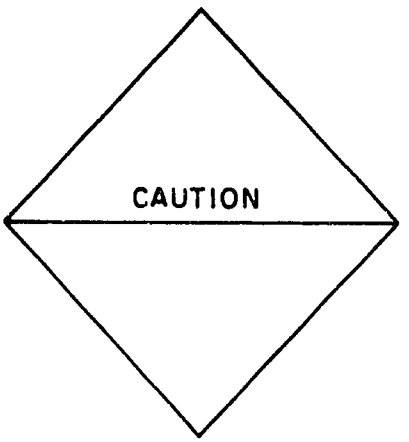


CATEGORY II PESTICIDE

Moderately Toxic

CATEGORY III - Slightly Toxic

These pesticides are "slightly toxic." The signal word "CAUTION" appears on Category III chemicals. It takes over one ounce to one half liter (or one half kilogram) of these pesticides to kill a man weighing 65 kilograms.

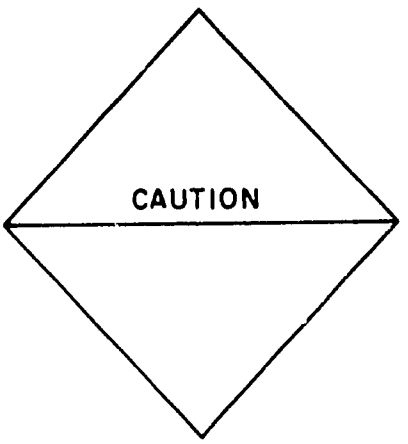


CATEGORY III PESTICIDE

Slightly Toxic

CATEGORY IV - Relatively Non-Toxic

Pesticides in this last category are considered "relatively non-toxic." However, the signal word "CAUTION" does appear on the label and care should be taken to keep these pesticides as well as those in the other three categories OUT OF THE REACH OF CHILDREN!



CATEGORY IV PESTICIDE

Relatively Non-Toxic

TO THE TRAINER: The concepts of signal words and symbols on labels are extremely important. The pictures of what each category looks like on the label should be enlarged and displayed so that the trainees can SEE what they look like as you talk about each one. Chart #1 should also be displayed to provide a general overview and help you summarize and conclude Step 3.

Chart #1

Categories of Acute Toxicity

Category	Signal Word Required on the label	Probable Oral Lethal Dose for 65 kilo man
I Highly Toxic	DANGER-POISON skull and crossbones	A few drops to a teaspoon
II Moderately Toxic	WARNING	Over one teaspoon to 10 grams
III Slightly Toxic	CAUTION	Over one ounce to one half liter or one half kilogram
IV Relatively Non-Toxic	CAUTION	Over one half liter or one half kilogram

TO THE TRAINER: In Steps 4-9 that follow, make sure you have an enlarged version of a proper label, plus samples of proper labels for the learners to use. For each of Steps 4-9, indicate on the enlarged label where specific information is to be found. Ask the learners to point out where the specific information is found on the sample labels.

STEP 4. PRESENTATION: LABEL INFORMATION

A proper label also lists the manufacturer of the pesticide. The label tells the name and address of the company that produced the pesticide. This enables you to contact the producer should the need occur.

The label should indicate the form of the pesticide you are using. This is called the formulation. There are several different forms which pesticides can come in: powders, liquids, granules, emulsions, etc. The same pesticide may be available in different formulations.

The label also indicates the net contents, or the amount of pesticide in the container by weight.

STEP 5. PRESENTATION: LABEL INFORMATION--HAZARDS

Each particular pesticide presents unique dangers--the label tells what special dangers the particular pesticide being used presents. This includes hazards to humans and domestic animals, hazards to the environment and chemical and physical hazards.

Under hazards to human beings, the label will tell how the pesticide may be poisonous to people or domestic animals. It tells you what steps to take in order to be safe, such as "wear proper protective clothing".

Hazards to the environment may include warnings to protect birds, fish, water and wildlife.

In chemical and physical hazards, the user is warned about fire or explosive dangers.

STEP 6. PRESENTATION: LABEL INFORMATION--FIRST AID TREATMENT AND DIRECTIONS FOR USE

Another very important part of the label is the Statement of Practical Treatment. This lists exactly what to do if someone has been poisoned. Read this part of the label before using the pesticide.

The label also explains how to use the pesticide in its DIRECTIONS FOR USE. Instructions for mixing and application appear here. These tell how much, how and when to apply the pesticide.

STEP 7. PRESENTATION: LABEL INFORMATION: STORAGE AND DISPOSAL

You can also find out how to properly store the particular pesticide being used. Directions for both storage and disposal are given on the label.

STEP 8. PRESENTATION: LABEL INFORMATION: CROP INFORMATION

A final and VERY important topic included on the pesticide label is the Crop (or Crops) Information. This part indicates which crops a particular pesticide will effectively treat. As we have said, all pesticides are NOT the same. Some will effectively treat a crop that another pesticide will not.

Other information is given along with each of the crops listed on the label. The dosage, or how much should be used, is given. The pests which can be controlled by this particular pesticide are also listed.

STEP 9. PRESENTATION: LABEL INFORMATION: REENTRY STATEMENT

Field reentry time is the interval between the time a crop was last sprayed with pesticide and the first time when it is safe for people without protective clothing to return to the field. The label tells how long field reentry time is, if applicable. In addition, it indicates how long to wait between spraying time and harvest, slaughter or grazing.

STEP 10. DISCUSSION: PROPER AND IMPROPER LABELS

Distribute to the work groups the matched sets of incorrect local pesticide labels. They should already have the samples of the proper labels. In groups of 3 or 4 students, have each group determine why the particular label or labels are improper or inadequate. Have each group give a brief report describing why the label is inadequate. Each group may even want to calculate what percentage (%) of the needed information is actually on the local labels. Finish the session with a brief discussion.

STEP 11. SUMMARY

The following items should appear on any pesticide label:

1. The product and chemical name;
2. Percent of ingredients;
3. Symbol and signal words;
4. Manufacturer information;
5. Type of formulation and net contents;
6. Hazards to humans and domestic animals, the environment, and chemical and physical dangers (Precautionary statements);
7. Statement of practical treatment, in case of poisoning;
8. Directions for use;
9. Storage and disposal instructions; and
10. Crop and pest information.

Ask trainees at random to identify the various parts of the sample labels. Encourage all trainees to participate.

The four categories of pesticides and their corresponding symbols and signal words are:

CATEGORY I	- HIGHLY TOXIC
	- **DANGER - POISON,**
	(skull and crossbones)
CATEGORY II	- MODERATELY TOXIC
	- **WARNING**
CATEGORY III	- SLIGHTLY TOXIC
	- **CAUTION**
CATEGORY IV	- RELATIVELY NON-TOXIC
	- **CAUTION**

An active ingredient is an ingredient in a pesticide that does the work.

A formulation is the form a pesticide takes; a powder, liquid, granules, emulsion, etc.

Field reentry time is the amount of time (in hours or days) between the time the pesticide was sprayed and the time that it is safe for people without protective clothing to enter the field area.

TOPIC C. HOW TO USE A LABEL

Purpose: To learn how to read and use the label to answer questions about pesticides. By the end of the Topic, learners will know:

1. The five times the label should be read.

STEP 1. PRESENTATION: READ THE LABEL!

The questions "How do you use a label?" or "How can you get the best use out of labels?" can be answered with one word: "READ!"

There are five times when you should read the label.

1. The first is before you buy the pesticide. The decision on which pesticide to buy may be made easier if the correct label is read! Labels enable a user to quickly identify the pesticide needed to treat a particular crop problem. Users should be alerted to any special dangers of the pesticide before purchase or use. Read the label before you buy and you will help make sure you are buying what you need.
2. The second time you should read the label is before you mix and apply the pesticide. Since the label includes directions for use as well as safety warnings, always read the label before you mix and/or apply the product. This will ensure that you are using the pesticide safely and effectively.
3. The third time you should read the label is before you store the pesticide. The label lists any special storage instructions for the particular pesticide used. It also includes a section on special chemical or physical dangers that will alert you to any potential storage hazards.

4. The fourth time a pesticide label should be read is before you dispose of the empty containers. The label should tell how to safely do this so that no harm will come to you, other people, animals or the environment.
5. Finally, read the label any time an emergency occurs - or in any situation involving the pesticide which you do not know how to handle. This includes a poisoning incident, leak or spill, or any natural disaster in which a pesticide is involved.

Any time you have a question, or even a slight doubt about how to deal with a pesticide, READ THE LABEL! Chances are that your question can be answered quickly, simply by reading the pesticide container!

STEP 2. SUMMARY

Summarize and conclude Topic C.

1. Read the pesticide label before you buy the pesticide.
2. Read the pesticide label before you mix and apply the pesticide.
3. Read the label before you store the pesticide.
4. Read the label before you dispose of the container.
5. Read the label in the event of an emergency involving the pesticide or if you have any questions.

TO THE TRAINER: You may wish to have several trainees volunteer to do a short skit or play acting on use (reading) of a label. Many variations exist but it is important to plan what each "actor" will do; e.g., play role of Extension Agent, or farmer, or pesticide sales representative, or farm manager. To begin, have the Extension Agent question what was purchased by the farmer and why; then, have the Agent read the label with the farmer to see that what the farmer purchased was really what he needed. This play acting should emphasize when labels should be read.

UNIT VI SUMMARY

Summarize the major points of each activity.

A. Any printed information received about a pesticide when buying it is called labelling. Only the information attached to the pesticide container is called a label. Labels are important because they can answer many questions, such as choice of pesticide, how to use the pesticide, what to use the pesticide on and how poisonous it is. Since all pesticides are not alike, they should not be treated alike. Labels tell you how to handle the particular chemical in the container.

B. The parts that should be included on a label are: the product name and the chemical name; percent of ingredients; symbol and signal words; manufacturer information; type of formulation and net contents; hazards to humans and domestic animals, the environment and chemical and physical hazards; directions for use; and storage and disposal instructions and crop information.

The four categories of pesticides are classified by toxicity, ranging from highly toxic to relatively non-toxic. An active ingredient is one that "does the work" to kill a pest. Formulation is the form which the pesticide comes in. Field reentry time is the period of time between the last spraying and when it is safe to reenter the field.

C. You should read the label: before you buy the pesticide; before you store the pesticide; before you mix or apply the pesticide; before you dispose of the container AND when you have a question or a pesticide emergency occurs.

TO THE TRAINER: Ask the trainees if they have any questions about labels. If not, have the trainees answer the following questions to test their understanding of the material presented.

QUESTIONS

UNIT VI: "Pesticide Labels"

1. What is the difference between labeling and labels? Explain and define both.
2. Name at least two questions that a label can answer.
3. Name the four categories of pesticides.
4. Which is the most dangerous?
5. What symbol appears on these pesticides?
6. Which category is the least dangerous?
7. What is the difference between "common" and "product names"?
8. What is an "active ingredient"?
9. What is a "formulation"?
10. What is a "field reentry" statement?
11. How can you get the best use out of your pesticide(s)? (in one word).
12. When are the five times you should read the pesticide label?

UNIT VII: WORKER SAFETY: PROTECTION OF THOSE WHO MIX AND APPLY

UNIT OVERVIEW

Mixers and applicators are two groups of people at special risk of pesticide poisoning. During mixing and application, direct contact with the chemical often occurs. It is at these times that the chemical or poison is handled in its most concentrated and dangerous form. It is no wonder that accidents often happen while mixing and applying pesticides! Learners must be able to reduce the risks of pesticide poisonings. This Unit should be particularly instructive to farmers, vendors and handlers of pesticides.

Three topics are included:

A. THE IMPORTANCE OF SAFETY DURING MIXING AND APPLICATION.

B. CLOTHING AND SAFETY EQUIPMENT.

C. BEFORE YOU GET STARTED.

OBJECTIVES:

The specific objectives for this Unit are to:

1. Teach basic facts why it is important to handle pesticides safely.
2. Teach and learn what clothing and equipment are necessary for safe protection when handling pesticides.
3. Learn specific safety rules.

It will take approximately 2 hours to complete Unit VII and includes activities that require the following teaching materials.

TEACHING MATERIAL PROVIDED	TEACHING MATERIALS YOU MUST PROVIDE
Posters.	Rubber boots, leather shoes, and plastic thongs.
	Long pants and long sleeved shirt, or coveralls.
	Waterproof smock or sheet of plastic.
	Long rubber gloves, cloth gloves and leather gloves.
	Several respirators of various types (at least one cartridge type, one supplied air type, and one paper mask for dusts).
	Goggles, several types.
	Waterproof hat, cloth hat and straw hat.

TOPIC A. THE IMPORTANCE OF SAFETY DURING MIXING AND APPLICATION

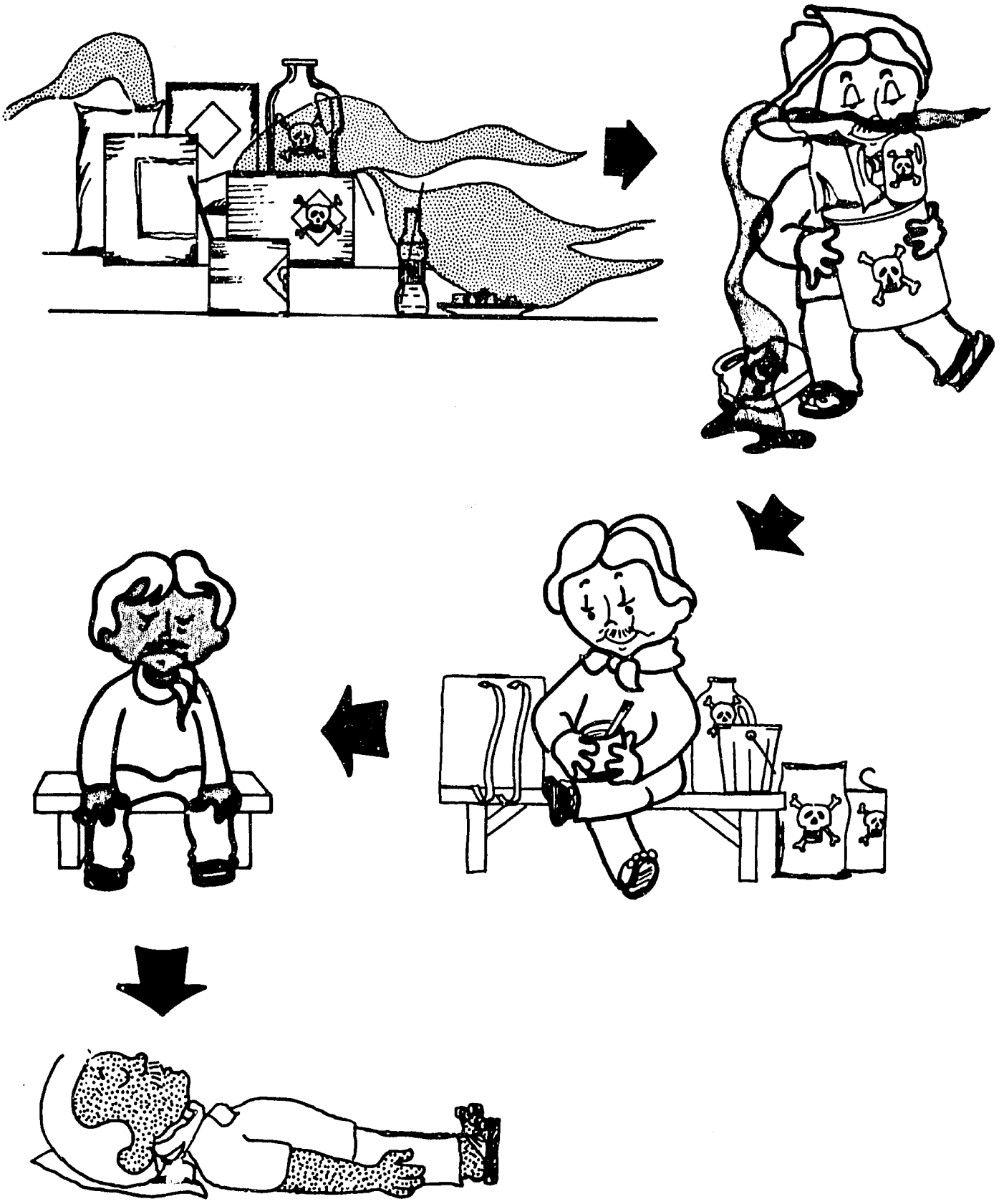
Purpose: To make learners aware of the need to follow good safety rules.

By the end of Topic A, each trainee should know:

1. That mixers and applicators are at very high risk for poisoning from pesticides.
2. That because of this risk, safety rules are very important and should be practiced.

STEP 1. DISCUSSION: A POISONING

TO THE TRAINER: Ask for volunteers to interpret the following series of drawings.



TO THE TRAINER: Encourage discussion of the picture series. Ask if any of the learners or if anyone they know has ever had an experience similar to this one.

STEP 2. PRESENTATION: DANGERS TO PESTICIDE MIXERS AND APPLICATORS

Pesticides are chemicals that act as poisons to kill insects and other pests. Pesticides are dangerous to these living things and they are dangerous to man. They can make him sick. They can even kill him.

Anytime that people come into contact with pesticides, there is a risk of poisoning. But, there are some times when this risk is even higher than usual. Pesticide workers and people who mix and apply toxic chemicals handle pesticides at a time when they are in their strongest form. This is before they have been mixed with water or other things to dilute, or weaken their strength. Pesticides are so strong at this point that they can poison a worker instantly if he breathes them into his lungs or accidently spills them on his skin. (Acute poisoning.)

There is another kind of poisoning that happens slowly over a period of time. Anyone who handles pesticides or is around them for a long time gradually collects the poison inside his body when he breathes or touches it. The amount of pesticide in his body slowly increases over time until it adds together to make a large amount of poison. A pesticide worker, or anyone, near pesticides for long periods of time is very likely to suffer this kind of poisoning. (Chronic poisoning.)

STEP 3. SUMMARY

There are two reasons why pesticide mixers and applicators are at a special risk of pesticide poisoning:

1. They often handle pesticides before these chemicals have been weakened by mixing with water or other substances and are in clear danger of being acutely poisoned; and
2. They are around pesticides repeatedly for an extended time period and are in danger of being victims of chronic poisoning.

TOPIC B. CLOTHING AND SAFETY EQUIPMENT

Purpose: To demonstrate use of the proper clothing and protective equipment for mixing and applying pesticides safely. By the end of Topic B, learners should:

1. Know the articles of clothing and equipment needed to protect a person from being poisoned.
2. Be familiar with each of these articles and know how to wear and use them.

STEP 1. PRESENTATION: PREVENTING SKIN POISONINGS

Now you know WHY it is important to be a safe worker around pesticides. Next, let's study HOW to be a safe worker.

The most common cause of pesticide poisoning for mixers and applicators is through contact with the skin. But, this is the easiest form of contact to prevent! With the right clothing and a few simple articles of safety equipment, a worker can protect himself against the high risk of poisoning. What an easy way to prevent the possibility of a tragic accident!

STEP 2. DEMONSTRATION: BUILDING A SAFE WORKER

TO THE TRAINER: Ask for several volunteers from the group to serve as models for the safety clothing and equipment. Since this will require some patience, select and talk with the volunteers prior to the class period when this Unit is taught. Explain to the learners that they will put on and wear several safety articles. Explain about how long this will take so that

they know what to expect. Volunteers should be willing participants.

Tell the learners that they are going to build, from start to finish, the ideal, safety conscious pesticide worker. Ask the volunteers to come to the front of the room.

Our friend here wants to mix and apply pesticides to fight the pests that are destroying his crops. He knows that wearing protective clothing and equipment is important, but he needs some help. Our friend has asked what articles he needs for protection and how to use each of them . . . And we're going to tell him.

TO THE TRAINER: Follow these steps and, as the script gradually builds the cartoon character, do the same with your volunteer. Use the teaching materials called for at the beginning of the unit and explain each article as the script does. Encourage informal discussion as the activity proceeds.

STEP 3. DEMONSTRATION: PROTECTIVE CLOTHING--FEET AND HANDS

Let's protect our friend's legs and feet. Coveralls or pants legs should be worn outside boots. The boots should be made of rubber and unlined.

> TO THE TRAINER: Have the learner put on long pants and boots which fit the description in the script. Again, stress that pants or coveralls should be worn outside the boots.

Since the hands and arms are used to lift, carry, pour, and spray pesticide chemicals, they are in direct contact with the poison. For this reason, <u>it is very important to protect them</u>.

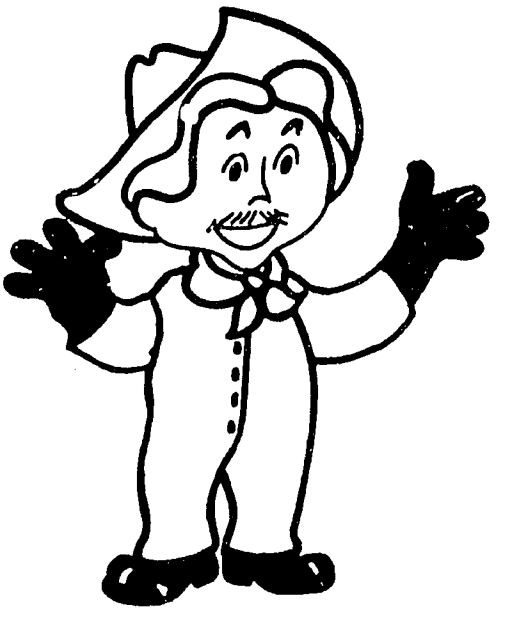
Rubber gloves must be worn. They should be rubber, unlined and elbow length. <u>Cloth or leather gloves should never be worn</u>. Check gloves for holes by filling the gloves with water and gently squeezing. Any hole that water can get out of is a hole that poisonous pesticides can get into. If any holes appear, the gloves must not be worn!

TO THE TRAINER: Demonstrate how to check rubber gloves for holes. Then have the volunteer put on a pair of gloves that fit the description given in the script.

A long sleeved shirt or long sleeved coverall should be worn. Sleeves should be worn outside gloves.

TO THE TRAINER: Have the learner put on a long sleeved shirt over his own. Or, if you have brought coveralls to class, have him put those on over his own clothes. Stress the importance of leaving the sleeves outside the gloves. Tell the learners that this is to keep pesticide chemicals from running down inside the gloves.

A waterproof smock or large sheet of plastic with a hole for the head, will protect against splatters or spills.

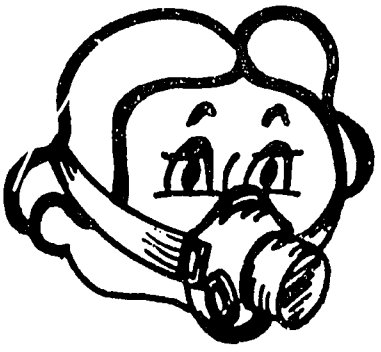


Now we must show our friend how to protect his head, neck and face.

STEP 4. DEMONSTRATION: PROTECTIVE CLOTHING AND EQUIPMENT FOR THE HEAD

Since breathing through the nose and mouth is one of the routes of entry for pesticides, the mouth and nose should be covered by a respiratory device. There are several kinds of respiratory devices.

TO THE TRAINER: Show the learners the respiratory devices you have brought to class and briefly explain each. After you have explained the devices, select one to have the volunteer model for the class. Stress the importance of a tight fit.



1. A cartridge respirator covers the mouth and nose and filters air that comes through it to remove poisonous vapors. Some cartridge respirators will cover the full face -- mouth, nose and eyes.

2. A supplied air respirator has clean air pumped through a hose to the face mask. The worker breathes this air instead of the poisonous chemical vapors.

3. A self contained breathing apparatus supplies the wearer with clean air from a cylinder carried on the back.

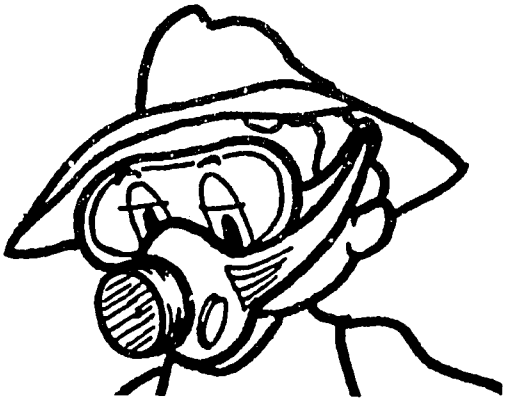
Some kind of respirator should be worn while mixing and applying pesticides. The respirator should fit properly. It should be worn tightly enough to form a seal all around the face, but not so tightly that it hurts.

Since contact with the eyes is very dangerous, and the eyes are very sensitive, our friend should wear something to protect them. Ask learners what should be worn. Tight fitting goggles with a rubber strap will protect the eyes from being poisoned.

TO THE TRAINER: Have the volunteer put the goggles on. Demonstrate to the learners that the goggles fit properly as the script dictates. Adjust them to obtain a proper fit.

The final thing we tell our friend is that he needs to protect the hair and skin on his neck, head and face. A washable rubber or plastic hat with a wide brim is excellent head protection. Cloth and straw hats should be avoided since they tend to absorb pesticides.

TO THE TRAINER: Put the hat which you brought to class as a teaching aid on a volunteer's head.



STEP 5. DEMONSTRATION: THE WELL DRESSED PESTICIDE WORKER

Our friend is now ready to go! But to make sure, let's take a look at this checklist:

Does he have:

1. Waterproof hat?
2. Goggles?
3. Respirator?
4. Rubber gloves?
5. Long sleeved shirt or coveralls?
6. Long pants or coveralls?
7. Waterproof boots?
8. Waterproof smock?

(The minimum equipment should be goggles, respirator, rubber gloves and boots)

Are his:

1. Sleeves outside his gloves?
2. Pants legs outside his boots?
3. Safety clothes and equipment free of holes and properly fitting?
4. Hat, gloves, boots and smock waterproof?

If the answer to every one of these questions is yes, then our friend will be protected.

TO THE TRAINER: Use an enlarged drawing of the picture on the previous page, or have another volunteer serve as a model for group review. What is wrong here? Ask trainers to explain what protective clothing is missing and why. Discuss why each item is important.

TOPIC C. BEFORE YOU GET STARTED

Purpose: To discuss other general safety rules that will help prevent pesticide accidents. By the end of Topic C, learners will know:

1. Several rules to remember while mixing pesticides.
2. Several rules to remember while applying pesticides.
3. Several rules to remember after handling pesticides.

STEP 1. PRESENTATION: SAFETY WHILE MIXING AND APPLYING PESTICIDES

Protective clothing and equipment is an important, but certainly not the only, safety measure you should take when working with pesticides. There are some other important rules that we should discuss "before you get started".

One of the most basic safety rules you should follow is: avoid exposure to pesticide while mixing. In addition to protective clothing, there are some things that you can do to limit the possibility of coming into contact with dangerous chemicals. You should make every effort to stay as far away from the pesticide as you can and still get the job done. For example, while mixing, keep the chemical well below eye level to avoid contact with the eyes.

Always mix outdoors where excess fumes can escape out and away from the mixer.

Use a long mixing utensil rather than a short one that will cause the mixer's hands to be close to the mixture.

When applying pesticides, avoid any drift of spray in the wind or runoff of pesticide from plants being treated. Do not wipe your hands on your clothing if pesticide has been spilled on your gloves. Do not use your mouth to clear clogged hoses or nozzles. And never smoke, eat or drink while handling pesticides or even when pesticides are near.

After application, don't return to the field too soon. Pay attention to reentry guidelines on the pesticide label. If none appear on the label, stay out of the crop area at least 24 hours before reentry after spraying. With even mildly toxic pesticides, 12 hours should be allowed to pass before returning to the field.

TO THE TRAINER: For review, present learners with local pictures (posters) or local photos of workers and have them discuss good vs. bad:

1. Mixing at eye level vs. below eye level
2. Using shallow container and short stirrer vs. proper utensils
3. Eating close to pesticide vs. eating at a distance.

STEP 2. PRESENTATION: SAFETY AFTER HANDLING OR APPLYING PESTICIDES

Another rule that should be followed when using pesticides involves cleanliness or hygiene. After using poisonous chemicals, special care should be taken to wash work clothes, especially if pesticide has been spilled on them. Washing should be done in a special tub stored in the pesticide storage facility (see Unit XI). Do not wash in a natural water source such as a stream or river. And don't forget to wash goggles, boots and gloves. All wash water and rinse water should be disposed of in a special area where it will not run directly into local waterways, streams, wells, etc. Such a spot will easily be found if the pesticide storage facility is properly located (see Unit XI).

TO THE TRAINER: You may wish to prepare a special handout for those who will do the washing. Such a sheet should indicate: what to do with rinse water, what needs to be washed (be careful not to get charcoal filters wet since it will inactivate them).

You also must thoroughly wash yourself after working with pesticides; if possible, wash immediately after finishing. Again, soap should be used. Don't forget to scrub hair and under fingernails.

Finally, practice the same rule of cleanliness with your equipment as you do with yourself. After using sprayers and other application equipment, clean them thoroughly with buckets of fresh water. Do not clean near streams or rivers or near living areas. The water used to clean equipment and work clothes picks up poisonous chemicals, becomes contaminated, and carries the poison with it. While cleaning equipment, check for leaks, breaks and other malfunctions. This will ensure that your equipment will be in good, safe working order the next time you use it.

STEP 3. PRESENTATION: PLAN AHEAD AND PREVENT ACCIDENTS

Perhaps the most important safety rule to remember is simply this: PLAN AHEAD. This means that it is wise to anticipate possible accidents before they occur. Do everything you can to prevent them, but be prepared to handle them if they do occur. The rule "PLAN AHEAD" also means that it is a good idea never to work alone. Use the "buddy system". Have at least one person nearby in case you become a victim of pesticide poisoning. If possible, have first aid materials, especially clean water and soap, on hand when handling pesticides. Choose a time when weather conditions are good for work with pesticides. And choose a pesticide that is the safest, most effective pesticide available.

Finally, exercise care when moving pesticides from one site to another. Plan to transport them in a manner that reduces the risk of a spill. Place containers in the transport vehicle so that they cannot shift, roll or bounce and NEVER place them near food or feed containers. Children should not be allowed to ride near pesticide containers. (Ask learners for examples of what can happen and of the special dangers to children).

STEP 4. SUMMARY

1. Remember, when mixing, applying, or handling chemical pesticides: Be Careful.
2. Protective clothing, when used correctly, will help avoid exposure to pesticides.
3. Mix pesticides outside, in a well ventilated area.
4. Use proper equipment for mixing.
5. Avoid drift or any contact with the material.
6. Do not re-enter a field too soon after applying pesticides.

7. Clean up safely and carefully yourself, your clothing and your equipment.
8. Remember: Plan Ahead, Prevent Accidents, and Never Work Alone when using pesticides.

TO THE TRAINER: Use the following chart, "General Instructions for Safety in Handling Pesticides", as another means for reviewing safety practices. If possible, make copies of the chart to be handed out.

GENERAL INSTRUCTIONS FOR SAFETY IN HANDLING PESTICIDES

1. Always read the pesticide label and follow its instructions carefully.
2. Wear clean and appropriate protective clothing and a respirator whenever recommended.
3. Never leave pesticides unattended in an insecure place.
4. Never transfer pesticides to other containers, especially beer, soft drink or other beverage bottles.
5. Never work alone when handling very toxic pesticides.
6. Handle pesticide containers with care and inspect them frequently for leaks or signs of corrosion.
7. Do not keep food, drink, tobacco or eating utensils anywhere in the work area or in work clothes.
8. Never eat, drink, smoke, rub your eyes or touch your mouth while working with pesticides.
9. Always have soap and plenty of water available and a clean change of clothing.
10. Always discard heavily contaminated clothing and faulty protective covering, especially gloves and respirators.
11. If leaks or spills occur, clean up contaminated area immediately.
12. Keep unauthorized persons, especially children, away from pesticides.

UNIT VII SUMMARY

The major points covered in Unit VII are:

A. Pesticide workers and people who mix and apply toxic chemicals are at a very high risk of becoming poisoning victims because they handle pesticides while they are at their strongest and because they are around pesticides for extended periods of time.

B. The use of protective clothing and equipment is necessary to protect pesticide workers from being poisoned. A pesticide worker should wear a waterproof hat with a wide brim, goggles, and some type of respiratory device to protect his head and face from exposure to pesticides. He should wear waterproof gloves and a long sleeved shirt with sleeves outside of the gloves to protect his arms and hands. Long pants or coveralls should be worn outside of waterproof boots. A waterproof smock completes the protective clothing. If all these things cannot be obtained, at least goggles, respirator, rubber gloves, and rubber boots should be worn.

C. In addition to the use of protective clothing, there are other safety precautions the pesticide worker should observe:

1. He should choose the safest pesticide available and the best weather to work in.
2. He should never work alone.
3. He should avoid exposure to pesticide chemicals by staying as far away from the mixture as possible.
4. He should keep the pesticide below eye level while mixing it.
5. He should perform the mixing operation outdoors and should use a long utensil to stir pesticide mixtures.

6. He should exercise care when transporting pesticides from place to place.
7. He should avoid drift, spray and runoff.
8. He should follow reentry rules after spraying a crop.
9. He should have soap and water available.
10. He should always wash his hands thoroughly before eating, drinking or smoking.
11. He should thoroughly clean his body, clothes and equipment each time after working with pesticides.
12. He should always clean equipment away from water sources and living areas.
13. He should never use his mouth to unclog equipment.
14. He should always plan ahead when using pesticides; know how to best prevent an accident and know what to do if one does occur.

QUESTIONS

UNIT VII: "Worker Safety: Protection of Those Who Mix and Apply"

1. When somebody is mixing, applying or handling pesticides, why are the following worn?
   a. Waterproof hat
   b. Goggles
   c. Respirator
   d. Rubber gloves
   e. Long sleeved shirt or coveralls
   f. Long pants or coveralls
   g. Waterproof boots
   h. Waterproof smock

2. Why are shirt sleeves kept outside of the rubber gloves?

3. List the minimum equipment that <u>must</u> be worn when mixing pesticides.

4. Why do people who mix or apply pesticides have a high risk of poisoning?

5. List other safety rules. (See previous 2 pages for list of 14 items).

UNIT VIII: FORMULATION, TYPES AND INHERENT DANGERS OF PESTICIDES

UNIT OVERVIEW

Pesticides can be purchased in many different forms. Each form (or formulation) has specific characteristics which make it either effective or ineffective for use in a particular situation.

This Unit covers the different formulations. Trainees will learn some general characteristics for several of the more common pesticide formulations. Knowing something about formulations can help not only in deciding which pesticide might be most effective for use in a particular situation, but also in recognizing special storage and safety problems associated with certain formulations.

Two topics are included. The topic titles are:

A. INTRODUCTION TO FORMULATIONS

B. CHARACTERISTICS AND INHERENT DANGERS.

OBJECTIVES:

The objectives of this Unit are to increase the awareness about pesticides and the different types available. By the end of this Unit, learners should:

1. Be able to name several common formulations.
2. Know general characteristics of these formulations.
3. Know certain special hazards that some formulations present.

Unit VIII requires approximately 2 hours to complete and includes activities that require the following teaching materials:

TEACHING MATERIALS PROVIDED	TEACHING MATERIALS YOU MUST PROVIDE
None.	Examples of all formulations.
	Several glass containers, 500 ml each.
	Water, 2-3 liters.
	Sugar or salt.

TOPIC A. INTRODUCTION TO FORMULATIONS

Purpose: To introduce learners to different pesticide formulations. By the end of Topic A, they should:

1. Know the names and abbreviations of some common formulations;
2. Know the definitions of the terms active ingredients, inert ingredients, solvent, solutions, formulation, and suspension; and
3. Know in simple terms how each formulation is made.

STEP 1. PRESENTATION: INGREDIENTS

Active ingredients are the chemicals in pesticides that do the work. Pesticides have other ingredients which are inactive and do nothing to help the active ingredients kill the pests. These are called inert ingredients.

If active ingredients are the only ingredients that do the work, why are inert ingredients needed in pesticides? Active ingredients alone are usually not in a form which can be used. They must be mixed with inert ingredients to make them effective, easy and safe to mix and apply.

The mixture of active and inert ingredients is called a formulation.

STEP 2. PRESENTATION: FORMULATIONS

There are many different kinds of formulations. Sometimes the same pesticide will be available in several different formulations. Active ingredients are mixed with different combinations of inert ingredients to make these different formulations.

Generally speaking, pesticides come in two broad categories of formulations: liquid formulations and dry formulations. Before we discuss these, we should become familiar with two words: solvent and solution.

A solvent is any fluid or material which has the power to dissolve a solid or dry material. Solvents make solid forms of material into liquids.

A solution is the liquid that results when solid material is dissolved by a solvent. A solution can also be the result of mixing a liquid with another liquid or even with a gas. A solution is always the result of these mixtures.

STEP 3. DEMONSTRATION: SOLVENTS AND SOLUTIONS

The words solvent and solution will be used in discussions about formulations. Thus, it is important that the learners know and can use these terms.

To demonstrate the action of a solvent, use water in a clear glass jar that is clearly visible to the learners, along with any amount of salt or other solid dry material which will dissolve in water. One that has a definite color would be excellent to use.

Tell the learners that the water in this demonstration is the solvent because it will make the solid material dissolve. Slowly pour the salt (or other material to be dissolved) into the jar of water and stir until it has dissolved and the mixture is homogeneous. Tell the learners that we now have a solution. The solid has mixed with the liquid, or solvent, to form the solution.

STEP 4. PRESENTATION: LIQUID FORMULATIONS

The more common liquid formulations are aerosols, emulsifiable concentrates, flowables, liquified gases and solutions.

Aerosols: There are two types of aerosols: one type has its active ingredient dissolved in a volatile solvent and contained in a can with a pressurized gas for a propellant. Activation of a manual valve releases the solution in a fine mist. The second type of aerosol uses the same type of solution but the mist is produced in a heat fogging machine. The solvent in both is usually diesel.

Emulsifiable Concentrates: An "emulsion" is a liquid/liquid collodial suspension. Water and oil will not mix, but if an amount of detergent or soap is added to the mixture of oil and water a collodial suspension of oil in water will form. This liquid/liquid collodial suspension is called an emulsion and the soap or detergent is called an emulsifier. Emulsifiable concentrate insecticides consist of a solution of insecticide in a petroleum based solvent and an emulsifier. When it is mixed with water, it forms an emulsion. The mixture must be agitated, if not it will settle to the bottom of the spray tank. The abbreviation for an emulsifiable concentrate is "EC"

TO THE TRAINER: To demonstrate an emulsion use a low toxicity insecticide such as malathion 57% EC or 5 EC. The students will be able to see that the insecticide is transparent like the water; however, when they are mixed they form an opaque, white liquid. This is an emulsion. An emulsion is a colloidal suspension of microdroplets of one liquid in another. Each microdroplet acts as a lens and disperses light, thus forming an opaque liquid.

Flowables or Flowable concentrates: A flowable is nothing more than a wettable powder mixed with a surfactant. It forms a suspension with water like a wettable powder. Constant agitation is required. The flowables require a ratio of water to concentrate of 3:1 as opposed to the 6:1 ratio required by wettable powders. The abbreviation for a flowable is "FW".

TO THE TRAINER: Mix a flowable such as AAtrx 4FW or Gesaprim 500 FW with water.

Liquified Gases: Some gases become liquids when under pressure. Pesticides with active ingredients which behave in this manner are stored under pressure. These are also liquified gases. Other active ingredients remain liquid in an ordinary container, but turn into a gas as soon as they are applied. These are also liquified gases.

Solutions: There are two basic groups of solutions; high concentrates and low concentrates. High concentrates have a large amount of active ingredient. They may even contain only active ingredients with no other ingredients added!

Low concentrates have only a small percentage of active ingredients and are usually added to oils to make solutions. Solutions are abbreviated with an "S".

STEP 5. PRESENTATION: DRY FORMULATIONS

TO THE TRAINER: For demonstration purposes, bring examples of baits, dusts, granules, soluble powders and wettable powders. Demonstrate each one in order.

Common dry formulations are baits, dusts, granules, soluble powders, and wettable powders.

Baits: A bait is a pesticide mixed with something which pests like to eat. They eat the bait because it tastes good and then die because of the pesticide mixed with it. The amount of active ingredient in most baits is small. The abbreviation for baits is "B".

Dusts: Dusts are a mixture of insecticide with a nonhygroscopic carrier such as talc. They are applied by airblast. Dusts generally have low percentages of active ingredient. The abbreviation for dusts is "D".

Granules: A granular formulation is made by applying the active ingredient in the form of a liquid to coarse particles or granules. The granules either soak in the active ingredient or become coated by it. Either way the granule becomes dry but the pesticide is still in (or on) the granule and works to kill pests. The abbreviation for granules is "G".

Soluble Powders: Soluble Powders are dry formulations which can be added to water. The water acts as a solvent. The water and the soluble powder

form a solution. The amount of active ingredient is high in soluble powders. The abbreviation for this formulation is "SP".

Wettable Powders: Wettable Powders differ from dusts in that the carrier is usually a clay and very hygroscopic. The percentage of active ingredient is high and their abbreviation is "WP".

STEP 6. SUMMARY

Summarize Topic A. The main points are:

1. Active ingredients are the chemicals in a pesticide that do the work. Inert ingredients are mixed with the active ingredients to insure that they can be effectively, easily and safely applied.
2. A formulation is the mixture formed when active and inert ingredients are combined.
3. A solvent is any liquid which can act to dissolve a solid substance.
4. A solution is the liquid which results when a solvent dissolves a substance.
5. A suspension occurs when solid particles remain solid and float in a liquid.
6. There are five common liquid formulations which we should be familiar with: Aerosols(A), Emulsifiable Concentrate(EC), Flowables(F), Liquified gases, and Solutions(S).
7. There are five common dry formulations: Baits(B), Dusts(D), Granules(G), Soluble Powders(SP), and Wettable Powders(WP).

TOPIC B. CHARACTERISTICS AND INHERENT DANGERS

Purpose: To explore and further discuss the characteristics of formulations, how they should be handled, hazards, etc.

By the end of Topic B, the learners should:

1. Know how the more common formulations are used.
2. Know advantages of specific formulations.
3. Know disadvantages or hazards of specific formulations.

STEP 1. PRESENTATION: HAZARDS OF LIQUID FORMULATIONS

Let's take a closer look at liquid formulations. Liquid formulations are made to be used for spray application. With spray application, there is always a problem with drift. Particles move away from or are wind blown from the target area. This results in contamination of the environment and/or people.

Another hazard common to all liquid formulations is that they produce gases as they begin to age. This creates a risk of container rupture. Pesticide containers used for storage of liquid formulations should be checked often for cracks or breaks.

Emulsifiable Concentrates (EC): An emulsifiable concentrate is a combination of two liquids which will not totally mix but remain somewhat separated from each other. One common problem with emulsifiable concentrates is that they may lose some of their emulsifiability if exposed to high temperatures or humidity. This means that the two liquids lose some of their properties which make them separate--this may make them ineffective!

When emulsifiable concentrates are stored properly, they handle well. They are easy to apply and convenient to mix. But EC's are also probably the most hazardous of the liquid formulations to use and they may damage some crops.

Flowables (F) or (L): Flowables are finely ground solid particles of active ingredient floating in liquid. They handle well, much like EC's. They seldom clog spray nozzles and they need only a little bit of agitation (or shaking) to be mixed and be ready for application.

Liquified Gases: Liquified Gases, whether stored under pressure or not, become gases when applied to crops. These pesticides must be applied by either injecting them into the ground or applying them to a confined area, such as a storage bin or an area over which a tarp has been placed. Otherwise, the gas escapes into the air, along with your money.

Solutions (S): High concentrate solutions contain chemicals that allow them to spread and stick well. These solutions can be used as is or be diluted with oil solvents.

Low concentrate solutions should be used with no further dilution. Read the label for exact use directions.

STEP 2. PRESENTATION: HAZARDS OF DRY FORMULATIONS

Dry formulations tend to cake or become compacted when stored near high temperatures or humidity. These two conditions should be avoided whenever storing any kind of formulation, but especially when storing dry dusts, granules, or powders.

Dusts (D): As with the liquid formulations, drift is a problem with finely ground dusts. Dusts can be easily blown or washed away from plant surfaces by wind or rain. This makes the time during which they are effective very short. Dusts tend to be less toxic when they come into contact with the skin than some of the other formulations. However, respiratory poisoning is a high risk if dusts are breathed into the nose, throat or lungs. Dusts must always be used dry.

Granules (G): Granules, like dusts, should always be used dry. Granules are safer to apply than either EC's or dusts and drift is not a problem. Granules are applied directly to soil or over plants.

Soluble Powders (SP): Soluble Powders act much the same way as wettable powders. Since soluble powders are completely dissolved by water (which is the solvent), the solution does not have to be agitated periodically.

Wettable Powders (WP) or (W): Wettable Powders mixed with water soon begin to settle out or separate from the water. This formulation must be stirred or agitated periodically. Wettable powders are safer than EC's and if mixed well, will not clog spray nozzles.

STEP 3. SUMMARY

TO THE TRAINER: Use the chart on the next page which can be enlarged so that the learners can see it as you talk. The chart can either be copied as is or can be divided into "flashcards"--one per formulation.

Chart 1: Formulation Characteristics

Formulation	Definition	Characteristics
AEROSOL (A)	Active ingredients in a solvent mixed with inert ingredients to form a solution. To be used as a fog or mist.	Drift problems. Risk of container rupture.
EMULSIFIABLE CONCENTRATE (EC)	Liquid active ingredient combined with water. Do not totally mix together.	Tendency to lose emulsifiability. Hazardous to some crops. Easy to apply.
FLOWABLES (F) or (L)	Solid, fine powder that will not totally dissolve but floats in liquids.	Easy to handle and apply. Only slight agitation is needed.
LIQUIFIED GASES	Liquids which become gases when under pressure or when applied.	Must be injected into the ground or in confined areas to keep gas from escaping.
SOLUTIONS (S)	An active ingredient that is dissolved completely by a liquid solvent to form a liquid.	Spread and stick well.
BAITS (B)	Pesticide mixed with food attractants.	Low active ingredient content.
DUSTS (D)	Fine, dry powder containing active ingredient.	Drift problem. Respiratory risk.
GRANULES (G)	Coarse particles with active ingredient inside or coating outside.	No drift problem. Safer to apply but may not be as effective.
SOLUBLE POWDERS (SP)	Dry active ingredient. When added to water, forms a solution.	Safer than EC's. Easy to apply. No agitation needed.
WETTABLE POWDERS (WP) or (W)	Dry active ingredient with wetting agent. When added to water, forms a suspension.	Problem with "settling out". Must be agitated periodically. Also safer than EC's.

UNIT VIII SUMMARY

Summarize the major points of each activity. Use Chart 1 or flashcards when talking about each formulation.

A. Active ingredients are the chemicals in a pesticide that do the work. These must be added to inert or inactive ingredients so that they will be in a form that we can safely and effectively use. The mixture of active and inert ingredients is called a formulation. There are two broad categories of formulations: liquid which include aerosols, emulsifiable concentrates, flowables, liquified gases, and solutions; and dry which include baits, dusts, granules, soluble powders, and wettable powders. A solvent is a fluid in a formulation that acts to dissolve solid, dry matter or another liquid material. A solution is the liquid that is formed when the solvent does this. In a suspension, no solvent is present to dissolve the added material so it simply floats, or is suspended, in the liquid.

B. Liquid formulations tend to create a drift problem since they are made to be used by spray applicators. They also tend to produce gases when they begin to age which creates a risk of container rupture or explosion. For characteristics of specific dry formulations, refer to chart.

TO THE TRAINER: Conclude Unit VIII with a question and answer period. Ask the learners if they have any questions. If so, address their questions before moving on to ask them the following.

QUESTIONS

UNIT VIII: "Formulation, Types, and Inherent Dangers of Pesticides"

1. What is the difference between active and inert ingredients? Define both.
2. Why are inert ingredients needed in pesticide formulations?
3. Consider the following experiment.

A. Water B. Salt C. Mixing D. Stirring E. Liquid

Name the letter of the step which pictures a solvent. _____

A solution. _____

4. What is a formulation?
5. What does "emulsion" mean?
6. What are the two common problems with liquid formulations?
7. Name one problem with emulsifiable concentrates.
8. What must you do to flowables before they can be sprayed without clogging the sprayer nozzle?
9. How must liquified gases be applied?
10. Name five common dry formulations by name and their abbreviations.
11. How do baits work?
12. What is a major problem with dusts?
13. Like flowables, wettable powders must be _____before use.

UNIT IX: MIXING PROCEDURES

UNIT OVERVIEW

People who mix pesticides are at special risk of pesticide poisoning. The process of mixing pesticides and diluting concentrates provides plenty of opportunities for accidents that can lead to poisonings.

Mixers are often subject to skin (dermal) exposure. Respiratory (breathing) exposure is also common. Worker safety, along with a knowledge of proper mixing procedures, can do much to reduce these problems. In this Unit, correct and safe mixing procedures are discussed.

This Unit includes 3 topics.

A. THE IMPORTANCE OF GOOD MIXING HABITS.

B. BEFORE WE GET STARTED . . .

C. MIXING PROCEDURES.

OBJECTIVES:

The objectives of this Unit are to review safe mixing procedures and to establish and practice a step-by-step set of rules for correct and safe mixing. By the end of this Unit learners will have:

1. Developed an awareness of the need for good mixing habits.
2. Learned how to safely prepare to mix pesticides.
3. Learned the practical, safe steps for mixing pesticides.

This Unit requires approximately 2 hours to complete and also requires the following teaching materials.

TEACHING MATERIALS PROVIDED	TEACHING MATERIALS YOU MUST PROVIDE
Posters.	Sharp & dull knives.
	Paper.
	Insecticide containers.
	Mixing container.
	Empty bag.
	Water.
	Empty pesticide container.

TOPIC A. THE IMPORTANCE OF GOOD MIXING HABITS

Purpose: To stress the need for good mixing habits. By the end of Topic A, the learners will:

1. Be aware that workers who mix pesticides are often involved in pesticide poisonings.
2. Realize that we CAN do something to limit the possibility of poisoning while mixing pesticides.

STEP 1. DEMONSTRATION: QUESTIONING

TO THE TRAINER: Show the learners the following three drawings. Ask them what is occurring in each drawing.

Mixing Indoors

No protective clothing

Stirring by hand

STEP 2. PRESENTATION: THE NEED FOR SAFETY

What do these three scenes have in common?

The character in each is about to become a statistic on the list of pesticide poisoning victims. The highest percentage of pesticide poisonings has occurred among workers who mix pesticides. Why? Because at the mixing stage pesticides are handled in very strong, or concentrated, forms. Mixers of pesticides who do not follow a few safety rules are prime targets for poisoning sickness, even death, especially if they do not wear protective clothing.

There are a few basic safety steps that must be followed. These will limit the risk of poisoning while mixing AND make sure pesticides do the job they are supposed to do.

STEP 3. SUMMARY

Summarize and conclude Topic A by recalling the major points:

1. Pesticide mixers are among the highest percentage of poisoning victims.
2. This is because mixers handle the pesticides while they are in a concentrated form.
3 There are steps we can take to mix pesticides safely AND effectively.

TOPIC B. BEFORE WE GET STARTED . . .

Purpose: To teach learners actions that should be taken before pesticides are mixed.

By the end of Topic B, each learner should be able to:

1. Name three things he should do before mixing.
2. Describe the ideal place for mixing pesticides.

STEP 1. PRESENTATION: BASIC SAFETY CONSIDERATIONS

A. The first thing that needs to be done before pesticides are mixed is to find a suitable place for the operation. Mixing should only be done in a place that is well ventilated. It is preferable to do it outdoors, but only if the area is well lighted. Mixing should be done outside during daylight hours, if possible, so there is plenty of light. Mixing should be done away from children, untrained people, livestock and pets.

B. Another thing you need to do is wear protective clothing and equipment. This includes a waterproof smock, boots, gloves, goggles, hat and respiratory equipment. Protective clothing should be checked before each use for tears or breaks. Pants should be worn outside boots and shirt sleeves should be worn outside gloves to prevent spilling pesticides inside gloves or boots.

C. A third action that should be taken before pesticides are mixed is to read the label on the pesticide container. Read the directions on the label before the pesticide container is opened.

The label should list instructions for mixing that particular pesticide. It will also warn you if there are certain chemicals you should avoid mixing with the pesticide. Pesticides mixed with the wrong substances can explode. The label tells which chemicals, if any, you should avoid.

STEP 2. SUMMARY

Summarize the things mixers should do before pesticides are mixed: (Ask learners to list these).

1. Find a suitable place that is well ventilated, well lighted, and away from people and animals;
2. Wear proper protective safety clothing and equipment;
3. Read the label before opening the container and study "Directions for Use."

TOPIC C. MIXING PROCEDURES

Purpose: To present and discuss general safety rules to be followed when mixing pesticides. By the end of this topic, the learners should:

1. Be able to describe safe ways to open paper pesticide containers.
2. Know how to safely pour pesticides from their containers.
3. Understand the importance of measuring carefully.
4. Know what the term "back siphonage" means and how to prevent it.
5. Know proper procedures for rinsing contents from pesticide containers.
6. Know what to do if pesticide is accidentally splashed or spilled on their or someone else's clothing.

STEP 1. DEMONSTRATION: OPENING PAPER CONTAINERS

Although each pesticide has its own mixing instructions, there are some general safety rules that should be followed while mixing any and all pesticides.

The first mixing step to be thought about and performed safely is opening the pesticide container. If the container is made of paper, be sure to use a very sharp knife that cuts cleanly. Do not tear the containers or use dull blades that would cause the containers to shred or tear and leave rough edges.

TO THE TRAINER: Bring to the class a variety of cutting utensils, ranging from very dull and non-suitable for cutting open packages, to very sharp. Demonstrate the cutting ability of several of these by using them to cut a piece of paper or sack similar in weight and appearance to paper pesticide containers. Do not use real pesticide containers for safety reasons. Show the learners the jagged edges that result from using the dull knives compared to the smooth, clean cut produced by the sharper knives and tell them that the clean cut is what we should aim for. Remind them to clean the knife afterwards and not to use it for other purposes.

STEP 2. DEMONSTRATION: POURING

Care should also be exercised when removing a pesticide from its container. The pesticide should be kept below eye level to avoid splash or spill on your goggles or protective clothing.

Keep the pesticide below eye level at all stages of mixing, including pouring and dumping.

STEP 3. DEMONSTRATION: MEASURING

Another safety step during mixing is to measure carefully. Follow the label carefully and use only the amount called for in the label's directions. Do not mix more pesticide than you know you can use since this will present a problem of storage or disposal.

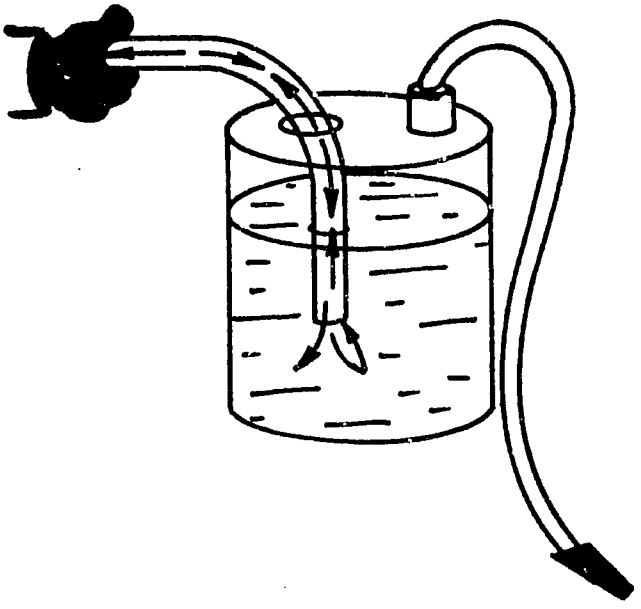
STEP 4. DEMONSTRATION: CLOSING CONTAINERS

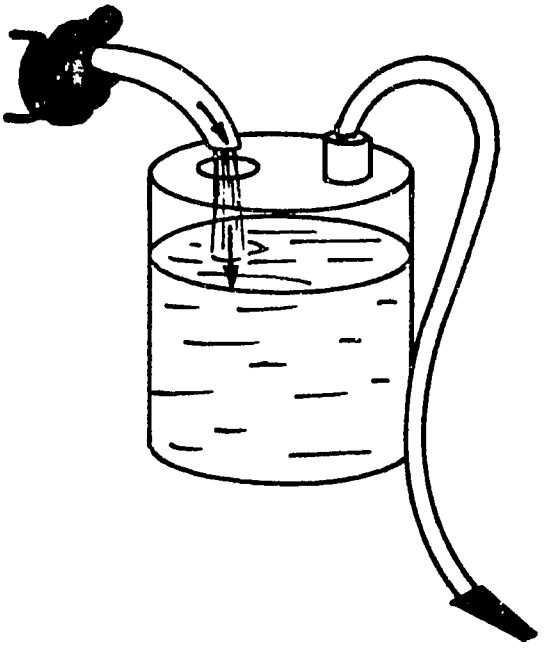
It is important during mixing to replace all pour caps and close containers after use. This will prevent an accidental spill.

STEP 5. DEMONSTRATION: BACK SIPHONAGE

A common and dangerous problem that occurs during mixing is what is called "back siphonage." This occurs when a hose is inserted into a spray container to add water or other substance to the mixture inside. If the end of the hose is allowed to enter the tank and touches the solution inside, the solution may be sucked up inside the hose, reversing the flow of the water or solvent.

Back siphonage frequently results in cases of environmental poisoning or poisoning of livestock when water tanks become contaminated.





The correct way to add water or solvent to a spray tank containing pesticide concentrate is to hold the hose outside the tank and carefully pour water through the opening down into the mixture.

STEP 6. DEMONSTRATION: CLEANING UP

After the pesticide has been poured into the spray tank, the empty pesticide container should be rinsed at least three times. During each rinse, the empty pesticide container should be filled about one-fourth full with water or any solvent recommended on the label to rinse the container.

TO THE TRAINER: Demonstrate this rinsing procedure for the trainees. Have an empty container to use as an empty pesticide container. For safety reasons, do not use a real pesticide container unless it is a very low toxicity level chemical AND it has been rinsed and re-rinsed many times to insure that the remaining contents are not dangerous.

Fill this container with water until it is one-fourth full as the step above indicates. Follow the directions above, rinsing three times with the water and pouring into a basin or sink that will act as the "spray tank".

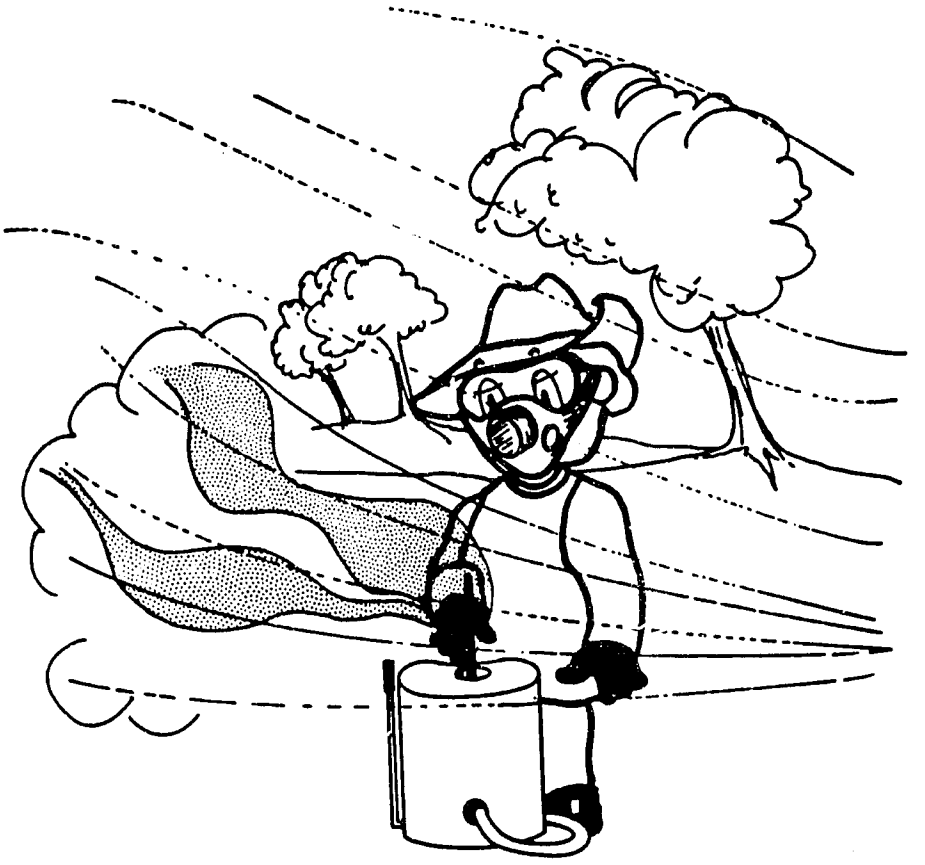
Wear at least minimal safety equipment such as gloves and a smock just to emphasize how important protective clothing is while mixing and cleaning up.

STEP 7. DEMONSTRATION: MIXING

It is better to mix pesticides in the spray tank by shaking or agitating the tank. Mixing by hand in a stirring action creates a greater chance for an accident. Why?

STEP 8. PRESENTATION: AVOIDING WIND

When mixing pesticides, remember to stand upwind, or in a place where the wind blows across your body from the right or left. Avoid having the pesticide blown into your skin or clothing.



STEP 9. PRESENTATION: SPILLAGE

Even when you do stand upwind and do follow the other safety steps, spills sometimes occur while mixing. If you spill pesticide on your clothing, you should STOP MIXING IMMEDIATELY!

The contaminated clothing should be removed and washed thoroughly with detergent. The spill should be cleaned up.

STEP 10. SUMMARY

Conclude Topic C with a brief summary:

1. Paper pesticide containers should be opened with a sharp knife.
2. All mixing of pesticides should be done below eye level.
3. Pesticides should be measured carefully according to the label directions.
4. Container lids and caps should be replaced immediately after pouring to prevent spills.
5. Back siphonage means the reverse flow of fluid through a hose. This can result in contamination. To prevent back siphonage, a hose should be held outside the spray tank when adding water rather than inside the tank where it might touch the concentrated pesticide.
6. Empty pesticide containers should be rinsed of their remaining contents with three water (or solvent) rinsings.
7. Mixers should stand upwind or in a place where the wind blows across the body.
8. Mixing should be done by agitation rather than by hand stirring.
9. If a spill on clothes occurs, stop, remove clothes and wash thoroughly.

UNIT IX SUMMARY

Summarize the major points covered in this Unit's activities.

A. It is important to mix pesticides correctly. Correct mixing will ensure that pesticides are used safely and effectively. Since it is at the mixing stage that pesticides are handled in a very strong, or concentrated form, mixers are often victims of pesticide poisoning. It is important to follow correct mixing steps to limit the possibility of such an accident.

B. There are several steps to follow before the actual mixing of a pesticide is begun. One of these is to find a suitable place. This place should be well ventilated, well lighted, and away from other people and pets, and livestock. Put on protective clothing and check to make sure that this clothing does not have any tears in it which might let pesticide come into contact with your skin. The protective clothing includes a waterproof smock, boots, gloves, goggles, hat and respiratory equipment. Finally, read the pesticide label for mixing instructions before the pesticide container is opened.

C. There are safety steps to follow while mixing. A sharp knife should be used whenever opening a paper pesticide container. This will prevent jagged edges which may be dangerous. Pesticides should be held well below eye level at all times. Measure carefully, following label directions. Avoid back siphonage by holding hoses outside the spray tank when adding water to mix. Mix the poison solution by agitation while it is inside the spray tank and the lid is on, rather than stirring by hand through the spray

tank opening. Stand so that the wind will not blow pesticide on you while you mix. If an accident does occur, STOP! and tend to the situation.

TO THE TRAINER: Conclude this Unit with a question and answer period. Ask the learners if they have any questions about the topics discussed in this Unit. After their questions have been addressed, ask the trainees the questions from page 188 to test their understanding of the material that has been presented.

QUESTIONS

UNIT IX: "Mixing Procedures"

1. Why are mixers of pesticides among the highest percentage of pesticide poisoning victims?
2. What three steps should be taken before beginning to mix pesticides?
3. Describe a "suitable" place for mixing pesticides.
4. What kind of protective clothing should be worn while mixing?
5. What will the label tell us about mixing?
6. What is the correct procedure for opening paper pesticide containers?
7. When mixing, should the pesticide be held (a) at eye level; (b) below eye level; or (c) slightly above eye level?
8. Replace all _____ to pesticide containers to prevent a spill.
9. What is back siphonage and how can it be prevented?
10. What can happen when back siphonage occurs?
11. How should we rinse pesticide containers after we have poured the pesticide into the spray tank to be mixed?
12. What is the correct procedure for mixing pesticides?
13. How can you keep the wind from blowing pesticide on your skin?

UNIT X: CLEAN UP OF PESTICIDE SPILLS AND DISPOSAL OF CONTAINERS

UNIT OVERVIEW

After a person has bought, mixed and applied pesticides, the job is not over! Empty pesticide containers cannot be treated like any other household garbage. Some of the pesticide chemical will be left inside the container. Even this tiny amount can be dangerous.

Also, no matter how careful you are while handling pesticides, accidents do occur. Pesticides may easily be spilled. Or pesticide containers in storage may break or crack, resulting in a leak that must be cleaned up immediately. This Unit will deal with the problem of disposal and clean up of pesticides and their containers.

The following 2 topics are covered in this Unit.

A. CLEAN UP OF PESTICIDE SPILLS.

B. DISPOSAL OF PESTICIDE CONTAINERS.

OBJECTIVES:

The objective of this Unit is to learn proper methods of pesticide container disposal and what to do when a spill happens. By the end of Unit X, the learners should know:

1. Several disposal methods and their advantages and disadvantages.
2. How to handle a pesticide spill safely.

This Unit requires approximately 2 hours to complete and also requires the following teaching materials.

TEACHING MATERIALS PROVIDED	TEACHING MATERIALS YOU MUST PROVIDE
None.	Basic safety equipment (see Unit VII).
	Bag of lime or Bag of ground up charcoal.
	Bag of sawdust.
	Soap.
	Mops and Brooms.
	Plastic bags.

TOPIC A. CLEAN UP OF PESTICIDE SPILLS

Purpose: To learn what to do in the event of an accidental spill or if a stored container is found to have a leak.

By the end of Activity A, learners will know:

1. What to do if pesticide is accidentally splashed on someone;
2. What to do if the pesticide spill is too big for them to handle;
3. How to clean up a minor pesticide spill.

STEP 1. PLANNED PESTICIDE SPILL

> TO THE TRAINER: Prior to staging this "accident", be thoroughly familiar with Unit X. It is important for you to review this Unit before proceeding with the "accidental" pesticide spill drama. The contents of the container you will spill may be:
>
> 1. A Dust (use flour rather than a real chemical), or
> 2. A Granular (use some type of chicken or cattle feed), or
> 3. A Liquid (use an ordinary household floor cleaning liquid compound).
>
> Of the three, the granular is the easiest to clean up.
>
> DO NOT USE A GENUINE PESTICIDE!

DRY SPILL:

In order to have everyone's attention when this "accident" occurs, pick up a "pesticide container" as you finish the questions on page 188 and begin talking about the lack of need to mix that compound (e.g., dust or granular), then "accidently" drop it. Make it look like a real accident and be

sure that the material spills. Be startled, too! React by initially moving away from the area rapidly.

Next, take appropriate action: remove any soiled clothes, wash off any "pesticide" that may have gotten on you and make sure trainees near you do the same, then direct clean up of the spill.

For this "spill", you will need certain equipment and materials:

1. Safety equipment for all who help (use 2-3 trainees at most), including: rubber boots, rubber gloves, face masks, and eye goggles
2. Buckets with water
3. Soap
4. Mops and brooms
5. Plastic bags for disposal of "spill"

WET SPILL:

The wet spill should be performed with a liquid in a non-breakable container. Again, as you discuss the need for being careful with the pesticide, open the container and "accidentally" drop it. Be surprised. Move away from the spill. Try to be sure some material gets on your shirt and hands. Then, take appropriate action as in the "DRY SPILL" accident.

In order to clean up this wet spill, you will need all the materials listed for the dry spill, plus:

1. A bag of lime or a bag of ground up charcoal, and
2. A bag of sawdust.

No matter which type of spill you employ for this activity, use the proper safety equipment and procedures for performing the clean up. (Try to complete this simulation in 30 minutes).

STEP 2. CASE REVIEW

TO THE TRAINER: Review what happened in Step 1 prior to, during, and immediately after clean up following the accidental "pesticide spill". Ask the following type of questions:

What type of compound was spilled?

Did any product get on anybody?

What happened immediately after spill?

Was basic safety equipment being worn when spill occurred?

Who cleaned up spill?

STEP 3. PRESENTATION: PREVENTING ACCIDENTS

Even when care is taken in handling pesticides, accidents occasionally happen. Pesticide chemicals may be splashed or spilled on the mixer as he pours the concentrate into the spray tank. Equipment that appeared to be in good working order before the applicator began spraying may suddenly and unexpectedly begin to leak. Or a pesticide container in storage may crack, spilling its dangerous chemical contents in the storage area. The pesticide user has to be prepared to deal with these problems.

<u>The best way to deal with these kinds of accidents is to prevent them from occurring in the first place</u>. Keeping in mind that pesticides are poisons,

follow safety rules and handle pesticides carefully at all times. If an accident does occur, knowing what to do may save someone's life.

Let's talk about what to do if we see that there has been a pesticide spill.

STEP 4. SIMULATION: REACTING TO SPILLS

The most serious kind of pesticide spill is one in which the chemical has been spilled on someone. This demands action right away!

If you spill pesticide on yourself (or someone else), stop and remove your (or the victim's) clothing at once. Wash your (or the victim's) skin with soap and water. Get out of the area where the spill occurred. And finally, if possible, see a doctor or take the victim to a doctor.

> TO THE TRAINER: Tell the trainees that they are going to simulate a spill situation. Ask for two volunteers. Indicate that one volunteer has spilled pesticide on his arm and that the other must act out the proper steps to handle the situation. The "victim's" shirt should be removed and soap and water should be made available so that this step can be acted out. Have the rest of the learners observe the simulation and offer suggestions to their classmates who are playing the parts.

STEP 5. PRESENTATION: USING SAFETY EQUIPMENT

Even if a spill has occurred and no one has been splashed by the chemical, your main concern should always be the safety of yourself and others. ALWAYS WEAR SAFETY EQUIPMENT WHEN HANDLING PESTICIDE OR CLEANING UP SPILLS!

The first decision you must make when you see that a pesticide spill has occurred is whether or not the situation is small enough for you to handle. In any case, clean up should never be done alone! Sometimes a spill is too big and none of us should try to clean it up alone. The clean up job may be too big for us to handle. Then, what do you do?

If this happens, here is what we can do until help arrives: Keep the spill from spreading. This can be done by sprinkling sand or soil around the edge of the spill.

Block off the area with rope, signs, logs, or anything which is available. Keep people away! Notify the extension agent or local authorities for help.

STEP 6. PRESENTATION: NEUTRALIZATION OF WET SPILLS

If you believe that a wet spill is small enough for you to clean up by yourself, confine it by sprinkling sand or dirt around the edges. Block off the area to keep people away.

Use sand, lime, charcoal, dirt or sawdust to soak up the wet spill. Pour the sand or dirt into the spilled solution until it becomes thick enough so that it can be shoveled into a leakproof container for disposal. Dispose of the spilled material just like you would surplus pesticides. Do not hose down the area with water! This will only spread the chemical.

The spilled chemical at this point is dangerous because of its chemical action. This action must be stopped so that the area where the pesticide has been spilled will not be hazardous. You can stop this chemical action by a process called neutralization with the use of lime or bleach.

The neutralization of pesticide chemical can be compared to the following situation.

Suppose that you had heated water in a container over a fire and it has become so hot that it would badly burn anyone who touched it. The water is dangerous because of its boiling action. But the boiling action can be stopped. If you add enough very cold water to the container, the boiling action ends and the water in the container becomes cool enough that it is no longer dangerous to touch. The heated water has been neutralized by the cold water.

In this same way, you can add something to the spilled pesticide to neutralize the area. Neutralization will make the area safe. Sprinkle substantial quantities of lime, bleach or coarsely ground charcoal on the

area to stop the pesticide's chemical action. After the area has been neutralized, shovel the dry lime or charcoal into a heavy gauge plastic bag for disposal. Once all wet pesticide has been neutralized with lime or charcoal and picked up, then water may be used. Water down the area thoroughly, collect the rinse water and hold it for disposal. Bury the wastes in an out of the way location as soon as possible.

STEP 7. PRESENTATION: CLEAN UP OF DRY SPILLS

Granular baits and dusts are generally easier to clean up than wet spills, but still may be dangerous. The use of safety equipment is still required (eye goggles, face mask, rubber gloves, rubber boots, etc.). Dust should not be swept up with a broom nor should granules be picked up by hand. Proper disposal of spilled material is also required (see step 6).

Cleaning up spills of dusts can be facilitated by sprinkling sawdust over spilled dust first. This will help keep the dust from becoming airborne when gently eased into a dust pan. Excess use of sawdust is preferable to risking inhalation of dust if enough sawdust is not used. A wet clean up may be conducted after all the dry material is picked up for disposal.

Cleaning up spills of granulars is less problematic but safety equipment should still be used. Addition of sawdust will help pick up most fine particles. Wet cleaning should follow the dry clean up.

STEP 8. SUMMARY

Conclude Topic A with a brief summary of the points covered. Be sure to include the following:

1. Even when you are careful, a pesticide spill may occur. Know what to do when this happens.
2. If the chemical has been spilled on someone, immediately remove clothing and wash skin with soap and water.
3. If the spill is too large for you to handle: confine its edges with dirt or sand; block off the area; and, get help.
4. If the spill is minor: confine its edges; block off the area; absorb the spill with dirt or sand; shovel wastes into leakproof container; sprinkle the area with lime, bleach or coarsely ground charcoal; pick up the "dried" and neutralized pesticide waste with a shovel and place into containers for disposal; wash down the area; and, collect and dispose of wash water.

TOPIC B. DISPOSAL OF PESTICIDE CONTAINERS

Purpose: To learn how to dispose of pesticide containers. By the end of Topic B, learners will know:

1. Several ways to dispose of pesticide containers;
2. Which of these ways is best in certain situations; and
3. The meanings of the words surplus and encapsulation.

STEP 1. PRESENTATION: THE NEED FOR DISPOSAL

Disposal of pesticide containers should be taken very seriously. Even when all the pesticide has been used, some residue will be left behind inside the container. It may be only a tiny amount, but even this amount can be enough to contaminate the environment or poison someone! Containers should not be reused!

One way to avoid having left over, or surplus, pesticide is to plan very carefully when you buy and mix the chemical. Buy and mix only what you think you will need. Any extra pesticide that has been mixed in the mixing tank must be disposed of or discarded. The first rule to remember regarding disposal is, if possible, to use all of the pesticide in the tank. If there is some pesticide left in your tank after you have sprayed the recommended dosage on your target area, you might use the remaining chemical to spray another crop. (Make sure it is a crop that is approved on the pesticide label!) If you cannot spray the left-over pesticide, you will have to dispose of it in another way.

STEP 2. PRESENTATION: DISPOSAL OF SURPLUS PESTICIDES

But, sometimes a surplus cannot be avoided. There are several safe ways to dispose of surplus. One is to simply return the chemical to the vendor.

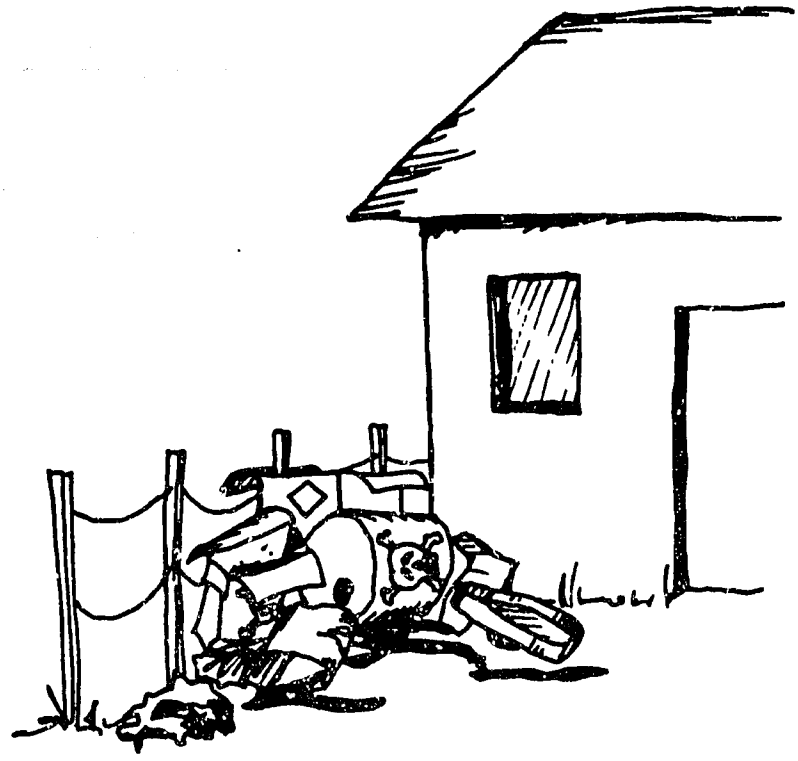
Check with your vendor or the pesticide manufacturer before you purchase it to see if you can return the leftover pesticide.

If not, another answer to the problem of disposal is to dilute, or weaken, the surplus, and to spray small amounts of it in an area where you are sure it can do no harm. Add about the same quantity of lime to the leftover tank mix as there is pesticide in the mix of water and pesticide. This will dilute the solution.

If there is ever a waiting period before you can properly dispose of surplus pesticide, keep the container in your locked storage area.

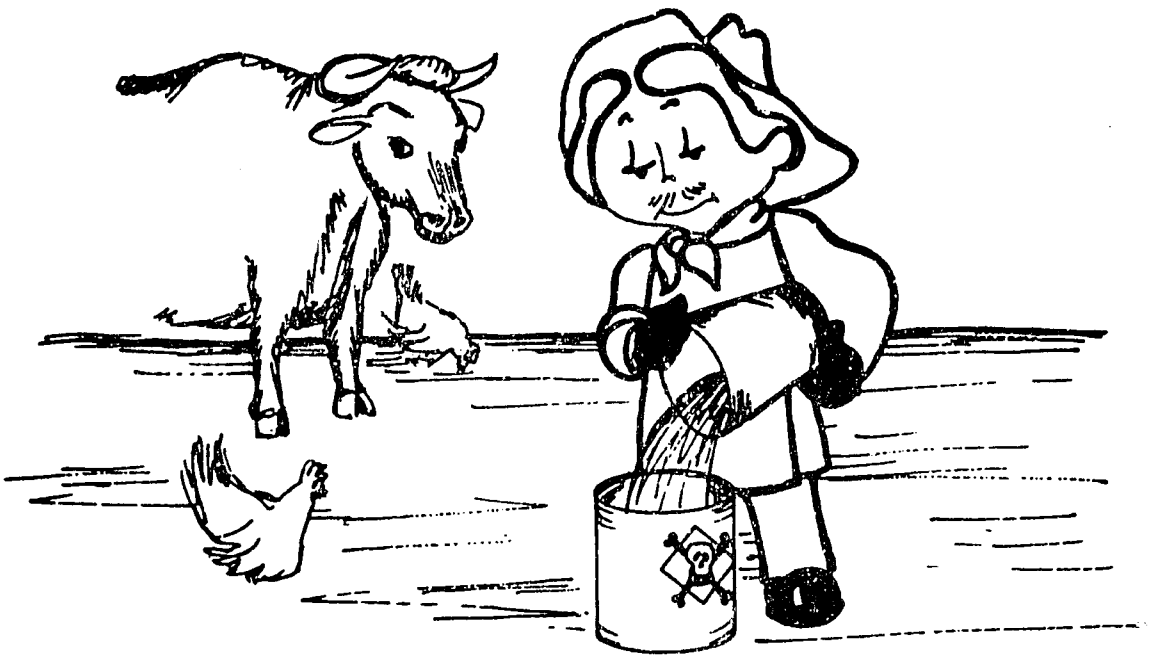
STEP 3. PRESENTATION: PROPER DISPOSAL OF CONTAINERS

"Empty" containers can be dangerous! Try to return them to the vendor. Do not toss them in streams or ponds. Do not leave them lying around. Remember: Never re-use pesticide containers.



"Empty" pesticide containers should not be used to store food, feed or seed. Any amount of pesticide left inside the container is enough to contaminate anything stored inside and cause poisonings or death.

Do not use the "empty" containers to hold water for animals or people. This can kill!



STEP 4. PRESENTATION: DISPOSING OF CONTAINERS

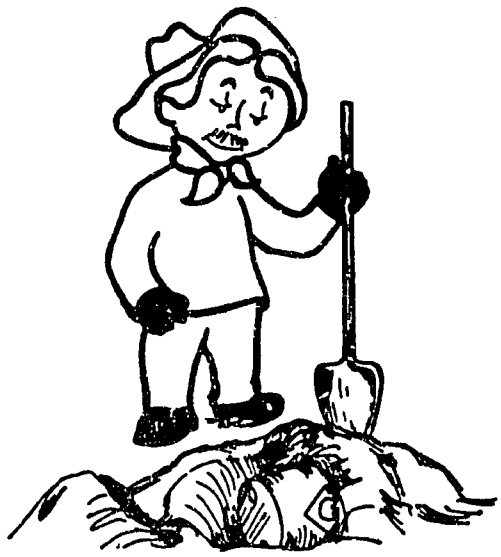
There are several proper ways to dispose of "empty" containers. The one that is right depends on the kind of container it is and what kind of pesticide it has stored. Generally, pesticide containers can be divided into one of three types:

1. Containers that will burn. These containers are usually wood, cardboard or paper. Check with an extension agent before you burn these containers to make sure it is safe. If it is safe, burn them only in a special high temperature incinerator. This will prevent poisonous gases from mixing with the air you breathe. Never burn containers in the open air or in an ordinary incinerator! The extension agent can tell you where the nearest proper incinerator is.

2. Containers that will not burn. These containers are usually made of glass, plastic or metal. If the manufacturer won't take them back, crush or break them so that they will be smaller and easier to store. Metal can be crushed. Glass can be carefully broken. Plastic can be cut apart.

Store these crushed or broken containers in a locked disposal or storage area until they can be permanently disposed of.

One way to permanently dispose of crushed containers is to bury them. Be careful to choose a burial site away from living things and water systems. Ask your extension agent if there is a special burial site in your area.



3. Containers that have stored mercury, lead, cadmium, arsenic or inorganic pesticides. These containers should be treated very carefully since they have stored very hazardous chemicals. Do not burn these! A method called "encapsulation" is the best for these containers. Encapsulation means to store them in a sealed, waterproof container so that the contents cannot escape. Check with the extension agent when disposing of these containers.

STEP 6. SUMMARY

The main points covered were:

1. "Empty" containers still have some pesticide inside even after rinsing. This means that you should be careful and safe in disposing these containers.
2. Try not to have extra pesticide or a surplus leftover after applications.
3. Returning containers to the vendor or manufacturer is a good answer to disposal.
4. Do not leave pesticide containers lying around or throw them in streams or ponds. Don't use them to store food or water.
5. Containers which will burn should be burned in a special incinerator.
6. Containers which will not burn can be buried. Crush containers for easier handling.
7. Treat mercury, lead, cadmium, arsenic and inorganic pesticide containers carefully.
8. Encapsulation means to enclose in a sealed, waterproof container.

UNIT X SUMMARY

Briefly summarize the points covered in this Unit:

A. If a pesticide is spilled on someone, remove the person's clothing and wash their skin with soap and water. If possible, take the victim to a doctor. If a pesticide spill has occurred, you must decide if it is minor enough for you to handle on your own. If the spill is large or you are not sure what to do, block the area off and keep people out of the area. Confine the edges of the spill by putting a ridge of soil or dirt around the spill. Call for help. If the spill is minor, do the same things mentioned above for serious spills. Then sprinkle an absorbent material such as soil, sand or sawdust on the spilled chemical until the solution has been absorbed and is thick enough to be shoveled into a leakproof container for disposal. Stop the chemical action in the area of the spill by neutralizing it with lime or bleach. Water down the area. Collect rinse water.

B. Try to use all the pesticide that you mix. If this is not possible, try to return the leftover, or surplus, to your pesticide vendor or manufacturer. Another way to get rid of surplus is to dilute, or weaken, the chemical that remains. Dilute the surplus in the spray tank with lime or clorox bleach. Spray this diluted mixture in an area where you are sure it will not cause damage. You can spray the surplus on another crop, if the label indicates it is OK. Properly store surplus until you dispose of it.

C. Even empty containers are dangerous. Try to return empty containers to the vendor. Burn them if they are burnable. Make sure that you do it in a special incinerator. Pesticide containers can also be crushed and buried. Another method of disposal is called encapsulation that involves putting the surplus in a waterproof, leakproof container. Check with the extension agent if you have any questions about disposal. Also, read the label for any special instructions.

TO THE TRAINER: Conclude this Unit with a question and answer period. Ask the learners if they have any questions over the topics discussed in the Unit. After their questions have been answered, ask them the following questions to test their understanding of the material that was presented. Also, conduct the recap on the case study.

RECAP OF CASE STUDY

Again review the "pesticide spill" which happened at the beginning of Topic A.

1. What happened just prior to the spill?
2. What was spilled?
3. How did the spill happen?
4. Did any product get on anybody?
5. What did these people do? How soon?
6. How could this "spill" have been avoided?
7. Is it a good idea to work with pesticides inside when they could have been worked with outside? Why or why not? What limitations are there?
8. Who cleaned up the spill? How much time did it take?
9. What was used? List items on board.
10. What was done with the "contaminated" material which was cleaned up?
11. What was learned as a result of the "spill"?

QUESTIONS

UNIT X: "Clean Up of Pesticide Spills and Disposal of Containers"

1. Why is it important to avoid having any leftover pesticide?
2. What are two methods for disposing of leftover pesticide?
3. What does the word surplus mean?
4. Why are "empty" containers dangerous?
5. Name three things that we should not do with "empty" pesticide containers.
6. What is the correct procedure for disposing of containers that can burn?
7. Why is it important not to burn pesticide containers in the open air or in an ordinary incinerator?
8. What is the correct procedure for disposing of containers made out of glass, plastic or metal?
9. Containers that contain mercury, lead, cadmium, arsenic or inorganic pesticides should not be encapsulated. True or False?
10. What does encapsulation mean?
11. Name three steps to follow if someone spills pesticide on his or her skin.
12. When should you not try to clean up a pesticide spill by yourself?
13. List three steps to follow if the pesticide spill is big and you know that you need help.
14. What does neutralization mean?
15. How can an area where a pesticide has been spilled be neutralized?

UNIT XI: SAFE STORAGE OF PESTICIDES

UNIT OVERVIEW

Children are at a special risk for pesticide poisoning. Their poisoning is very often the result of improper storage. The sequence of events is repeated all too often: a child at play comes across a pesticide in a bottle that reminds him of his favorite drink. The chemical pesticide is swallowed . . .! Adults are also often poisoned as a result of improper storage. Pesticides are stored on the same shelf as food products or animal feed. Grabbing the wrong sack, box or bottle is an easy but fatal mistake to make.

This Unit stresses the importance of proper storage procedures and includes the following topics:

A. WHY IS PROPER STORAGE IMPORTANT?

B. PROPER STORAGE PROCEDURES.

C. TROUBLE SHOOTING.

OBJECTIVES:

The objectives of this Unit are to learn how to prevent pesticide accidents and how to prolong the effectiveness of pesticides by storing them properly. By the end of this Unit, the learners should:

1. Be aware of the need to store pesticides properly.
2. <u>Know how to store</u> pesticides properly.
3. Be able to handle some common storage problem situations that may occur.

This Unit will require approximately 1-1/2 hours to complete. No special teaching material is required.

TOPIC A: WHY IS PROPER STORAGE IMPORTANT?

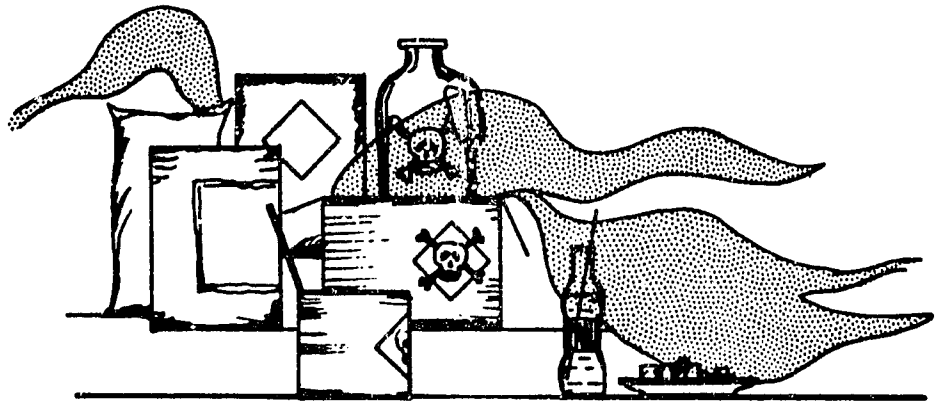
Purpose: To explain to trainees the reasons why it is important to properly store pesticides. By the end of Topic A, they will:

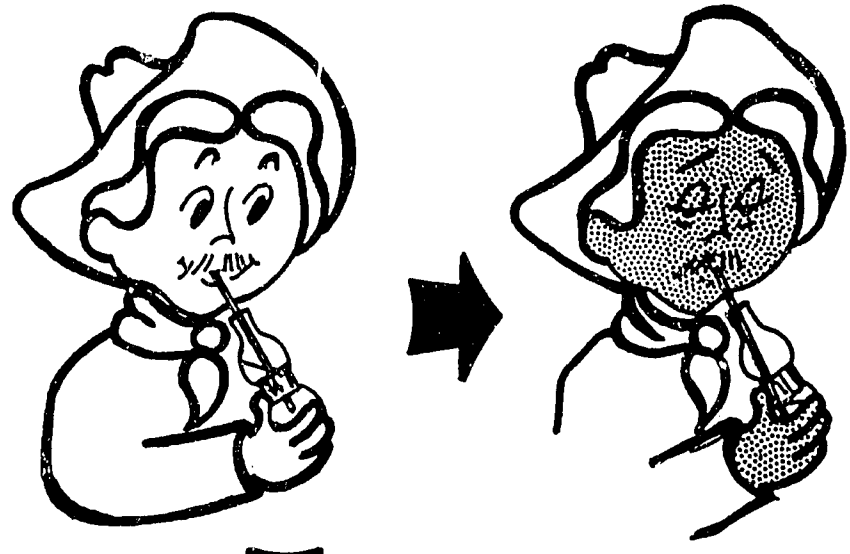
1. Be able to name three of these reasons.
2. Understand the term "shelf life".

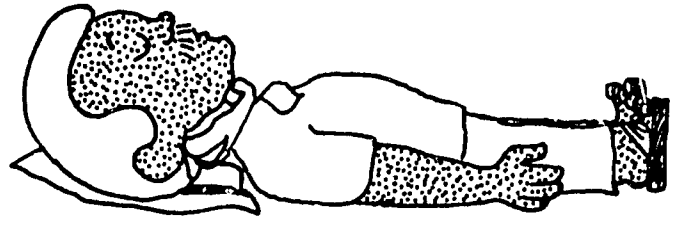
STEP 1. ILLUSTRATION: IMPROPER STORAGE/BAD PROBLEMS

Tell the learners that you have a story you would like to share with them.

TO THE TRAINER: With the use of this picture series, ask the learners to tell the story illustrated here. Characters can be named to make the story realistic.







Ask the trainees to name one reason why pesticides should be safely stored (Suggested answer: to protect our children). Point out that children are not the only ones who can make this mistake. Whenever pesticides are stored near food or near living space for people or animals, there is a risk of making a deadly mistake.

This is only one important reason to store pesticides properly. There are at least two more reasons that we should consider.

STEP 2. DISCUSSION

Ask learners to each come up with two reasons to properly store pesticides. Then, go around the group, ask each learner for one reason. List those on the board.

STEP 3. PRESENTATION: REASONS FOR PROPER STORAGE

When pesticides are improperly stored, damage to the environment can result. Leaky containers will release chemicals that kill plants and animals. Poisons in containers without lids can release dangerous vapors into the air. And pesticides stored near a water supply can easily make the water poisonous, killing fish and other animals that live in the water and harming animals and people who drink the water.

There is also a third important reason to store pesticides properly.

Just as each of us has a life that lasts a certain number of years, a pesticide only lasts (or is good for) a certain amount of time. The amount of time that a pesticide can be stored (and still keep its effectiveness) is its "shelf life." And just as a person who takes good care of himself or herself should live a longer life than someone who doesn't, a pesticide

that is stored properly and receives some care will have a longer shelf life than a pesticide that isn't stored properly. In other words, storing pesticides properly will make them last longer. This saves money!

STEP 4. SUMMARY

Summarize the reasons for safe storage procedures.

1. Proper storage will help keep your family and friends safe.
2. Proper storage will help keep the environment safe.
3. Proper storage will help prolong the effectiveness or "shelf life" of pesticides and save you money.

TOPIC B. PROPER STORAGE PROCEDURES

Purpose: To provide guidelines for properly storing pesticides. By the end of Topic B, trainees should know:

1. Where pesticides should be stored, and
2. How pesticides should be stored.

STEP 1. PRESENTATION: RULES FOR STORAGE

The following are general rules for storing pesticides of all kinds:

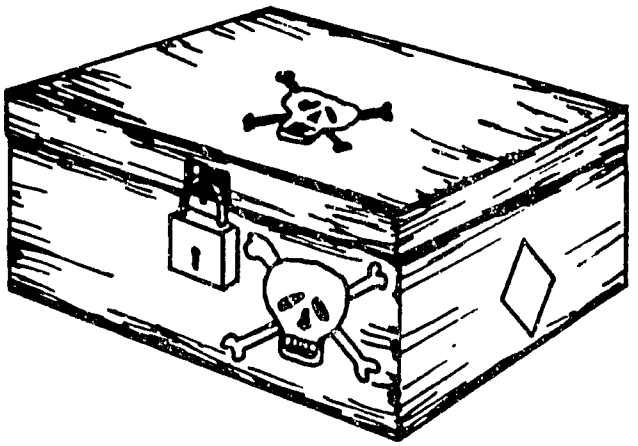
1. Have a special place for storage.
2. Keep untrained people and children away from this place.
3. Use properly labeled containers for pesticide storage.
4. Be familiar with and know how to correct common storage problem situations.

Let's take a look at each rule a little more closely. We will look at rules 1-3 in Topic B and Rule 4 in Topic C.

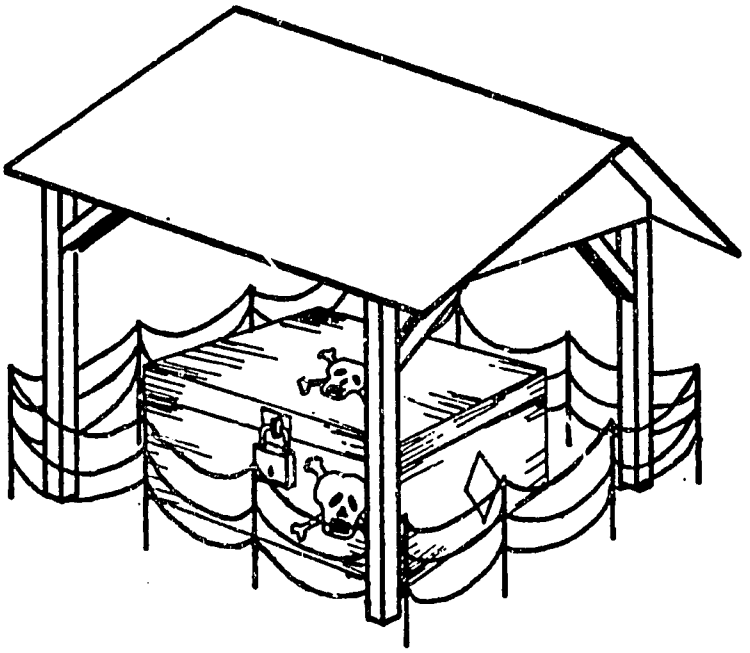
STEP 2. PRESENTATION: RULE 1

Rule 1: Have a special place for storage. Just as you have a special place for other things that are important to you, have a special place to store pesticides. If possible, a special storage room or building should be used. This room or building should be kept locked and labeled with warning signs at each point of entry and on all sides.

If such a room or building is not available, a storage box that can be locked and labeled should be used.

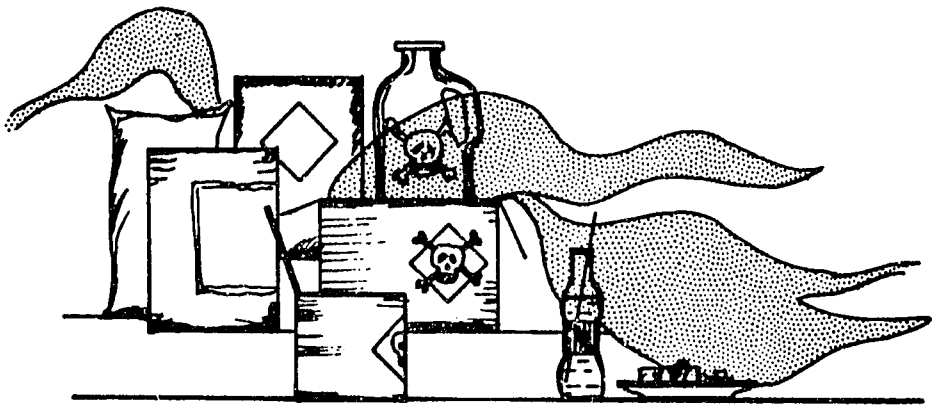


Keep the box out of the reach of children.



TO THE TRAINER: See plans for storage box and shed in Unit XVI. Which plans you use will depend on the financial ability of those you are working with.

The storage area should be away from food, feed, seed and water.



The special storage area should also be dry, cool, out of direct sunlight, and sheltered from freezing or overheating. It should also be well ventilated.

> TO THE TRAINER: Ask how the learners store their pesticides! Hold discussion for 5-10 minutes.

STEP 3. PRESENTATION: RULE 2

Tell the learners that rule 2 is perhaps the most important:

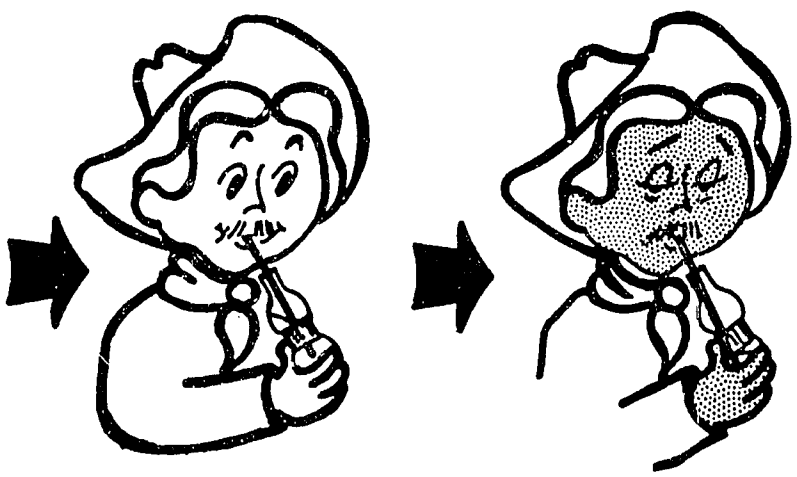
Rule 2: Keep untrained people and children away from your special pesticide storage space. In order to prevent accidental poisonings, pesticides MUST be stored away from people (and animals) who might mistake the chemical for a food product or handle the pesticide dangerously. Also, when pesticides are stored near food or water, it is easy for a leak from a container to contaminate the food or water and make it poisonous. Your special storage place should be away from living areas.

TO THE TRAINER: Ask trainees if their current storage practices follow Rule 2.

STEP 4. PRESENTATION: RULE 3

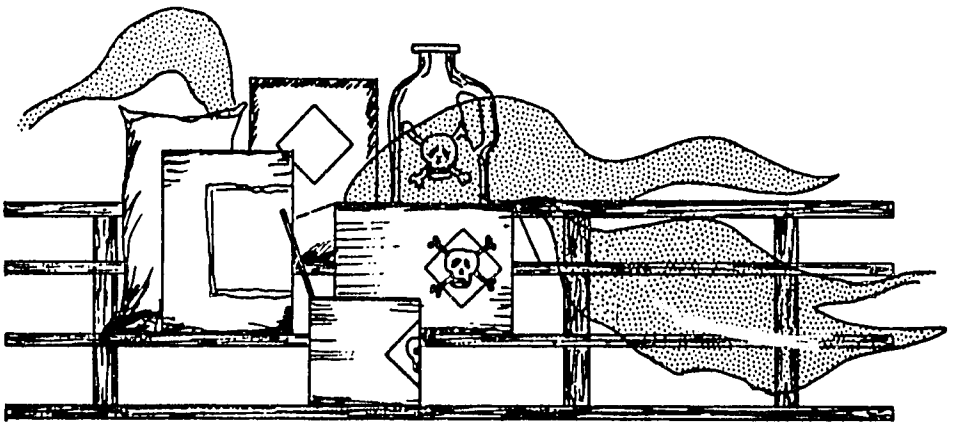
The third rule:

Rule 3: Use proper containers for pesticide storage. There are several things to think about concerning the containers used to store pesticides and the manner in which these containers are stored. Pesticides should ALWAYS be stored in their original, labeled containers. They should not be transferred to a different kind of bottle, especially one that is similar to those used for drinking. Remember the story in Topic A:



To prevent such mistakes, store pesticides in their original, labeled container.

Pesticide containers should ALWAYS be covered with fitted lids to prevent vapors from escaping into the air. Pesticides without lids pose not only a contamination and safety problem, but also the risk of a decreased shelf life for the pesticide.



Do not store pesticide containers directly on the ground. Rather, keep them elevated from the ground or floor by secure shelves of some sort.

TO THE TRAINER: Ask learners if they follow Rule 3. Ask how they can improve their storage of pesticides.

STEP 5. SUMMARY

Conclude Topic B with a brief summary. These are the general rules to follow when storing pesticides:

1. Have a special storage place.
2. Keep untrained people and children away from this place.
3. Use proper containers for pesticide storage.
4. Finally, know how to correct a storage problem situation if and when one does occur.

Explain that some of these problems will be dealt with next.

TOPIC C. TROUBLE SHOOTING -- RULE 4

Purpose: To discuss problem situations that often arise when pesticides are stored. By the end of Topic C, the learners should know:

1. Examples of some of the common problems that may occur when storing pesticides.
2. How to handle some of these situations.

Three major potential storage problems exist: leaks, fires and flooding.

STEP 1. PRESENTATION: POTENTIAL PROBLEMS

Even when Rules 1 through 3 are followed and pesticides are stored correctly, problems may occasionally occur. That is why rule 4 is important. Be aware of, watch for, and be prepared to handle some common potential problems.

STEP 2. PRESENTATION: LEAKS

Leaks. Pesticide containers should be checked periodically to see if there are any leaks or breaks. If a container is damaged, transfer the contents to a container that has held exactly the same pesticide. Immediate action should be taken to clean up any resulting spills, according to the procedures given in Unit X, "Clean up of pesticide spills and disposal of containers."

STEP 3. PRESENTATION: FIRES

Fires. The risk of fires and explosions is very great with the storage of some pesticides. There are certain chemicals that have warnings on their labels such as:

"Danger - Extremely Flammable!
Keep away from sparks and heated surfaces."

"Warning - Flammable! Keep away from heat and open flame."

or

"Do not use or store near heat or open flame."

These pesticides should be watched closely. Care should be taken to make sure that they are not exposed to overheating or flame. Even lighting a cigarette near these containers can cause an explosion! Fires that involve pesticides present unique problems. Both the fumes from the fire and the residue after the fire are poisonous.

Once a fire begins, protective clothing and breathing equipment should be worn and the following rules observed:

1. Stay upwind of the fire.
2. Keep a safe distance from a fire in which pesticide containers are present since they may explode if they become overheated.
3. If the fire cannot be fought successfully from a position where air is suitable to breathe, people should move away and the property should be allowed to burn. Sense of smell can serve as a warning here.
4. The use of large, heavy hoses should be avoided since the force of their water streams can spread contamination.

5. As much as possible, confine wastes for collecting and proper disposal. Runoff water from a fire can contaminate streams.
6. After the fire has been put out, the hot pesticide residues can give off dangerous vapors. No one should enter the area until these deposits of pesticides have cooled.

> TO THE TRAINER: Stress to the learners that pesticide related fires are VERY DANGEROUS. Protective clothing is very important and a safe amount of distance should be maintained between the firefighter and the fire!

STEP 4. PRESENTATION: FLOODS

Floods. Stored pesticides create very serious problems should they become involved in a flood. The flood water can become contaminated with pesticides, poisoning everything and everyone with whom the flood water comes into contact. Pesticides packaged in soaked cardboard or paper may be ruined and present problems of handling and disposal even after drying out. Even products stored in water-tight containers are not safe--they may float away, hit an obstacle, and spill their contents.

An important preventative measure to lessen the danger of pesticide contamination in the event of flooding is to store pesticides in an area where they can remain relatively dry during flooding. This will probably need to be an elevated area.

The following steps should be taken if pesticides are involved in a flood.

1. If any pesticide containers have been carried away from the storage site, every effort must be made to locate and collect them. Keep an inventory of the pesticides you have in storage. An up-to-date inventory list of what kind and how many pesticides you store will help identify missing containers in the event of flooding or other emergencies.

2. If the water has become contaminated, people or communities who have access to this water supply should be notified.

STEP 5. SUMMARY

Conclude Topic C with a summary:

1. In case of leaks or breaks in pesticide containers, transfer the contents into a container that has held exactly the same pesticide. Clean up spills according to procedures in Unit X.
2. Fires should be handled by firefighters who wear protective equipment, including respiratory devices. Distance should be maintained from the fire and from the pesticide containers that have been heated in the fire. Ashes and residue should be handled with care since they may remain toxic. Heated pesticide chemicals should be allowed to cool before people are allowed to enter the area.
3. Floods may carry away containers or damage them. Efforts should be made to locate any missing containers after a flood. Damaged containers should be replaced by containers that have held <u>exactly</u> the same pesticide. People who have access to water supplies that

may have been contaminated by flood waters that have carried pesticide should be warned.

UNIT XI SUMMARY

Briefly outline the major topics discussed in Unit XI:

A. There are three important reasons to store pesticides properly:

1. Proper storage will help to prevent poisoning accidents,
2. Proper storage will help protect the environment, and
3. Proper storage will help prolong the effectiveness or "shelf life" of pesticides.

B. General rules for properly storing pesticides are:

1. Have a special place that is isolated from areas where people or animals live, preferably a separate building or room, or at least a box that can be locked and labeled with warning signs.
2. The place should be out of reach of children and away from food, feed, seed and water. It should be dry, cool, out of direct sunlight, and sheltered from freezing or overheating. And finally, the storage area should be well ventilated.
3. Proper containers should be used for pesticide storage. Pesticides should always be stored in their original labeled containers. The containers should be covered with lids. The containers should be elevated from the ground by shelves or blocks.

C. Even when proper storage methods are followed, accidents may occasionally occur. In case of leaks or breaks in containers, the contents should be carefully transferred to a container which has held exactly the same pesticide.

Fires should be approached with care since pesticide induced fires present special risks. Firefighters should keep a distance. Remains left after the fire should be handled with care and pesticide residue that remains after the fire should be allowed to cool before people enter the area.

An inventory should be kept of the pesticides that you keep in storage. Thus, if a flood or some other emergency occurs, you will know if any pesticide containers are missing. If so, retrieve them. Warn people who use water supplies that may have been contaminated by pesticides carried by the flood.

TO THE TRAINER: Conclude Unit XI with a question and answer period. Ask the trainees if they have any questions about the topics discussed in this Unit. After questions have been addressed, ask them the following questions to test their comprehension of the material presented.

QUESTIONS

UNIT XI: "Safe Storage of Pesticides"

1. Name three reasons why it is important to properly store pesticides.
2. What does the term "shelf life" mean?
3. Briefly discuss the special place where you would store pesticides. Where should this place be and what should it be like?
4. What kind of containers should pesticides be stored in?
5. Why should the containers have lids?
6. Should pesticides be stored on the ground? If not, where should they be stored?
7. Name three common problems that may occur when pesticides are stored.
8. What should you do if you discover that a pesticide container has a leak?
9. Name four safety measures that should be taken when fighting fires that involve pesticides.
10. Name two steps that should be taken if pesticides are involved in a flood.
11. Why should you keep a list of the pesticides you have in storage?

UNIT XII: APPLICATION EQUIPMENT AND CALIBRATION

UNIT OVERVIEW

It is estimated that 80% of the failures associated with the use of pesticides are due to improper applications, e.g. the use of incorrect dosages, equipment in bad repair or not calibrated correctly, and applications made under unfavorable environmental conditions. In order for a pesticide application to be economical and effective, the correct rate of the chemical must be applied.

The purpose of this Unit is to stress the importance of making a correct application of pesticides to obtain effective pest control. Use of the correct amount of pesticide also avoids a waste of money and reduces problems of phytotoxicity and environmental contamination.

Four primary topic areas are included in Unit XII. The topic titles are:

A. CORRECT APPLICATION.

B. CALIBRATION OF EQUIPMENT.

C. CALCULATION OF THE AMOUNT OF PESTICIDE.

D. APPLICATION EQUIPMENT: CLEAN UP, MAINTENANCE AND REPAIR.

OBJECTIVES:

The objective of this Unit is to assure a precise and uniform application of pesticides. At the end of this Unit, participants should know:

1. How to calibrate.
2. How to adjust the output/ha of a sprayer to any amount desired.

3. How to calculate the amount of pesticide to apply in a given area.
4. How to choose the correct equipment, clean and maintain it to avoid harmful residues.

The time required to complete Unit XII is approximately four hours and includes activities that require the following teaching materials:

TEACHING MATERIAL PROVIDED	TEACHING MATERIALS YOU MUST PROVIDE
None.	Different types of nozzles: flat, cone, impact, etc.
	Knapsack sprayers (lever-operated, compression or motorized).
	Buckets.
	Safety equipment (rubber gloves, boots, goggles, respirators, etc.
	Calibrated cylinders or beakers.
	Measuring tape (25-50 m).
	Sample pesticide labels from local area

TO THE TRAINER: Conversion factors of terms used in this Unit are:

1 hectare (ha) = 10,000 square meters (m^2)

1 liter (l) = 1,000 milliliters (ml)

1 kilogram (kg) = 1,000 grams (g)

TOPIC A. CORRECT APPLICATION

Purpose: To discuss several problems which result from faulty pesticide applications. At the end of this activity, participants should know:

1. Several factors which contribute to poor application of pesticides.

STEP 1. PRESENTATION: CAUSES OF POOR APPLICATION

A number of circumstances contribute to applications which produce unexpected and undesired results. Examples of these are:

1. Application of incorrect dosage (too much or too little pesticide), and
2. Use of contaminated or faulty equipment.

The use of an incorrect dosage of pesticide can cause a number of problems. For example, a pesticide that is applied at too high a dosage may:

-- waste pesticide and money

-- cause phytotoxicity (leaf burn, flower shedding, etc.)

-- speed up development of resistance

-- increase amount of pesticide residue in the soil

-- produce increased environmental contamination and human health risk.

If the pesticide is applied at too low a dosage, the pest may not be controlled, resulting in the need for additional control measures, thereby increasing production costs. Economic loss may also occur because of damage from the pest that was not controlled.

Other problems arise if the application equipment is in need of repair or has not been properly cleaned. Equipment in this condition may produce such problems as uneven applications, a loss of product or damage to the

crop because of pesticide leaks or pesticide residues, and unexpected contamination of the environment or of the operator.

> TO THE TRAINER: Inform the learners that it is very important for them to become familiar with the operation of a sprayer and to acquire a knowledge of the factors regulating its output (flow). This information will assist them with calibration of the sprayer and in making a correct application.

STEP 2. SUMMARY

Conclude this activity with a summary of the key points covered:

1. Use of an excessive dosage of a pesticide can:
    a. Waste money
    b. Cause phytotoxicity
    c. Accelerate development of resistance
    d. Increase soil residues
    e. Increase environmental contamination and human health problems.
2. When a pesticide is applied at too low a dosage, the following consequences may result:
    a. Pest may not be controlled
    b. Additional control measures may be required
    c. Economic loss to crop may occur from pest damage.
3. Pesticide application equipment that is contaminated or in a state of bad repair may cause additional problems, such as:
    a. Uneven application
    b. Loss of product

c. Contamination of operator and environment

d. Damage to crop from residues or leaks

TOPIC B. CALIBRATION OF EQUIPMENT

Purpose: To understand what is meant by calibration and to learn the factors that affect the output of a sprayer. At the end of this activity, learners will know:

1. Procedure for calibrating a knapsack sprayer.
2. Three basic factors that determine output of a sprayer.

STEP 1. PRESENTATION: DEFINITION OF CALIBRATION

The calibration of application equipment helps to ensure that the correct amount of pesticide is applied. This procedure is extremely important since, if accurately carried out, it will assist in safeguarding the operator, other persons, wildlife, crops and the environment.

Calibration is the adjustment of spraying equipment (and the operator) to a degree that permits the uniform distribution of a precise volume or amount of a pesticide in a determined area. These adjustments presume and require a general familiarity of the operator with the sprayer, a knowledge of factors regulating output (flow) of sprayer, and a suitable area where the actual spraying operation can take place.

STEP 2. PRESENTATION: FACTORS AFFECTING OUTPUT (FLOW) OF A SPRAYER

Three basic factors determine the output of a sprayer: size of nozzle orifice, speed and pressure. The output changes in direct proportion to changes in the size of the nozzle orifice, but changes inversely to speed. Pressure has a less direct effect on the change in output and is an approximate function of the square root of the change in pressure. These relations are illustrated in Tables 1 and 2.

Table 1. Influence of Nozzle Size and Pressure on Output

Size of Nozzle Orifice	Output in liter/min at 1.4 kg/cm^2	Output in liter/min at 2.8 kg/cm^2	Change in Output due to Pressure	Change in Output due to Size
8001	0.265	0.380	43	---
8002	0.530	0.760	43	100
8004	1.060	1.520	43	100

Table 2. Relation between output (liter/ha) and speed (at constant pressure)

Speed (km/hr)	Output (liter/ha)
3.0	600
4.5	450
6.0	300

Pressure is the least useful factor for making major adjustments in the output. For example, if 100 liters/ha is applied at 2.8 kg/cm^2 (40 lbs/in^2), and an increase in output to 200 liters/ha is to be obtained only by changing the pressure, the latter would have to be increased to approximately 11.2 kg/cm^2 (160 lbs/in^2). Obviously, such pressure is difficult or impossible to obtain with most equipment and would cause the rupture of several components. Accelerated wear of the equipment would also occur at such a high pressure.

A large change in sprayer output would best be achieved by changing the size of the nozzle orifice or modifying the travel speed of the opera-

tor (or tractor). With manual equipment, only minor adjustments in walking speed are advisable. Ideally, the operator should walk at a pace that is comfortable and which can be maintained for several hours during the spraying operation.

STEP 3. PRESENTATION: PROCEDURES BEFORE CALIBRATING SPRAYER

> TO THE TRAINER: Tell the participants that before they calibrate their equipment, it is important for them to inspect it to make sure it is in good repair, i.e. that the hoses are in good condition and connections fit tightly, without leaks, and that the control valve and other components function well.

Inspect and examine nozzles, hoses, valves, etc. before the sprayer tank is filled with water. The tank itself should be clean and care must be taken to ensure that it contains no pesticide residues. Lubricate moving parts and correctly adjust washers (seals). After water is added to the tank, pressure should be introduced into the system in the usual manner, then water is discharged through the wand and nozzle to determine if there are any leaks. Correct any equipment failures before proceeding.

STEP 4. DEMONSTRATION: CALIBRATING THE SPRAYER

Two methods will be presented for determining or measuring the volume of liquid applied in a given area with a lever-operated knapsack sprayer. For both methods, the individual should maintain a comfortable walking pace, maintaining a tempo or rhythm between walking and pumping that permits a high degree of uniformity in application. Both methods can also be used for calibrating manual or motorized sprayers.

TO THE TRAINER: The calibration methods explained on the pages that follow should be performed in the field by as many of the trainees as time permits. Select a nearby vacant dirt lot or cement playground for this exercise and arrange to have adequate transportation available to take participants to the site. Divide trainees into groups of 4-6 persons and provide a knapsack sprayer for each group's use. For this exercise, only water should be used. Emphasize to the class that calibration of their equipment should be done frequently and should be performed on the same terrain as that on which the proposed application will take place.

Before learners begin exercise, explain the procedures and concepts of calibration described in this Unit. If few of the learners are familiar with the knapsack sprayer, provide a demonstration of its use and operation. At the end of the practice, return to the meeting room and review the results of the calibration exercises obtained by each group.

Method A:

To determine the output [1/] of the sprayer, add a known quantity of water to the spray tank. Maintaining uniform pressure and speed, spray a known area and then determine the amount of water used. Calibration should take place on the same terrain where the pesticide application is to be made. The volume of output in liters/hectare may be calculated using the following formula:

$$\text{liters/ha} = \frac{\text{amount (liters) applied} \times 10{,}000\ m^2/\text{ha}}{\text{area } (m^2)} \qquad \text{(Equation 1)}$$

Example: 3.15 liters were used in making an application over an area 3 m x 50 m. This is equivalent to how many liters/ha?

- area = 3 m X 50 m = 150 m^2
- water used = 3.15 liters

$$\text{liters/ha} = \frac{\text{water used} \times 10{,}000\ m^2/\text{ha}}{\text{area } (m^2)}$$

$$= \frac{3.15 \text{ liters} \times 10{,}000\ m^2/\text{ha}}{150\ m^2} = 210 \text{ liters/ha}$$

[1/] Adding a pesticide to water modifies the viscosity of the solution and changes the flow (the output is nearly always reduced). Thus, it is recommended that the time spent in making the application be measured. In this way, after adding the pesticide, spraying into a container for the same period of time can be effected (maintaining the same pressure) and the output verified (the liquid collected is returned to the tank in order not to waste it). If there is a change in the output, the amount of product to be added to the tank may be adjusted.

Note: This procedure should be repeated until a consistent output is obtained. The amount of water needed for a given area is easily calculated using the following formula:

$$\text{liters/Area} = \frac{\text{output (liters/ha) X Area } (m^2)}{10{,}000\ m^2/\text{ha}} \qquad \text{(Equation 2)}$$

Remember! If a change in output is desired, speed, nozzle size or pressure (for small adjustments) may be changed.

Method B:

The procedure used in this method is similar to Method A except that the time needed to travel a measured distance is determined. With the equipment stationary and operated at a constant pressure, discharge water into a container during the same amount of time needed to cover the measured distance. The amount of water discharged is recorded and the width of the spray swath is measured to determine the total area sprayed. The output in liters/ha can then be calculated using the same formula as before.

For example: The time taken to spray an area 200 meters long was two minutes. A swath width of 1.45 m was produced. The sprayer is equipped with four nozzles and, on collecting the discharge for two minutes, an average of 1.785 liters per nozzle was obtained. What is the output of this sprayer per hectare?

Calculations:

Time to walk 200 m = 120 seconds

Width of spray swath = 1.45 m

Total water discharged in 120 seconds =

4 nozzles X 1.785 liters/nozzle = 7.14 liters

Area sprayed = 1.45 m X 200 m = 290 m^2

$$\text{Output/ha} = \frac{7.14 \text{ liters} \times 10{,}000 \text{ m}^2/\text{ha}}{290 \text{ m}^2} = 246 \text{ liters/ha}$$

Note: If spraying operations take longer than four hours, sprayer should be recalibrated. Each individual operator must calibrate with specific sprayer used.

STEP 5. SUMMARY

Summarize this activity with a brief review of the procedures used to calibrate a sprayer. The key points are:

1. Calibration of equipment is necessary to ensure that the correct amount of pesticide is applied to the area treated.
2. Three factors determine the output of a sprayer:
    a. Size of nozzle orifice
    b. Speed
    c. Pressure
3. Applicator, when spraying with lever-operated knapsack sprayer, should walk at a pace that is comfortable and should develop a rhythym in his pace between walking and pumping.
4. Equipment should be inspected carefully before use.

TOPIC C. CALCULATION OF THE AMOUNT OF PESTICIDE

Purpose: To present the computational procedures needed to determine the amount of pesticide to put in the spray tank. At the end of this activity, learners should know:

1. The amount of pesticide to put in tank to spray a determined area when the recommendation is made on the basis of:
    a. Commercial product
    b. Percentage of pesticide
    c. Active ingredient

STEP 1. PRESENTATION: CALCULATION OF AMOUNT OF PESTICIDE NEEDED

Prior to making calculations, several conversion factors need to be known:

1 hectare (ha) = 10,000 square meters (m^2)

1 liter (l) = 1,000 milliliters (ml)

1 kilogram (kg) = 1,000 grams (g)

Even after the recommended rate of a pesticide is known, how is the amount of pesticide needed for a given area determined? There are several things to know before making the calculations:

1. The rate of pesticide to be applied.
2. Area to be treated.
3. The % active ingredient (a.i.) of the pesticide in the commercial formulation (for certain recommendations).

In order to determine how much chemical to put into the spray tank, two additional facts are helpful: the calibrated output (liters/ha) (see Topic B) and the amount of water the tank holds. The first source of information concerning application rates is the pesticide label. Always

READ THE LABEL before applying a pesticide. A second source of correct application rates is the recommendation given by an extension agent or pest control advisor.

The recommendation given may be a precise amount of chemical in a given area, e.g. 1,500 g/ha or 1.0 liter/ha, etc. It may also be stated as a percentage or concentration in which a measured amount of pesticide is used for a specific amount of water, e.g. 10cc of pesticide/liter of water or 3 teaspoons per liter of water, etc.

> TO THE TRAINER: Distribute and discuss information contained in local pesticide labels. Inform the participants that, with all this information as background, they are now ready to learn how to calculate the exact amount of pesticide to put into the tank. Use the blackboard to solve the examples presented on this and subsequent pages. Ask learners to find the answers to additional problems you will provide.

1. Recommendation stated as commercial product in a given area or volume of carrier.

Normally, the pesticide dosage recommended on the label is given as the amount of commercial product (C.P.) that should be applied per hectare or the amount of C.P. that should be mixed in a specific amount of water.

If the recommendation is on a per hectare basis, then the amount to be applied in an area that is less or more than a hectare is determined by using the following formula:

$$C.P. = \frac{\text{recommended dosage X area } (m^2)}{10{,}000\ m^2/ha} \qquad \text{(Equation 3)}$$

Ex. - 1.0 liter/ha of Folidol is recommended

- Area to be sprayed = 1400 m^2

$$\text{Folidol/1400 } m^2 = \frac{1.0 \text{ liter/ha} \times 1400 \ m^2}{10{,}000 \ m^2/\text{ha}} = 0.14 \text{ liter}$$

Although several methods may be used to calculate amount of C.P. to be placed in each sprayer load when applying on an area basis, only two are presented here. The first (A) is frequently used for small areas where the amount of water needed is less than the sprayer tank capacity. The second method (B) is frequently used where more than one sprayer load is needed.

<u>Method A.</u> From Equation 2 calculate the amount of water needed for a given area. Then determine the amount of C.P. for the area by using Equation 3. The respective amounts of water and pesticide would then be combined and applied.

Ex. Recommendation = 2.0 liters/ha of Kocide (Liquid Fungicide)

Area to be sprayed = 190 m^2

Sprayer output = 210 liters/ha

Sprayer tank capacity = 15 liters

$$\text{From Equation 2: water/190 } m^2 = \frac{210 \text{ liters/ha} \times 190 \ m^2}{10{,}000 \ m^2/\text{ha}} = 3.990 \text{ l}$$

$$\text{From Equation 3: Kocide/190 } m^2 = \frac{2.0 \text{ liters/ha} \times 190 \ m^2}{10{,}000 \ m^2/\text{ha}}$$

$$= 0.038 \text{ liters or 38 ml}$$

Thus, 38 ml of Kocide would be added to 3.990 liters of water to spray the 190 m^2. The 3.990 liters of water could be reduced by 38 ml (the amount of pesticide) to give an exact

quantity of spray solution (3.952 liters), if more precision is desired.

Note: Most sprayers do not pump out 100% of the spray solution from the tank, pump, pressure chamber and hoses. When spraying small areas, this amount should be measured and at least this amount of extra water and a proportional amount of pesticide should be added to ensure coverage of the entire area.

Ex. In the above example, 3.952 liters of water and 38 ml of Kocide were used to spray 190 m^2. Assume that 540 ml of solution remain in the sprayer. The total volume of solution necessary to spray the 190 m^2 would be 3.952 liters + .540 liters = 4.492 liters, and the Kocide would have to be increased by a proportional amount (0.540 liters/3.952 liters X 100 = 14%), to maintain the desired dosage, i.e. 14% X 38 ml = 5.32 ml. The amount of pesticide which needs to be added after adjusting the volume of water can be calculated directly with the following formula:

$$\text{C.P.} = \frac{\text{Total water in liters}}{\text{Output (liter/ha)}} \times \text{desired dosage}$$

Thus in the above example,

$$\text{Kocide/190 m}^2 = \frac{\text{4.492 liters}}{\text{210 liters/ha}} \times \text{2.0 liters/ha} = \text{0.043 liters or 43 ml}$$

<u>Method B</u>. In this method, the C.P./liter of water is determined and multiplied by the amount of water in each sprayer load.

$$\text{C.P./liter} = \frac{\text{C.P./ha}}{\text{Output (liter/ha)}}$$

Example: Recommendation = 2.5 kg/ha of the C.P. Karmex

Area to be sprayed = 3000 m^2

Sprayer output = 180 liters/ha

Spray tank capacity = 15 liters

$$\text{Karmex/liter} = \frac{2.5 \text{ kg/ha}}{180 \text{ liters/ha}} = 0.01389 \text{ kg} = 13.89 \text{ g}$$

From Equation 2:

$$\text{water}/3000\ m^2 = \frac{180 \text{ liters/ha} \times 3000\ m^2}{10{,}000\ m^2/\text{ha}} = 54 \text{ liters}$$

Sprayer loads = 54 liters/15 liters = 3.6

The amount of Karmex needed in each of the first three sprayer loads = 13.89 g/liter X 15 liters = 208.35 g

The amount of Karmex to be added to the last sprayer load* is 13.89 g/liter X 9 liters = 125 g

---

* Assuming that 540 ml of solution remain in the sprayer, the amount of water and Karmex in the last sprayer load could be adjusted as previously explained for greater precision:

$$\frac{9.54 \text{ liters}}{180 \text{ liters/ha}} \times 2.5 \text{ kg/ha} = 132.5 \text{ g of Karmex}$$

The total amount of Karmex required is =

$$\begin{aligned} 208.35 \text{ g} \times 3 &= 625 \text{ g} \\ 125 \text{ g} \times 1 &= 125 \text{ g} \\ \hline & 750 \text{ g} \end{aligned}$$

This total can be verified using Equation 3:

$$\frac{\text{recommended dosage} \times \text{area}(m^2)}{10{,}000\ m^2/\text{ha}} = \frac{2.5 \text{ kg/ha} \times 3000\ m^2}{10{,}000\ m^2/\text{ha}} = .750\text{kg}$$

2. Recommendation stated as a percentage.

   a. In other cases, the amount of pesticide recommended is given as a measured amount of C.P. in a specific amount of water. In this case, multiply the amount of C.P./unit of water by the number of units of water.

      Ex. - The recommendation is 10 cc of Folidol/liter of water

      - tank capacity = 15 liters

      Folidol/tank = 15 liters X 10 cc/liter = 150 cc

   b. The recommended rate of pesticide may also be given as a percentage of the pesticide for a given volume of water. When this is the case, the percentage of pesticide is multiplied by the amount of water specified to obtain the amount of commercial product required. The following formula is used:

      C.P. = percentage of pesticide X volume of water

      Ex. - A concentration of 1.5% is recommended

      - amount of water = 12 liters

      C.P. = 0.015 X 12 liters = 0.18 liter

3. Recommendation on the basis of active ingredient.

   a. When research results are reported, it is common to refer to the amount of active ingredient (a.i.) used, instead of reporting the amount of commercial product. This is important as it enables individuals that work with different formulations of a pesticide containing the same active ingredient to compare their results and allows them to replicate the experiments of other workers. This is especially important when the active ingredient of a pesticide is available in different commercial brands or in different

concentrations, e.g. the product Folidol is available in both a 48% and 72% concentration of the a.i. methyl parathion.

To determine the amount of C.P./ha, the recommended dosage, given as active ingredient, is divided by the concentration, also expressed in active ingredient, of the C.P., or expressed mathematically:

$$C.P. = \frac{\text{Recommended dosage (a.i./ha)}}{\text{percent a.i.}} \qquad \text{(Equation 4)}$$

Ex. - The recommendation is 2.0 kg/ha of the a.i. diuron

- Karmex 80 WP contains 80% diuron.

$$\text{Karmex/ha} = \frac{2.0 \text{ kg/ha}}{0.80} = 2.5 \text{ kg/ha}$$

The Rule of Proportionality:

When the area to be applied is not a hectare, the amount of C.P. may be determined using a calculation of proportions.

Ex. Using the example above:

- amount of Karmex = 2.5 kg/ha
- area to be sprayed = 180 m^2

Karmex = 2.5 kg/ha: 10,000 m^2/ha

X: 180 m^2

= 0.045 kg

or

$$X = \frac{2.5 \text{ kg/ha} \times 180 \text{ m}^2}{10{,}000 \text{ m}^2/\text{ha}} = 0.045 \text{ kg}$$

However, there is a very simple formula for calculating the amount of C.P. needed to spray a given area if the recommen-

dation is presented on the basis of active ingredient, as follows:

$$C.P. = \frac{\text{recommended dosage in a.i. X Area}}{\text{concentration of a.i. (\%) X 10,000 } m^2/ha}$$

(Equation 5)

Ex. - 2.0 kg/ha diuron is recommended

- Karmex 80 WP contains 80% diuron
- area to be sprayed = 180 m^2

$$\text{Karmex/180 } m^2 = \frac{2.0 \text{ kg/ha X 180 } m^2}{0.8 \text{ X 10,000 } m^2/ha} = 0.045 \text{ kg}$$

In some instances, the recommendation may also be given on the basis of a percentage of the active ingredient. The following formula is used to calculate the amount of commercial product required:

$$C.P. = \frac{\text{percentage a.i. X amount of water}}{\text{concentration of a.i. (\%)}} \quad \text{(Equation 6)}$$

Ex. - Recommendation = 0.75% methyl parathion

- product = Folidol, 48% methyl parathion

$$\text{Folidol/liter} = \frac{0.0075 \text{ X 1.0 liter}}{0.48} = 0.0156 \text{ liters or 15.6 ml}$$

STEP 2. PRESENTATION: DROPLET SIZE AND NUMBER

After the appropriate chemical has been selected, and the correct dilution has been prepared in the spray tank, the next important step is to properly apply the recommended amount. "How much water is needed to obtain an adequate coverage of the crop to be sprayed?" is a question that is frequently asked. Actually, a more accurate way of phrasing the question

would be to ask, "How many drops per square centimeter are required to obtain adequate biological efficiency?" The answer to this question depends on the pest as well as on the kind of pesticide and equipment that is being used. Some brief general guidelines follow.

The density of coverage, or rather the number of droplets per unit of surface area (droplet density), is very important in determining the success of the application. Droplet density for a given volume of carrier will be determined by the size of the droplets (for this discussion the carrier is water). The size of the droplets is determined by the pressure at the nozzle, by the size of the nozzle orifice, by nozzle characteristics and by physical properties of the chemical. The most common unit of measurement for the diameter of a droplet is the micron (μm). (A micron is 0.001 mm). The speed at which a droplet falls in still air (terminal velocity) depends on droplet size. Smaller droplets have a reduced terminal velocity and thus remain suspended in the air for a longer period of time.

The two most common parameters of droplet size are Volume Median Diameter (vmd) and Number Median Diameter (nmd). The vmd is the average size of droplets in relation to the total volume, that is, 50% of the volume contains droplets larger than the average size and the other half of the volume contains droplets smaller than the vmd. The nmd is the average diameter of the droplets without considering their volume. With conventional hydraulic equipment, the diameter of the droplet is determined by the size of the nozzle orifice (and its design), and the spraying pressure. With a smaller orifice size, the spray is broken up into finer particles, which is the same thing that occurs with greater pressure.

Table 3 presents a classification of sprays according to droplet size.

Table 3. Classification of sprays according to droplet size. After Matthews, 1979.

Diameter of droplets (μm)	Droplet size classification
< 50	aerosol
51 - 100	mist
101 - 200	fine spray
201 - 400	medium spray
> 400	coarse spray

With pesticides applied to foliage, generally speaking, as the droplet density is increased, biological efficiency is increased. With a constant volume, the number of droplets per area can be increased by reducing the size of the droplets, as indicated in Table 4.

Table 4. Theoretical number of droplets/cm^2 at different droplet diameters when spraying 1 liter of water evenly over 1 hectare. After Matthews, 1979.

Droplet diameter (μm)	Number of droplets/cm^2
10	19,099
20	2,387
50	153
100	19
200	2.4
400	0.298
1000	0.019

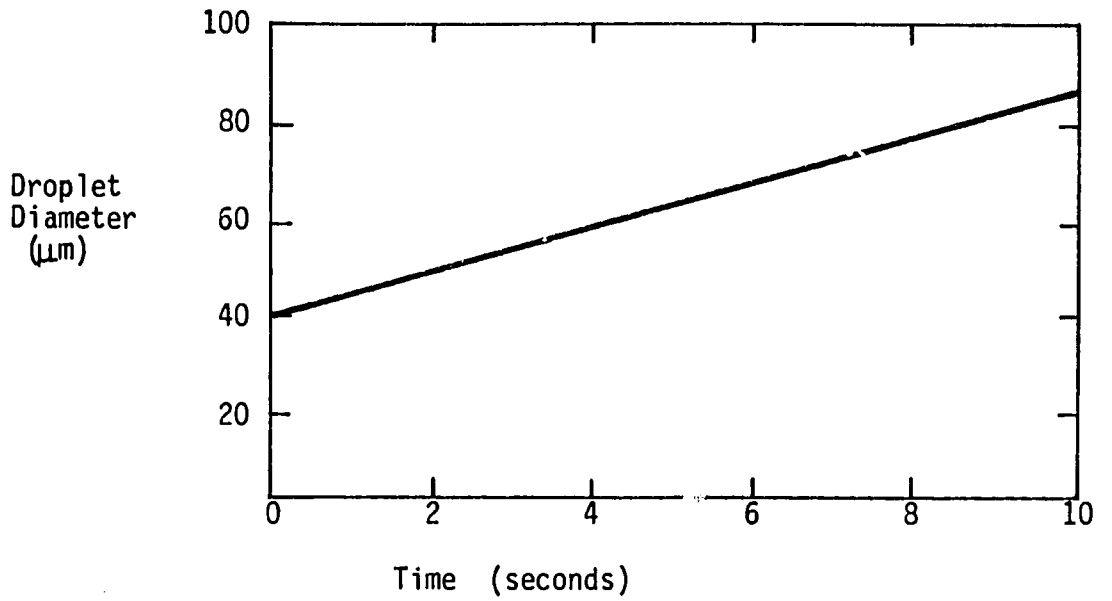
From the data in this table, one might conclude that the best practice would be to make pesticide applications using very fine droplets. Nevertheless, it isn't that simple, because reducing droplet size to improve coverage increases the risk of losing the product due to physical drift by the wind or by evaporation/volatilization, as demonstrated in Table 5 and Graph 1.

Table 5. Relationship between droplet size, number of droplets/cm^2, and drift distance in a wind of 5 kph when applying 1 liter/ha.

Droplet size (µm)	Type of droplet	Fall time from 3 m (still air)	Number of droplets/cm^2 (when applying 1.0 liter/ha)	Drift distance (wind speed:5kph)
0.5	---	112.5 hrs	$1,528 \times 10^8$	502.5 km
1		28.1 "	19,098 600	140.5 "
5	fog	66 min	152,789	5.5 "
10		16.9 "	19,099	1.4 "
20		4.2 "	2,387	350 m
50		40.5 sec	153	56.3 "
100	mist	10.9 "	19.1	15.1 "
200		4.2 "	2.4	5.8 "
500	light rain	1.7 "	0.298	2.3 "
1000	moderate rain	1.0 "	0.019	1.4 "

Adapted from G.A. Matthews, 1979 and Klingman, 1961.

Graph 1. Time (in seconds) for droplets of various size to lose 90% of their volume at 25.6°C and 70% relative humidity.



There are practical limits to the droplet size that should be applied. If the droplet is too small, there is a great risk of losing it through drift and/or evaporation. If the droplets are too large, coverage is not adequate. (Obviously the height of the nozzle above the target and wind velocity will influence the distance that a droplet will drift from the point of application).

The problem with ordinary hydraulic equipment (for example, knapsack or tractor sprayers) is that there is a very wide range in the size of the droplets that are produced, varying from 10 or 15 microns to greater than 600 or 700 microns. A very high percentage of droplets smaller than 100µm never reach the target. Spinning disk sprayers, (often called controlled droplet applicators) provide a very uniform droplet size. From 90 to 95% of the droplets will be of the same diameter. The speed of rotation and disk design determine droplet size. This type of equipment frequently

produces droplets from 100 to 300 μm, depending on the factors just discussed.

In view of the speed with which small droplets lose their volume from evaporation, ultra low volume equipment or equipment that breaks up droplets into very fine particles should not be used to apply just any pesticide. Formulations that contain special adjuvants to reduce evaporation must be used.

STEP 3. SUMMARY

Summarize Topic C with these general conclusions:

1. The correct amount of pesticide needed to spray a determined area may be calculated by using appropriate formulae.
2. Use of a particular formula depends on whether the recommendation is given on the basis of the commercial product or active ingredient.
3. The density of coverage, or number of spray droplets per unit area, is very important in determining success of application.
4. Spray droplet size is determined by the size of nozzle orifice, design or characteristics of nozzle, pressure at the nozzle and physical properties of the chemical.
5. Reducing droplet size increases risk of loss of product through drift or volatilization and evaporation.
6. The distance spray will travel (drift), and the thoroughness of coverage, depend, in part, on droplet size. Wind velocity and height of nozzle above the target are also important factors.

TOPIC D. APPLICATION EQUIPMENT: CLEAN UP, MAINTENANCE AND REPAIR

Purpose: To discuss the common types of pesticide sprayers and how best to maintain and keep them clean. By the end of this topic, the trainees should be able (1) to identify the most common types of sprayers; (2) to specify how to properly clean spray equipment; and (3) to specify how to repair and maintain common types of sprayers.

STEP 1. PRESENTATION: COMMON TYPES OF SPRAYERS

The introduction of granular insecticide, fungicide and herbicide formulations has simplified pest control operations for many farmers. However, it has not eliminated the need for foliar sprays, especially when eradication is needed as in an outbreak of leafhoppers, hispa, rice bugs, blast, sheath blight, etc. The farmer must know how to choose appropriate spray equipment for pest control and how to use it.

In many Third World countries, most pesticides are applied with small, hand-operated, hydraulic sprayers. Depending on the type of agricultural practices and the economic development of an area, mistblowers, power-operated hydraulic sprayers mounted on tractors or aircraft, spinning disk sprayers, and fogging machines may also be used extensively. Additionally, special or adapted applicators for dust and granular formulations are available. The most common types of sprayers are as follows:

Hand-operated sprayers with hydraulic pumps

- -- Trombone (or slide-action) sprayers
- -- Stirrup-or bucket-pump sprayers

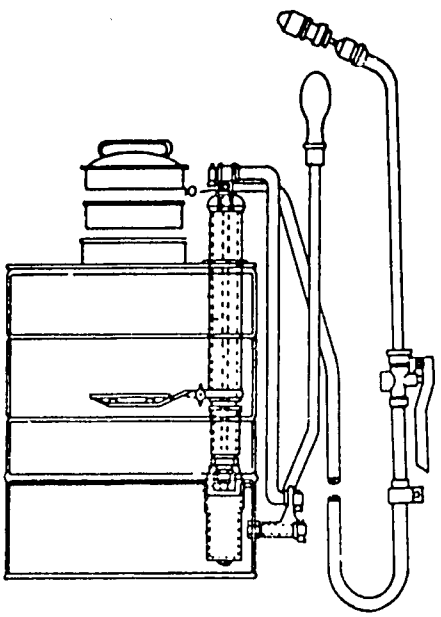
- -- Lever-operated knapsack sprayers
  - -- piston-type pumps
  - -- diaphragm-type pumps
- -- Compression or pneumatic sprayers

Motorized knapsack mistblowers

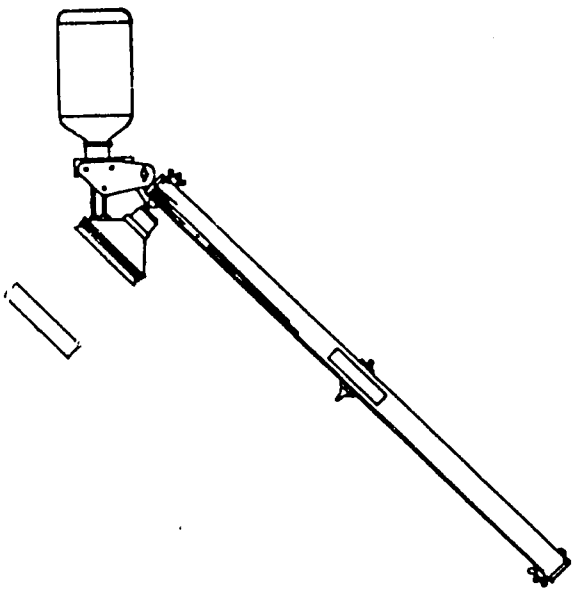
Hand-carried spinning disk sprayers (rotary atomizers)

- -- Insecticide sprayers
- -- Herbicide sprayers

Hand-operated rotary dusters (carried in front of body)



Lever-operated
Knapsack sprayer



Spinning Disk
Sprayer

STEP 2. DEMONSTRATION: KNAPSACK SPRAYER

The knapsack sprayer is the equipment most commonly used for applying pesticides on small farms, worldwide. Unfortunately, many persons use the same nozzle for applying all types of pesticides. However, the use of an inappropriate nozzle can result in an ineffective application (biologically) and, at times, economic damage and loss.

In general, with hand-operated hydraulic equipment (like the knapsack sprayer), an application volume from 300 to 600 liters/ha is recommended to ensure complete coverage. However, as every drop of spray that falls from the plant represents a loss of pesticide, an excessive amount of water should not be applied. The foliage should be well-wetted, but not to the point of runoff. With mechanized equipment, the foliage can be wetted uniformly with much less water and the recommended rate is 50 to 200 liters/ha. With spinning-disk equipment, 10 to 50 liters/ha is applied. With ultra low volume equipment, less than 5 liters/ha, total volume, is used.

A. Nozzles

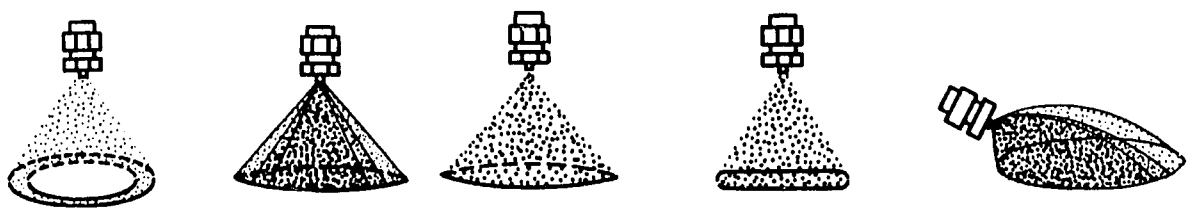
The nozzle is the most important component of spray equipment under direct control of the operator. There are three kinds of nozzles used in knapsack sprayers: cone, fan and impact.

1. Cone nozzles

Two types of cone nozzles are available which produce different patterns: hollow-cone and solid-cone (see Figure 1). The difference between these two patterns depends on the design of the internal components. In practice, both nozzles are used for applying fungicides and insecticides.

One of the goals in applying fungicides and insecticides to plants is to deposit the pesticide on all the foliage, including both the top and underside of the leaves. Cone nozzles break up the liquid into much finer droplets, and create more turbulence than other types of nozzles, resulting in greater coverage of the foliage. At the same time, these nozzles are more effective at higher pressures, from 2.0 - 4.0 kg/cm^2.

Figure 1. Different types of nozzles for knapsack sprayers.



Hollow Cone | Solid Cone | Flat Fan | Even-spray Fan | Impact

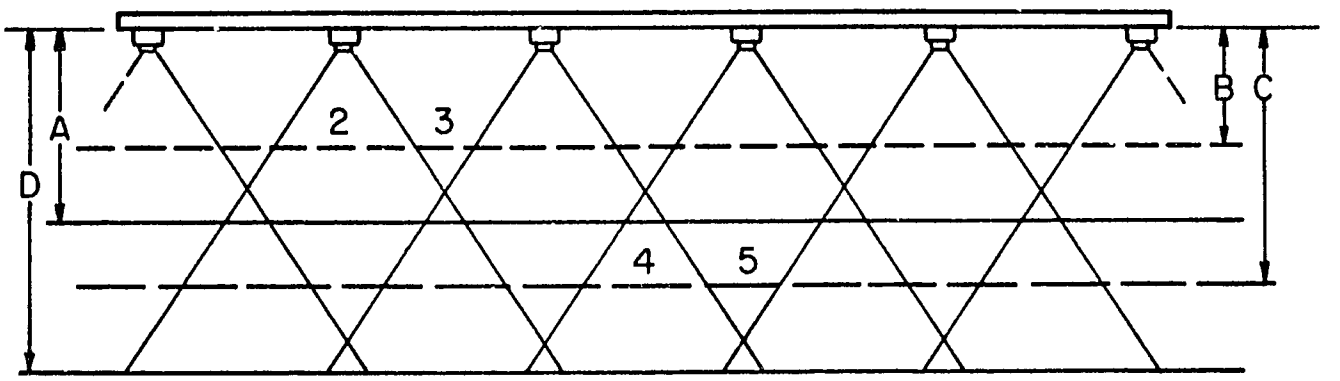
2. Fan nozzles

Fan nozzles have two basic patterns: (1) those that do not apply the same amount of spray at the two extremes of the swath width, and (2) even-spray nozzles, which apply the spray uniformly throughout the width of application. Both nozzle types are used to apply herbicides. The even-spray nozzle is used to apply herbicides in bands in the crop row or between the rows.

The uneven fan nozzle is used to obtain a correct overlap from one pass to the next, or when a spray bar (boom) with multiple nozzles is used. With herbicides applied to the soil, it is especially important that there be an exact overlap between nozzles in order to avoid unsprayed areas or areas that receive a higher dosage than desired.

Figure 2 illustrates the effect of nozzle height on overlap, whether from an application using a single nozzle or a boom with multiple nozzles.

Figure 2. Effect of nozzle height on overlap between several nozzles or several passes with a single nozzle.



A = Correct height (overlap). Uniform application (1).

B = Insufficient height (incomplete overlap). Leaves area with elevated dosage of pesticide (2) and other areas without pesticides (3).

C = Incorrect height (overlap). Leaves areas that are sprayed twice (4) and others that are sprayed only once (5).

D = Correct height for double coverage.

In view of the fact that increasing the pressure produces finer droplets, for applying herbicides it is recommended that the pressure be adjusted between 1.4 and 2.8 kg/cm^2 with fan nozzles. At higher pressures, the risk of a greater amount of drift increases because the number of

fine droplets increases. At lower pressures, the application pattern will be poor unless the nozzle is specifically designed to function at pressures as low as 0.5 kg/cm^2.

3. Impact nozzles

Impact nozzles (also called flood jet) have the advantage of functioning at pressures near 1.0 kg/cm^2, thus reducing the danger of drift. Also, they produce a 1.0 to 2.0 m wide swath at a relatively low height above the target. (At increased heights of application, the probability of drift is increased.)

B. Filters

All sprayers should have three filters--a primary filter in the lance or wand to eliminate large particles, a basket filter at the filler port, and a secondary filter in the nozzle to eliminate fine particles which could obstruct the orifice of the tip or distort the pattern of application.

cap tip filter body

Nozzle Components

C. Tank - Pressure chamber

The spray tank serves to hold the spray mixture. In addition, all lever operated knapsack sprayers have a pressure chamber (located either inside or outside the tank). The pres-

sure chamber's function is to assure that the liquid leaves the sprayer in a uniform stream. Without the pressure chamber, there would be a pulsating exit stream with each pumping motion, as is the case with the trombone sprayer.

It is important to remember that some part of the solution nearly always remains in the tank and the pressure chamber. It is necessary to wash these two components well to avoid physical damage to the pump and contamination of crops with pesticide residues that may remain in the equipment.

D. During application

1. Agitation

With pesticides formulated as wettable powders, it is important to maintain the pesticide in a uniform suspension in the tank. If agitation is not adequate, the wettable powder settles to the bottom of the tank, resulting in a very low concentration of the pesticide at the beginning of the application, while at its termination the pesticide is very concentrated. This results in poor control initially and can result in phytotoxicity and environmental contamination with the residues at the end of the application. In order to avoid these problems, it is necessary to agitate the solution in the tank (shaking the knapsack sprayer) every 2-3 minutes. This is particularly important with equipment that does not have mechanical or hydraulic agitation.

2. Precautions

a. Verify that nozzle application pattern is correct.

b. Maintain the appropriate height of the nozzle(s).

c. Take care to prevent drift.

d. Maintain a uniform rhythm of walking and pumping.

e. Agitate periodically (especially wettable powders).

STEP 3. PRESENTATION: CLEANING AND MAINTENANCE OF SPRAY EQUIPMENT

Many pesticides are corrosive to equipment. Consequently, it is very important to wash the equipment well after completing an application. Even if the job is not finished and the same product will be applied the following day, the equipment should be washed thoroughly at the end of the day to avoid corrosion. Never leave the sprayer with pesticides overnight. Besides the corrosion problem, certain pesticides, especially wettable powders, settle to the bottom of the tank and, when attempting to use it again, the pesticide may not go into suspension.

When cleaning a sprayer or discarding an empty chemical container, protective clothing should be worn until all the work is finished. Only after the sprayer has been stored away and all waste has been removed, should the operator remove protective clothing, wash and change clothes.

To clean the equipment thoroughly, the tank should be filled one-quarter full with clean water and soap, rinsing it well and discharging the contents through the nozzle. (The contents of the first rinsing should not be emptied in a single spot; rather, they should be discarded as if making a normal application in order to avoid a concentration of the pesticide.) An area free of humans and animals and away from water sources should be chosen for this operation to avoid contamination of the environment. Rinsing with clean water and soap is repeated twice more, discharging a large part of the solution through the nozzle. If possible, the nozzle should be taken apart to clean the filter and other components.

In the case of the hormonal herbicides, rinse three times with soap and water, add a solution of water with 1.0% ammonia, agitate well, and discharge a part of the solution through the nozzle. Leave the solution in the tank overnight. The following day, the tank may be emptied, rinsed anew with clean water and thus remain free of residues.

It is especially important to avoid pesticide residue in the sprayer when the same equipment is used for applying different types of pesticides on a variety of crops.

Finally, the equipment should be inspected and connections, hoses and control valves adjusted after cleaning, in order for it to be ready for its next use.

When finished with the spraying operation, the following procedures should be observed:

Steps	Key Points
1. Empty the spray tank of all remaining pesticide	a) Spray contents until the tank is empty. Do this on the target crop or on waste land selected for this purpose (e.g., in areas where people and animals will not have access). b) Do not contaminate irrigation canals, streams, water supplies and agricultural land.
2. Rinse the tank	a) Use clean water and detergent. Fill the tank one quarter full and shake vigorously. b) In some models, rinsing the tank also cleans out the pressure cylinder if the latter is located inside the tank.
3. Spray with the water-soap mixture	This will clean the tank, hose, lance and nozzle. The nozzle may be removed after 2 minutes to speed up the washing process.
4. Repeat steps 2 and 3 without detergent	Use only clean water this time.
5. Drain the sprayer	Remove as much water from all parts as possible.

STEP 4. DEMONSTRATION: CLEANING A SPRAYER

TO THE TRAINER: For this demonstration, you will need at least one sprayer of the type most commonly used in the area. If several types are common, try to use all varieties. With these sprayers, demonstrate the proper procedures for cleaning.

STEP 5. PRESENTATION: DRYING AND STORING SPRAYERS

After each use of spray equipment and at the end of the season, a complete check should be made of the sprayer. Store the sprayer only in a dry place. All sprayers should be locked in a secure place, away from children and animals. When storing the sprayer at the end of the season, wipe the metal tank with a solution containing equal parts of water and kerosene. This practice will help prolong the life of the sprayer and protect it against bad weather.

STEP 6. PRESENTATION: ROUTINE MAINTENANCE OF SPRAY EQUIPMENT

It is advantageous to routinely take good care of spray equipment. If the equipment breaks or doesn't function properly, not only time but also money is lost. When any part of the sprayer breaks or doesn't operate properly, fix the problem immediately. There are several repairs which can be made:

HOSES: Make sure there are no breaks in the outer covering, especially where the hose is attached to couplings. Replace a broken hose. To avoid breaking it, don't carry the sprayer by the hose. Avoid kinks in the hose.

STRAINERS: Use the operator's manual to find where to locate the strainer. Remove strainers and flush them with water. To eliminate hard-to-remove dirt, soak the strainer in kerosene. Replace any broken screen or ones that are impossible to clean.

SHUT OFF VALVES: If this valve is operating correctly, it should be easy to open and close. When spray leaks from this valve, replace the gaskets with new ones.

PUMP ASSEMBLY: The plunger or piston should be lubricated regularly. Use animal or vegetable oil to lubricate the plunger. If the leather cup becomes worn out or hardened, replace it with a new one.

SEALS OR WASHERS: Any worn or damaged seals or washers should be replaced as soon as possible. Leaking at joints in the sprayer system is usually caused by dried out seals.

NOZZLES: The effectiveness of any pesticide application depends on the proper functioning of the nozzle. Every nozzle tip is designed to give a specific spray pattern with a specific type of droplet at a set pressure. REMEMBER THE FOLLOWING TIPS WHEN CLEANING SPRAYER NOZZLES:

- -- Never use a nail or sharp object to clean the orifice and screen
- -- Never put a nozzle or screen to your mouth to blow it clean
- -- Do not overtighten a nozzle cap on the body
- -- Replace a nozzle or strainer if it cannot be cleaned easily or if the orifice is damaged by abrasion or otherwise
- -- Carry a spare nozzle to prevent much loss of time in the field

-- Rinse the strainer and nozzle several times with water after use to keep them free from pesticide deposits and dirt

-- Destroy the toothbrush or toothpick which has been used for cleaning, or store out of reach of other persons.

CLEAN NOZZLES ACCORDING TO FOLLOWING PROCEDURES:

Steps	Key Points
1. Dismantle the nozzle	a) Unscrew the nozzle cap from the nozzle body. b) Remove nozzle tip and strainer.
2. Wash nozzle tip	a) Clean the hole in the nozzle tip by flushing with clean water. b) If the hole cannot be cleaned that way, use a toothbrush, toothpick or copper wire that is softer than the material in the tip itself. The diameter of the wire should be smaller than the hole so that the tip is not damaged or enlarged while being cleaned.
3. Clean strainer	As described above
4. Assemble the nozzle	

STEP 7. DEMONSTRATION: MAINTENANCE PROCEDURES

With the spray equipment used in Step 3, demonstrate the sprayer parts that often break. Specifically demonstrate the simple repair procedures for strainers, valves and seals. Also, demonstrate the procedures for correctly repairing spray nozzles.

STEP 8. SUMMARY

The key points for Topic D are:

1. There are a limited number of sprayers used by small farmers.
2. Each sprayer must be cleaned properly after every use.
3. There are proper procedures for cleaning, maintaining, and repairing this equipment.
4. Make all sprayer repairs as soon as you are aware that it needs the repair.
5. A sprayer kept in good repair saves you money.

UNIT XII SUMMARY

The major points covered in Unit XII are:

A. More than 80% of control failures using chemicals can be attributed to faulty pesticide applications. Some of the reasons for a poor application include the use of incorrect dosages and poorly maintained equipment.

B. Application of a pesticide at an incorrect dosage may waste money, cause phytotoxicity, accelerate the development of resistance, increase the likelihood of higher residues in the soil, result in inadequate control of the pest and lead to higher production costs.

C. The output of a sprayer is determined by three basic factors: size of the nozzle orifice, speed and pressure. The least appropriate factor for effecting a major change in sprayer output is pressure.

D. The operator should know how to calibrate his equipment and himself. When spraying, he should maintain a comfortable and uniform rhythm of walking and pumping. Each operator should calibrate at least twice daily.

E. Application equipment should be inspected before calibration to ascertain if moving parts are functioning well and to be sure that there are no leaks or breaks in the system.

TO THE TRAINER: Conclude Unit XII with a question and answer period. Ask the learners if they have any questions about the Unit and answer them. Ask the learners the following questions to make sure that they understand the concepts presented.

QUESTIONS

UNIT XII: "Application Equipment and Calibration"

1. Name three things that may be a result of a poor pesticide application.
2. Why is it important to clean application equipment after each use? List two reasons.
3. Where may information on the recommended application rate for a pesticide be obtained? Name two sources.
4. What happens to droplet size if the pressure is increased?
5. Name two ways to increase sprayer output.
6. If height of the spray bar (boom) is decreased, the amount of drift will increase. True or false?
7. What is the dosage rate per hectare if 1000 liters of spray containing 12 liters of Folidol 48% were used to spray 5 hectares?
8. If the recommended rate of a pesticide is known, how is the correct amount of the pesticide needed for a given area determined?
9. Why is the application rate of a pesticide often expressed in terms of the active ingredient?

UNIT XIII: APPLICATION OF PESTICIDES: DO'S AND DON'TS

UNIT OVERVIEW

Even after the user has carefully studied the label, bought the correct pesticide to solve a particular pest problem, and followed the label's instructions to correctly mix the pesticide, he may still experience failure in using pesticides. If the right product is applied in the wrong way, your efforts become useless. This Unit discusses application procedures and the "do's and don'ts" of application. The objective of this Unit is to develop understanding of how to apply pesticides safely and effectively.

The following topics appear in Unit XIII:

A. CONSIDERATIONS.

B. PROBLEM SHOOTING.

C. GROUND APPLICATION*.

D. AERIAL APPLICATION*.

(The topic Application is divided into two subtopics: ground application and aerial application. Each subtopic is complete within itself and may be taught alone.)

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* Either Topic C or Topic D is optional in this training unit.

OBJECTIVES:

By the end of the Unit, the participant will know:

1. That proper application is necessary to ensure that pesticides are effective.
2. Steps to consider and to do before applying pesticides.
3. Certain problems that may be encountered when applying pesticides.
4. How to deal with these problems.

*5. The do's and don'ts of ground application.

*6. The do's and don'ts of aerial application.

Unit XIII requires approximately 1 hour to complete and includes exercises that require teaching materials.

TEACHING MATERIALS PROVIDED	TEACHING MATERIALS YOU MUST PROVIDE
None.	Different size nozzles.

TOPIC A. CONSIDERATIONS

Purpose: To discuss the significance of the ways pesticides are applied. The question "Why does it matter how we apply our pesticides?" is addressed and some things the user should do before applying pesticides are discussed. By the end of Topic A, the learners should:

1. Be able to answer the question, "Why does it matter how pesticides are applied?".
2. Know several things to consider before applying pesticides.

STEP 1. PRESENTATION: APPLYING PESTICIDES

The way pesticides are applied to crops is very important. Even though the user can take a long time to select just the right pesticide and an even longer time to measure and mix just the right solution, if the solution is applied incorrectly, the efforts to do everything else right may be wasted. If applied incorrectly, a pesticide may not be effective. Even worse, contamination of the environment or living things may result.

The question "Why does it matter how we apply our pesticides?" can be answered, "Because only by properly applying pesticides that have been selected and mixed correctly can we be sure that the pesticide will eliminate the pest problem."

STEP 2. PRESENTATION: APPLICATION CONSIDERATIONS: FORMULATIONS

To apply pesticides correctly, several things must be considered.

First, there are several ways to apply pesticides. The way a pesticide is applied depends on the type of pesticide used. For example, pesticides come in dry dusts or powders, liquids, sprays, dry granules, and several

other forms. These different types of pesticides are called formulations. Each formulation is applied differently. For instance, liquids are not applied like dusts or granules. Formulation affects application so much that when buying a pesticide, the choice should be based in part on how the pesticide will be applied to the crop.

Read the label on the pesticide container to find out how that particular pesticide should be applied.

STEP 3. PRESENTATION: APPLICATION CONSIDERATIONS: EQUIPMENT AND SAFETY

A second consideration for applying pesticides is the equipment used. (Specific equipment for application will be discussed later in this unit.) For the moment, remember to follow good safety rules with application equipment in general.

First, make sure to use the proper equipment for the particular pesticide being handled. The label, along with advice from an extension agent or pesticide manufacturer, can help make this decision.

Next, take good care of the equipment. Check before each use to make sure the equipment is clean. Equipment should be cleaned as soon as you finish using it. Only those trained to use pesticides should do the cleaning and this person should wear protective clothing.

Cleaning should be done in a special place so that contaminated wash water does not harm living things. Keep away from streams and water supplies.

Also, check equipment for possible needed repairs before each use. Look for leaking hoses, pumps, or connections. Also watch for worn, plugged or dripping nozzles. If repairs are needed, make sure the person working on the equipment understands the hazards that may be involved with the job.

STEP 4. SUMMARY

Conclude Topic A with a summary of the major points:

1. Only when the right pesticide is CORRECTLY MIXED AND APPLIED CORRECTLY, can you be sure that pest problems will be controlled and that it will be done safely.
2. Before application of a pesticide, it is important to consider 3 important factors:

a. The way pesticides are applied depends on the type or formulation of pesticide used.

b. Read the label for application instructions.

c. Equipment should be selected carefully and be kept clean and in good shape.

3. Cleaning of equipment should be done in an area where water and living things will not be contaminated.

TOPIC B. PROBLEM SHOOTING

Purpose: To explore some common problems in applying pesticides. By the end of Topic B, the learners will know:

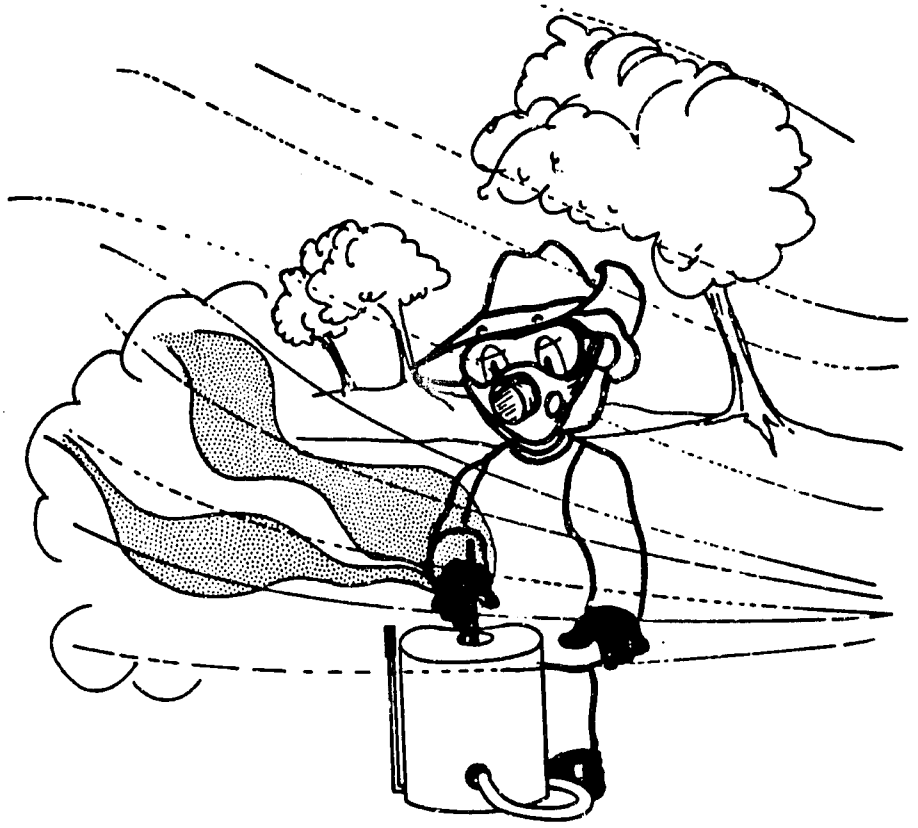
1. What are some of these common problems.
2. How these problems can be prevented.
3. The meaning of the terms drift and vaporization.

STEP 1. PRESENTATION: AVOIDING DRIFT

A common occurrence when pesticides are applied is the problem of drift. Drift is what happens when pesticide spray droplets or dust move through the air away from the area sprayed. The area to be sprayed is called the target area.

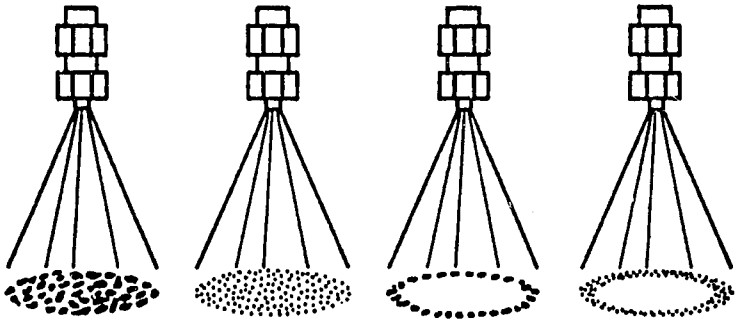
Drift creates several problems: Drift results in loss of the pesticide from the target area. Even worse, drift can result in a contamination or a poisoning accident as the pesticide moves to an area where there are people, animals or other crops.

Certain actions will limit drift. Since wind carries the particles through the air, drift is particularly bad on a windy day. Therefore, to reduce drift, spray on less windy days or spray only during less windy times of the day.



Check the weather before you spray. Wind can make application dangerous!

Another step to help reduce drift is: <u>use the largest practical nozzle opening</u>. Larger drops reduce drift and larger nozzles produce larger drops. The smaller and lighter weight pesticide droplets are, the easier it is for them to be carried in the air (or to drift).



TO THE TRAINER: Bring several different size spray nozzles to the class. Show them to the trainees and indicate why the larger nozzle will help limit drift.

A final step can be taken to reduce drift. If spraying is done at low pressure, the drift problem is decreased. Droplets which are sprayed with high pressure come out of the nozzle with a burst of speed and spread in all directions. Drift results.

STEP 2. PRESENTATION: VAPORIZATION

When pesticides are applied, they do not just fall out onto the plants and remain there forever. Sometimes, pesticides do not remain on the plants for very long at all. One way they leave the crops is by vaporization. Vaporization occurs when the applied pesticide is "soaked up" into the air and becomes a vapor (like water evaporation). Pesticide vapors can cause harm to people as they move through an area where the pesticide was applied.

Vaporization is greatest when the temperature is the hottest. This dangerous problem can be limited very easily: apply pesticides during the cooler parts of the day. That's all that's needed.

STEP 3. PRESENTATION: DECOMPOSITION

Let's suppose for a moment that a pesticide has been applied and the problems of drift and vaporization have been avoided. The pesticide chemical reaches the target area and clings to the crops to which it was applied. Are your worries over? . . . . Not quite yet!

Even after a pesticide safely reaches the target area, there are several things that can happen to reduce its effectiveness. One problem is decomposition. Decomposition means that the pesticide chemical breaks down and no longer works. This may happen in several ways.

Even if the chemical is left alone, time will eventually cause the ingredients to break apart, or decompose. The sun may make this breakdown happen faster. Near the tropics, where the sun is strong, decomposition may be a severe problem for pesticide applicators.

Also, the pesticide may be a mixture of chemicals that does not hold together well. After application, these chemicals may separate and breakdown, thereby destroying the pesticide.

Rain also causes decomposition. Rain water will wash a pesticide off a plant. In areas of heavy rainfall, almost all of the chemical can be washed off quickly.

Decomposition of pesticides by any of these three causes (age, sunlight and rain) cannot be prevented. Perhaps new formulations will be developed in the future which will decrease the amount of decomposition.

STEP 4. SUMMARY

Summarize by briefly reminding the trainees of the key points.

1. There are at least three common application problems.
   a. Drift occurs when pesticide droplets move through the air away from the target area. Drift can be avoided by spraying during the calmest parts of the day, using a larger spray nozzle, and spraying at a low pressure.

b. When a pesticide is "soaked up" from plants into the air, vaporization has occurred. Avoiding hot temperatures is one way to reduce vaporization. Apply pesticides during the cooler parts of the day.

c. Breakdown of the pesticide chemical, or decomposition, occurs naturally over a period of time and may be speeded by the sun or rain. Not much can be done to avoid decomposition.

TOPIC C. GROUND APPLICATION

Purpose: To discuss preparations to follow before application of pesticides and precautions to use during application. The question "What should be checked on the equipment before filling with pesticide?" and a recap of "Safety During Application" are addressed. By the end of Topic C, the learners should know:

1. What checks, prior to filling, should be made on ground application equipment.
2. Specific safety precautions to take during application.

STEP 1. PRESENTATION: PREFILLING CHECK

All equipment (tanks) should be checked twice--once when empty and dry and again when filled only with water. A visual and physical prefilling check made of the equipment when dry should cover 4 points:

1. Are all parts present on the equipment?
2. Are all moving parts free to move as they should?
3. Are all nozzles and filters clean and clear of obstructions?
4. Do all hoses appear to be in good condition?

Once this visual and physical check of the application equipment is made, then you should proceed to the next step--a clean water checkout.

STEP 2. PRESENTATION: CLEAN WATER CHECKOUT

The visual check is made to be sure that all parts are present and that the equipment moves freely. The clean water check is done to make sure that the equipment will operate correctly. Do this check with clean water and not a "water and pesticide" mixture! If the equipment does not function correctly when loaded with pesticide, the effectiveness of the pesticide

may be lost during the time it will take to repair the equipment. Also, draining and refilling of the spray mixture presents an extra hazard to the applicator.

The steps to take in the clean water checkout are:

1. If a small backpack tank is used, then extend the spray arm. If the equipment is large, connect it to the tractor, and move it to a clear area where the booms can be extended and water sprayed.
2. Remove all nozzles and nozzle filters.
3. Fill tank between 1/4 and 1/2 full with clean water.
4. Bring up pressure and pump water through the whole system for one minute making sure that water exits freely from all nozzle bodies.
5. Replace nozzles, nozzle filters, and line filters.
6. Bring up pressure again and pump water through nozzles observing for unusual spray patterns that might indicate a blocked nozzle and for leaks.
7. Check the pressure regulator (if present) to make sure it will function over the pressure range required by the type of application.
8. Repair any problems.

STEP 3. PRESENTATION: APPLICATION CONSIDERATIONS

There are several considerations to bear in mind during application. If you attend to these points, you can ensure a safe and effective application:

1. Use maximum nozzle size and minimum pressure necessary to do the job.
2. Apply with the wind in the case of back-pack and motorized mist blower sprayers.
3. Always use (as a minimum) a respirator, goggles, and rubber gloves when applying pesticides.
4. Follow all other safety rules--such as: no smoking, no drinking and no eating. Wash hands and face afterwards.

STEP 4. SUMMARY

The key points in this topic are:

1. Be sure to physically and visually check all equipment before filling with water.
2. Run a clean water checkout at full pressure before adding pesticide.
3. Observe all safety precautions while making ground applications.

TOPIC D. AERIAL APPLICATION

Purpose: To discuss several points that the pesticide user should consider during aerial applications. The objective of this topic is to ensure that trainees understand certain steps for safe application by airplanes.

STEP 1. PRESENTATION: AERIAL EQUIPMENT CHECK

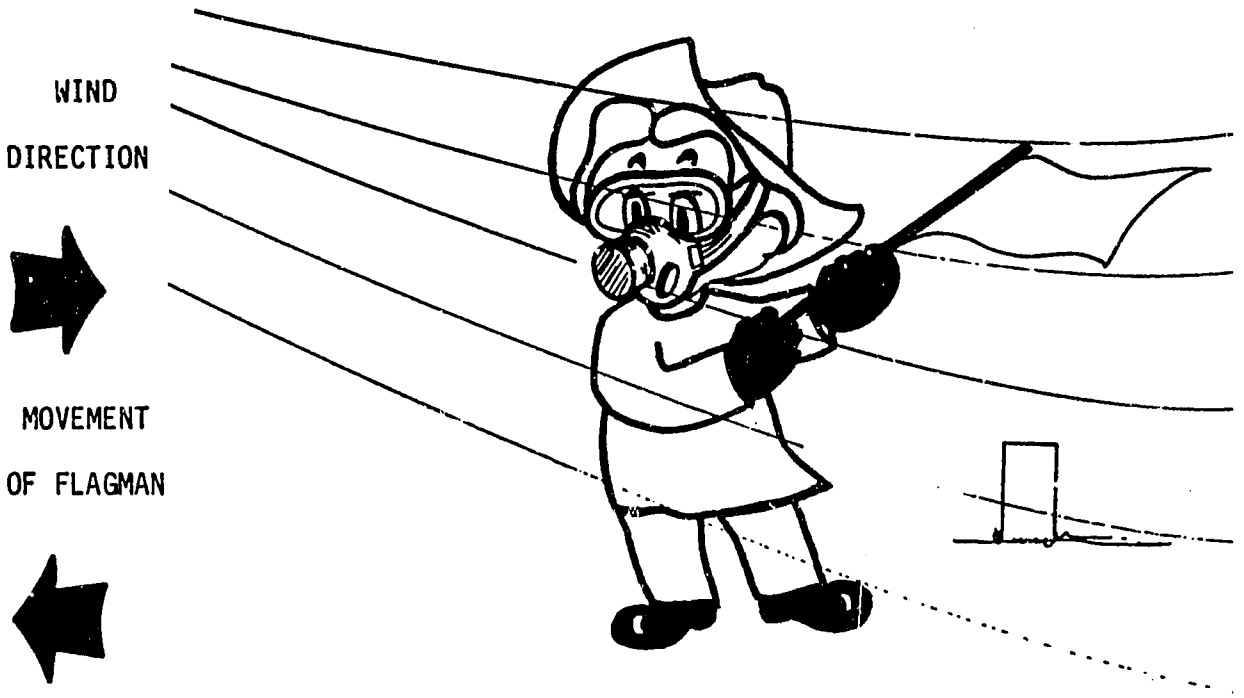
Even though aircraft mechanics maintain the application equipment on the aircraft, there are several items the applicator should check:

1. Make sure the nozzles are of the correct and uniform size.
2. Assure that the line filter and the nozzle filters are of the correct size (50 mesh for wettable powders and flowables, and 100 mesh for other formulations).
3. As a courtesy, and to assure efficient operation, have all pesticides and aircraft loaders at the landing field early.

STEP 2. PRESENTATION: FLAGMEN SAFETY

Flagmen are essential to proper aerial application. But their work is very hazardous. Proper training and equipment must be provided to these personnel. Two considerations are very important to ensure the well being of the flagmen:

1. Flagmen should always move one or two stakes upwind of their flagging position when the aircraft is about 100 meters away.



2. Flagmen are constantly bathed in pesticides and should wear a respirator, goggles, and rubber gloves as minimum protective equipment.

UNIT XIII SUMMARY

Summarize the major points covered in this Unit:

1. Even if you buy the right pesticide and mix it correctly, you can still fail in the effort to protect crops if you don't apply the pesticide correctly. Pesticides come in different formulations, such as powders, dusts or liquids. The formulation determines how to apply the pesticide. The label should tell how to apply the formulation used. The right application equipment must be used and this equipment should be kept clean and in good working condition.

2. There are several common problems which may occur when applying pesticides. Drift happens when particles of the pesticide being applied escape into the air and move through the air to an area other than the target area. Drift can be reduced by avoiding spraying when it is windy, using a larger spray nozzle, and spraying at low pressure.

   A second problem that can occur is vaporization or when pesticide particles leave the crops to become part of the air. Spraying during cooler weather limits vaporization.

   Decomposition, or breakdown of the pesticide chemical, is another application problem. Decomposition happens naturally over time and can be speeded by the sun or rain.

3. Ground application equipment should be checked while dry and then again by running clean water through the system.

4. Assure yourself that the aircraft nozzles and filters are of the correct uniform size.

5. Flagmen are in the most hazardous position during aerial applications and must use an aspirator, goggles and rubber gloves as minimum protection.

6. Spray equipment must be regularly cleaned, maintained and repaired.

TO THE TRAINER: Be sure to allow time for questions from the trainees. Review this Unit by asking the following questions.

QUESTIONS

UNIT XIII: "Application of Pesticides: Do's and Don'ts"

1. Why does it matter how you apply pesticides?
2. The way you apply pesticides depends on the type, or _____ of pesticide being used.
3. What is a formulation?
4. How can you find out how to apply a particular pesticide?
5. What should you do to equipment each time before you spray? After you spray?
6. What should you look for when you check application equipment?
7. Name three common problems you may have to face during application.
8. What is drift?
9. Name 3 things you can do to prevent drift.
10. What is vaporization?
11. How can the chance for vaporization be limited?
12. What is decomposition?
13. What two things make decomposition happen faster?
14. Why should you "waste" time and water with a clean water checkout of ground application equipment?
15. Which way should a flagman move as the aircraft approaches?
16. How should spray equipment be cleaned?

UNIT XIV: WHAT HAPPENS TO PESTICIDES AFTER THEY ARE APPLIED?

UNIT OVERVIEW

This Unit focuses on questions and issues related to what happens to pesticides after they are applied. People who work with pesticides must become aware of the effects pesticides have on plants, on soil, on the environment in general, and on man. Unit XIV discusses and demonstrates such topics as DRIFT, RESIDUE, VAPORIZATION, DECOMPOSITION, RUNOFF and the effects of pesticides on the FOOD CHAIN

The following topic titles appear in Unit XIV:

A. WHAT HAPPENS TO APPLIED PESTICIDES?

B. ENVIRONMENTAL CONSIDERATIONS AND DANGERS.

C. WHAT CAN WE DO?

OBJECTIVES:

The objectives of this Unit are to teach what happens to pesticides once applied and to use this knowledge to apply pesticides more safely and effectively. Learners will know:

1. Specific things that can happen to pesticides once applied.
2. How these things can affect the environment.
3. What you can do to minimize these harmful effects.

This Unit should be particularly useful with the following audiences: Extension Agents, Farmers and Health officials.

Unit XIV requires approximately 1 hour to teach.

Exercises in Unit XIV require the following teaching materials.

TEACHING MATERIALS PROVIDED	TEACHING MATERIALS YOU MUST PROVIDE
None.	Pot of water and a heat source to boil water.
	A vial of perfume or a can of spray deodorant.
	Can of spray paint or regular paint and brush.
	A piece of wood.

TOPIC A. WHAT HAPPENS TO APPLIED PESTICIDES?

Purpose: To discuss specific things that can happen to pesticides once applied. By the end of Topic A, trainees will know:

1. Three things that can happen to pesticides; and
2. What the terms deposit and residue mean.

STEP 1. PRESENTATION: THE DANGER OF DRIFT

When pesticides are applied, there are a number of things that can happen to them. Sometimes the pesticide chemical reaches the target area and remains there for a long time. But sometimes the chemical is quickly gone after it is applied. The pesticide is quickly absorbed into the environment. In fact, some pesticides never reach the target area to begin with! Let's talk about the pesticides that never reach the target area.

In Unit XIII, some problems that applicators frequently face when applying pesticides were discussed. One problem was DRIFT. Remember: drift is what happens when pesticide spray droplets or dust particles are picked up by air currents and carried through the air away from the target area to other places. When drift occurs, the pesticides may never reach the crop area. The pesticide is carried away to an area not intended to be sprayed. The impact of such drift can frequently be seen when herbicides are poorly applied, drift, and cause "burning" of non-target plants.

If drift is avoided, then the pesticide reaches the target area and falls on the area's crops. The pesticide that is left on the surface of the target area right after application is called the DEPOSIT. This deposit may break down quickly in the environment. Heat, light, moisture and living things in the soil can cause these pesticides to quickly be absorbed

by the air, ground or nearby sources of water. Let's talk for a moment about how this happens.

STEP 2. PRESENTATION: VAPORIZATION

Unit XIII used the term VAPORIZATION. Vaporization happens when the pesticide chemical applied to crops begins to be absorbed into the surrounding air. The pesticide became a vapor, or gas, much like water does when it is boiled and steam is produced. As soon as the pesticide chemical is in a vapor form, it is easy for it to mix with the air around it since air is in a gas form too.

> TO THE TRAINER: In the classroom setting, bring the materials needed to boil water, including a heat source and water in a heatable container. Heat the water to a boil until steam is produced. Show the learners how the steam escapes into the air and becomes part of it and tell them that this is what happens when pesticide chemicals go through vaporization.

STEP 3. PRESENTATION: DECOMPOSITION AND RUNOFF

Vaporization is one way that pesticide deposits can be quickly absorbed into the atmosphere. Another way that this happens is through DECOMPOSITION. Decomposition is the breaking down of pesticide chemicals into the environment. The chemicals in the pesticide will hold together for a limited amount of time. Time will eventually cause the mixture's ingredients to break apart, or decompose.

Certain chemical mixtures tend to break down faster than others. Sunlight can make the decomposition or breakdown of a pesticide proceed faster. Water can also make it proceed faster. When it rains and plants become wet, the pesticide deposit or residue on the plant also becomes wet. The water and pesticide then enter into a chemical reaction which breaks down the pesticide. Decomposition is just one more thing than can happen to applied pesticides to make them quickly disappear into the environment.

Another thing that happens to the deposit of pesticides when it rains is called RUNOFF. This simply means that the rain washes the pesticide deposit from the target area plants and carries it away.

Remember the four things that can cause a pesticide deposit to be quickly absorbed by the environment:

1. Drift
2. Vaporization
3. Decomposition
4. Runoff

STEP 4. PRESENTATION: RESIDUES

What about pesticides that reach the target area and remain there for a long time? When a pesticide deposit remains on the surface of the crop area for a period of time, it is called a RESIDUE. Drift, vaporization, decomposition, and runoff work to quickly destroy the pesticide and there is little or no residue. But some deposit stubbornly resist breakdown. They leave a residue on the crop or in the environment for a long time--weeks, months, or even years!

STEP 5. SUMMARY

Summarize the major topics as outlined here. There are a number of things that can happen to a pesticide once it has been applied:

1. Some of it may never even reach the crop area. Drift causes the pesticide spray or dust to be carried away from the crop area by air currents.
2. Once applied, some of the pesticide may reach the crop area and leave a deposit, but it does not remain for very long.
3. Vaporization, decomposition, and runoff are three things that can occur to make the pesticide disappear into the environment very quickly.
4. Once applied, some pesticides leave deposits or residues that remain in the crop area and environment for long periods of time.

TOPIC B. ENVIRONMENTAL CONSIDERATIONS AND DANGERS

Purpose: To develop an understanding of the effects of deposits and residues on the environment. By the end of Topic B, trainees will know:

1. Some ways that long lasting residues can affect us;
2. What the term "food chain" means; and
3. The meaning of the term "accumulated pesticide."

STEP 1. PRESENTATION: LONG LASTING RESIDUES

Sometimes, a long lasting residue is desired because the longer the deposit remains on the crop, the longer it is effective in fighting pests. A long lasting residue means that the pesticide will not have to be applied as often. This, in turn, means that the pesticide is cheaper to use. But a long lasting residue may also seriously affect the environment. Since pesticides are poisons, they can also be dangerous to other living things. The longer a residue lingers on crops and in the environment, the greater the chance for contact with the poison. Let's talk about ways that contact with long lasting pesticide residues can occur.

First of all, residues affect the water, soil, and air. Runoff, spills, or drift into rivers, lakes and streams can kill fish and make the water unsafe to drink or even to wash in. Large doses of pesticides that remain in the soil for a long time can ruin the soil. Crops may absorb the pesticide from the soil and be poisonous to eat once they are harvested. Pesticides in the soil can kill plant life and make land useless for farming. Finally, pesticide particles carried in the air during vaporization can contaminate the air and make it dangerous to breathe. Pesticides once in the air cannot be controlled. They may be carried away and settle into water sources, wooded areas, or worse yet, living areas for people.

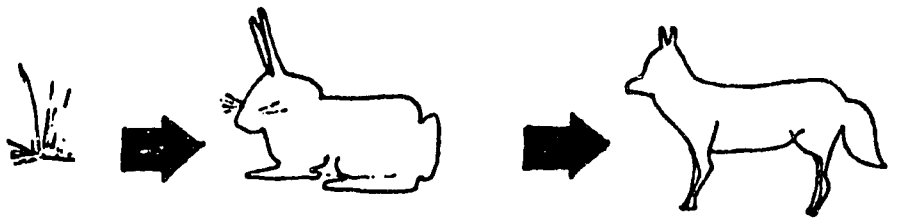
Uncontaminated water, healthy soil, and clean air are needed to live, but the existence of pesticide deposits and residues threaten these conditions and, as a result, our very lives are threatened!

STEP 2. PRESENTATION: DANGERS TO THE FOOD CHAIN

Pesticides can be poisonous to wildlife. We know, for example, that careless use of pesticides can destroy a pest's natural enemies. Upsets in the balance of pest populations may result. When pesticides are misused, you may actually help pests by destroying the animals that naturally control their numbers!

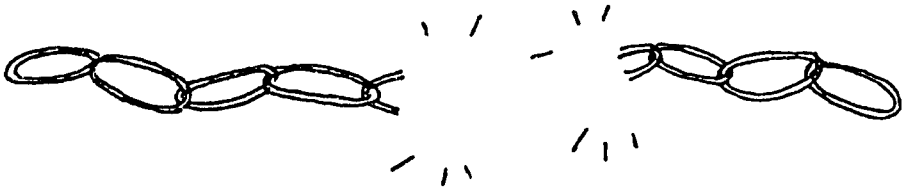
Animals useful to us may also be injured by contact with pesticide residues. Some of these residues are very dangerous to wildlife while other pesticide residues are relatively harmless. But a pesticide which is harmless to one living thing may be very dangerous to another living thing. For example, a pesticide residue that is safe for birds may be very poisonous to mammals. We do not know how dangerous every chemical is to all the different animals in the world.

Direct contact with a pesticide residue is not the only way that these deposits can harm the environment's living things. In any environment of living things, animals must eat to live. Some animals must eat other animals in the environment. In this way, animals--including people--depend on other animals to survive. Consider the following illustration of a <u>food chain</u>:



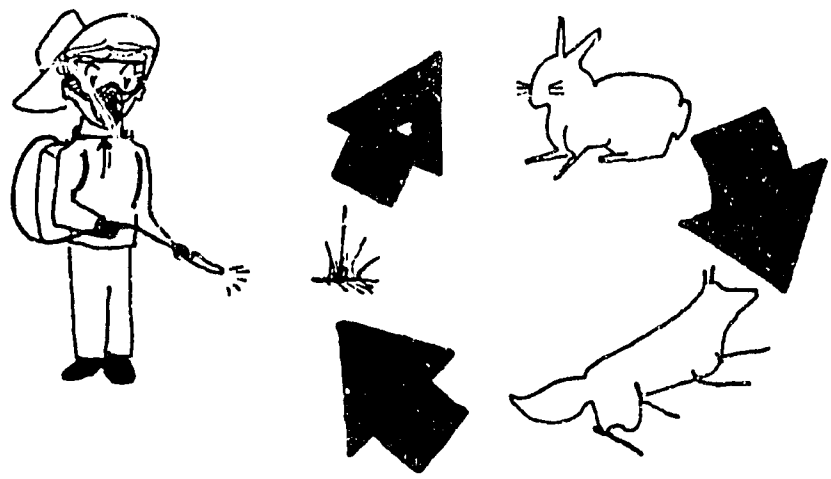
In the food chain, animals at the lowest level eat only plants. These animals are in turn eaten by animals at the next higher level, and so on up to the highest level. Each animal at each successive level in the chain depends on an animal at a lower level for food.

The dependency of animals on plants and on other animals for food is called the "food chain." Each animal has a place in the chain depending on the type of food it eats. Some animals eat only plants (herbivores) and occupy a position at the bottom of the chain. Animals which feed on these plant-eaters (1° predators or carnivores) form the next level on the chain. Animals which eat the meat of other animals (2° predators) are at the top of the chain. Each species of animal is important in the food chain. If any link were missing from the chain, it would be broken and disruption would result!



Some pesticides can build up in the body of an animal slowly over a period of time. The food material the animal takes in may contain a pesticide and that part of the pesticide deposit or residue which is not excreted or metabolized remains in the animal's body. As more food is obtained and

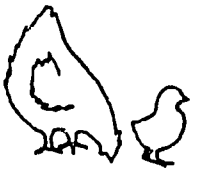
eaten, the amount of pesticide in the animal's body slowly increases. Just as pesticides can build up in the body of an animal, they can also accumulate in the food chain. Animals at lower levels of the food chain may accumulate amounts of a pesticide of a particular concentration. When they are fed upon by animals at a higher level in the chain, these animals in turn will build up quantities of pesticides in their bodies, but at a higher concentration. The carnivores located at the top of the food chain thus may be acquiring high doses of poison. In this way, the meat-eater can be poisoned without even ever coming into direct contact with the pesticide!



The transfer of energy and substances in the food chain becomes dangerous when pesticide contaminated plants are eaten by the lower level animals who are in turn eaten by higher level animals. The pesticide can build up in the chain just as it can in the bodies of individual animals.

Hypothetical Case of Pesticide Accumulation:

Whitegrubs	Herbivore	0.001 mg/grub of pesticide obtained from soil and plant roots it feeds on.
Chickens	1° Predator	0.05 mg accumulated from eating 50 herbivores.
Man	2° Predator	0.25 mg accumulated from eating 5 chickens during several months.



The same sort of thing happens when a cow eats grass that has been contaminated with pesticides. The milk and meat from this animal will contain pesticide. Subsequently, if a person eats the meat from this cow or drinks its milk, he or she can become poisoned. Remember that much less poison, in the form of contaminated milk, is necessary to poison a 5 kg baby than a 70 kg adult. Also, anyone in poor health is more susceptible to pesticides than a healthy person.

For these reasons, consider the effect of pesticide residues in the environment . . . and do something to prevent them.

STEP 3. DISCUSSION: LOCAL FOOD CHAINS

Ask learners to describe examples of food chains. Draw these on a board. Ask trainees to indicate where pesticides might enter the food chain.

STEP 4. DEMONSTRATION: DRIFT, RESIDUE AND RUNOFF

TO THE TRAINER: It is also essential that you demonstrate the principles of drift, residue and runoff:

Drift: You need either a vial of perfume or a spray can of deodorant. In an enclosed area, open up the container and note how the odor spreads throughout the room. By fanning the air, the spread (or drift) is faster. If outside, a can of spray deodorant can be used to demonstrate the principle of drift. Make sure you point out the connection to pesticide drift -- that pesticides, particularly on windy days, drift far and fast--and they are dangerous.

Runoff: Use a can of spray paint or paint and a brush, and a piece of wood. Spray or paint a very heavy coat of paint until it runs off the board. Note the runoff and link it to pesticide runoff.

Residue: Use the same piece of painted board. Take water and wash off the paint. A residue of paint should remain on the board. Point out the similarity to pesticide residue.

Discussion: Ask the learners how these principles (drift, runoff and residue) affect them in their work.

STEP 5. SUMMARY

Conclude Topic B with the summary outlined below:

1. Long lasting pesticide residues may be desired. But they may be dangerous to:

   a. Water
   b. Soil
   c. Air
   d. Non-Target Insects
   e. Wildlife
   f. People

2. The food chain illustrates the fact that the animals in an environment depend on each other for food. Each animal, including man, has a special place in the food chain, depending on what the animal eats.

3. Accumulated pesticides build up in an animal's body over a period of time until they reach a dangerously high level.

4. Accumulated pesticides may build up in the food chain. Although animals at the lower levels of the chain may be unaffected by the chemicals, animals at higher levels may be injured when they eat these animals with built up pesticides. A greater pest problem may result.

TOPIC C. WHAT CAN WE DO?

Purpose: To discuss effective ways to limit the risk of poisoning or environmental contamination once pesticides have been applied. By the end of Topic C, trainees should know:

1. Some ways to limit the problem of drift.
2. What the term "tolerance" means.
3. How to use safe re-entry times to protect themselves and others from poisoning.

STEP 1. PRESENTATION: PREVENTING DRIFT

Once applied, pesticides can either be absorbed by and become part of the environment, or they can form residues which linger on the surface of the target area--sometimes for a very long time. Drift, vaporization, decomposition and runoff can contaminate the air, ground and water. Residues can harm animals and people.

But what can you do about these problems? Several things!

First, you have taken a very important first step by becoming informed and aware of the things than can happen to pesticides once applied. But let's go a step further. It is important to be informed about the specific pesticide you use. All pesticides are not alike. Some are more poisonous than others. Some of the less poisonous chemicals are still hazardous because they are "accumulative pesticides" and build up in the bodies of animals or elsewhere in the food chain. You should know enough about any pesticide you use to know how it will react with the environment once applied. Certain pesticides can injure crops and nearby plants. Others may be safe for plants, but highly dangerous to animals. Choose the pesti-

cide which is least hazardous to the target crops you are treating. More importantly, choose a pesticide that is least hazardous to people and animals. Once you have chosen the right pesticide, you must consider the things which can happen to pesticides once applied.

What about drift? Is there anything you can do to limit this problem? Certainly! Wind increases the chances that pesticide spray droplets or dust particles will drift. If you spray on a less windy day, or during part of the day that is less windy, drift can be reduced. The size of the nozzle opening used to spray pesticides can have a significant effect on the amount of drift that occurs. A larger nozzle will produce larger, heavier droplets that are not as easily carried by the air. Likewise, if there is too much pressure in the spray tank, the droplets will be very fine and easily carried away by the wind.

STEP 2. PRESENTATION: RESIDUES AND TOLERANCE

Let's now discuss deposits and residues. What can you do to protect yourself and the environment from toxic deposits? Residues often linger on crop surfaces and injure you or workers who re-enter the treated area. The way to prevent this is to pay close attention to the "re-entry periods" that should be recommended on all pesticide labels. The label should indicate the number of days that must be allowed to pass before workers can safely re-enter the crop area. A 24 hour period should be considered as a minimum re-entry period.

Even when the pesticide residue is no longer dangerous to workers who come into contact with it, enough of the deposit may linger on the plant to be dangerous if eaten. Many times residues remain on food or feed crops at harvest time.

The maximum amount of pesticide residue that can remain on a harvested crop is called a tolerance. Tolerance is measured by the weight of the residue compared to the weight of the crop. For example, the tolerance for a particular pesticide might be one part per million (written 1 ppm). This means that the safe tolerance level is one part of pesticide to one million parts of crop. Tolerance is different for different crops. Sometimes, the tolerance level is very small and we can say that it is a "negligible residue tolerance," or far below the toxic level. Crops with a negligible residue are safe to eat. But, if the residue is greater than the set tolerance, the crop should not be eaten or marketed.

STEP 3. SUMMARY

Conclude Topic C with a summary:

There are several things that you can do to reduce the risk of poisoning or harm to the environment that pesticide deposits and residues create:

1. Become informed about what can happen to pesticides once applied.
2. Be acquainted with the particular pesticide used. Is it the least dangerous pesticide to the environment and living things that we could be using to fight our pest problem?
3. Reduce the likelihood of drift by not spraying on windy days and using the appropriate size of applicator nozzle.
4. Pay close attention to safe re-entry times as specified on the pesticide label or pointed out by the extension agent.
5. Be acquainted with the tolerance associated with the crop sprayed and the pesticide used. Remember: Pesticide residues on crops should be lower than the set tolerance level before they are harvested and eaten.

UNIT XIV SUMMARY

These are the major points covered in Unit XIV:

A. There are a number of things that can happen to pesticides once applied. The pesticide may never reach the target area, as in the case of drift. When pesticide spray or dust particles are carried away by air currents, drift has occurred. Or, the pesticide may reach the crop but quickly mixes with the air, through vaporization; or with the soil, through decomposition; or with water, through runoff. Finally, some pesticides may form long lasting residues by clinging to the surface of the sprayed area. Residues may remain on the surface of a sprayed area for a very long time.

B. Sometimes, long lasting residues are desired because they are highly effective for a long time in controlling pests. However, these residues can also have a harmful effect on the soil, water, air, wildlife and human beings in the environment. Pesticide residues can contaminate lakes, streams and rivers. They can make land unhealthy for growing crops. They can build up (or accumulate) in the bodies of living things (including man) until they reach a poisonous level. Accumulated residues build up in the food chain so that a meat-eater that eats an animal that has had contact with pesticides can be poisoned.

C. The harmful effects of pesticide residues can be limited in several ways. A good knowledge of the things that can happen to pesticides once applied and a wise choice of the safest pesticide to use are two important first steps. You can limit the problem of drift by avoiding wind and using large applicator nozzles. You

can protect the worker by becoming aware of and enforcing re-entry times. And finally, be informed about the tolerance level of the crop sprayed with a particular pesticide.

TO THE TRAINER: Conclude this Unit by asking the trainees if they have any questions. After you have answered their questions, it's your turn. Ask them the following questions.

QUESTIONS

UNIT XIV: "What Happens to Pesticides After They Are Applied?"

1. Name three things that can happen to pesticides after they have been applied.
2. What is drift?
3. How do you prevent drift?
4. What happens when a pesticide has vaporized?
5. What is a pesticide deposit?
6. Name two things that cause decomposition to occur more rapidly.
7. What is runoff?
8. What is a residue?
9. Name three ways that pesticide residues can be dangerous to the environment and living things, including man.
10. What are accumulative pesticides?
11. Define the term "food chain." (You may draw a picture or define with words).
12. Why is every animal in a food chain important?
13. How can you become indirectly poisoned by pesticides?
14. Define the terms "tolerance" and "re-entry periods" and tell how they can help us to limit the dangers of pesticide residues.

UNIT XV: EVALUATION

If it is important enough to teach all or part of this training program, then it should also be important to evaluate whether or not the trainees can apply the material presented. The idea of evaluation, at least for this training program, is not to test each person for their understanding or ability to repeat facts. Rather, the evaluation must be one of application of the knowledge, skills and subject matter. To that end, UNIT XV is designed to assist you to create a limited number of situations that require the trainees to apply what they have learned.

This Unit incorporates simulations of common situations which the trainees (as well as those individuals whom the trainees will train) will encounter. These situations relate specifically to the question of selecting the proper pesticide to be used; to the question of economic threshold and evaluation; to the question of an accidental pesticide spill; and to the questions of correct storage and disposal of pesticide materials. These simulations must be designed by you to permit the trainees to evaluate themselves. As you design these simulations, be sure to use local materials and supplies (including locally available pesticides and equipment) and examples of pest problems found in the area (including crops and pests). Tailor the simulations to the realities that trainees are likely to face. The true intent of this Unit is to create another opportunity to learn, not to make participants feel that they know very little.

ORGANIZATION: Divide the trainees into working groups of 4 to 7 persons each. Consider the mix of students in each group. If trainees from several different organizations or programs are participating, try to

ensure that there is a "random" mix of trainees in each group. Each simulation requires the full participation of every group member. Each group should have no more than 3 hours to complete their tasks. In addition, allow 1/2 hour per group to report their conclusions and recommendations to the rest of the groups. Therefore, with 4 work groups, you will have to make sure that a total of 5 hours is available for this evaluation.

EVALUATION KITS: Each group should be given an EVALUATION (OR SIMULATION) KIT. It is the responsibility of the trainer (you) to prepare these KITS, using locally available materials. Each KIT should include the following:

1. LABELS - 4 to 6 labels of pesticides available locally
2. PESTICIDE INFORMATION - this information should include locally available written or printed information such as brochures, advertising flyers, control or field guides, etc. Material should correspond to the LABELS used.
3. PEST SITUATION - This situation will be in written form and should describe a typical field situation from that area. Include specific information such as the type of crops, the size of the field, and the type and scope of damage. In short, be prepared to write a "case situation" that includes sufficient information for the trainees to understand, to react to, and finally to answer specific questions.
4. PEST SITUATION - Prepare for each case a set of questions that directly relate to the pest situation and to which each group

is expected to respond with recommendations. Questions should include the following:

a. Should they apply any pesticide?

b. If yes, which one or ones?

c. Which one is the most toxic? The least toxic?

d. What precautions should be taken when applying/mixing the materials?

e. Are there available alternatives to using pesticides?

f. What other information is needed in order to make intelligent decisions about the use of pesticides?

Be prepared with other relevant questions. Prepare them in writing.

5. SAFETY PROBLEM - As part of the KIT, write a specific case that describes an emergency to which the group must respond. The emergency might be a pesticide spill in a warehouse, a broken application sprayer tank that ruptures, or a spill that leads to a poisoning of a child. The important element is that the case be realistic and that you provide enough background information (e.g., name and type of pesticide, what happened, etc.). Again, you must prepare a set of questions to which the group must respond. For example: What steps would the group take to respond to the emergency? What supplies should be available? What first aid procedures should they take? etc. Prepare these questions in writing.

6. DISPOSAL PROBLEM - This component focuses on problems that usually occur as a result of disposal. Specifically, describe a situation in which after using a particular material, excess material remains and must be disposed of. Also, after this

use, there remains the problem of clean up of equipment, clothing, and self. Describe in detail the particulars and pose specific questions to which the work group must respond. For example: How will the excess pesticide be handled or disposed of? What steps could be taken to avoid having an excess? How do they clean up the equipment? etc.

PROCEDURE: Explain to the assembled groups the goal of the evaluation and what you expect of them. Indicate that each group independently should review the EVALUATION KIT materials and, if necessary, to ask questions for clarification. Indicate that each group has a different and distinct KIT. Once the groups begin, each is expected to determine what and how they will respond to the material and the questions. Each group should work independently of every other group. You, as the trainer, must be prepared and available to help answer questions that help the groups to better understand the materials and their tasks. Make sure that everyone understands the time limitations and the reporting procedure.

REPORTING PROCEDURE: Each work group is expected to brief the full assembly on <u>conclusions</u>, <u>recommendations</u> and <u>answers</u>. It is up to you as trainer to encourage the work groups to do more than give an oral report. Encourage the groups to use role playing, acting, or other dramatic means to give their report. They might also use charts to make points. The challenge is to see if the groups can have fun as they participate in their evaluation and deliver their reports. Make sure that there is participation by all members in the reporting group. Also, allow other trainees to comment. Finally, keep an eye on the clock. It is your job to ensure that you finish on time!

UNIT XVI: VISUAL AIDS AND HANDOUTS

This Unit contains various training aids and other materials.

1. Series of 11 drawings: "Safe Use of Pesticides"

2. Handouts

   a. LD_{50} List

   b. Relative Toxicity of Insecticides

   c. Plans for Pesticide Storage Chest

   d. Illustration of Pesticide Storage Facility

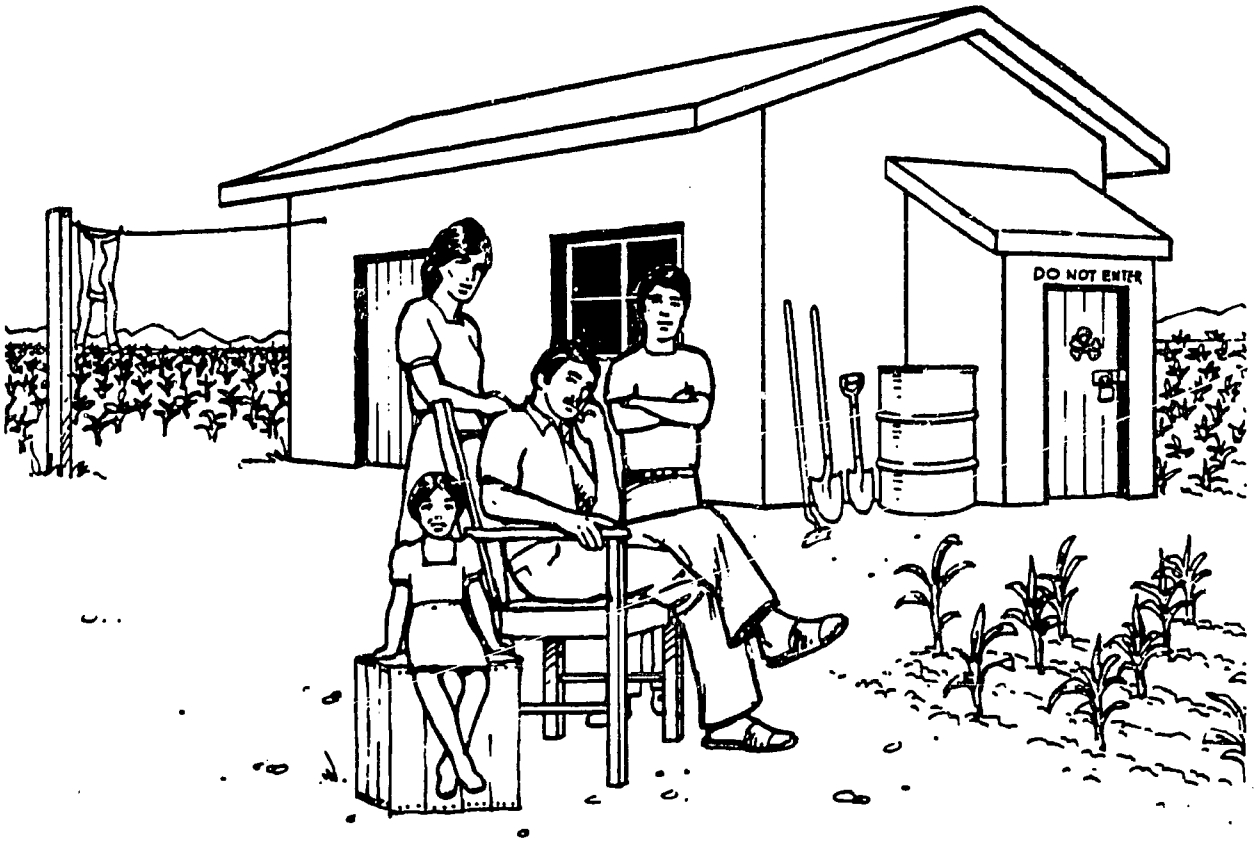
VISUAL AIDS ON THE THEME, "SAFE USE OF PESTICIDES"

The following set of 11 drawings portray a farm family using recommended practices for the safe use of agricultural pesticides. These illustrations are intended for use as visual aids in pesticide safety training programs and, for this purpose, can be used as instructional posters, classroom aids, in pamphlets, or on calendars.

The drawings represent various practical aspects and safety measures dealing with the management and use of pesticides. The intended message of each drawing is as follows:

1. Introduction of the family to the viewer. Father, mother, son and daughter on a "typical" small farm.
2. Store dangerous chemicals safely out of reach of children.
3. Always read label instructions before using pesticides and be sure to have all necessary equipment at hand.
4. Always use protective equipment when handling pesticides.
5. Always use the correct dosage of each chemical, as indicated on the label. Always use protective equipment while mixing.
6. Always use protective clothing while spraying.
7. Always clean pesticide spraying equipment away from water sources.
8. Always wash clothes after each use of pesticides.
9. Always wash hands and body after using pesticides (especially before eating).
10. Dispose of used pesticide containers properly. (i.e. bury pesticide containers).
11. Two results of safe pesticide use are a happy, healthy family and productive, healthy crops.

Users of this manual are encouraged and urged to modify and adapt these illustrations to their proper social, economic and environmental conditions. The drawings may be used singly or together as a set with groups of farmers, housewives and/or children as focal points of discussions on the need for safe and proper use of pesticides. Discussion may be stimulated with each picture by asking questions, such as why is safe use necessary?, what are some safety steps that may be taken to reduce the risk involved?, what are the risks associated with improper or careless use of pesticides?, etc.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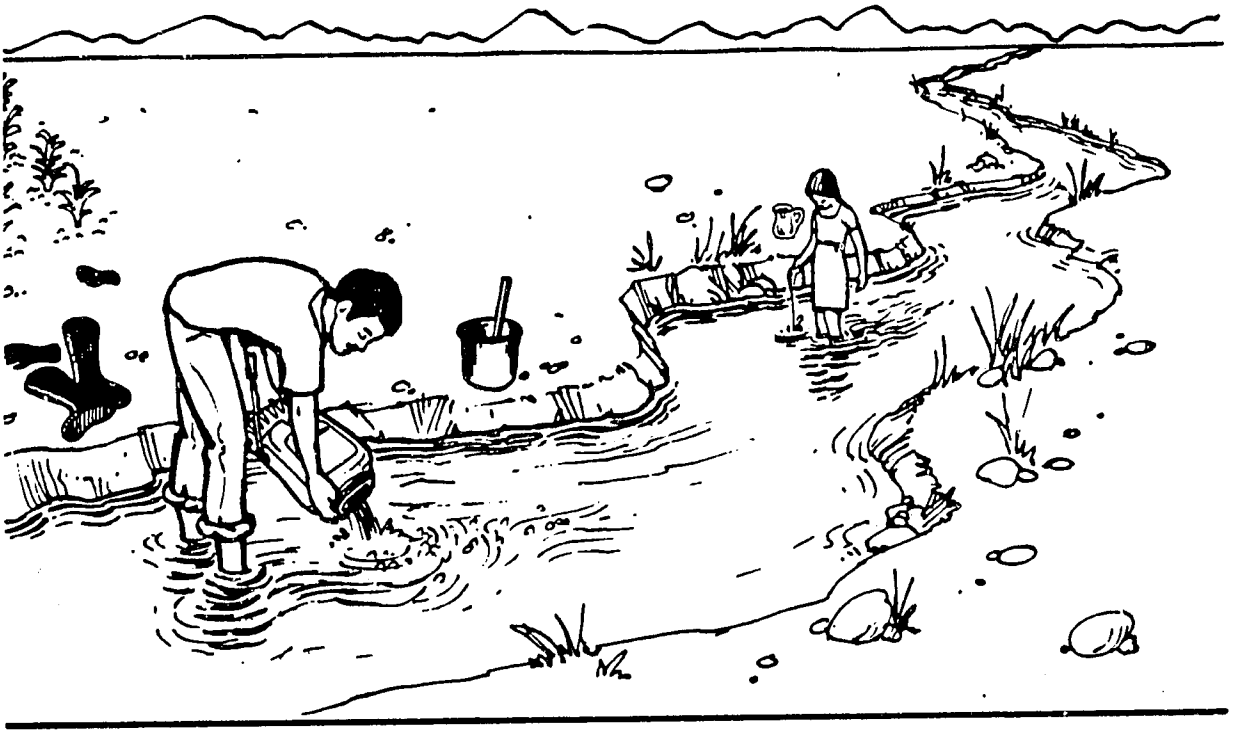

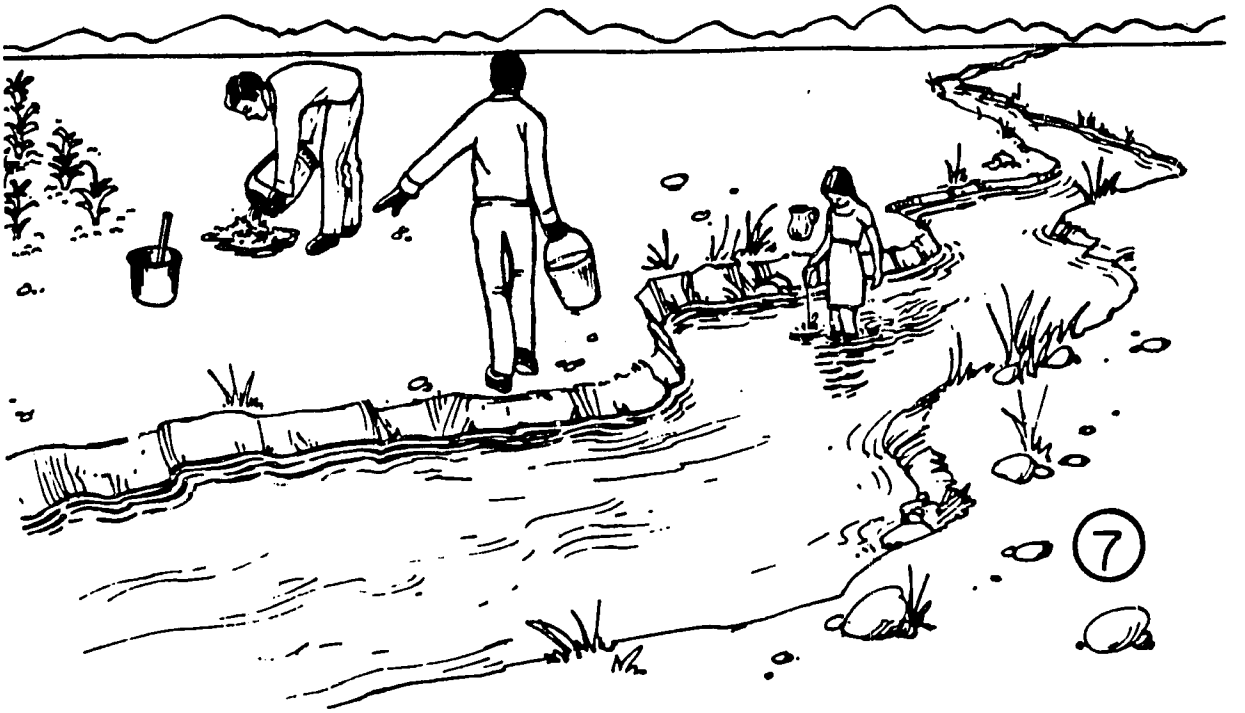
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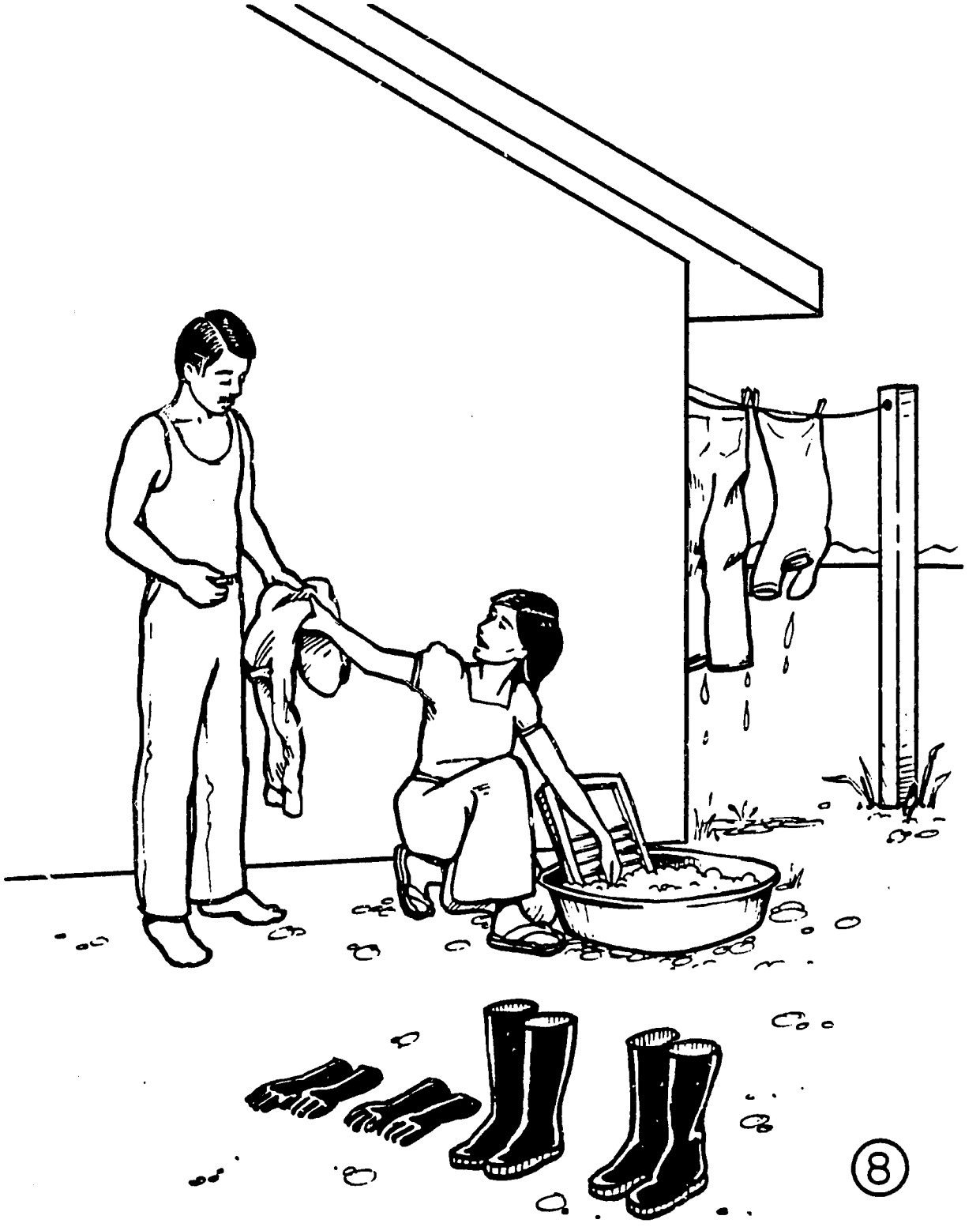

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11

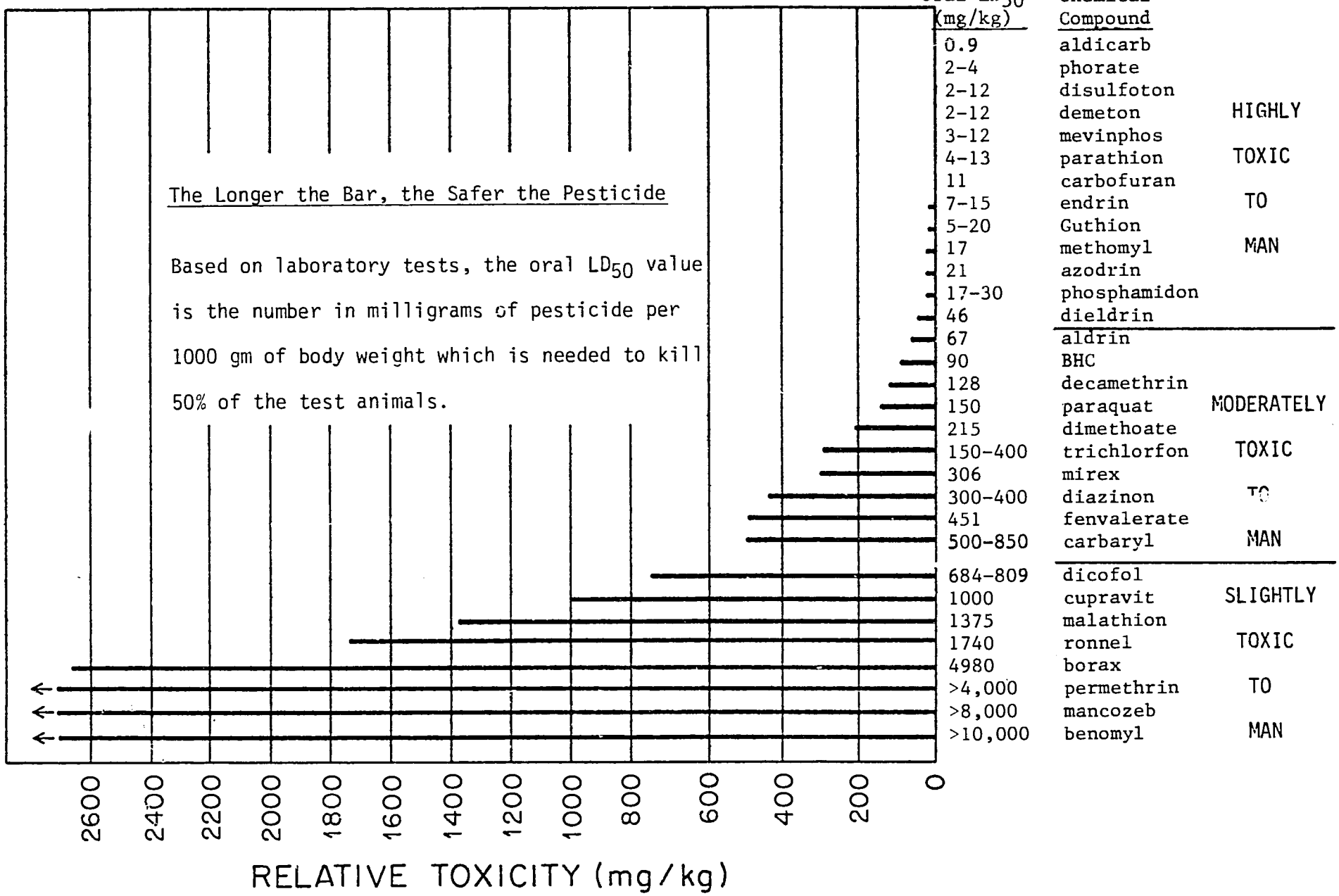
ACUTE TOXICITY OF SOME PESTICIDES

Chemical	Oral LD_{50} (mg/kg) (rat)	Use
phorate	2 - 4	insecticide
warfarin	3	rodenticide
Dasanit	2 - 10	insecticide-nematocide
parathion	4 - 13	insecticide
Nemacur	8.1 - 9.6	nematocide
Furadan	11	insecticide-nematocide-acaricide
endrin	7 - 15	insecticide
Guthion	5 - 20	insecticide
methyl parathion	9 - 25	insecticide
Lannate	17 - 24	insecticide
Trithion	6.8 - 36.9	insecticide-acaricide
Paris green	22	insecticide
strychnine	30 - 60	vertebrate poison
dieldrin	46	insecticide
dinoseb	40 - 60	herbicide
nicotine	50 - 60	insecticide
Mocap	61.5	insecticide-nematocide
Metasystox	64	insecticide-acaricide
aldrin	67	insecticide
arsenic	48 - 100	insecticide-herbicide

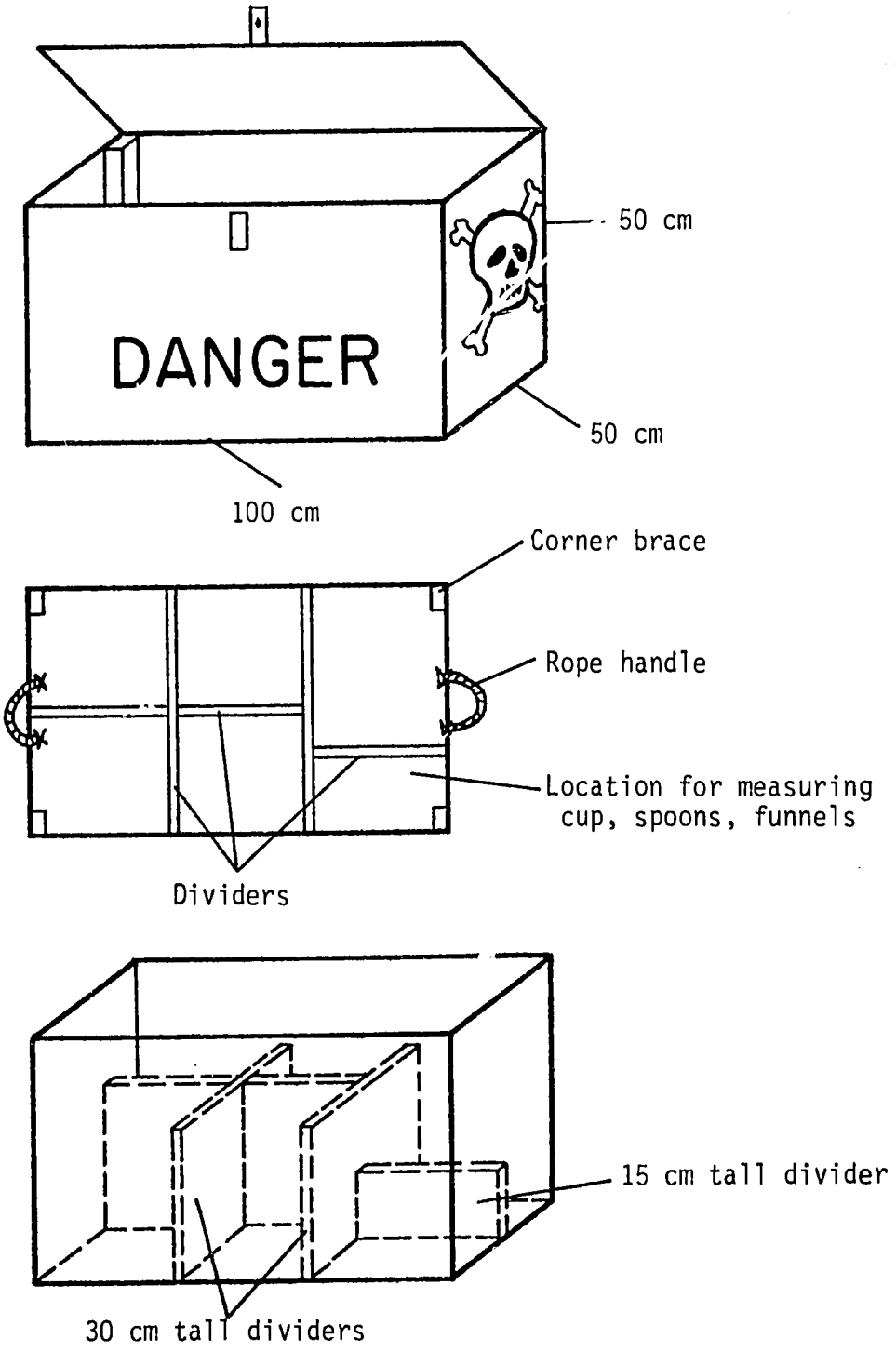
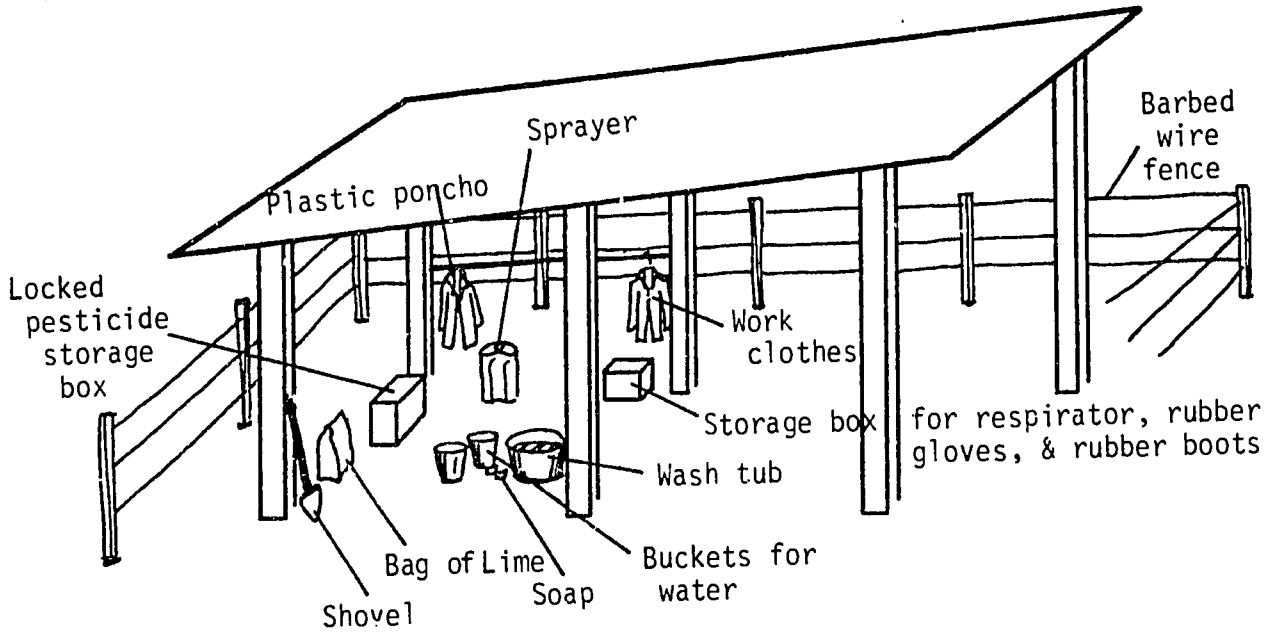
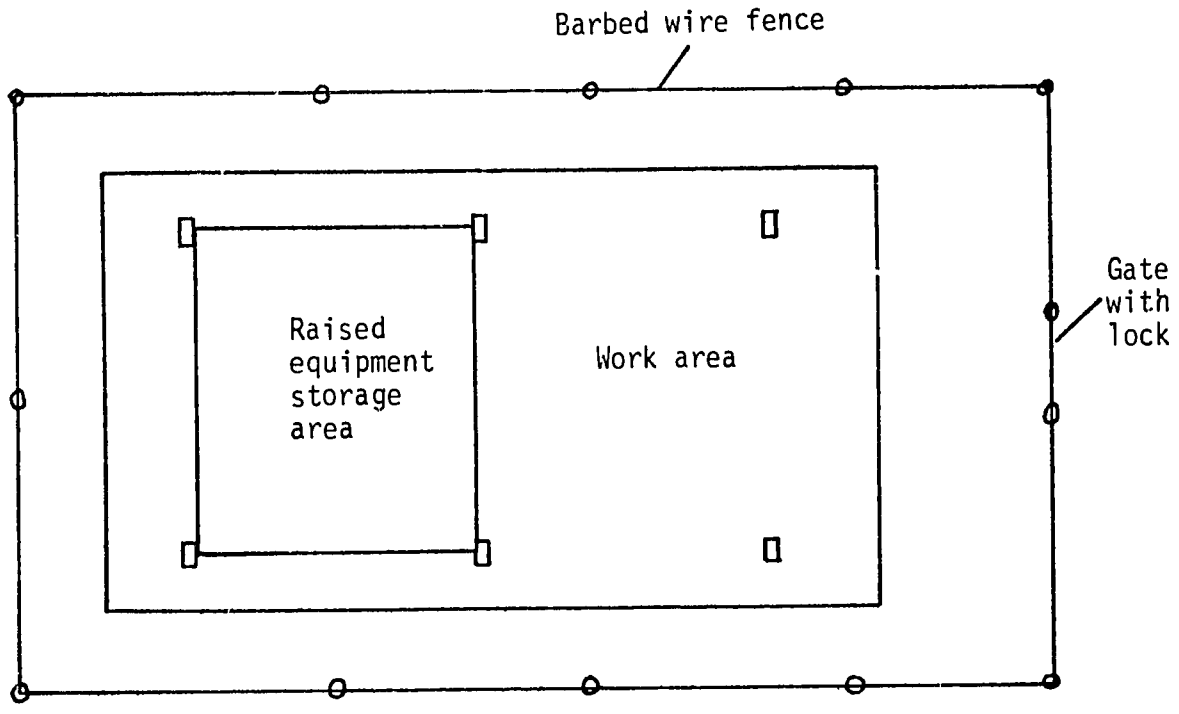
Chemical	Oral LD_{50} (mg/kg) (rat)	Use
pentachlorophenol	50 - 140	wood preservative-molluscide
lindane	88 - 125	insecticide
sodium fluoride	75 - 150	insecticide
Ciodrin	125	insecticide
Baygon	100 - 200	insecticide
mercurials	210	fungicide
Perfekthion	215	insecticide-acaricide
Nemagon	170 - 300	nematocide
DDT	250	insecticide
Dipterex	150 - 400	insecticide
Lebaycid	255 - 298	insecticide
mirex	306	insecticide
diazinon	300 - 400	insecticide-nematocide
nabam	395	fungicide
Dibrom	430	insecticide-acaricide
chlordane	367 - 515	insecticide
2,4-D	375 - 700	herbicide
carbaryl	500 - 850	insecticide
rotenone	132 - 1500	insecticide
malathion	1375	insecticide
pyrethrum	1500	insecticide
Eptam (EPTC)	1630	herbicide
ronnel	1740	insecticide
atrazine	1780	herbicide

Chemical	Oral LD_{50} (mg/kg) (rat)	Use
salt	3320	food preservative herbicide
diuron	3400	herbicide
Agroxone (MCPA)	3500	herbicide
borax	2660 - 5190	herbicide
linuron	4000	herbicide
simazine	5000	herbicide
bromacil	5200	herbicide
Amiben	5620	herbicide
Dybar	6400	herbicide
piperonyl butoxide	7500	synergist
maneb	7990	fungicide
captan	9000	fungicide
trifluralin	10,000	herbicide
Dipel	inoffensive	insecticide (microbial product)

RELATIVE TOXICITY OF PESTICIDES BASED ON ORAL LD_{50} (MG/KG)



PESTICIDE STORAGE CHEST



PESTICIDE STORAGE & WORK FACILITY