Oregon Pesticide Safety Education Manual

A Guide to the Safe Use and Handling of Pesticides

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Introduction

This manual is intended to be a resource for persons involved in different aspects of pesticide use, including those who are preparing to take certification exams and those who already are certified pesticide applicators, pesticide operators, dealers, and consultants.

In this edition, we have attempted to use a language that is more "reader friendly"; that is, often less technical, but still technically and legally correct. At the same time, we have attempted to include all technical terms that are common in the industry and which may appear on Oregon State pesticide exams.

Certified users in a specific category may feel that the Manual contains more information than they need. However, we think that a single manual is more convenient and more economical than having two or more manuals. It can serve as a reference for those persons who may want detailed information on pesticide registration, establishment of tolerances, or label comprehension. Nevertheless, additional manuals still may be required for specific uses such as landscape, forestry, rights-of-way, and aerial application.

We have added a short introduction in Chapter 2, which we hope will remove some of the public fear and confusion about "What is a chemical?" and to clarify the terms "poison" and "toxicity."

At the time of printing, all information in this Manual was up to date. However, the reader must realize that pesticide laws and regulations, labels, and label standards can be modified from time to time. The reader must consult the appropriate state or federal agency if there is any doubt about any issue related to the use of pesticides or other aspects of the pesticide industry.

Remember: the pesticide label is the law. Always read the pesticide label.

Contents

Chapter 1

Pesticide Laws

Goals of this chapter

- List the major laws regulating pesticides in the U.S.
- List federal and state agencies involved in pesticide regulation.
- Describe the main role of each of these agencies.
- Describe the process required to register a pesticide.
- Describe the process required to establish tolerances for pesticide residues.
- Describe the certification and licensing process for Oregon pesticide applicators.
- Explain the difference between general-use and restricted-use pesticides.

In the past 50 years, pesticides have become a major tool for managing pests. Pesticide applicators must have special knowledge and skills to apply pesticides safely and effectively. They must be able to identify the pest of concern and the pesticide that will control it. They also must be aware of possible impacts on people, wildlife, and the environment.

Federal and state pesticide laws are meant to protect public health and the environment from harmful effects of pesticides. At the same time, they are meant to keep pesticides safe tools for pest management. Many federal and state agencies are responsible for regulating pesticides.

Federal pesticide laws

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

FIFRA is the most important federal law dealing with pesticides.

- FIFRA requires that the U.S. Environmental Protection Agency (commonly known as EPA) register all pesticides (assign a product registration number). It requires the EPA to approve each use of that pesticide and approve the product label.
- FIFRA requires that all registered pesticides be classified as either general-use or restricted-use.
- FIFRA requires that the users of restricted-use pesticides be certified or work under the direct supervision of a licensed private or commercial pesticide applicator. As do other states, Oregon conducts its own applicator certification program.
- FIFRA provides penalties for “use inconsistent with the labeling” of a pesticide.

- FIFRA makes it illegal to store or dispose of pesticides or containers in a manner other than as directed by regulations.
- FIFRA provides civil penalties when the violation of a regulation is unintentional (when the person did not mean to break the law).
- FIFRA provides criminal penalties when the law is violated knowingly (when the person broke the law on purpose).
- FIFRA gives the EPA authority to develop regulations. These are interpretations of the FIFRA Act and have the full force of a law. These EPA regulations are published in the Code of Federal Regulations (CFR) Title 40.

Find EPA regulations at http://www.epa.gov/pesticides/regulating/index.htm

The Environmental Protection Agency has the main responsibility for regulating the manufacture, distribution, sale, and use of pesticides in the United States.

Under the authority granted by FIFRA, the EPA must make sure pesticide companies and pesticide handlers follow this law. The first concern of EPA officials is that pesticides will not harm humans, animals, wildlife, and the environment.

The Federal Food, Drug, and Cosmetics Act of 1938

Setting the tolerance

After applying a pesticide, a small amount of it remains on plants and produce. This is called **residue**. Under the Federal Food, Drug, and Cosmetic Act (FFDCA), a certain amount of residue is allowed on food and feed crops after harvest. The amount legally permitted is called the **tolerance**.

To learn more about residue and tolerance, see Chapter 3.

The FFDCA created the Food and Drug Administration (FDA). The EPA sets the tolerance, but FDA is responsible for enforcement of tolerances.

In Oregon, the Oregon Department of Agriculture (ODA) Food Safety Division cooperates with FDA to make sure that the pesticide residue levels on food crops and in milk are not greater than the tolerance.

Pesticide registration by the EPA

The EPA has registered some 50,000 pesticide products. How the EPA handles each registration application depends on whether the product is new or is already registered. Pesticide companies must submit a great amount of scientific information about newly discovered pesticide active ingredients before they can be registered by EPA for distribution and use. If a pesticide company plans to sell new formulations containing active ingredients already registered with the EPA, or new uses of existing products, the registration packet they must submit is less extensive.

You can access EPA at: http://www.epa.gov/

For the Office of Pesticides Programs, go to: http://www.epa.gov/pesticides/

Aerial application of pesticides

The Federal Aviation Administration (FAA) is in charge of the rules for applying pesticides by airplane. The FAA certifies commercial and private farm aircraft pilots. Pilots also must have the correct pesticide license from Oregon Department of Agriculture before applying pesticides.

Pesticide use

Label directions

The pesticide label is a legal document under both federal and state laws. Anyone who applies a pesticide in a way that does not agree with label directions is breaking the law.

The label tells you on which sites and target pests to use the pesticide. The label gives directions for mixing, loading, and application.

You must have the original, complete labeling for all pesticide products. Section 24(c) and Section 18 products need special labeling.

If you apply pesticides:

- Read and follow the label! It is the law! If you break the law, you could be punished.

If you register a pesticide:

- You must give proper directions for how to use it.
- You must give distributors the SLN or Section 24(c) labels.
- You must be sure that the correct Section 18 labeling is attached to products for emergency use.

If you sell pesticides:

- You must have special labeling for uses that are not stated on the container label. This is called **supplemental labeling**.

Restricted-use and general-use pesticides

EPA classifies all pesticides in one of two groups. They are classified as general-use or restricted-use.

If a product's label does not state "restricted-use pesticide," then it is a general-use pesticide. General-use pesticides should not harm people, animals, or the environment when used according to label directions. You must apply them according to label directions.

Any pesticide that poses special risks, even when used according to the label, is classified as a restricted-use pesticide (RUP). All RUPs must have a restricted-use statement that is easy to see on the front of the label.

You must have a pesticide applicator license to buy or use a RUP or be working under the supervision of someone who does.

Registration of pesticides in Oregon

Pesticide companies must register products with both the federal and state governments. States have the right to make their laws more strict than federal law, but not less strict.

Oregon Department of Agriculture mainly grants three types of pesticide registrations. They are known by their FIFRA section: Section 3, Section 24(c), and Section 18.

You can access these two state statutes at:

http://www.leg.state.or.us/ors/

http://arcweb.sos.state.or.us/rules/OARS_600/OAR_603/603_057.html

http://landru.leg.state.or.us/ors/634.html

Registration under FIFRA Section 3

Oregon Revised Statutes 634 (ORS 634) and The Oregon Pesticide Regulations (Oregon Administrative Rules [OAR] Chapter 603, Division 57) are Oregon's main Pesticide Control Laws. ORS 634 states that each pesticide product distributed, sold, or offered for sale in Oregon must be registered with ODA. Each product must be registered every year. ODA only registers products that the EPA has registered first under Section 3 of FIFRA.

You can get copies of these laws from:

Oregon Department of Agriculture
Pesticides Division
635 Capitol Street NE
Salem, Oregon 97301-2532
Telephone: 503-986-4635

Registration under Section 24(c) (Special Local Need registration)

If a pest causes serious damage to a crop and there is no pesticide that already is registered to control it, Section 24(c) of FIFRA allows states to give a **Special Local Need** (**SLN**) registration. This also is called a **24(c)**.

The 24(c) may add sites, increase rates, or change the way to apply the pesticide. These are different from the federally registered label.

The person or group asking for a SLN registration must give specific data to ODA. The data must show that the product will control the pest and that it will not harm the treated animals, plants, or crop. The pesticide must have an existing tolerance set by EPA.

The EPA reviews all SLN registrations. An SLN registration lasts until it is amended or canceled.

The company registering the pesticide must give special SLN labeling to dealers, who must give the labeling to the person who buys the pesticide.

You must have the SLN label with you when you use a pesticide registered under Section 24(c). If you don't have the label, you are breaking federal and state law.

Section 18 emergency exemption

Sometimes, there is a pest crisis for farmers.

1. A pest may invade a site for which there is no registered pesticide to control it.
2. The pest could cause farmers in the area serious economic loss.
3. There is a pesticide product that could control the pest, but it hasn't been registered with EPA.
4. There is no other way to help control the pest.

ODA must show EPA that this truly is a crisis and request permission for farmers to use the unregistered pesticide. This is called an **emergency exemption** and is permitted under Section 18 of FIFRA.

The unregistered pesticide already must have a set tolerance. The person registering the pesticide must show that the pesticide will control the pest. The pesticide must not leave harmful residues on food or feed crops. Then, EPA may allow farmers to use the pesticide only for the crisis situation.

Section 18 exemptions are valid for less than 1 year. They allow use of a specific amount of the pesticide on a specific site for a specific purpose.

To learn about setting the tolerance, see Chapter 3.

Misbranded and adulterated pesticides

Pesticides with labeling that makes false statements or labeling that does not follow the rules of ORS 634 are called **misbranded** pesticides.

Some pesticides do not contain the same ingredients or amounts or concentrations that are listed on the container. These are called **adulterated** pesticides.

It is against the law in Oregon to sell or distribute misbranded or adulterated pesticides.

Non-registered pesticides

Some pesticide products do not need federal or Oregon State registration. They are exempt from registration under FIFRA section 25(b). Their ingredients are called "low risk" by EPA. You can use or sell these pesticides legally without a registration.

There also are special state and federal permits for testing pesticides. These are called **experimental use** permits.

State Experimental Use Permit

If you want to test a pesticide on 10 acres or less, you need a permit from ODA. This is called a State Experimental Use Permit (**EUP**). You must notify ODA at least 72 hours before you apply the pesticide. You must destroy any food or feed crops that you test under an EUP. You must register the experimental pesticide if you want to sell it.

You can get application forms and more information from:

ODA—Pesticides Division
Telephone: 503-986-4635.

Federal Experimental Use Permit

If you want to test a pesticide on more than 10 acres, you must get a Federal Experimental Use Permit.

You can get application forms and more information from the two offices listed below:

Oregon Operations Office of the EPA
Telephone: 503-326-6869

Region 10 Office of the EPA
Telephone: 206-553-1091

Certification and licensing

Certification and licensing are two separate processes that are controlled by ODA.

Certification

This is the first step to becoming a pesticide applicator or consultant. You must show you have enough knowledge and skill to apply pesticides safely.

You must pass written tests (**examinations**) on the pesticide application work you want to do. Each type of license has special tests you must pass. You must score at least 70 percent to pass the tests.

Consultants and pesticide applicators are certified beginning on the date they pass the required tests. The certificate lasts for 5 years.

Recertification

You can keep your certificate up-to-date or renew it in one of two ways.

1. Take and pass again all the same tests you first took to get your license.
2. Attend training programs approved by ODA to earn credit hours.

You may start earning credit hours toward recertification the day after your certification begins. The number of credit hours you need for recertification is different for each type of license.

Private pesticide applicators

Take the test again

To recertify, you can pass the Private Applicator test again. It's best to take it between November 17 and December 31 of your last year of certification. That way, there's no break in certification. And, you get the full 5 years of certification for your renewal license.

Training

Instead of taking the test, you can earn 16 credit hours of training. This is made up of 4 hours of CORE training and 12 hours of other training.

You may earn no more than 8 hours of credit in 1 year (January 1 through December 31). Even if you attend more than 8 hours of training per year, only 8 hours will count toward recertification.

You must earn all 16 credit hours before your certificate expires.

Commercial pesticide applicators
Public pesticide applicators
Pesticide consultants

You must earn 40 credit hours of training to recertify for these licenses. You may earn no more than 15 hours of credit in 1 year (January 1 through December 31). Even if you take more than 15 hours of training per year, only 15 hours will count toward recertification.

You must earn all 40 credit hours before your certificate expires.

Where to find training

Call any of the businesses listed below to find out about training classes for recertification.

- The Oregon State University Extension Service (OSU-ES)
- Your local community college
- Agrichemical dealers
- Industry associations

You also can call or write to the person in charge of pesticide applicator training at Oregon State University.

Pesticide Safety Education Program Coordinator
Integrated Plant Protection Center
Oregon State University
Cordley 2040
Corvallis, OR 97331-2915
Telephone: 503-737- 6279

You can find a complete list of training programs on the Internet. Open the ODA Pesticides Division home page, then open the recertification training link.

ODA Pesticides Division home page: http://oregon.gov/ODA/PEST/index.shtml

Licensing

To get a pesticide applicator or trainee license, you must:

1. Be at least 18 years of age
2. Pass the written test to be certified
3. Pay the licensing fee

Private Pesticide Applicator License

With this license, you can buy and use restricted-use pesticides (RUPs). You can use RUPs on land you own or rent, or on your employer's land. You can apply the RUPs only on farm crops or products.

You don't need a license to apply general-use pesticides on your own land or on your employer's land.

When you pass the private applicator exam, ODA will notify you and send you a form to request your pesticide applicator license. You can get your license by giving the application form and licensing fee to ODA. This license expires on December 31 of the fifth year.

Commercial Pesticide Applicator License

You need a Commercial Pesticide Applicator License if you work for a commercial pesticide operator. With this license, you can apply pesticides on property owned by other persons, as a way to earn money. You also can supervise a trainee.

You must pass the Laws and Safety Examination plus the specific category examinations (called **endorsements**) related to your work. Each endorsement you get is printed on your license. (See Table 2, "Oregon Pesticide License Categories" on page 11 to know which ones you need.)

You can get your license by giving the application form and licensing fee to ODA. You must renew this license every year. It expires on December 31.

Table 1. Oregon Pesticide License Types.

Bring identification such as a driver's license to the examination session.

License type	Requirements in addition to application form	Description
Private Pesticide Applicator	1. Passing score on Private Applicator examination 2. Licensing fee	A person who uses restricted-use pesticides on land in agricultural production, owned, leased, or rented by the person or his or her immediate employer
Commercial Pesticide Operator	1. Completed financial responsibility insurance certificate 2. Licensing fee 3. Must hold Commercial Applicator License (see next item)	A business that applies pesticides for others as a commercial activity
Commercial Pesticide Applicator	1. Passing scores on Laws and Safety examination and Category examination(s) 2. Licensing fee	A person employed by a licensed commercial operator, in direct charge of or supervising the application of pesticides; a person other than a private or public applicator who applies restricted-use pesticides
Public Pesticide Applicator	1. Passing scores on Laws and Safety examination and Category examination(s) 2. Licensing fee	A person employed by a government agency or its subdivision, or public utility, in direct charge of, or supervising the application of restricted-use pesticides, or any other pesticide applied with machine-powered equipment
Directly Supervised Commercial Pesticide Trainee	1. Passing score on Trainee examination 2. Licensing fee 3. Can be renewed only once	A person working under the **direct** supervision of a properly licensed commercial applicator (on-site supervision **not required**)
Immediately Supervised Commercial Pesticide Trainee	1. Licensing fee (no examination required) 2. Can be renewed indefinitely	A person working under the **immediate** supervision of a properly licensed commercial applicator (on-site supervision **required**)
Directly Supervised Public Pesticide Trainee	1. Passing score on Trainee examination 2. Licensing fee 3. Can be renewed only once	A person working under the **direct** supervision of a properly licensed public applicator (on-site supervision **not required**)
Immediately Supervised Public Pesticide Trainee	1. Licensing fee (no examination required) 2. Can be renewed indefinitely	A person working under the **immediate** supervision of a properly licensed public applicator (on-site supervision **required**)
Pesticide Consultant	1. Passing score on Pesticide Consultant examination 2. Licensing fee	A person who offers or provides technical advice to the users of restricted-use pesticides
Pesticide Dealer	1. Licensing fee (no examination required)	A pesticide sales outlet that sells restricted-use pesticides to users

Public Pesticide Applicator License

You need a Public Pesticide Applicator License if you work for any publicly owned and/or operated company such as schools, telephone, electricity, highway department, etc. With this license, you can apply pesticides or supervise a trainee.

- You can apply RUPs on property under the public company's control.
- You must have this license even to apply general-use pesticides with power-driven equipment on property under the public company's control.

You also can work as a consultant in certain ways stated on the license.

You must pass the Laws and Safety Examination plus the specific category examinations (called **endorsements**) related to your work to be certified for this license. Each endorsement you get is printed on your license. (See "Oregon Pesticide License Categories" on page 11 to know which ones you need).

You can get your license by giving the application form and licensing fee to ODA. You must renew this license every year. It expires on December 31.

If you work for a public company and you apply general-use pesticides with hand-powered equipment, then you don't need a license.

Pesticide Trainee License

With a Pesticide Trainee license, you can apply pesticides if you are supervised by a licensed applicator. You cannot buy RUPs with this license.

The Oregon Department of Agriculture grants two main types of trainee licenses: Immediately Supervised Trainee and Directly Supervised Trainee.

Immediately Supervised Pesticide Trainee License

With this license, you can apply pesticides only when you are supervised by a licensed pesticide applicator.

- Your supervisor must be on site at all times during the application.
- Your supervisor must be able to come to the place you are applying pesticides within 5 minutes.

You can get an Immediately Supervised Trainee License by giving the application form and licensing fee to ODA. The kinds of work you plan to do (license categories) must be the same as your supervisor's license.

You must renew this kind of license every year. It expires on December 31.

Directly Supervised Pesticide Trainee License

With this license, you can apply pesticides only when you are supervised by a licensed pesticide applicator.

- Your supervisor must be ready to speak with you on the phone or radio when you have a question.
- Your supervisor does not need to be at the site while you apply the pesticides.

You must pass a written test before you can apply for this license. Then, give your application form and licensing fee to ODA. The kinds of

work you plan to do (license categories) must be the same as your supervisor's license.

You can renew this kind of license only once, for 1 year. It expires on December 31.

Commercial Pesticide Operator License

You need this kind of license if you want to start your own pesticide application business. To get this license, you must do three things.

1. Give your application and licensing fee to ODA.
2. Have a Commercial Pesticide Applicator License.
3. Ask your insurance agent to fill out a Financial Responsibility Insurance Certificate (ODA Form 4018). Give the Certificate to ODA.

With the Commercial Pesticide Operator License, you only may do the kinds of work you can do with your Commercial Applicator License.

This license lasts 1 year. You can renew it every year. It is valid only if you are covered by insurance.

Pesticide Consultant License

You need this license if you want to give technical advice on RUPs. With this license, you can apply pesticides to show how to use them. You also can apply pesticides for research. You cannot use this license instead of the Private, Commercial, or Public Pesticide Applicator licenses.

You must pass a special pesticide consultant test to be certified. Then, you can get your license by giving an application form and licensing fee to ODA.

You must renew this license every year. It expires December 31.

Pesticide Dealer License

With this license, you or your business can sell or distribute RUPs. You can get this license by giving an application form and licensing fee to ODA. You don't need to take a test.

You must renew this license every year.

If you have a Pesticide Dealer License, you must keep records of restricted-use pesticide sales.

To learn more about keeping records, see Chapter 19.

Reciprocal licensing

You can get an Oregon Private Pesticide Applicator license if you have one in Washington or Idaho. You cannot get any other pesticide license in Oregon based on a license from another State. You must pass the Oregon certification tests to get these Oregon pesticide licenses.

Table 2. Oregon Pesticide License Categories

Category	Description
Marine Fouling Organism Control	Using marine anti-fouling paints or coatings on boats or ships
Agriculture: Insecticide-Fungicide	Using insecticides, fungicides, and/or nematicides on farm lands. This includes Christmas tree plantings and commercial nurseries.
Agriculture: Herbicide	Using herbicides on farm lands. This includes Christmas tree plantings and commercial nurseries.
Agriculture: Soil Fumigation	Using soil-applied fumigants on farm lands. This includes Christmas tree plantings and commercial nurseries.
Agriculture: Livestock	Using pesticides to control pests on livestock. These could be insects, mites, or ticks.
Agriculture: Vertebrate Pest Control	Using pesticides in farm areas to control animals that affect crops or livestock
Aquatic	Using pesticides to treat standing or running water
Forest	Using pesticides on forest lands
Public Health	Using pesticides for any pest that may harm public health
Right-of-way	Using pesticides in “right-of-way” areas. These include road shoulders, utility lines, and irrigation ditch banks.
IIHS: General Pest Control (Industrial, Institutional, Health, and Structural)	Using pesticides around buildings to protect products stored inside or to protect the health of people who use the building
IIHS: Structural Pest Control	Using pesticides in or around buildings to control insects that live in wood. This does not include fumigants.
IIHS: Space Fumigation	Using fumigants indoors. This does not include fumigants used in soil or on any outdoor structure.
IIHS: Moss Control	Using pesticides to control moss and algae on structures
IIHS: Wood Treatment	Using pesticides to treat wood products before they are used for building. Or, using fumigants to treat wood products
Ornamental and Turf: Insecticide-Fungicide	Using insecticides and fungicides on ornamental plants and turf grass
Ornamental and Turf: Herbicide	Using herbicides on ornamental plants and turf grass
Seed Treatment	Using pesticides on seed
Regulatory Predator Control (Public Applicators and Trainees only)	Using pesticides against certain animals that hunt other animals or humans
Regulatory Weed Control (Public Applicators and Trainees only)	Using pesticides against wild plants that compete with crops and nursery plants. These plants are called **noxious weeds**.

Protecting people in the workplace

Occupational Safety and Health Act of 1970 (OSHA)

The U.S. Department of Labor is in charge of OSHA. The law applies to an employer who has 11 or more workers. The employer must keep records when workers have a serious accident that causes them to become injured, become sick, or die. The employer must make regular reports to OSHA. The employer does not need to record minor harm that needed only first aid.

If workers have concerns about pesticide use, reentry, potential health effects, or other hazards or accidents, their employer must provide them with the appropriate information and assistance.

The Oregon Occupational Safety and Health Division (OR-OSHA) enforces this law in Oregon. OR-OSHA also has some rules that are more strict than federal OSHA. For example, Oregon inspects all farms, even those with less than 11 workers.

You can access OR-OSHA at:

http://www.cbs.state.or.us/external/osha

For more information, call:

OR-OSHA
Telephone: 800-922-2689—message only
503-378-3272

Worker Protection Standard (WPS)

EPA created the Worker Protection Standard to protect workers from exposure to pesticides at work. OR-OSHA is in charge of WPS rules in Oregon.

Who is covered by WPS?

WPS covers people who work on farms and in forests, nurseries, and greenhouses. The goal of WPS is to reduce the risk of poisoning and injury to these workers. WPS protects two types of workers:

- Pesticide handlers ("handlers")—**Handlers** work directly with pesticides. They mix, load, or apply pesticides. They clean or repair contaminated equipment and dispose of pesticides and empty pesticide containers.
- Agricultural workers ("workers")—**Workers** grow and harvest plants on farms, forests, nurseries, or in greenhouses but do not work directly with pesticides.

Who is not covered by WPS?

Not all people who use pesticides are affected by WPS. WPS rules do not apply to the following:

- Public pest control funded by the government
- Livestock uses
- Plants in houses and apartments, gardens, and home greenhouses
- Ornamental gardens, parks, and public or private lawns
- Direct injection into farm plants

- Pasture/rangeland, rights-of-way, and buildings
- Animal pests
- Pesticides in traps
- Some post-harvest applications
- Tests of unregistered pesticides

WPS rules for employers

WPS affects you if:

1. You own or manage a farm, forest, nursery, or greenhouse where you use WPS-labeled pesticides on farm plants.
2. You hire or contract with workers to produce farm plants on a farm or in a forest, nursery, or greenhouse.
3. You run a business in which you (or people you hire) apply pesticides on farm plants on a farm or in a forest, nursery, or greenhouse.
4. You are a custom pesticide applicator or crop consultant hired by a farm, forest, nursery, or greenhouse operator.

If you are an employer, you must be sure to protect workers and handlers according to WPS rules.

Protect people during applications: Applicators must not apply a pesticide in any way that may expose workers or other persons. Workers may not enter areas during application of pesticides.

Restricted-entry intervals (REIs): All WPS-qualified pesticides have REIs that range from 4 hours to 30 days or more. The product label tells how long the REI lasts. Workers may not enter areas under an REI without special preparation.

Personal protective equipment (PPE): Workers and handlers must wear special types of clothes and equipment to protect them from pesticides. These special clothes and equipment are called **personal protective equipment**.

Employers must give PPE to handlers and early-entry workers. Employers must keep the PPE in good condition.

Emergency help: Employers must take a worker or handler to a hospital or clinic if he or she has been poisoned or injured by a pesticide. The employer must give facts about the pesticide to doctors and nurses.

Cleanup supplies: Employers must give soap, water, and towels to workers and handlers for normal and emergency cleanup.

Pesticide safety training: All workers and handlers must take pesticide safety training.

- Handlers must get training before they start any work with pesticides. The training program must be approved by EPA.
- Farm, forest, greenhouse, and nursery workers must get basic facts before they enter a treated area. Workers must get complete WPS training within 5 days of being hired.

Contact with the applicator: Someone must see or talk to the applicator at least every 2 hours while he or she is applying a pesticide that has a skull-and-crossbones symbol on the label.

Someone must see or talk to the pesticide handler all the time while he or she is using any fumigant in a greenhouse.

Warning to workers: Employers always must warn workers of areas treated with pesticides. You must give warning either by voice (**verbal notification**) or by a written field sign. You must give warning both ways if it says to do so on the product label. You must:

- Give warning in a language the worker knows.
- Give warning before applying a pesticide.
- Give the location and description of the treated area.
- State the time the REI is in effect.
- Tell workers not to enter the treated area until after the REI.

The law says what the size, symbols, colors, and words must be for field signs.

Worker information place: Each farm workplace must keep information at a central place that is easy to see. The information must include:

- WPS safety poster made by EPA
- Name, address, and telephone number of the nearest emergency hospital or clinic
- Facts about each pesticide application. These records must stay on file for 30 days after the REI.

Workers and handlers must know where to find the information they need. You must tell workers if the emergency information changes. Keep all signs easy to read.

Remember: Employers, supervisors, and others must not stop any worker or handler from complying or trying to comply with WPS. You may not fire or take revenge in any way against a worker or handler who tries to comply.

WPS compliance and enforcement

Oregon Occupational Safety and Health Division is responsible for administering WPS compliance and enforcement in our State. You can contact them at:

Oregon Occupational Safety and Health Division, OR-OSHA
Telephone: 503-378-3272
800-922-2689
Consultations: 503-373-7819

Oregon Department of Agriculture
Pesticide Division
Telephone: 503-986-4635

Oregon's Hazard Communication Standard (HCS)

OR-OSHA also administers the HCS to make sure that employers and workers learn about the dangerous chemicals they use. HCS states the following:

- Employers must read the Standard. They must understand what they have to do.
- Employers must have in the workplace a list of the dangerous chemicals present.
- Employers must maintain Material Safety Data Sheets (**MSDS**) for all dangerous chemicals on their list.
- There must be labels on all pesticide containers.

- Employers must write and use a hazard communication program at the workplace.
- Employers must give workers training based on the chemical list, MSDS, and label information.
- Employers must let a worker see any MSDS for products the employee may use whenever he or she asks.

Employers must give safety information and training to agricultural workers and to pesticide handlers. Employers also must give to workers and handlers the brochure *Safe Practices When Working Around Hazardous Agricultural Chemicals.* Upon request, OSHA can supply this brochure in several different languages.

OR-OSHA has a booklet called *Questions and Answers for Hazardous Communication Rules.* Contact OR-OSHA to get this booklet and other information.

OR-OSHA
Standards and Technical Services Section
Labor and Industries Building, Room 160
350 Winter Street NE
Salem, OR 97310
Telephone: 503-378-3272
800-922-2689

Environmental and other laws

Resource Conservation and Recovery Act of 1976

The Resource Conservation and Recovery Act (RCRA) is a federal law. The Department of Environmental Quality (DEQ) is in charge of it in Oregon. This law regulates disposal of excess pesticides and empty pesticide containers.

If you store or abandon large amounts of pesticide on-site, you must report to the DEQ. DEQ then puts you on a list as a **hazardous waste generator**. You must get an ID number and follow special DEQ rules.

You may choose to use excess pesticides legally and according to the label. For example, you can save pesticide rinse water to use in later applications. If you do this, you do not have to report to DEQ. If you save rinse water or excess pesticide for later use, you must keep it in a specially marked container.

You must clean empty pesticide containers before disposing of them. Muliple-rinsed containers are called **decontaminated**. Decontaminated containers are not hazardous wastes. You can dispose of them in a landfill (if the landfill accepts them). Instead of throwing away decontaminated **metal** and **plastic** pesticide containers, you can recycle them.

To learn more about cleaning empty pesticide containers before disposing of them, see Chapter 17.

To find out more about using excess pesticides and how to recycle decontaminated containers, call:

Department of Environmental Quality
Telephone: 503-229-5913 or
503-229-6753

Transportation Safety Act of 1974

The U.S. Department of Transportation (DOT) is in charge of this Act, which has laws for shipping hazardous materials. The rules apply to highly toxic, flammable, or explosive substances.

The laws require the following:

- The shipper must give a shipping paper to the person who hauls the hazardous material.
- The driver of the vehicle must keep the shipping papers within reach while she or he is in the seat belt.
- When the driver is away from the vehicle, the shipping paper must be on the driver's seat or in a pouch on the vehicle door.

DOT rules also apply to some fertilizers. To learn which fertilizers these are, call:

Oregon Dept. of Transportation—Hazardous Materials Transportation
Telephone: 503-378-3667
or
Federal Motor Carrier Safety Administration
Telephone: 503-399-5775

Superfund Amendments and Reauthorization Act of 1986 (SARA Title III)

SARA Title III is a federal law that affects people who produce or store hazardous chemicals. The law says that people have a right to know about hazardous chemicals that are in their town. Its purpose is to help towns prepare a plan of action in case of an accident.

SARA Title III has many sections, but only four affect the pesticide applicator, applicator business, or dealer, as follows:

Section 302: Emergency Planning and Notification

This section describes when you are required to report stored chemicals to state and local officials. The EPA has assigned a maximum amount (**Threshold Planning Quantity** [**TPQ**]) for some active ingredients. When the amount of product in storage is at or above the TPQ, you must report it to the Office of the State Fire Marshal. Send notification to:

Office of the State Fire Marshal
4760 Portland Rd. NE
Salem, OR 97305
Telephone 503-378-3473

Section 302 also requires you to choose a coordinator to work with the **Local Emergency Planning Committee** (**LEPC**). Send the name of this person to LEPC, Office of the State Fire Marshal.

In Oregon, pesticide makers, sellers, and some applicators also must report certain amounts of hazardous chemicals to the Office of the State Fire Marshal. They must report when the amount of the chemical is more than 50 gallons of liquid, 500 pounds of solid, or 200 cubic feet of gas. These amounts are called the **reportable quantity**.

They also must report chemicals that have a Material Safety Data Sheet (MSDS). Most businesses in the industry must complete the

Hazardous Substance Information Survey each year. They also must keep a complete set of MSDS.

For information on SARA Title III rules in Oregon, you can contact the Office of the State Fire Marshal, or:

Hazardous Materials Information Hotline/
Community Right-to-Know Hotline
Telephone: 503-378-3473

Section 304: Emergency release report

You should report all pesticide spills to the Oregon Emergency Response System. Depending on the toxicity class and the amount spilled, they will tell you if you should also report to the National Response Center. Those two agencies and their telephone numbers are:

Oregon Emergency Response System (OERS)
Telephone: 800-452-0311

National Response Center (NRC)
Telephone: 800-424-8802

Section 311: Material Safety Data Sheets (MSDS)

Under the WPS, employers are required to get and keep, at a central location, MSDS for all chemicals they use. Also, for certain chemicals, all employers must submit copies of all MSDS (or a listing of them) to their local fire department and to the Office of the State Fire Marshal. But, if a chemical is used only for household, consumer, or routine agricultural operations, notification is not required. If you have doubts about your situation, call:

Office of the State Fire Marshal
Telephone: 503-373-1540
or
Hazardous Materials Information Hotline
Telephone: 503-378-6835

Section 312: Annual Chemical Inventory

You must report any chemical that requires a MSDS if the amount is equal to or greater than 55 gallons for liquids, 500 pound for solids, and 200 cubic feet for gases. For extremely hazardous chemicals, different rules apply. You must use the Office of the State Fire Marshal's Hazardous Substances Survey Form for reporting your inventory.

Note: Chemicals used in routine agricultural activities are exempt from this Annual Chemical Inventory reporting requirement.

The Endangered Species Act of 1973

The Endangered Species Act (ESA) protects threatened and endangered species. An **endangered species** is a plant or animal at risk of extinction. **Extinction** means to die out forever. A **threatened species** is a plant or animal that is soon to be endangered. (See Chapter 4.)

Species often become endangered or threatened because humans destroy their natural habitat. Industry, farming, and growth of towns can reduce habitat.

Two agencies decide whether a species is threatened or endangered. They are the Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS). They also are in charge of protecting threatened and endangered species.

When a species is listed as endangered, the FWS or NMFS must set apart the natural places that are vital to saving its life. These places might need special protection. These places are called **critical habitat**. (**Note**: Critical habitat applies only to federal lands.)

The Endangered Species Act makes it illegal to kill, harm, harass, or collect listed animals or fish. It is against the law to take endangered plants from protected areas. Other federal agencies must be sure that they do not do anything to threaten the life of any listed species. They must not harm or change its critical habitat.

Within the United States, about 374 animals and 317 plants have been listed as endangered or threatened. Once a species is listed as endangered, the FWS or NMFS is required to reserve its critical habitat on federal lands or in other areas that are needed for the plant or animal to live. The ESA requires that work that is done (including applying pesticides) within critical habitat areas not harm the listed species. You should ask your pesticide dealer or county Extension agent if EPA has issued an **endangered species bulletin** with directions for using the pesticide in your area. See Table 3 for a list of Threatened and Endangered Species in Oregon.

In the end, you—the pesticide applicator—are responsible for protecting endangered species from pesticides.

Other agencies regulating pesticides in Oregon

Oregon Department of Human Services—Health Services

State law requires all health care providers (for example, doctors, nurses, chiropractors, osteopaths, hospitals) to report confirmed or even suspected symptoms, sickness, and harm from pesticide exposure. Reports can be made to the local health department or directly to Oregon Department of Human Services—Health Services (DHS-HS). Cases may be investigated to find out if pesticides were the cause. If they were, then this information may be used to prevent future exposure, illness, and/or harm.

DHS-HS works with and refers to the Oregon Poison Center to ensure that health care providers have the information they need to diagnose and treat pesticide-related illness and injury. Case information is analyzed to find patterns or trends in exposure or illness. These are used to focus prevention efforts.

Also see the Oregon DHS-HS Web site: http://www.dhs.state.or.us/publichealth/pesticide/

For more information, call:
Oregon Department of Human Services—Health Services
Telephone: 503-731-4025

Table 3. Oregon's Threatened and Endangered Species.

Common name	Scientific name	Category
Fish		
Hutton Spring Tui Chub	*Gila bicolor* spp.	Endangered
Borax Lake Chub	*Gila boraxobius*	Endangered
Foskett Spring Speckled Dace	*Rhinicthys osulus* spp.	Threatened
Warmer Sucker	*Catostomus warnerensis*	Threatened
Lahontan Cutthroat	*Oncorhynchus clarki henshawi*	Threatened
Lost River Sucker	*Deltistes luxatus*	Endangered
Snake River Stocks of Chinook Salmon	*Oncorhynchus tshawytscha*	Threatened
Shortnose Sucker	*Chasmistes brevirostris*	Endangered
Snake River Stocks of Sockeye Salmon	*Oncorhynchus nerka*	Endangered
Insects		
Oregon Silverspot Butterfly	*Speyeria zerene hippolyta*	Threatened
Amphibians and reptiles		
Green Sea Turtle	*Chelonia mydas*	Endangered
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered
Loggerhead Sea Turtle	*Caretta caretta*	Threatened
Pacific Ridley Sea Turtle	*Lepidochelys olivacea*	Threatened
Birds		
Short-Tailed Albatross	*Diomedea albatrus*	Endangered
Brown Pelican	*Pelecanus occidentalis*	Endangered
Aleutian Canada Goose	*Branta Canadensis leucopareia*	Threatened
Bald Eagle	*Haliaeetus leucocephalus*	Endangered
American Peregrine Falcon	*Falco peregrinus anatum*	Endangered
Arctic Peregrine Falcon	*Falco peregrinus tundrius*	Threatened
California Least Tern	*Sterna antillarum browni*	Endangered
Northern Spotted Owl	*Strix occidentalis caurina*	Threatened
Marbled Murrelet	*Brachyramphus marmoratus*	Threatened
Mammals		
Gray Wolf	*Canis lupus*	Endangered
Gray Whale	*Eschrichitus robustus*	Endangered
Sei Whale	*Balaenoptera borealis*	Endangered
Sperm Whale	*Physeter catodon*	Endangered
Blue Whale	*Balanenoptera musculus*	Endangered
Humpback Whale	*Megaptera novaeangliae*	Endangered
Black Right Whale	*Balaena glacialis*	Endangered
Fin Whale	*Balaenoptera physalus*	Endangered
Sea Otter	*Enhydra lutris*	Threatened
Columbia White-Tailed Deer	*Odocoileus virginianus leucurus*	Endangered
Plants		
Macfarlane's Four-O'Clock	*Mirabilis macfarlanei*	Endangered
Malheur Wire-Lettuce	*Stephanomeria malheurensis*	Endangered
Bradshaw's Desert Parsley	*Lomatium bradshawii*	Endangered

A separate section of Health Services enforces rules regarding the maximum levels of contaminants, including pesticides, allowed in public water supplies. For information about drinking water training, rules, and other aspects, call:

Drinking Water Program
Telephone: 503-731-4317

Also see the Drinking Water Program Web site at http://www.oregon.gov/DHS/ph/dwp/index.shtml

Pesticide Analytical and Response Center

The Pesticide Analytical and Response Center (PARC) was established in state statute ORS 634.550. PARC is charged with managing state agencies' response to complaints and questions about pesticide exposure and illness.

PARC's governing board includes members from eight state agencies that have some legal power or interest in pesticides (Oregon Departments of Agriculture, Environmental Quality, Fish & Wildlife, and Forestry; Oregon Health Services; State Fire Marshal's Office; Oregon OSHA; and Oregon Poison Center) and one public member. The governing board reviews cases and actions taken, and recommends action to member agencies or other groups to prevent or reduce exposure and illnesses. PARC also has developed educational materials and gives training to interested groups.

For emergency help with pesticide-related health concerns, call:

Oregon Poison Center
Telephone: 800-222-1222

To find out about PARC programs, call:

Oregon Department of Human Services—Health Services
Telephone: 503-731-4025

Or, you can call the Oregon Department of Agriculture—Pesticide Division.

Or, visit the PARC Web site at: http://www.oregon.gov/DHS/ph/pesticide/index.shtml

Oregon Department of Environmental Quality

The Department of Environmental Quality (DEQ) is the main state agency involved with environmental regulation in Oregon. The DEQ is in charge of rules governing the management of pesticide wastes and empty pesticide containers.

DEQ uses the word "residue" to refer to pesticide wastes: unused pesticides in their original form or in a spray mixture, rinse water, or pesticide spills and contaminated soil. Notice that this DEQ term differs from the EPA use of the word "residue," which refers to pesticide that remains on food and feed after an application.

For more information about managing pesticide residues and empty containers, refer to Oregon Administrative Rules 340 (OAR 340), Division 109, or call:

Department of Environmental Quality (DEQ)
Telephone: 503-229-5913 or
503-229-6753

Read Oregon Administrative Rules online at: http://arcweb.sos.state.or.us/banners/rules.htm

Oregon Water Resources Department

The Oregon Water Resources Department enforces rules on using back-siphon prevention equipment on irrigation and other watering systems that connect to groundwater sources and are used with pesticide or fertilizer application. This is called **chemigation**.

If you plan to apply pesticides or fertilizers through irrigation or other water systems, contact the Water Resources Department. They will send you a copy of the laws governing the use of groundwater and required equipment for chemigation. Specific rules requiring back-siphon prevention equipment went into effect January 1, 1992 (ORS Chapter 690.215.017[3]).

Oregon Water Resources Department
Telephone: 503-986-0900

Oregon Department of Forestry rules

The Oregon Department of Forestry administers rules regulating commercial, forestry-related work on forestland in Oregon. These rules are contained in the Oregon Forest Practices Act. They specifically regulate the application of pesticides to forestland.

For more information, call:

Oregon Department of Forestry (ODF)
Telephone: 503-945-7200

For more information, see the ODF Web site at: http://egov.oregon.gov/ODF/

Oregon Department of Transportation Hazardous Materials Transportation

The Oregon Department of Transportation regulates the transportation of hazardous materials in Oregon. It also enforces requirements for putting the proper signs and warnings on shipments of hazardous materials carried over public roads and highways. For more information, call:

Hazardous Materials Transportation
Telephone: 503-378-3667

Other regulations

Oregon pesticide rules

Special risk pesticides

There are special rules for the pesticides listed below. What is written here is not complete. If you use any of the following pesticides, you must call ODA Pesticides Division at telephone 503-986-4635 to find out all you need to know, or consult OAR 603-057-0376 through 0384.

Microencapsulated methyl parathion—There are exact rules on when to apply this pesticide. You must protect honeybees from this insecticide, especially while they are on flowering plants.

2,4-D high volatility esters—You must have a use permit if you work in parts of Umatilla and Morrow counties from April 1 to September 1. Call 541-938-6466 for permits.

Limitations on pesticide products containing clopyralid. Any application or use of a pesticide product known to contain the active ingredient clopyralid to a location other than an agricultural, forest, right-of-way, golf course, or cemetery site is prohibited.

Persistent bioaccumulative and toxic pollutants (PBTs)—You must **never** use any pesticides that are listed as PBTs in Oregon. It is against the law. Some old pesticides that are included in this list are aldrin, chlordane, DDT, dieldrin, hexachlorobenzene, mercury-based pesticides, mirex, toxaphene, heptachlor, and 2,4,5-T. See Oregon Administrative Rules 603-057-0384.

You can see OAR 603-057-0384 online at: http://arcweb.sos.state.or.us/rules/OARS_600/OAR_603/603_057.html

Thiram on forest seedlings—OR-OSHA enforces special rules regarding the use of thiram on forest seedlings (see Oregon Administrative Rules 437-004-9720).

If you handle treated seedlings, you must wear special equipment to protect yourself. You must handle the seedlings in a certain way to protect yourself. There must be a special label on treated seedlings.

You can see OAR 437-004-9720 online at: http://arcweb.sos.state.or.us/rules/OARS_400/OAR_437/437_tofc.html

Nuisance animal trapping rules

Wild animals that cause unwanted mess, damage, or danger are called **nuisance animals**. Trapping nuisance animals is not a pesticide use issue, but it is a pest management issue. Pest control operators, especially in urban areas, often trap animals such as raccoon, opossum, and skunks live in traps for release in other areas.

To do live animal trapping as a business in Oregon, you must have a **Letter of Authorization** from the Oregon Department of Fish & Wildlife (ODF&W). The Letter of Authorization is issued by local District Offices of ODF&W. If you plan to trap animals as part of your pest control business, first contact your District Office of ODF&W.

Rules for pesticides combine science, public policy, and law. Scientific knowledge and people's needs are always changing. Pesticide laws change, too. The EPA always is keeping pesticide rules current. Call your local Extension agent or Oregon Department of Agriculture for the most current information.

Oregon law violations and enforcement

The Oregon Pesticide Control Law lists actions that are against the law. These are called **law violations**. Violations can apply to making, using, and selling pesticide products.

ODA decides whether someone has broken a law. If ODA decides there has been a violation, it can take action to enforce the law.

Prohibited acts

It is against the law to do the following:

1. Make false or misleading claims through any media, about the effect of pesticides or which application methods to use
2. As a pesticide applicator or operator, to apply or use on purpose a worthless pesticide
3. As a pesticide applicator or operator, to apply or use on purpose any pesticide in a way not stated on the label
4. As a pesticide consultant or dealer, recommend or distribute a worthless pesticide or any pesticide in a way not stated on the label
5. Use any faulty or unsafe pesticide application device or equipment, including aircraft
6. Apply pesticides in a faulty, careless, or negligent manner
7. Refuse or neglect to keep records required by the law
8. Make false or misleading records, reports, or application forms required by the law
9. Operate pesticide application equipment if you are not licensed or certified. There must be a licensed pesticide applicator or certified private applicator to apply the pesticide or to supervise the application. This prohibition does not apply to the operation of tractors, trucks, or other vehicles used only under the supervision of a certified private applicator.
10. As a pesticide applicator, work with or apply any kind of pesticide without a Pesticide Applicator's License
11. As a pesticide applicator, apply pesticides that are not listed on your Pesticide Applicator's License
12. As a pesticide operator, do business applying pesticides on someone's land without a Pesticide Operator's License.
13. As a pesticide operator, run a kind of pesticide application business that is not allowed by your ODA license
14. Hire or use any other person to apply or spray pesticides who does not have a pesticide applicator or pesticide trainee license
15. Work or apply any kind of pesticide as a trainee without a Pesticide Trainee's Certificate
16. Act as, or claim to be, a pesticide dealer without having a Pesticide Dealer's License

17. Act as, or claim to be, a pesticide consultant without having a Pesticide Consultant's License
18. Apply any restricted-use or highly toxic pesticide to farm or forest crops on your own or leased land without a private applicator certificate
19. As a person described in ORS 634.106(5), use power-driven pesticide application equipment or devices (use hand or backpack types only), or use or apply any pesticides other than those prescribed by the department
20. Deliver, distribute, sell, or offer for sale any pesticide that is misbranded
21. Make, deliver, distribute, sell, or offer for sale any pesticide that is adulterated
22. Formulate, deliver, distribute, sell, or offer for sale any pesticide that has not been registered as required by ORS 634-57
23. Formulate, deliver, distribute, sell, or offer for sale any powdered pesticide that has arsenic in it, or any highly toxic fluoride, that is not distinctly colored
24. Distribute, sell, or offer for sale any pesticide if it is not in the original, unbroken package
25. Apply pesticides within a protected or restricted area without first getting a permit to apply pesticides there. Or, to make the application without following the terms of the permit
26. Use isopropyl ester of 2,4-D, or any other ester of equal or higher volatility, without first getting a permit to use it
27. Sell, use, or remove any pesticide or device under a "stop sale, use, or removal" order before the pesticide or device has been released from the order

Enforcement actions

ODA may take the following actions to enforce the Oregon Pesticide Control Law:

- Send you a letter of advisement or written notice of violation
- Deny, suspend, or revoke your license
- Refer you to the district attorney—class "C" misdemeanor
- Refer you to the office of the attorney general—consent order
- Refer you to the United States Environmental Protection Agency (for violations of the Federal Insecticide, Fungicide, and Rodenticide Act)
- Order you to stop the sale, use, or removal of your pesticide products
- Forbid (**embargo**) the sale of your crops
- Give you a civil penalty. The head of ODA may give you a civil penalty for breaking the laws on pesticide application, sale, or labeling. The civil penalty for the first violation is a fine of up to $1,000. The civil penalty for a second violation is a fine of up to $2,000.

For more information on civil penalties, read Oregon Revised Statutes (ORS)—Chapter 634, and Oregon Administrative Rules (OAR)—Chapter 603, Division 57.

Pesticide violations under ORS 634 also may break other federal, state, or local laws. More than one agency can take action against you. Agencies may cite more than one violation for any one event.

Be sure you know **all** your responsibilities when working with pesticides.

Questions for study—Chapter 1

1. What federal law authorized the regulation of pesticides as we know it today?
2. Which federal agency registers pesticides in the U.S.?
3. What is a pesticide tolerance?
4. Which federal agency sets food tolerances for pesticides? Which agency enforces these tolerances?
5. What are two types of penalties FIFRA allows for applicators who violate the law?
6. What act authorizes the EPA to manage hazardous waste?
7. What agency and what act have direct regulatory roles in the application of a herbicide on forestlands in Oregon?
8. What state agency administers (is in charge of) the EPA Worker Protection Standard in Oregon?
9. What agency administers the Hazard Communication Standard?
10. What agency enforces the installation of back-siphon or anti-siphon devices on systems used for chemigation?
11. What act makes it illegal to harm a threatened or endangered species?
12. Which species is closer to extinction: an endangered or a threatened species?
13. Can a private pesticide applicator legally apply a general-use herbicide along the fence of the school playground, if the school board president asks him or her to do so?
14. Can a private applicator spray a highly toxic pesticide for a neighbor who is not licensed?

Chapter 2

Toxicity of Pesticides

Goals of this chapter

- Explain what a chemical is.
- Explain what "poison" means.
- Explain what "toxicity" means.
- Describe how pesticides enter the body.
- Explain the importance of the four main routes of entry.
- Explain how to measure toxicity.
- Explain label warning statements.

What is toxicity?

What is a chemical?

All matter is composed of chemical **elements**. There are around 90 stable elements in nature, such as hydrogen, oxygen, carbon, nitrogen, gold, and silver.

The simplest unit of an element is an **atom**. When two or more atoms are linked together by chemical bonding, they form units called **molecules**. A substance composed of molecules all of the same kind is called a **compound**. Water, sugar, and salt are compounds.

Everything in the physical world is chemical—the food we eat, the water we drink, the clothes we wear, the medicines we take, the cosmetics we use, our garden plants, our homes, and even ourselves. All substances are composed of chemical and physical combinations of atoms (elements) and molecules (compounds).

Many people think that the term "organic chemical" means the same as "natural chemical." Early scientists found that compounds made by living organisms were different from other chemicals known at that time. They called them organic because they were derived from organisms. In the nineteenth century, scientists found that the element **carbon** was present in all organic chemicals. Thus, carbon chemistry came to mean the same as **organic chemistry**. So, chemicals made by humans that have carbon in them (including plastics) are also **organic chemicals**.

To learn more about toxicology, see *The Dose Makes the Poison; A Plain-language Guide to Toxicology* by Alice Ottoboni (Van Nostrand Reinhold, New York, 1991)

Poison, toxicity, and dose

It is important to know the difference between **poison** and **toxicity**.

Any substance, natural or synthetic, that can cause illness, harm, or death, whether it is ingested, inhaled, or absorbed, is a **poison**. This includes vitamins, salt, alcohol, natural inorganic elements such as sulfur

and lead, and natural and synthetic carbon compounds, including pesticides.

The science and study of poisons is called **toxicology**. One of the basic truths of toxicology is that **the dose makes the poison.** Theophrastus Phillippus Aureolus Bombastus von Hohenheim is better known as **Paracelsus**, the father of modern toxicology (1493–1541). He stated, "What is there that is not a poison? All things are poison and nothing is without poison. It is only the dose that makes a thing not a poison."

Dose is the amount of chemical absorbed into the body through the skin or through the eye, gut, or lung surfaces. Thus, any substance can be a poison at some dose. Or, in other words, "**at sufficient dose**." We could say that a pesticide is not a poison at a dose far below the level of harm, in the same way that we do not call vitamins and salt "poisons," because we are exposed to them at low doses. (But, we must not ignore the possibility that an adverse effect might result from repeated exposure to low doses over a long period of time.)

Toxicity refers to how a substance adversely affects a living system. A living system can be many things. It can be a human body or one system of the body (such as the respiratory system). Or, it can be a pond or forest and the creatures living in it.

If you do not handle pesticides the right way, you can cause severe harm or even kill humans and other creatures. Always use great care when you handle or apply a pesticide.

When speaking of toxicity, we should emphasize the **dose-time relationship**. The dose-time relationship affects how we respond to a toxic substance. For example, we might take one aspirin a day for 100 days to help us feel better, but if we took 100 aspirins in one day, it might kill us.

Exposure and dose

It is important to know the difference between **exposure** and **dose.**

If a chemical contacts a body surface, that is called **exposure**. Exposure could occur to the skin, eyes, lungs, or stomach. The **level of exposure** is how much chemical contacted the body surface. Most of the time, the higher the level of exposure, the higher the dose.

The larger the dose, the greater the effect. This is called the **dose-response relationship**. If there is no exposure and no dose, there will be no toxic effect.

The more **often** an exposure occurs, the larger the expected dose, and the greater the risk of toxic effects.

Types of exposure

There are two types of pesticide exposure: **acute** and **chronic**.

A one-time or limited contact with a pesticide is called **acute exposure**. In the laboratory, acute exposure is contact with a pesticide for 24 hours or less.

Contact with a pesticide again and again is called **chronic exposure**. Frequent exposure to a chemical can cause both acute and chronic

symptoms. The chance of a chronic effect depends on the amount of pesticide, how often you were exposed, and the nature of the chemical.

It is easier to observe and study effects of acute exposure than effects of chronic exposure. Rapid damage to the body is more likely from pesticides that are absorbed quickly.

Types of toxicity

Pesticide handlers must know and understand two different types of toxicity: **acute** and **chronic** toxicity.

Acute

Acute toxicity is how poisonous a substance is after an **acute exposure**. Acute toxicity describes effects that appear within minutes to a couple of days after exposure. A pesticide with a high acute toxicity may be deadly even when a small amount is absorbed.

Acute toxicity levels are used to assess and compare how poisonous a pesticide is. **The acute toxicity of a pesticide is the basis for the warning statements on the label.**

Acute toxicity is measured in these three ways:

1. Acute oral toxicity. This is the effect when the pesticide is swallowed.
2. Acute dermal toxicity. This is the effect when the pesticide is absorbed through the skin.
3. Acute inhalation toxicity. This is the effect when the pesticide is breathed in and absorbed by the lungs.

Chronic

Chronic toxicity is how poisonous a substance is after **chronic exposure** to it at low doses. Effects appear over a long period of time.

People who work with pesticides must always beware of the risk of chronic toxicity. Chronic toxicity of pesticides also concerns the public, because people can be exposed to pesticide residues in food, water, and the air.

Risk of harm

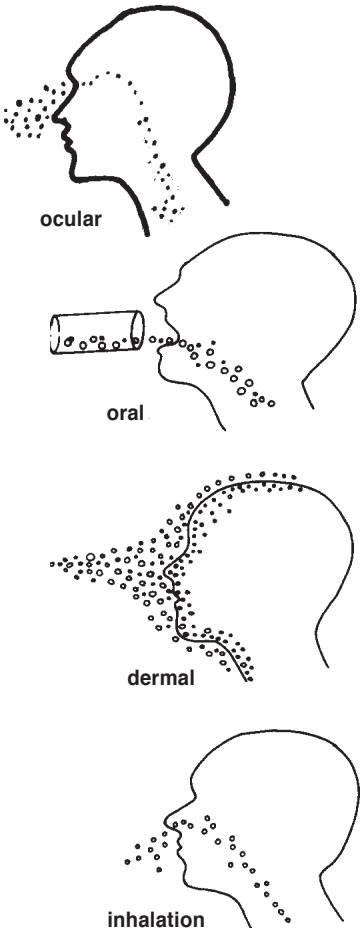
The risk of harm from pesticide exposure depends on how poisonous the pesticide is, the amount, and the route of exposure. You can think of it this way:

Risk = Toxicity x Exposure

The effects of both acute toxicity and chronic toxicity depend on the dose. **The larger the dose, the greater the effect**. We also can say, **zero exposure, zero risk**. This is why it is so important to reduce exposure to pesticides as much as possible.

A chemical that has high acute toxicity might not have high chronic toxicity. A chemical with low acute toxicity might not have low chronic toxicity. The toxic effects of a single acute exposure to a chemical might be quite different from the effects of chronic exposure to the same chemical.

The toxicity of a pesticide is a feature of the chemical itself. This cannot be changed. But, you can limit the chance of being poisoned if you prevent or limit exposure.



Routes of entry

Routes of entry

There are four ways pesticides can enter your body.

1. Through the skin. This is called the **dermal** route.
2. Through the lungs. This is called the **inhalation** route.
3. Through the mouth. This is called the **oral** route.
4. Through the eyes. This is called the **ocular** route.

Dermal route

Liquid, dry, or gaseous forms of pesticides can be absorbed through the **skin**. This occurs by direct contact with the skin. It can happen if you do not remove pesticide-contaminated clothing right away. It can happen if you do not clean your clothes very well before you wear them again.

Some pesticides do not readily pass through the skin. Others are absorbed quickly and can be as dangerous as if you swallowed them. The skin absorbs oil-based formulations, such as emulsifiable concentrates, more easily than water-based pesticides.

The eyes, eardrums, forehead, scalp, and groin absorb pesticides more quickly than other areas of the body. Pesticides can go through chapped, cut, or scraped skin more readily than healthy, intact skin.

Once they go through the skin, pesticides can enter the bloodstream and be carried throughout the body.

Inhalation route

You can inhale pesticides into the **lungs** as dusts or particles, spray mist, and fumes (vapors). You can be poisoned if you fumigate or spray without proper respiratory protection. The largest particles that you inhale tend to stay on the surface of the throat and nasal passages, and do not enter the lungs. Vapors and smaller particles can go directly into the lungs.

Once they are absorbed through the surface of the lungs, chemicals enter the bloodstream. Then, they are carried throughout the rest of the body.

Oral route

Pesticides can enter the body through the **mouth**. This is called **ingestion**. You can ingest a pesticide if you do not wash your hands well before eating, drinking, or smoking. You might swallow a pesticide by mistake if it is stored in food containers.

Ingested chemicals can be absorbed anywhere along the digestive tract. Once they are absorbed, pesticides can enter the bloodstream. Then, they are carried throughout the body.

Ocular route

You can absorb pesticides through your **eyes**. Exposure can occur in these ways:

- If a pesticide splashes, sprays, or drifts into your eyes
- If you rub your eyes or forehead with contaminated gloves or hands
- When you handle powder, dust, or granule formulations

Eyes are very sensitive to some chemicals. They readily absorb them. This can cause severe irritation. Or, you might go blind for a short time or for the rest of your life.

Some pesticides might be absorbed by the eyes without irritating them. They make their way into the bloodstream without you knowing it.

Which route is more important?

You can be poisoned no matter how the pesticide enters your body. Many pesticides can enter **all four ways**. Parathion is an example of a pesticide that can poison you no matter how it is absorbed. But, most chemicals cannot poison you to the same degree through all routes of entry.

The most common routes of pesticide applicator exposure are dermal and inhalation. It is easy to inhale pesticides or splash them on the skin. Sometimes you can be poisoned without even knowing it, especially if the pesticide has entered through the skin or lungs.

Factors that influence toxic effects

There are certain factors that affect how you respond to chemical exposure. These are some of the factors:

- **Health conditions—**Your heredity, general health, how well you eat, if you are pregnant, or if you are sick, all can affect how you respond.
- **Age—**Very young and very old people tend to be most sensitive.
- **Gender—**Males and females might respond in different ways.
- **Environment—**Other toxic substances might be in food, air, or water. They can affect how you respond.
- **Health habits—**Smoking, eating poorly, drug use, and not keeping clean can affect response to exposure.
- **Body size and weight—**In most cases, a large, heavy person can absorb a greater amount of poison before there is an acute effect.

Types of toxic effects

Local

Local effects take place at the body site of contact with a chemical. They result from exposure to irritants or corrosive materials. Signs and symptoms of local effects could be these things:

- Red, sore skin on the hand where pesticide touched it
- Irritated lungs after breathing in toxic fumes

Systemic

Systemic effects occur when pesticides are carried throughout the body. They affect how the body works.

For example, exposure to organophosphate and N-methyl carbamate pesticides can affect your nervous system. They are very harmful to cholinesterase (pronounced “ko-lin-**es**-ter-ace”), an essential enzyme of the nervous system. They are called **cholinesterase inhibitors**.

Immediate

Immediate toxic effects happen either right when you are exposed to a pesticide, or shortly after. An immediate effect could be a sneezing attack right after you inhale pesticides during mixing, or dizziness or nausea within an hour or two of exposure.

Delayed

Once in a while, acute effects may not show up for several days. This is called **delayed effects**. (This is different from chronic effects, which might not show up until after 20 or 30 years of exposure. Cancer and emphysema can be chronic effects.)

Both immediate and delayed effects can occur with some chemicals.

Reversible

Reversible effects do not last forever. You can change or heal them. Skin rash, nausea, eye irritation, and dizziness are reversible toxic effects. In many cases, harm to the liver is also reversible, because the liver can heal itself.

Irreversible

Effects that last for the rest of your life are called **irreversible effects**. You cannot change them. Some chronic effects are irreversible.

These are some chronic effects:

- **Reproductive—**Damage to the organs and systems of the body that produce babies.
- **Teratogenic—**Effects are to unborn children. These are called birth defects.
- **Carcinogenic—**Exposure to the chemical causes cancer.
- **Oncogenic—**Exposure causes tumors to form. They might or might not be cancer.
- **Mutagenic—**The effects are to your genetic material. The damage can pass down to your unborn children. This is called mutation.
- **Neurotoxicity—**Exposure poisons the nervous system and the brain. Nervous system cells cannot divide. They cannot be replaced.
- **Immunosuppression—**The effects are to block the natural response of the immune system. The immune system protects the body from disease.
- **Endocrine disruption—**The body system that controls your hormones is called the endocrine system. Exposure to certain chemicals harms this system.

Measuring toxicity

EPA does not allow testing on humans. So, scientists do **animal testing** to measure pesticide toxicity. They do tests on rats, rabbits, mice, guinea pigs, and dogs.

Scientists study the effects of pesticides on the animals. Then, they compare and assess what the toxic effects could be on humans. To assign the level of toxicity of a pesticide to humans, the EPA uses toxicology results from the **most sensitive** animal species studied.

In science, we can only talk about what we can see or observe. So, we have to use the words **observed** or **detected** when we talk about measuring toxic effects.

Acute toxicity measures

Scientists give animals different doses of a pesticide. They carefully study what effect each dose causes. This is called a **dose-response study.**

The scientists give the doses either through the animal's mouth, its eyes or skin, or in its air or water. Then, they observe the animals carefully for changes. There are new techniques using cell or enzyme testing that make it possible to do some tests without using animals.

The highest dose that does not cause an adverse effect that the scientist can observe is called the **No Observed Effect Level** or the **NOEL.** EPA uses the NOEL to decide whether to register a pesticide.

To learn more about the NOEL, see Chapter 3.

Lethal Dose Fifty

The **Lethal Dose Fifty (LD_{50})** is the dose of a pesticide that kills half the animals (50 percent) in a dose-response study. An LD_{50} does not tell us how a chemical acts. It does not tell us how sensitive different organs within an animal or human might be.

An **acute oral LD_{50}** shows how much chemical taken by mouth killed half of the animals tested. A **dermal LD_{50}** shows how much chemical absorbed through the skin killed half of the animals tested.

You can compare the LD_{50} for different chemicals only if the same test animal was used.

By 2003 or 2004, scientists hope to be able to use special cells to study chemical toxicity. Hopefully, this will reduce greatly the number of animals used in toxicity studies.

Milligrams per kilogram

Pesticide LD_{50} values are measured in units of weight: **milligrams per kilogram (mg/kg)**. This refers to the number of milligrams of pesticide per kilogram of the test animal's body weight.

One paper clip weighs about 1 gram. If you cut the paper clip into 1,000 equal parts, you will make pieces that weigh 1 milligram each.

A kilogram equals about 2.2 pounds.

Suppose you have an acute oral LD_{50} of 5 mg/kg for pesticide "A." This means that 50 percent of the test animals died when they ate 5 milligrams of pesticide "A" for every kilogram of their weight.

A lower LD_{50} value means that less chemical was needed to kill half the test animals. So, **the lower the LD_{50} value, the more toxic the pesticide.** A pesticide with a LD_{50} of 25 mg/kg is **more** poisonous than a pesticide with a LD_{50} of 2,000 mg/kg.

Parts per million

Suppose an amount of solution or mixture is divided into a million parts. One out of a million parts is called one **part per million** (**ppm**). The measures **mg/kg** and **ppm** are really the same, because 1 milligram is one millionth of a kilogram.

There are other measures that describe the toxicity of a pesticide. You might see **parts per billion (ppb)** and **parts per trillion (ppt)**. The list below might give you an idea of the scale of these measures.

- parts per million (ppm) = 1 milligram (mg) in 1 kilogram (kg)
  1 inch in 16 miles
  1 minute in 2 years

- parts per billion (ppb) = 1 inch in 16,000 miles
1 second in 32 years
- parts per trillion (ppt) = 1 inch in 16,000,000 miles
1 second in 32,000 years

Lethal Concentration Fifty

Scientists add a known amount of pesticide to air to measure its **acute inhalation toxicity**. The amount that causes half of the animals to die is the **Lethal Concentration Fifty (LC_{50})** of the pesticide.

LC_{50} values also are used to describe how toxic a pesticide is in water. This is called the **acute aquatic toxicity** of a pesticide. It measures effects on fish and other aquatic species.

LC_{50} is measured in **milligrams per liter (mg/l)** or ppm. Sometimes, it is measured in **milligrams per cubic meter (mg/m^3)**.

The lower the LC_{50} value, the more poisonous the pesticide.

Acute toxicity label warning statements

Each pesticide is put into a **toxicity category**. Toxicity categories are based on acute oral, dermal, and inhalation toxicity. They also are based on eye and skin irritation effects of each pesticide.

Each pesticide also is given a **signal word**. A signal word must appear on every pesticide product label. The signal word gives you an idea of the pesticide's acute toxicity or other special hazards.

A pesticide is put into a category based on its **highest level** of toxicity. If the acute oral toxicity and acute dermal toxicity of a pesticide are in the "slightly toxic" category, but its acute inhalation toxicity is in the "highly toxic" category, the pesticide label must have the signal words for a highly toxic pesticide.

Table 4 shows the four categories of pesticide toxicity and the signal word that goes with each category.

Table 4. Categories of acute toxicity.

		LD_{50}		LC_{50}	
		Oral	**Dermal**	**Inhalation**	
Category	**Signal word required on label**	**mg/kg**	**mg/kg**	**mg/l**	**Approximate oral dose that can kill an average person**
I Highly Toxic	DANGER—POISON! 	0 to 50	0 to 200	0 to 0.2	A few drops to 1 teaspoonful (or a few drops on the skin)
II Moderately Toxic	WARNING!	50 to 500	200 to 2,000	0.2 to 2	Over 1 teaspoonful to 1 ounce
III Slightly Toxic	CAUTION!	500 to 5,000	2,000 to 20,000	2 to 20	Over 1 ounce to 1 pint or 1 pound
IV Relatively Nontoxic	CAUTION!	More than 5,000	More than 20,000	More than 20	Over 1 pint or 1 pound

Chronic toxicity measures

There is no standard measure (such as LD_{50}) for chronic toxicity studies. The studies often last for months or years, and the amount of each dose is stated. A study of chronic oral toxicity might read, "8 milligrams of pesticide were fed to rats daily for 2 years. No symptoms of poisoning appeared."

It is difficult to test for chronic exposure to many pesticides. But, doctors can measure for chronic organophosphate and carbamate toxicity. They test for changes in cholinesterase levels in the blood. If your blood cholinesterase level has lowered, it is a sure sign that you have had too much exposure to these types of pesticides. You must avoid exposure until your blood cholinesterase level is normal again.

Hazard

The chance or risk that harm will result from the use of a pesticide is called **hazard**. Hazard is not the same as toxicity. The hazard of a chemical is always based on these two things:

1. How toxic or corrosive the chemical is.
2. The amount of chemical a person comes in contact with.

A highly toxic pesticide is **hazardous** because it poses a risk to the public or the environment. But, a highly toxic pesticide can pose a lower risk or hazard if you handle it correctly.

Many factors besides a pesticide's toxicity can make it hazardous. These include the skill of the handler, the formulation, the other ingredients in the formulation, and the concentration and dosage used.

Applicator

A certified applicator must have the skill and knowledge to handle all pesticides safely. Highly toxic materials could be less of a hazard if a skilled, practiced applicator uses them safely.

Formulation

The way a pesticide is put together can make it more or less of a hazard. This is called its **formulation** for use.

Formulations that are absorbed easily or inhaled might be more of a hazard. Figure 1 shows the toxicity hazard of types of formulations.

Choose the safest formulation there is to do the job.

For more detail on formulations, see Chapter 12.

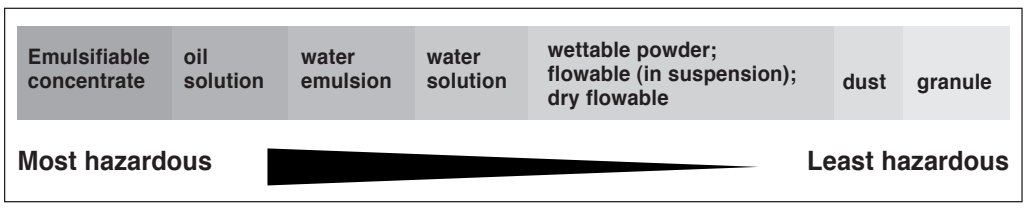


Figure 1. Toxicity hazard of different formulations with skin exposure, from most hazardous to least hazardous.

Concentration and dosage

Most of the time, the more **concentrated** a formulation is, the more hazardous it is. If you dilute the concentrated pesticide, you reduce the hazard.

Suppose that pesticide "A" is toxic both orally and dermally, and that 1 ounce contains a lethal oral dose. If the same 1 ounce of pesticide "A" is diluted in 10 gallons of water, then each ounce of the diluted mixture contains only 0.0008 ounce of pesticide "A." If the diluted mixture were to be swallowed or to spill on the applicator's hand, it would cause less harm than the concentrate would. The hazard of handling the diluted mixture is less than for the concentrate.

Always use the lowest concentration and dosage you need to control the target pest.

Target

The pest or pest's habitat is called the **target**. The target could be plants, soil, insects, animals, or structures.

The intended use of a pesticide is to control target pests without harming **nontarget species.** The best pesticide controls the target pest with little or no hazard to nontarget species or to the target area itself.

All pesticides are hazardous if misused. Use caution whenever you handle them! You cannot do anything about the toxicity of a chemical. But, you can control exposure. **You can lessen the risk of adverse effects from pesticides for yourself and others by reducing exposure!**

Questions for study—Chapter 2

1. What is toxicity?
2. Name four ways pesticides can enter the body.
3. Some pesticides can be as dangerous when they are absorbed through the skin as they are when they are swallowed. True or false?
4. Which is absorbed more easily through the skin—an oil- or water-based pesticide solution?
5. Name three areas of the body surface that absorb pesticides more quickly than other areas.
6. Which are the two most common routes of entry for the pesticide handler?
7. What should you do to avoid getting pesticides in your mouth by mistake?
8. What is pesticide exposure?
9. Name and define the two types of pesticide exposure.

10. Of those two types of pesticide exposure, which one's effects are easier to detect and study?
11. Explain the difference between exposure and dose.
12. Explain the difference between acute toxicity and chronic toxicity.
13. What does LD_{50} mean? To what does is refer? What does LC_{50} mean? To what does it refer?
14. The higher the LD_{50}, the more toxic the pesticide. True or false?
15. How many parts per million (ppm) is 6 milligrams per kilogram (mg/kg)?
16. Name and describe five types of effects of pesticides to humans.
17. What types of toxicity are label signal words and warning statements based on?
18. Which signal words are required on the label for pesticides classified as: Relatively nontoxic? Highly toxic? Slightly toxic? Moderately toxic?
19. Is there a difference between the toxicity and hazard of a substance? What is the difference?
20. Is a highly toxic substance always very hazardous?
21. What are some of the factors that make a chemical hazardous?

Chapter 3

Residue, Tolerance, and Registration

Strict laws control the use of pesticides in the United States. Before a chemical can be used as a pesticide, it must be studied carefully. Studies must prove that it does control the intended pest or pests and that it has no harmful effect on humans, other animals, and the environment.

Goals of this chapter

- Define what is meant by pesticide residue.
- Define tolerance.
- Explain the standards for setting a tolerance.
- Define "preharvest interval."
- Describe pesticide registration and re-registration.

Residues

The pesticide found on leaves, skin, or other surfaces just after application is called the **deposit**. In some cases, the deposit can be seen, as with dusts and wettable powders. In other cases, it cannot be seen with the naked eye.

In most cases, the amount of pesticide that remains on the surface decreases with time. In some cases, part of the pesticide is absorbed by the plant or animal that was treated.

The pesticide deposit that remains in or on the crop after a certain length of time is called the **residue**. How long a residue remains in or on the crop varies depending on the pesticide and environmental factors.

Some pesticides leave little or no residue, because heat, light, moisture, soil organisms, and chemical reactions break them down quickly. Food often does not have any residue because it never was treated, or because the residues have degraded by harvest time.

Other pesticides leave a residue on the crop or in the environment for weeks, months, or years. A long-lasting residue might be a good thing, because the pesticide will be effective for a longer time. But, a long-lasting residue on food or feed could be a hazard to those who eat it. Also, residues that remain in the soil might affect crops planted at a later date. Residues can poison anyone who enters a treated area.

For these reasons, the EPA requires many studies before registering a pesticide to ensure that no harmful residues remain on crops at harvest.

Preharvest interval (PHI)

Most pesticides break down in the environment. As they break down, the residue on or in a crop or animal becomes less. In most cases, the longer the time between applying a pesticide and harvest, the smaller the amount of residue that remains at harvest. The **preharvest interval** is the least number of days allowed between the last pesticide application and the harvest day. Read the label to find out what the preharvest interval is for a pesticide.

Tolerances

Pesticide residues often remain on food or feed crops at harvest time. To protect people and other animals, we must know what amount of residue is safe. The maximum amount of residue allowed to remain on a harvested crop is called a **tolerance**.

The Federal Food, Drug, and Cosmetic Act (FFDCA) requires the EPA to set a tolerance for every food or feed crop use before a pesticide is registered. The tolerance is a standard that defines what is legal and what is not. For example, if inspectors find that residues on a grower's crop exceed the tolerance, the crop could be condemned and seized by federal or state regulatory agencies.

Residue chemistry and toxicity data are used to set a tolerance. **Residue chemistry** is the chemical analysis done to find out how much pesticide remains on the food or feed crop. **Toxicity data** refers to the results of the many toxicity studies that are required to set the tolerance and support registration of the pesticide.

The EPA must answer three main questions:

1. What is the chemical residue?
2. How much residue is there?
3. Is this amount of residue too high a level of exposure to be safe for humans or other animals?

There are many studies done before a tolerance can be set, which include:

- Acute and chronic toxicity studies on test animals, such as rats, mice, fish, birds, and other mammals
- What happens to a pesticide and how long it remains in the environment
- Possible long-term effects, such as a buildup in the bodies of animals and the environment

To learn more about toxicity studies, see Chapter 2.

Residue levels and exposure

The EPA gets residue data to set a tolerance from experiments done by the registrant. After many experiments such as testing rates, frequency of application, and persistence of residues, the crop is grown under extreme application conditions (such as maximum application rate, maximum applications per year, and minimum preharvest interval). We could say that **the tolerance is the maximum residue level likely to be found under worst-case conditions.** In this way, the tolerance is used to enforce the law. If the tolerance is exceeded, the law assumes that the chemical was misused.

Theoretical Maximum Residue Contribution (TMRC)

To figure the level of pesticide exposure for each food, the EPA multiplies the maximum tolerance of a pesticide by the daily amount of that food eaten by an average adult in the U.S. The result is called the Theoretical Maximum Residue Contribution **(TMRC)**.

The total exposure to a certain pesticide from all sources is called the **cumulative TMRC**. To figure the cumulative TMRC (including the new use), the EPA adds together the TMRCs for all food sources of that pesticide. Then, EPA compares the cumulative TMRC with the level of pesticide exposure found to be without adverse effect (the NOEL). (The NOEL is the highest dose in a dose-response study that does not cause an adverse effect that scientists can observe).

To learn more about the NOEL, see Chapter 2.

Anticipated residue levels

Because tolerances are set using extreme application conditions, in most cases **the tolerance is *not* a measure of the level of pesticide that should be found in or on food when you buy it.** Most of the time, pesticide residues lessen as time passes after application. In most cases, washing, peeling, cooking, and other food processing reduce residues even more. Studies have shown that pesticide residues are almost always at a level far below the tolerance.

With this in mind, the EPA has adopted "market basket" residue studies to assess the level of pesticide residues in or on food crops, processed foods, and foods ready to buy in the store. They collect fruit, vegetables, and other foods in stores and test them for residues. The EPA concludes that the level of pesticide residue measured this way is the level to expect on or in crops treated the same way. This is called the **anticipated residue level**.

The EPA now also uses the anticipated residue level to figure the TMRC in order to assess whether the pesticide residues in or on food pose a health risk. This is a big change from assuming that the pesticide is present at the tolerance level. The EPA believes that this method gives a more true measure of what the effects might be of pesticides in the diet. (See "The Food Quality Protection Act" on page 42.)

Toxicity and the tolerance

Reference dose (RfD)

Before setting a tolerance, the EPA must use toxicity studies to find out how the pesticide might affect human health. Based on these studies, **the EPA decides what dose of pesticide a person can be exposed to daily without being likely to suffer an adverse effect over a lifetime**. For pesticides that do not cause cancer, this dose is called the **reference dose**, or **RfD**.

To figure the RfD, the EPA divides the NOEL by a **safety factor** (or **uncertainty factor**) of at least 100. The safety factor of 100 comes from: (1) a factor of 10 to account for what is unknown about how results from animal studies apply to humans, and (2) another factor of 10 to account for how sensitivity to chemicals varies from one person to another. Other safety factors also may be added. In other words, the RfD is at least 100 times lower than the NOEL.

To decide whether to grant a tolerance for a **noncarcinogenic** pesticide (a pesticide that does not cause cancer), **the EPA compares the cumulative TMRC with the RfD**. In most cases, **if the cumulative TMRC is less than the RfD, the new tolerance is granted**.

Negligible risk level

Pesticides that cause or are suspected to cause cancer are called **carcinogens**. For carcinogens, the EPA does not use the RfD. For them, the EPA uses the concept of **negligible risk**. This is expressed in terms of **probability**. The negligible risk level used by EPA is the probability of one (or less than one) more case of cancer in a million persons exposed to a chemical daily for 70 years.

So, on the basis of toxicity studies with animals, the EPA decides what is the dose that is not likely to cause more than one additional case of cancer in a million persons. This is called the **negligible risk level**. In most cases, **if the cumulative TMRC is not higher than the negligible risk level, the EPA grants the tolerance.**

The Food Quality Protection Act (FQPA)

The FQPA, passed in 1996, requires that tolerances be safe. The law defines "safe" as "reasonable certainty that no harm will result from aggregate exposure." The law defines **aggregated exposure** as "**all possible residue exposure from all foods (and water), residential (non-occupational), and occupational uses for which tolerances have been granted for the same pesticide, *and all pesticides with a similar mechanism of toxicity***." This means all the exposure there could be to residues from all uses of a pesticide on food, water, in the home, and on the job, **plus** all pesticides with a similar mode of action.

Also, the FQPA requires that tolerances include infants, children, and others at special risk. An extra safety factor of up to 10 may be added to protect these persons.

The new FQPA uses the term **risk cup**. The risk cup is the maximum daily exposure allowed for a person from the combined tolerance levels of all pesticides with a similar mode of action. Instead of each pesticide having its own risk cup, all pesticides with a similar mode of action are now put into a single risk cup. This has the effect of reducing the size of the risk cup. When the aggregated exposure level is exceeded, manufacturers must decide which uses they will give up. Of course, in most cases, they give up those uses that do not make them as much profit.

The FQPA also requires that all pesticides be tested to find out if they act as **endocrine disruptors** (in other words, act like hormones, especially estrogenic hormones). Pesticides that are strong endocrine disruptors most likely will not be granted a tolerance, and so they cannot be registered.

Enforcement of tolerances

Tolerances are set by the EPA, but they are enforced by the Food and Drug Administration, the U.S. Department of Agriculture, and in Oregon by the Oregon Department of Agriculture. Both federal and state inspectors sample food and feed crops soon after growers market them, so tolerance violations can be traced to their source.

Pesticide registration

Even though a tolerance is set for a pesticide on a certain crop, it is against the law to use the pesticide until it is registered by the EPA. **FIFRA established two main goals of the registration process**. They are:

1. To ensure that when it is used according to label directions, a pesticide is not a hazard to human health and the environment
2. **To ensure that use of the pesticide has benefits that outweigh any risks that might exist.** Under the FQPA, the standard of "reasonable certainty that no harm will result from aggregate exposure" has changed how EPA looks at benefits and risk.

The EPA decides whether or not to register a pesticide based on the test data given by the registration applicant (such as the manufacturer). Much data is required for registration of a pesticide. There can be more than 70 different kinds of tests required, depending on the type of pesticide and its properties.

These tests help the EPA decide whether a pesticide might cause adverse effects on humans, wildlife, and plants. Toxicity tests reveal what might be risks to humans from acute (short-term) toxic reactions as well as chronic toxic effects (resulting from long-term exposure). Data on **environmental fate** (how a pesticide behaves in the environment) also are required.

The list below shows some of the many questions that must be answered through these tests.

- **Chemistry**. What is the active ingredient? What are its chemical and physical properties? What impurities does it have? What methods exist to detect the pesticide?
- **Environmental fate**. Is the pesticide **hydrolyzed** (broken down in water)? Might it leach and contaminate groundwater? How does it move in the environment? Does it degrade by sunlight? Do soil microorganisms degrade it? Does it carry over in the soil from one crop to the next?
- **Toxicity (both short-term and long-term).** What is the pesticide's acute toxicity via oral, dermal, and respiratory exposure? Does it irritate the eyes? What is its chronic toxicity? Does it affect the reproductive system? How is it metabolized (i.e., degraded by the body)? Are its **metabolites** (new compounds formed when it is metabolized) toxic? Does it cause mutations, birth defects, or cancer? Does the pesticide cause **neurotoxicity** (is it toxic to the nervous system)?
- **Ecological effects**. What are the acute and chronic toxic effects of the pesticide on aquatic organisms, animals, birds, and plants; especially endangered species?

As part of the registration process, the EPA also decides whether a pesticide should be classified as a restricted-use pesticide (RUP) or have other special restrictions.

It can take from 6 to 9 years to move a new active ingredient from its making in the laboratory, through the complete EPA registration process, to its sale on retail shelves. For a major food-use pesticide, testing can cost the manufacturer from $20 million to $50 million. Registration of a new formulation (product) that contains an active ingredient already registered with the EPA takes much less time.

Note: There is more and more knowledge about what must be studied in order to respond to the effects of pesticides on human health and the environment. Because of this, the kinds of data that are required to support pesticide registration always are changing. So, pesticides registered for use today might not be able to meet future standards for data required. These pesticides would be removed from use or have their use very much restricted. Likewise, changing standards for the data required could make it harder to register new pesticide active ingredients.

Pesticide re-registration

The EPA is required by law to re-register pesticides in current use that first were registered when standards for the test data and approval were less strict. To be re-registered, these older pesticides must meet the same standards as new pesticides.

Starting in 1980, registration was handled through the **Registration Standards Program**. By the mid- to late 1980s, it became clear that the EPA would not be able to complete the re-registration of pesticides in use as Congress wished under the Registration Standards Program. Increased public concern about the safety of pesticide products in use and the slow pace of the re-registration process prompted Congress to change the EPA's approach.

Congress amended FIFRA in 1988 (**FIFRA '88**). FIFRA '88 decreed that pesticides first registered before November 1984 must be re-registered within a 9-year time frame. This could not be done, since there were about 45,000 pesticide products to be re-registered.

FIFRA '88 has been changed again with passage of the FQPA. Besides requiring **tolerance reviews**, the FQPA requires EPA to establish a system to review and update all pesticide registrations every 15 years. If new data are needed for these reviews or for any other review, EPA may require them at any time under FIFRA's "data call-in" authority in Section 3(c)(2)(B). EPA retains the right to require data and take action if needed at any time within the 15-year time frame.

The new law requires EPA to take into account these things:

- Whether the study data are valid, complete, and reliable
- What kinds of toxic effects there might be, and what is known about how study results relate to human risk
- The varied sensitivity to pesticides of infants, children, and others at special risk, and the foods that they eat most

Minor uses and the risk cup

When they are re-registering old pesticides, chemical companies must decide which uses they will support. In most cases, a company will give up registration on the uses that bring it the least profit. In the U.S., corn, soybeans, cotton, and wheat are grown on millions of acres each year. Many crops, especially vegetables and specialty crops, are grown on a much smaller scale, often measured in tens of thousands of acres. Pesticides used on these small acreage crops are called **minor-use pesticides**.

Minor-use pesticides do not make much profit for their manufacturers (or registrants) compared to the high cost of getting and keeping the registrations. There is little reason in terms of business for a company to

register new products or re-register existing ones for minor uses, or to add minor uses to approved pesticide labels. **Minor-use pesticides often are lost during the re-registration process.**

For example, assume that an insecticide is registered in corn and soybeans, lawns, and residential structures (buildings such as houses, barns, and sheds). Much more of the pesticide is sold for corn and soybean crops than for lawns and residential structures. If the company has three other pesticides with a similar mode of action, and the combined uses of the four pesticides exceeds the risk cup, then they would give up registrations on residential structures and lawns first. Or, they might decide to stop making one of the related compounds (and give up its registration) to free up use (space in the risk cup) of the chosen product.

Many, if not most, pesticide uses on fruit and vegetable crops are minor-use pesticide registrations. Commercial flowers, ornamentals, trees, and turf also are minor uses. Without these small-scale but vital pesticide uses, growers could not produce many fruits, vegetables, and ornamentals—worth billions of dollars—that buyers want. Oregon agriculture very much depends on minor crops. So, Oregon's economy is hit hard when these pesticides are dropped during re-registration.

Unsupported cases

When a registrant does not want to re-register a chemical, we say it is **unsupported** for re-registration. In that case, the EPA may cancel the chemical's use.

A registrant may choose not to support re-registration of an active ingredient for many reasons. One reason is the high cost of getting more data as required by the EPA. Another reason could be the lack of a large market for the product. But, some other registrant can support a chemical case by giving the needed data and fees to the EPA. This is called a **revived case**.

Because of the high costs of re-registration, the added restrictions of the FQPA, and changing pest control options, there are many less active ingredients being registered as pesticides. As of 2003, there are less than 700 (compared to more than 1,150 in 1988), with some 50,000 registered pesticide products.

Special Review, cancellation, and suspension

New data on registered products sometimes show a problem or a hazard that was not known when the products first were registered. In cases like this, there are three methods that Congress and the EPA have developed to make re-registration decisions.

Special Review

If the EPA seeks to revoke the registration of a pesticide, they first must announce their reasons and offer the registrant a formal hearing to present opposing facts. Because the cancellation process takes a lot of time and money, the EPA often uses a simpler process called **Special Review**.

Special Review is a thorough and ordered examination process. People both for and against revoking the pesticide can give comments

and facts on the risks and benefits of a pesticide. In many cases, the Special Review results in an agreement to change the registration in a way that reduces the risk enough that a formal hearing no longer is needed.

Cancellation

If the Special Review process fails to resolve the issues, or if the EPA decides the problem is severe enough that the registration must be cancelled, then the EPA may issue a proposed Notice of Intent to Cancel without holding a Special Review. The EPA also is required by FIFRA to send the proposed notice to the EPA Scientific Advisory Panel and the U.S. Department of Agriculture. The EPA must take into account their comments before proceeding with a final Notice of Intent to Cancel Registration.

If the registrant does not request a hearing within 30 days of the notice, the pesticide's registration is canceled right away. If the registrant does request a hearing, it is conducted in the form of a trial before an EPA administrative law judge. The judge issues a recommended decision to the EPA administrator.

The cancellation process can take 2 years or more. After the EPA decides, the judgment still may be challenged in a federal court of appeals. If there is no appeal to a decision to cancel, all registrations of the pesticide to which the judgment applies are canceled. These products no longer may be sold or distributed in the United States.

Suspension

In most cases, the pesticide remains on the market during a Special Review or cancellation process. But, if the EPA thinks that leaving the pesticide on the market poses too high a risk, they can issue a **suspension order**. A suspension order bans the sale or use of the pesticide until the pesticide's status is decided.

To issue a suspension order, the EPA must show in a legal hearing that use of the pesticide is a hazard. In most cases, the EPA will offer the registrant a speedy hearing on the suspension issues. But, the EPA might find that even during the time needed for a suspension hearing, use of the pesticide would cause very adverse effects. In that case, the EPA can **suspend** (ban) the sale and use of a pesticide, to go into effect at once.

Questions for Study—Chapter 3

1. What is the difference between a deposit and a residue?
2. How can long-lasting residues be desirable? Undesirable?
3. What is a tolerance? When must a tolerance be set?
4. Can a food or feed crop have more than the set tolerance of a pesticide on it and still be marketed legally?
5. Do all food and feed products you buy have the maximum tolerance of each pesticide registered in that crop?
6. What is a minor-use pesticide?
7. What does the term NOEL mean?
8. At least what margin of safety (the safety factor) is used in setting tolerances?
9. The FQPA requires that pesticide tolerances be “safe.” How do they define safe?
10. How does the FQPA define aggregate exposure?
11. What is a preharvest interval?
12. What is the reference dose? How is it figured?
13. How does a pesticide cancellation differ from a suspension?

Chapter 4

Ecology and the Environment

People are concerned about pesticide use. Pesticide drift affects air quality. Pesticides in the food chain can threaten wildlife. Soil contaminated with chemicals may no longer grow crops. Pesticides pollute the natural water supply. Plants, animals, and humans need clean air and water, wholesome food, and a safe environment in order to survive.

Pesticide handlers must think about the hazards to the environment. You must use pesticides carefully and wisely.

Goals of this chapter

- Describe some of the dangers of pesticides in the environment.
- Explain how to protect plants and animals from pesticide damage.
- Explain how pesticides pollute surface and groundwater and how to prevent water pollution .
- Explain how pesticides persist in the environment.

Air and pesticides

Air is vital for plants and animals to live. It takes the carbon dioxide waste that we breathe out. It contains the oxygen that we breathe in.

Air can carry dust, mist, and other particles over long distances. Most of the time this helps people, such as carrying water in clouds and helping to cause rain. But air also can carry pesticides.

Drift

Moving air can cause pesticides to drift. **Drift** is the movement of spray droplets, vapors, or dust particles away from the intended target. After they drift away, they may land on lakes, rivers, homes, lawns, or wilderness areas.

This is trouble for the pesticide applicator. Drift from the target area can injure people, pets, wildlife, and sensitive plants. Drift can kill bees and other helpful insects. **You must minimize drift as much as possible.**

Drift also can be a problem indoors. You must take care that pesticides do not move to other parts of the building by forced air heating and air cooling systems.

Vapor drift

Evaporation means to turn a liquid or solid into a vapor. Air currents can carry pesticide vapors away from the treated area. This is called **vapor drift**. **Vapor drift is not visible**.

To learn more about weather conditions and application of pesticides, see Chapter 16

Volatile means that a pesticide evaporates easily. Do not apply a volatile pesticide when weather conditions are not right. High temperatures cause a pesticide to turn into vapor more easily.

Also, do not apply pesticides when there is an **inversion** layer.

Pesticide vapors inside a home can injure the people and animals that live there.

Labels give warning statements that you must read and follow. These are some sample statements:

- At high air or ground surface temperatures, vapors from this product may injure susceptible plants.
- Under very high temperatures, vapors from this product may injure susceptible plants in the immediate vicinity.
- Off-site movement of spray drift or vapors of this product can cause foliar whitening or yellowing of some plants.

Particle drift

The smaller the droplet or particle, the easier the pesticide can drift. Dust formulations have small particles. They are more likely to drift than granular formulations.

Small liquid droplets, especially those smaller than 100 microns, drift very easily. Researchers estimate that 90 percent of all droplets smaller than 40 microns never reach their target.

A micron is about $\frac{1}{25{,}000}$ of an inch. Fog droplets are about 40 microns. A drop of water dripping off a faucet is about 5,000 microns.

You should use the largest droplet size that gives good pest control as long as you follow the label.

Nozzle size, placement, and type

The opening in the nozzle is called the **orifice**. The size of the nozzle orifice affects particle drift. **The smaller the nozzle orifice, the smaller (finer) the droplet.** All nozzles make a range of droplet sizes. Try not to use nozzles that make fine droplets if drift will be a problem.

How you place the nozzle in air-blast and aerial application equipment also affects droplet size. The more the nozzle is at a right angle to the air stream, the greater the **shear effect**. The shear effect makes smaller droplets.

To learn more about nozzles and spray patterns, see Chapter 13.

In most cases, floodjet (impact) nozzles make larger droplets than flat-fan nozzles. Flat-fan nozzles make larger droplets than cone nozzles.

Pressure

The higher the pressure, the smaller the droplet. You might get better coverage with smaller droplets, but smaller droplets drift more easily. Larger droplets are heavier and don't move off target as much. If you lower the pressure, you can help control drift, because lower pressure makes larger droplets.

Height of nozzle

If the nozzles are too high, then the spray is more likely to drift. The spray has to fall farther before it hits the ground.

Nozzles set too high may change the spray pattern. If you lower the nozzle, that narrows the spray width. You might need to change to nozzles with a wider spray angle, so you can lower the spray boom.

Check what the nozzle maker suggests for proper height and overlap.

Air movement

Wind direction and speed affect the direction, amount, and distance of drift. Temperature inversion or stagnant air seem to be ideal for pesticide application, but they can cause severe drift. **Do not apply pesticides when there is an inversion layer.**

For more detail on the inversion layer, see Chapter 16.

Temperature and humidity

Small droplets evaporate faster when the temperature is high and the air is dry. Droplets that evaporate before reaching the target do not control the pest. So, it is best not to spray when temperatures are high and relative humidity is low (air is dry). In some climates, it is best to spray only early in the day, late in the evening, or at night.

Drift-control additives

You can put a drift-control additive in your spray tank along with your pesticides. The drift-control additive tends to make your spray solution thicker (increases **viscosity**). This both reduces the number of very small droplets and makes the spray droplets heavier, which slows drift.

There are several drift-control additive products. You can buy them from your chemical dealer or supplier.

How can I minimize drift?

- Choose low- or non-volatile pesticide formulations, if you can.
- Use nozzles that produce larger droplets.
- Use the lowest pressure that still does the job.
- Choose nozzles designed to reduce drift.
- Place nozzles **with** the air stream, not across it.
- Apply as close to the target as you can.
- Use a drift-control additive.
- Do not apply when wind, temperature, or dry air favor drift.

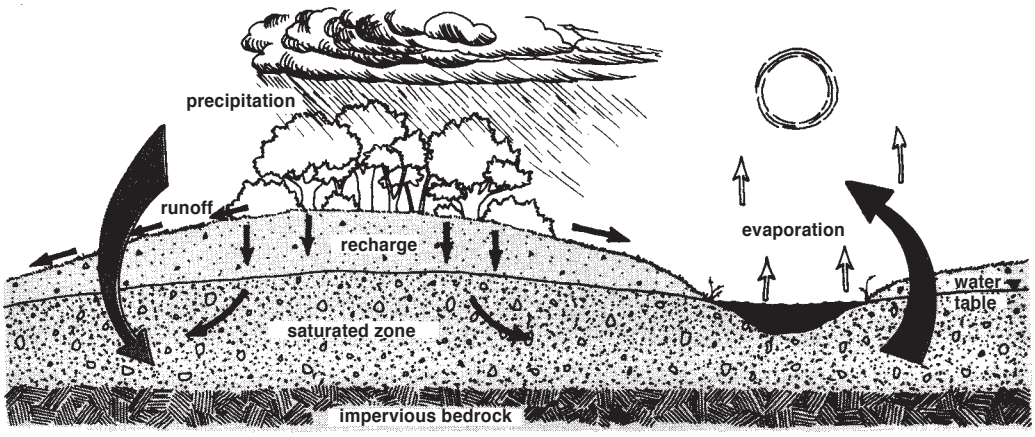
Even when you use common sense and apply the pesticide correctly, you still can have a problem with drift. Read and follow the label carefully. Know the conditions that favor drift.

Pesticides and water

Groundwater and the water cycle

Water is vital for all life. About 96 percent of the world's total fresh water comes from groundwater. Sadly, groundwater pollution is increasing.

Groundwater mostly is stored in formations of rock, sand, and gravel called "aquifers." An aquifer may be confined to a small area or it may



The water cycle

involve hundreds of square miles of underground stored water. Groundwater may come to the surface naturally as a spring. Or, it may be pumped to the surface from a well.

The water cycle begins with rain or snow. Runoff enters lakes, streams, and rivers. Some of this water also seeps through the ground, where plants draw it into their roots. Water moves even further down through the soil and joins the groundwater.

Water returns to the sky through evaporation from plants, soil, and surface water. The water vapor condenses and falls to the earth as rain or snow. This completes the water cycle.

How pesticides pollute groundwater

Pesticides applied to a site may move down with rain or irrigation water and reach the water table below. This is called **nonpoint source pollution**.

Pesticides may enter a well from a spill or back-siphoning and get into the groundwater directly. This is called **point source pollution**.

Pesticides in groundwater break down slowly. There is much less light, heat, air, and microbes underground. So, pollutants stay in groundwater for a long time.

Groundwater moves slowly, so pollutants do not spread quickly. The pollution usually has spread far by the time it is found.

It is very costly and hard to clean groundwater. It may take years before an aquifer can purify itself naturally. The best way to protect groundwater from pollution is to prevent it.

Pesticides, soil, and groundwater

Several factors affect what happens to pesticides in the environment. The two main factors are those things that "transfer" or influence movement of a chemical, and those things that break down or degrade a chemical (see "Pesticide degradation," page 57).

There are four main factors that determine whether a pesticide will move from soil into the groundwater. These are called **transfer processes**. They are:

1. Adsorption
2. Runoff
3. Leaching
4. Volatilization

Adsorption

Adsorption is the binding of one particle to another particle. Pesticide adsorption onto soil particles depends on these things:

- The kind of pesticide
- Soil organic matter content
- Soil moisture content
- Soil pH (acidity)
- Soil texture

Soils high in organic matter or clay are the most adsorptive. Coarse, sandy soils that lack organic matter or clay are much less adsorptive.

Adsorption differs from **ab**sorption. Absorption refers to something being taken up, such as a sponge or plant roots that absorb water.

A pesticide that is bound tightly to soil particles is less likely to volatilize, leach, or degrade. It is less easy for plants and microorganisms to absorb it.

Runoff

Rain and irrigation water wash pesticides off plants onto the soil. The polluted water runs into streams, rivers, and lakes. This is called **runoff**.

Sometimes, soil washes away with rain or irrigation water. This is called **erosion**. Soil-adsorbed pesticides can wash into water sources by erosion.

The amount of pesticide runoff depends on these things:

- The slope of an area
- The texture of the soil
- Soil moisture content
- The amount and timing of irrigation or rainfall
- The kind of pesticide

Leaching

Some pesticides move down through the soil and into groundwater. This is called **leaching**. Pesticides leaching from treated areas, mixing and rinsing sites, waste disposal areas, and factories are a major concern.

Several things can affect pesticide leaching.

- A pesticide that dissolves easily in water moves with the water as it seeps through the soil.
- Soil structure and texture affect how fast and how deep the pesticide leaches. Sandy and gravel soils allow water and pesticides to leach more easily. A heavy clay soil does not allow water to leach very much.
- **Adsorption affects pesticide leaching. Pesticides that are bound tightly to soil particles leach less.**

Depth to groundwater and halflife of the pesticide also affect whether the pesticide reaches groundwater.

Volatilization

A solid or liquid can change into a gas or vapor. This is called "evaporation." It also is called **volatilization**. If we say a pesticide is **volatile**, it means it can change easily into a vapor. Pesticides that volatilize easily do not leach much. However, sometimes the vapors rise with hot air, cool off in the clouds, and the pesticide falls back to earth in raindrops. This is why some pesticides are found in arctic ice.

Some pesticides are very volatile. **The volatility of a pesticide depends on its vapor pressure**. Vapor pressure is a measure of the natural tendency of a liquid or solid to change into a vapor. For example, water has a low vapor pressure. You have to heat it to 212°F to make it volatilize (boil and produce steam). **Air temperature** also affects volatility. Pesticides are more volatile with higher air temperature, more air movement, dry air, and smaller spray droplets.

How to protect groundwater

- Read the label for any warnings.
- Judge the need, the way to apply, and how often to apply the pesticide.
- Use other pest control methods whenever you can.
- Know the kind of soil you are working with. Know whether the pesticide you are using leaches easily through the soil.
- When you can, choose pesticides that do not leach easily into the groundwater.
- Think about where you are applying the pesticide in relation to groundwater and surface water. Know the water table depth. Know if water can seep easily down from the surface into the groundwater. Be careful around sinkholes and old wells.
- Reduce pesticide use and handling close to wells, streams, ponds, and other water sources. Pesticides can enter the groundwater directly through a well, through cracks near the pump base, or through soil next to the well. Seal wells properly. Avoid pesticide spills.
- Follow the directions on the label.
- Apply pesticides at the proper rate and at the right time.
- Calibrate accurately and often. During calibration, check the equipment for leaks. Be sure the equipment is working well.
- Direct the application exactly onto the target site.
- Dispose of extra pesticides properly. You must follow local, state, and federal laws. To avoid the need for disposal, mix only the amount you need.

For details on proper disposal of extra pesticides, see Chapter 17

- Clean containers by multiple rinsing. Rinse at least three times or until the rinse water is clear. Pour the rinse water back into the spray tank to treat labeled sites or crops.

For details on cleaning pesticide containers, see Chapter 15

- Store pesticides safely. Build storage sites away from wells, cisterns, springs, and other water sources.
- Keep records of pesticide use.
- Avoid spills and back-siphoning. Hold the end of the fill hose above the water level in the spray tank. This keeps chemicals from back-siphoning into the water supply. Use an anti-backflow device (an air gap or check valve) when siphoning or pumping water directly from a well, pond, or stream.

In Oregon, you must use an anti-backflow device on all filling/loading equipment attached to a groundwater source. The person who owns the land must ensure that the anti-backflow device is installed and works well.

You can get a copy of the rules for using back-siphon equipment and irrigation equipment to apply chemicals. Call:

Oregon Water Resources Department
Telephone: 503-986-0900

Wildlife and pesticides

Wildlife habitat

Fish, birds, and mammals are vital to the ecosystem. Wildlife make their homes in parks, farmland, lawns, golf courses, and the waterways and woods around them. Take care to protect these places when you apply pesticides.

Endangered species

An **endangered species** is a plant or animal at risk of extinction. **Extinction** means to die out forever. A **threatened species** is a plant or animal that is soon to be endangered.

Species often become endangered or threatened because humans destroy their natural homes. Industry, farming, and growth of towns all destroy natural homes of animals and plants.

The natural places that are home to wildlife are called its **habitat**. Wildlife is in danger when its habitat is harmed by exposure to pesticides. Small amounts of pesticides can affect breeding and birth.

All living things are part of a complex, balanced network. The loss of one species can lead to the loss of many others. Saving an endangered species is very hard. Sometimes, it cannot be saved.

The EPA figures that about 900 U.S. counties have endangered species living in them. We must be sure to protect them.

For details on the laws that protect endangered species, see Chapter 1.

Honeybees

Honeybees and other insects help pollinate commercial crops and home gardens. You must take good care to protect them from pesticides.

Choose the right pesticide and the right way to apply it. Do not apply or allow pesticides to drift onto crops in bloom. Do not spray shade trees, crops, or weeds during bloom. If you have to spray the area, mow cover crops and weeds to remove the blooms. This way, fewer bees are attracted to the area.

It is best to apply pesticides when bees are not visiting plants in the area. You can keep the threat to bees low if you make the application late in the day. And, use a pesticide that breaks down in a few hours. In general, evening applications are the least harmful to bees.

Do not treat near hives

You may need to move bees or cover them before you apply pesticides near their hives. Do not let spray drip and form puddles. Do not

make area-wide application of pesticides. Bees cannot avoid contact with the spray on flowers or in water. Many bees will die.

Choose the right pesticide product

Choose the pesticide that is least harmful to bees.

- Dusts are more of a hazard than sprays.
- Wettable powders are more dangerous to bees than either emulsifiable concentrates or water-soluble formulations.
- Microencapsulated insecticides are tiny capsules that bees can carry back to the hive just like pollen. The bees spread the capsules through the hive. This affects much of the colony.
- Ultralow-volume applications can be more toxic than regular sprays.
- Granular formulations are generally the safest for bees.

Check the product label for hazards to bees.

Pesticides in food

Food crops

If you apply too much pesticide, you can cause good farmland to become unfit to grow food. If you apply too much pesticide, you can raise the chances of too much pesticide residue in crops, food, and soil. **If you apply pesticides at a rate higher than the label directs, you violate state and federal law.**

The food chain

Each animal on our planet needs some other kind of animal or plant for food. This bond of dependence on other species is called the **food chain**.

Each animal has a place in the chain based on the type of food it eats. Animals that eat plants are near the bottom of the chain. Animals that eat other animals are at the top of the chain. In this complex food chain, each animal has an important place.

Applying pesticides over broad areas can kill the plants or animals that are food for another kind of animal. This causes that animal to move into other places where it must compete for food and space. Or, this can cause the animal to eat some other food, such as a farmer's livestock. Or, it can cause that animal to die.

Pesticides can enter the food chain through nontarget plants and animals. Fish and wildlife are exposed to pesticides by eating insects, earthworms, animals, and plants that have pesticides in them.

Accumulative pesticides

Some pesticides build up in the body of animals. The pesticide builds up to a level where it causes sickness. This happens when animals eat a steady diet of plants or other animals that have pesticides in them. This is called **bioaccumulation.**

Humans are at the top of the food chain. The same thing can happen to humans as happens to other animals who eat food polluted with pesticides. We must be sure that the food we eat does not have harmful levels of pesticides.

Nonaccumulative pesticides

Some pesticides do not build up in the body of animals or in the food chain. These are called **nonaccumulative**. These pesticides leave the body in urine, feces, and sweat. Even though they do not build up in the body, they still can cause harm.

Pesticide degradation

Persistent pesticides

Pesticides that stay in the environment in soil, water, and the air for a long time are called **persistent**. This is different from pesticides that build up (**accumulate**) in animal bodies or in the food chain. Persistent pesticides can harm plants and animals later on. They also can cause pests to build up resistance to that pesticide faster.

The persistence of some pesticides can help us. Pesticides that protect wood in buildings from termites cost a lot of money and are hard to apply. It helps that these pesticides last a long time with one application.

Most of the time, pesticides that break down quickly are less harmful to the environment.

How pesticides degrade

There are three main ways that pesticides break down. These are called **degradation processes**. They are:

1. Microbial degradation
2. Chemical degradation
3. Photodegradation

Microbial degradation

Some soil fungi and bacteria use certain pesticides as food. They destroy the pesticide by eating it. This is called **microbial degradation**.

If soil conditions are right, microbial degradation can be fast and complete. Good conditions are warm temperature, the right pH levels, enough soil moisture, enough air in the soil, and the presence of certain minerals and elements in the soil.

Adsorption also affects microbial degradation. Adsorbed pesticides are harder for microorganisms to eat.

Sometimes, pesticide applications can cause certain microorganisms to build up in the soil. These microorganisms degrade the pesticide fast. Pesticides that normally work well for weeks suddenly stop working within days. This effect is called **soil microbial enrichment**.

Chemical degradation

Some pesticides break down through chemical action alone. This is called **chemical degradation**. Chemicals that are tightly **ad**sorbed (physically adhere) to soil particles (colloids) are less subject to chemical degradation. Soil pH, soil temperature, and moisture also affect the rate and type of chemical action. Chemical degradation usually makes the pesticide less potent.

Photodegradation

Sunlight breaks down pesticides. This is called **photodegradation**.

Pesticides applied to plants, soil, or structures can change a lot when exposed to sunlight. Photodegradation lowers the amount of effective pesticide, which lowers pest control. Certain pesticides are affected so much by photodegradation that they lose their value quickly.

You can reduce pesticide exposure to sunlight. Incorporate the pesticide into the soil during or after application as indicated by the label. Or, you can irrigate after the application. Or, you can apply the pesticide before rain.

Protect yourself and the environment by practicing proper pesticide use.

Questions for study—Chapter 4

1. When a pesticide turns into vapor and moves off target, what is this called?
2. Name four of the eight factors that affect drift.
3. What are two atmospheric conditions that increase pesticide drift?
4. How can you protect honeybees from pesticide exposure?
5. How can the use of pesticides affect wildlife?
6. How do mammals, fish, and birds build up high pesticide residue levels in their bodies?
7. How do pesticides reach groundwater?
8. When can a pesticide be a dangerous pollutant?
9. How do pesticides reach streams and ponds?
10. How do you change pressure to reduce liquid droplet drift?
11. What are two things that could happen if a pesticide drifts onto forage or pastureland or into drinking water?
12. What is an aquifer? Why is it important?
13. What do we call the complex relationship of all animals (including humans) who need each other for food?
14. What is the best way to protect against groundwater pollution?
15. Where are humans in the food chain?

16. What is a nonaccumulative pesticide?
17. What is the difference between accumulative and persistent pesticides?
18. Do persistent pesticides accumulate?
19. Do persistent pesticides cause much harm to the environment? Why?
20. Briefly describe the water cycle.
21. What is an endangered species?
22. Name three ways pesticides break down after application.

Chapter 5

Personal Protective Equipment

Key concepts

- Pesticides enter the body through the skin, lungs, mouth, and eyes.
- Pesticide is absorbed most easily through skin of the groin, forehead, scalp, ear canal, and eyes.
- Always use the right personal protective equipment (PPE).
- Not all materials are chemical resistant.
- Chemical resistance of PPE is affected by chemicals and how long the equipment is exposed.
- Never use gloves, footwear, or hats made of materials that can absorb pesticides, except when you use fumigants.
- Dust/mist filters are very different from vapor-removing respirators.
- You must take care of PPE so it will protect you the way it should.

What is personal protective equipment?

Pesticides can enter the body through the skin, the eyes, the mouth, and the lungs. Skin (dermal) exposure is the most common route of entry for pesticide handlers in agriculture and forestry. The skin of the groin, forehead, scalp, ear canal, and eyes absorbs pesticides faster than other body parts.

Protect yourself from contact with pesticides by wearing special clothing and equipment. It is called **personal protective equipment** (**PPE**). PPE includes coveralls or protective suits, footwear, gloves, aprons, respirators, eyewear, and headgear.

Most of the time, normal shirts, pants, shoes, and other regular work clothing are **not** PPE. But, sometimes, the pesticide label states that you must wear certain work clothing to do some tasks.

To prevent or reduce exposure to pesticides, you need to wear PPE. The pesticide label tells you which PPE you must wear. **By law, you must comply with all PPE instructions on the label.**

The pesticide label lists the **minimum** personal protective equipment you must wear while handling the pesticide (see Tables 6, 7, 8, and 9). But, you might need more protection. Read the warning statements on the label. Think about the task you need to do. Use common sense. Then, you can choose the proper PPE for the job.

Sometimes, the label states that you must use different PPE for different tasks. You might need more PPE for mixing and loading than for application.

Chemical-resistant materials

Some pesticide labeling requires you to wear **chemical-resistant** PPE. Chemical-resistant means that the material doesn't let the chemical go through. You must choose a material that will be resistant for the length of time that you will be exposed to the pesticide.

Factors that affect chemical resistance

Length of exposure

Chemical resistance often is stated in terms of exposure time. Chemical-resistant materials differ in how long they can protect you. The chemical, solvent, and other additives also affect the length of protection a certain material gives.

Neoprene is a chemical-resistant material. It is resistant to acetone for as little as 10 minutes. If you wear neoprene gloves to handle pesticides with an acetone solvent, you must change the gloves at least every 10 minutes to keep the pesticide from going through the material and onto your hands.

But, neoprene is resistant to diesel fuel for more than 4 hours.

Job hazard

Even a chemical-resistant material will not protect you if it becomes damaged. When you handle sharp or pointed objects or walk through rough terrain, choose a stronger material.

Type of chemical

Very few materials can protect you from all pesticide products. The level of chemical resistance depends on the active ingredient, the formulation, and the solvents and diluents (liquid or dust used to make a pesticide less concentrated) used.

How to choose chemical-resistant materials

Always read the pesticide label to learn which materials are resistant to the pesticide product. Manufacturers of PPE also can tell you the facts about their product.

Absorbent materials are not chemical resistant, even to dry formulations. This includes cotton, leather, and canvas. Powders and dusts sometimes move through cotton and other woven materials fairly quickly. They can stay in the fibers even after many washings.

Do not wear hats with cloth or leather sweatbands. Do not use cloth or cloth-lined gloves, footwear, or aprons.

Most of the time, the best choices of material for chemical-resistant hoods and suits are these:

- Rubber or plastic, such as butyl, neoprene, or polyvinyl chloride (PVC)
- Nonwoven fabric coated with plastic

Read the package carefully to see if the suit is chemical resistant, chemical protective, or liquid-proof.

Barrier-laminate materials are resistant to most pesticides. But, many pesticide handlers do not like to wear them. They are hard to work in.

Materials resistant to dry and water-based pesticides

Most plastic or rubber material is resistant to dry pesticides and to water-based pesticides.

Dry pesticides include:

- Dusts
- Granules
- Pellets
- Some baits

Water-based pesticides include:

- Wettable and soluble powders
- Some solutions
- Dry flowables/water-dispersible granules
- Microencapsulated pesticides

Materials resistant to pesticides in solvents

Pesticides that do not dissolve in water are called **nonwater-based liquid pesticides.** Liquid pesticides that are not water based include:

- Emulsifiable concentrates
- Ultralow-volume and low-volume concentrates
- Low-concentrate solutions
- Some flowables
- Aerosols
- Invert emulsions

Liquid formulations often are made with organic solvents. Chemical resistance of a material depends on the type of solvent used. Common solvents are:

- Xylene
- Fuel oil
- Other petroleum distillates
- Alcohol

When xylene is in a formulation, the pesticide label must list it in the ingredient statement on the front panel. If xylene is listed as an ingredient, choose one of the chemical-resistant materials listed in Table 5.

Table 5. Materials resistant to pesticides with xylene.

Chemical-resistant materials	Pesticide strength plus exposure time		
	Concentrated + any exposure	Diluted + long period	Diluted + short period
Barrier laminates	Yes	Yes	Yes
Nitrile rubber	Yes	Yes	Yes
Butyl rubber	Yes	Yes	Yes
Neoprene rubber	No	No	Yes
PVC	No	No	Yes
Natural rubber	No	No	No
Polyethylene	No	No	No

Many solvents do not have to be listed in the ingredient statement. Be sure to watch for signs that the material you are wearing is not chemical resistant. Material that is not resistant to a pesticide might do these things:

- Change color
- Become soft or spongy
- Swell or bubble up
- Dissolve or become like jelly
- Crack or get holes
- Become stiff or brittle

If any of these changes occur, throw away the PPE you are wearing. Choose some other type of material.

Protect your skin

Skin is the most common route of pesticide exposure. Cover as much of your skin as you can.

PPE protects you only if the pesticide stays on the outside of the PPE. If the pesticide gets on the inside, the PPE works against you. It holds the pesticide tightly to your skin. This increases the degree of exposure.

Body protection

Table 6 lists PPE that the label might require for body protection and tells which PPE you may wear in each case.

Long-sleeved shirt and long-legged pants

When you handle pesticides, wear at least a long-sleeved shirt and long-legged pants. They should be made of sturdy material. Close the shirt collar around your neck. Put the pants legs on the outside of your boots.

Coveralls

Many times, the pesticide label states that you must wear a coverall. A **coverall** is a full-length protective outer garment that covers you from neck to ankle.

Coveralls should be made of sturdy material. When you wear a coverall, close it securely. If you wear a two-piece coverall, do not tuck it in at the waist. The shirt should extend well below the waist of the pants. Good coveralls have tight seams and snug, overlapping closures that do not gap or unfasten easily.

When you handle pesticides that are highly or moderately toxic through the skin, or are skin irritants, always wear a coverall over a set of clothing that covers your body. The pesticide label might state a certain type of clothing you should wear under the coverall.

The coverall should fit loosely so there is a layer of air between it and your skin. Each layer of clothing and each layer of air between the pesticide and your skin gives more protection.

Chemical-resistant suit

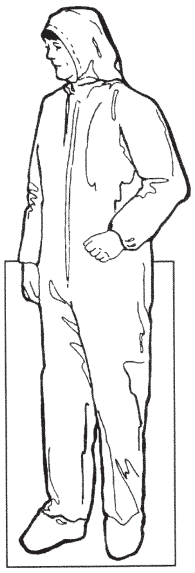
When the pesticide label states that you must wear a chemical-resistant suit, it means that the pesticide is very hazardous.

Sometimes, the method you plan to use to apply a pesticide will cause a lot of it to fall on your clothing. If this application will take a long time, wear a chemical-resistant suit. Wear it even if the pesticide labeling does not require it. In a case like this, even pesticides that are applied dry, such as dusts or granules, can go through normal fabric.

The biggest drawback to chemical-resistant suits and coated nonwoven fabric is that they can make you very warm. Even when it is not hot or humid, a chemical-resistant suit can cause you to overheat very quickly. In hot, humid weather, **heat stress** is a major concern. Drink plenty of water, and take rest breaks often to cool down.

Chemical-resistant suits also are called **rainsuits**.

To learn more on heat stress, see Chapter 7.



Chemical-resistant suit

Chemical-resistant apron

The pesticide label might require you to wear a chemical-resistant apron while you mix and load pesticides and while you clean pesticide equipment. Wear an apron every time you handle pesticide concentrates. It adds extra protection from splashes, spills, and billowing dusts.

An apron can be a safety hazard around some kinds of machines. In such cases, wear a chemical-resistant suit instead.

Table 6. Label PPE statements for body protection.

If the label states you must wear this	Then this is the PPE that you may wear
Long-sleeved shirt and long-legged pants	Long-sleeved shirt and long-legged pants. Woven or nonwoven coverall. Plastic- or other barrier-coated coverall. Rubber or plastic suit.
Coverall worn over short-sleeved shirt and short pants	Coverall worn over short-sleeved shirt and short pants. Coverall worn over long-sleeved shirt and long-legged pants. Coverall worn over another coverall. Plastic- or other barrier-coated coverall. Rubber or plastic suit.
Coverall worn over long-sleeved shirt and long-legged pants	Coverall worn over long-sleeved shirt and long-legged pants. Coverall worn over another coverall. Plastic- or other barrier-coated coverall. Rubber or plastic suit.
Chemical-resistant apron worn over coverall or over long-sleeved shirt and long-legged pants	Chemical-resistant apron worn over coverall or long-sleeved shirt and long-legged pants. Plastic- or other barrier-coated coverall. Rubber or plastic suit.
Chemical-resistant protective suit	Plastic- or other barrier-coated coverall. Rubber or plastic suit.
Waterproof suit or liquid-proof suit	Plastic- or other barrier-coated coverall. Rubber or plastic suit.

Hand and foot protection

Table 7 lists PPE that the label might require for hand and foot protection and tells which PPE you may wear in each case.

Gloves

Pesticide handlers' hands and forearms get more exposure to pesticides than other body parts do. For this reason, most pesticide labeling requires you to wear **chemical-resistant gloves** when you handle pesticides.

Wear chemical-resistant gloves and a long-sleeved shirt any time you might get pesticides on your hands. Wear gloves over your cuffs. But, if you are working in a drenching spray from above, put your gloves under your sleeves. That way, the chemical does not run down your sleeve into the glove.

Some gloves are thicker than others. Glove thickness is measured in gauge (inches) or mils (millimeters). The larger the number, the thicker the glove.

Most of the time, thicker gloves have more resistance to chemicals and to tears and punctures. But, their chemical resistance depends more on the material they are made of than how thick they are. Thicker gloves also make it harder to use your hands well.

If gloves are too large, they are clumsy and awkward to use. If gloves are too small, you must stretch them. It is harder to get them on and off. Stretching also makes the glove material thinner. So, it offers less protection. Tight gloves can make your hands feel tired more quickly.

Make sure your gloves do not leak. To test gloves for leaks, fill each one with water, close the top, and squeeze the glove. If water leaks out, replace the glove. Pesticides can go through tiny holes.

Footwear

The pesticide label often states that you must wear **chemical-resistant footwear**. If a pesticide is likely to get on your lower legs or feet, wear chemical-resistant boots that come at least halfway up to your knee.

Always wear your pants legs outside your boots. That way, pesticide running down your pants legs does not get into your boots.

It is not possible to clean pesticide residues well from canvas, cloth, and leather. Always wear boots made of chemical-resistant materials if pesticides or pesticide residues might get on your footwear.

Do not wear chemical-resistant gloves, footwear, and other PPE when you **handle some fumigants,** such as methyl bromide. They can trap the gas near your skin, which causes burns. Always follow the label instructions.

Use gloves and footwear correctly

Always use clean gloves and footwear. Don't choose a pair just because they are nearby. They might be contaminated and increase your exposure.

Avoid contaminating the inside of your gloves and footwear. **Be sure to do these things**:

- Wear gloves and footwear that are chemical-resistant to the pesticide you are handling.

- Wear them the right way.
- Check that they are in good condition.
- Clean them and take good care of them.
- Replace them often.

If pesticide gets inside your gloves or footwear, remove them right away. Wash and dry the exposed skin. Then, put on a clean pair.

Keep an extra pair of clean gloves and footwear nearby. That way, you can change the ones you're wearing if you think the inside has become contaminated.

You can contaminate the inside of your gloves if you remove them to adjust equipment, open a pesticide container, or wipe your face, and then put the gloves on again over your contaminated hands. **If you must remove your gloves during a handling task, follow these steps**:

1. Wash your gloves well before you take them off.
2. Wash your hands very well and dry them.
3. Then, put the gloves on again.

Do not put footwear on with contaminated hands. You could transfer the pesticide from your hands to your socks and feet.

Table 7. Label PPE statements for hand and foot protection.

If the label states you must wear this	Then this is the PPE that you may wear
Waterproof gloves	Any rubber or plastic gloves sturdy enough to stay intact throughout the task you are doing.
Chemical-resistant gloves	Barrier-laminate gloves. Other gloves that glove selection charts or guidance documents state are chemical resistant to the pesticide for the length of time you need to do the task.
Chemical-resistant gloves such as butyl or nitrile	Butyl gloves. Nitrile gloves. Other gloves that glove selection charts or guidance documents state are chemical resistant to the pesticide for the length of time you need to do the task.
Shoes	Leather, canvas, or fabric shoes. Chemical-resistant shoes. Chemical-resistant boots. Chemical-resistant shoe coverings (booties).
Chemical-resistant footwear	Chemical-resistant shoes. Chemical-resistant boots. Chemical-resistant shoe coverings (booties).
Chemical-resistant boots	Chemical-resistant boots.

Head and neck protection

Table 8 lists PPE that the label might require for head and neck protection and tells which PPE you may wear in each case.

If you will be exposed to pesticides from above, wear a **chemical-resistant hood** or **wide-brimmed hat**. They help keep pesticides off your head, neck, eyes, mouth, and face. The sweatband should be made of a non-absorbent material.

Some chemical-resistant jackets or coveralls have protective hoods attached to them.

Protect your eyes

Eyes are very sensitive to some pesticide formulations. Some pesticides can cause harm to your eyes that lasts the rest of your life. This is called **permanent eye injury**.

The pesticide labeling might state that you must wear protective eyewear. Be aware that Oregon law might be more strict than federal law. **If** the label states that the pesticide can cause **permanent eye injury**, Oregon law states that you **must** wear **chemical-resistant goggles** or **safety glasses with** a **full-face shield**. Safety glasses or a face shield alone are not enough in this case.

Sometimes the label does not require eye protection. But, it's a good choice to wear shielded safety glasses or full-face shields anyway. They are more comfortable than goggles and they do not fog as readily.

Face shields that are cupped inward toward your throat protect you better from splashes than straight face shields. But, at any time when you will be inside a cloud of spray, mist, or dust, wear **chemical-resistant goggles**. **Full-face respirators** also are a good choice. They have their their own face shield, so you don't need to wear something more to protect your eyes.

Table 8. Label PPE statements for head and neck protection.

If the label states you must wear this	Then this is the PPE that you may wear
Chemical-resistant hood or wide-brimmed hat	Rubber- or plastic-coated safari-style hat. Rubber- or plastic-coated firefighter-style hat. Plastic- or other barrier-coated hood. Rubber or plastic hood. Full hood or helmet that is part of some respirators.
Protective eyewear	Shielded safety glasses. Face shield. Goggles. Full-face style respirator.
Goggles	Goggles. Full-face style respirator.

Protect your respiratory tract

The lungs and other parts of the breathing system are called **the respiratory tract**. The respiratory tract is much more absorbent than the skin.

You must wear a **respirator** when the pesticide labeling directs you to do so. Table 9 (page 73) lists PPE that the label might require for respiratory tract protection and tells which PPE you may wear in each case. The respirator must be one approved by The National Institute for Occupational Safety and Health (NIOSH) or the Mine Safety and Health Administration (MSHA). If the respirator has parts, all the parts must be approved.

Head, eye, and respiratory tract protection.

Even if the label does not require it, wear a respirator in these cases:

- If you are in an enclosed area, and the pesticide you are handling has a statement on the label such as, "Do not breathe vapors or spray mist" or "Harmful or fatal if inhaled"
- If you will be exposed for a long time to pesticide vapors

Some fumigants and a few other pesticide formulations contain additives that have a special odor or are a mild irritant. This is to alert you that you need a respirator or that your respirator is not protecting you. Products contain these warning agents when their active ingredients are highly toxic ones that you would not be able to detect.

Many pesticide handlers do not use respirators the right way. So, they are not protected well. Be sure someone teaches you the correct way to choose, fit, clean and sanitize, inspect, and maintain your respirator.

There are two basic types of respirators:

- **Air-supplying respirators**. These supply air to you from their own source of clean air.
- **Air-purifying respirators**. These remove contaminants from the air around you.

Air-supplying respirators

The pesticide labeling states when you must use an air-supplying respirator. Or, use one when other types of respirators do not give enough protection for the job, such as:

- You are handling pesticides when the oxygen supply is low.
- You are fumigating in enclosed areas, such as greenhouses or other buildings, railcars, ship holds, or grain bins.

Supplied air respirators

These respirators pump clean air from the source through a hose to the face mask. You can work only within the distance the hose can reach from the clean air supply.

Self-contained breathing apparatus

These respirators supply clean air from cylinders that you carry with you, usually on your back. They let you move more freely than you can with a supplied-air respirator. But, they contain a limited air supply. You can use it up even more quickly in hot weather or if you are breathing

hard. Get training from qualified teachers before you use self-contained breathing equipment.

Air-purifying respirators

Most times that you need a respirator, some type of air-purifying respirator is enough protection. Air-purifying respirators do not protect you from fumigants, from very high concentrations of vapor, or when the oxygen supply is low.

Air-purifying respirators remove contaminants from the air in two ways:

- They filter dusts, mists, and particles.
- They remove gases and vapors.

Dust/mist-filtering types

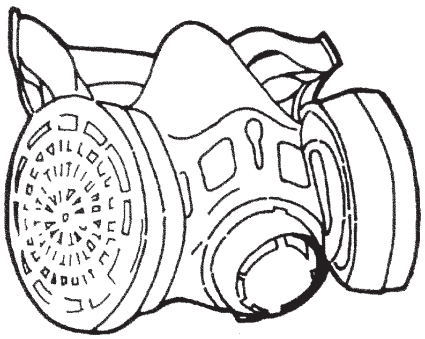
Dust/mist masks usually are shaped filters that cover the nose and mouth. Wear a dust/mist-filtering mask when the pesticide label states that you must. Or, wear one if you will be exposed to pesticide dusts, powders, or mists.

If the label requires dust/mist-filtering masks, **you must wear dust/mist filtering masks or cartridges approved by NIOSH/MSHA**.

Look for a dust/mist mask held in place by two straps. One-strap styles are not approved by NIOSH and MSHA. They do not seal the mask well enough against your face.

Do not wear dust masks when you mix liquids. If there is a splash or spill, or if the liquid turns to vapor, the mask can absorb the pesticide. This increases the chance that pesticide will contact your skin and breathing passage. Do not use a dust/mist mask when it is moist or soaked with pesticide.

Vapor-removing types



Half-face cartridge respirator

Cartridges

Cartridges protect against certain gases and vapors in concentrations up to 0.1 percent by volume. The cartridge contains absorbent materials that purify the air. You must use a **prefilter** with vapor-removing cartridges. The prefilter removes dusts, mists, and other particles before the air passes through the vapor-removing cartridge.

You must use a cartridge approved by NIOSH for organic vapor removal plus a prefilter approved for pesticides.

Canisters

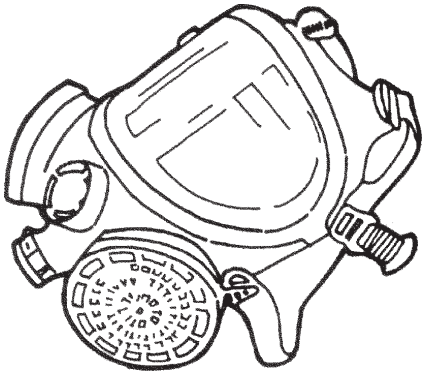
Canisters contain more air-purifying material than cartridges. They last longer and protect against certain gases and vapors in concentrations up to 2 percent by volume. They also give some protection when you fumigate buildings or where oxygen supply is low. Canister-type respirators often are called **gas masks**.

Most kinds of canisters are connected directly to the facepiece. Or, they are worn on a belt and connected to the facepiece by a flexible hose. You can clean and reuse the body of the respirator. You can replace canisters when needed.

You must use a canister approved by NIOSH for pesticides.

Vapor-remover service life

Vapor-removing materials lose their power to absorb more gases and vapors over time. Some vapor-removing materials have a way to let you know the material has nearly reached the end of its service life. This is called a **service-life indicator**. Other materials direct you to replace them after a certain number of hours. If there are no instructions, change the cartridge or canister after 8 hours of use.



Full-face cartridge respirator

Their useful life can vary greatly depending upon these things:

- The amount of particles in the air
- The concentration of the vapor they are filtering
- The amount of absorbent material they contain
- The breathing rate of the wearer
- The temperature and humidity
- The length of time they have been stored before use and between uses

If you notice an odor, taste, irritation, or dizziness, it could be a signal that your respirator is not protecting you.

Air flow

Air-purifying respirators draw air through the filters and absorbent materials in one of two ways.

Most air-purifying respirators depend on your lung power to draw air through the absorbent material with each breath. You need strong lung pressure to draw the air through the purifiers into your lungs. If you have a breathing problem—even something like a cold or allergy—you might not be able to use normal cartridge and canister respirators.

Before you use one of these respirators, have your doctor check you to make sure there is no reason why it might be hard for you to breathe through one. If your respirator is working right, but you still have trouble breathing with it, have your doctor check you for a health problem.

Powered air-purifying respirators (PAPR) assist the wearer by pulling the air through mechanically. Do not confuse powered air-purifying respirators with air-supplying respirators. PAPRs do not supply clean air. They simply clean the air using cartridges or canisters.

Fitting vapor-removing respirators

Respirators either seal tightly to the face or fit loosely.

Face-sealing respirators

Face-sealing respirators must form a tight seal against your face. Full-face styles form and keep a tight seal better than half-face styles.

You cannot wear this style of respirator if you have a beard. The seal cannot be tight enough through the hair.

The respirator must fit your own face. You cannot wear one that fits someone else.

Dust/mist masks are face-sealing respirators. They fit over your nose and mouth. They have a clip that you press around the bridge of your nose to help form a fairly loose seal. Most cartridge and canister respirators are also face-sealing respirators.

Many pesticide handlers pull the cartridge or canister respirator away from their face to get a moment of relief from heat, sweat, itching, or hard breathing. But, this breaks the seal. Once the seal is broken in the

exposure area, the respirator will not protect you well. Face-sealing cartridge and canister respirators are better for short-term tasks.

Fit tests. Conduct a **fit test** before you use your cartridge or canister respirator the first time. Then, test it again every so often. Be sure the fit test is approved by NIOSH/OSHA. In Oregon, ask OR-OSHA, your public health department, or your fire department to help you find an approved fit testing program.

These are the two main types of fit tests:

- Testing whether you can detect a substance by irritation, odor, or taste
- Measuring the amount of test substance that gets inside the facepiece

Fit checks. The **fit check** makes sure the respirator is working right before you use it. Do a fit check each time you use a face-sealing respirator. There are two methods for checking the seal.

Method #1:

1. Cover the inlet of the cartridge or canister with your palm, or squeeze the breathing tube so air cannot pass through.
2. Inhale gently so the facepiece collapses slightly.
3. Hold your breath for about 10 seconds.

If the facepiece remains slightly collapsed and you detect no inward leakage, the respirator probably fits tightly enough and will protect you. This method does not work for dust/mist masks.

Method #2:

1. Close the exhalation valve with your palm.
2. Exhale gently into the facepiece.

If slight pressure builds up inside the facepiece, and you detect no outward leakage, the respirator probably fits tightly enough. Do not use this method on a respirator with an exhalation valve cover that you have to remove first.

Another kind of fit check uses a substance called a **test agent** to test whether you can detect an odor, taste, or irritant. This fit check tests the facepiece seal and also tests whether a vapor-removing cartridge or canister is still working. If you cannot detect the test agent while you are wearing the respirator, it probably is working right.

Most test agents are gases or vapors. They do not work on a dust/mist filtering mask or cartridge.

You can buy test agents from catalogs and dealers that sell many kinds of respirators.

Loose-fitting respirators

Loose-fitting respirators are powered air-purifying respirators. They pump air nonstop through a cartridge or canister into a loose-fitting head covering like a helmet or hood. The constant outward pressure caused by the steady flow of air prevents contaminants from getting into the head-piece.

The purified air circles through the hood and provides some cooling. If you are doing very hard work, use a respirator with an airflow rate of at least 6 cubic feet per minute.

Loose-fitting respirators do not have to form a seal on your face, so people with a beard can use them safely. Though they cost a lot more

money than face-sealing respirators, sometimes loose-fitting respirators are the best choice. They might be best to use at these times:

- If you have breathing problems
- If you will be exposed to pesticides for many hours at a time
- If you are working where heat stress is a concern

PPE for handling fumigants

The poisoning action of fumigants is in the form of a gas. Fumigants are highly toxic to plants and animals. **Use extreme caution and wear the right PPE any time you handle fumigants.**

The personal protective equipment you must wear to protect you from fumigants is not the same as for other types of pesticides. **Carefully follow labeling directions for each fumigant.**

Some fumigants readily go through plastic, rubber, and leather. These fumigants can be trapped **inside** gloves, boots, or tight-fitting coveralls. They can cause severe skin irritation or poisoning through skin absorption. The labeling on these fumigants tells you the right PPE to wear while you handle them.

The labeling often tells you to wear loose-fitting clothes and footwear made of canvas or other fabric. The labeling might tell you not to wear any gloves or to wear cotton or other absorbent gloves.

If you inhale even a small amount of some fumigant gases, it can kill you or cause you severe harm. You **must** wear the respirator listed on the fumigant label. Wear it during any handling task, including removing tarps or other covers, when you could be exposed to the gas.

Never work alone with fumigants. Be sure another handler is checking on you at all times. Be sure that handler has access to the right kind of respirator, in case you need rescue.

If you handle a fumigant indoors or in any enclosed area, use an **air-supplying** respirator. In enclosed places like greenhouses, ship holds, railcars, bins, vaults, and chambers, there may **not** be **enough oxygen** for you. **Cartridge and canister respirators will not protect you** in these cases.

Table 9. Label PPE statements for respiratory tract protection.

If the label states you must wear this:	Then this is the PPE that you may wear:
Dust/mist filtering respirator	Dust/mist mask respirator. Respirator with dust/mist filtering cartridge. Respirator with organic vapor-removing cartridge and pesticide prefilter. Respirator with canister approved for pesticides. Air-supplying respirator.
Cartridge respirator	Respirator with organic vapor-removing cartridge and pesticide prefilter. Respirator with canister approved for pesticides. Air-supplying respirator.
Canister respirator (gas mask)	Respirator with canister approved for pesticides. Air-supplying respirator.
Air-supplying respirator or self-contained breathing apparatus (SCBA)	Air-supplying respirator Self-contained breathing apparatus (SCBA).

Disposable and reusable

Personal protective equipment items either should be thrown away or should be easy to clean and sturdy enough to use again.

Disposables

PPE that you use only once or a couple of times is called **disposable**. Disposable PPE items are not designed to be cleaned and reused. Throw them away once they become contaminated with pesticides.

Chemical-resistant gloves, footwear, and aprons **labeled as disposable** are meant to be worn only once. Then, throw them away. They often are made of thin vinyl, latex, or polyethylene. You can wear them for brief pesticide handling tasks that require flexibility and don't threaten to tear the thin plastic.

Nonwoven (including coated nonwoven) coveralls and hoods usually are meant to be thrown away after use. Most are meant to be worn for only one workday's exposure time. The instructions for some coated nonwoven suits and hoods might permit more than one use if each use time is short and they do not get much pesticide on them. Change them any time you see signs that pesticides are going through the material. Change them if the inside surface is contaminated.

Disposable dust/mist masks, prefilters, canisters, filtering and vapor-removing cartridges, and cartridge respirators cannot be cleaned. Replace them often. If it is hard to breathe through any masks or filters, or if odors pass through a canister, replace them at once with clean ones.

Reusables

Some PPE is meant to be cleaned and reused many times. These items are called **reusable**. But, be sure you do not reuse these items when they no longer protect you.

Rubber and plastic suits, gloves, boots, aprons, capes, and headgear are meant to be cleaned and reused. Wash them very well between uses. Always inspect them carefully for signs of wear or tear.

Dispose of them if they show **any** sign of wear. Even tiny holes or thin places can let pesticides go through and get on your skin. Check for rips and leaks during cleaning by using air or water to form a "balloon." Or, hold the items up to the light.

Chemical-resistant material resists pesticides less and less each time you wear it, and after repeated exposure to pesticides. Even though you do not see any changes in the material, the pesticide could be moving through the material and getting on your skin. Replace footwear, aprons, headgear, and protective suits often and at any sign of wear.

Protect your hands. This is the biggest concern for pesticide handlers. Be sure you replace your gloves often. It's better to spend the money to replace your gloves than to suffer the effects of acute or chronic exposure.

You can clean **fabric coveralls** after each day's use and reuse them. But, you cannot clean absorbent materials such as cotton, polyester,

cotton blends, denim, and canvas well enough if they are drenched or very contaminated with concentrated pesticides labeled with the signal words DANGER or WARNING. **Always** dispose of any such clothing or footwear. You cannot reuse them safely.

Most protective eyewear and respirator bodies, facepieces, and helmets are designed to be cleaned and reused. If you buy good quality and take care of them, they will last a long time.

Take care of your PPE

When you finish handling pesticides, or if you are exposed to them, take off your PPE right away. **Wash the outside of your gloves with detergent and water before you take them off.** Also, wash the outside of other chemical-resistant items before you take them off. This helps you avoid contact with the contaminated surface of the items while you are taking them off. And, it helps you avoid contaminating the inside surface. To reduce contamination even more, grasp gloves just at the edge of the cuff and pull or roll them down over your arm and hand. Use your best judgment to decide whether to throw the PPE away or clean it to use again.

Place the items you want to wash in a plastic bag or hamper away from other clothing. Place disposables in a separate plastic bag or container. Do not let children or pets go near them.

Do not wash contaminated gloves, boots, respirators, or other equipment in streams, ponds, or other bodies of water.

Clean all reusable PPE items between each use. Even if you wore them for only a short time that day, wash them. Pesticide residues that remain on PPE can move slowly through the PPE material, even if it is chemical-resistant. These residues can reach a level that can harm you.

Washing personal protective equipment

Wash contaminated items apart from normal clothes and laundry. Pesticide residues can transfer onto other clothing or laundry and cause harm later.

Remember: Do not wash coveralls or other absorbent clothing that is soaked with highly toxic pesticide concentrate. **Dispose of them.**

Tell the persons who do your laundry

Be sure the people who clean your PPE and other work clothes know they can be harmed by touching the contaminated items. **Be sure they do these things:**

- Wear gloves and an apron if they handle contaminated items often, or if ever they handle items contaminated with highly toxic pesticides.
- Work in an area where there is lots of fresh air, if they can, and avoid inhaling steam from the washer or dryer.

Washing procedure

Follow the manufacturer's instructions for cleaning chemical-resistant items. If the manufacturer instructs you to wash the item but gives no details, follow the steps listed below. Follow the same steps to wash items that are not chemical-resistant, such as cotton, cotton/polyester, denim, canvas, and other absorbent materials.

- **Rinse** once in a washing machine or by hand. Wear gloves if you rinse by hand.
- **Wash only a few items at a time**, so there will be plenty of agitation and water for dilution.
- **Wash in a washing machine**. Use a heavy-duty liquid detergent and hot water for the wash cycle.
- **Rinse twice** after the wash cycle. Use two entire rinse cycles and warm water.
- **Use two wash and rinse cycles** to wash items that have medium to heavy contamination.
- **Run the washer through at least one more entire cycle** without clothes, using detergent and hot water. Do this to clean the machine after each batch of contaminated items, and before you wash any other laundry.

Some chemical-resistant items that are not flat, such as gloves, footwear, and coveralls, must be washed twice. The first wash cleans the outside of the item. For the second wash, turn the item inside out.

Some chemical-resistant items, such as heavy-duty boots and rigid hats or helmets, can be washed by hand with hot water and a heavy-duty liquid detergent.

See "Drying procedure," below, for how to dry and air PPE after you wash it.

Drying procedure

Hang items to dry, if you can. It is best to let them hang for at least 24 hours in an area with plenty of fresh air and sunlight. Even after you wash them well, some items still might contain pesticides. When the items are exposed to clean air, the pesticide residues move to the surface and evaporate or degrade in the sunlight.

It's a good idea to buy two or more sets of equipment. Then, you can leave one set airing in a clean place while you use the other set.

Do not hang items in enclosed living areas. Pesticides that remain in the items can evaporate and expose people or animals.

You can use a clothes dryer for fabric items, if you don't have a place to hang them to dry. But, over time, the dryer can become contaminated with pesticide residues.

Cleaning eyewear and respirators

Wash goggles, face shields, shielded safety glasses, and respirator bodies and facepieces each day after you use them.

1. Use detergent and hot water to wash them well.
2. Sanitize them by soaking them for at least 2 minutes in a mixture of 2 tablespoons of chlorine bleach in 1 gallon of hot water.

3. Rinse them very well to remove the detergent and bleach.
4. Dry them well with a paper or cloth towel or hang them in a clean area to dry.

It is most important to take good care of your respirator. Inspect your respirator before each use. Repair or replace any part that shows sign of wear. If you keep a respirator for standby or emergency use, inspect it at least once a month and before you use it.

At the end of any workday when you wear a reusable respirator, do these things:

- Remove the filters and cartridges or canisters. Dispose of them. Or, if you still can use them, wipe them with a clean cloth, replace filters and caps, and seal them in an airtight container.
- Clean and dry the respirator as directed above. As soon as you clean and dry your respirator, **seal it in a sturdy, airtight container**. A zip-close plastic bag works well.

Store respirators and eyewear in a place where they are protected from dust, sunlight, extreme temperatures, too much moisture, and chemicals. If you don't, you'll have to replace the disposable parts more often. Cartridges, canisters, prefilters, and filters collect dirt as long as they are exposed to the air.

Discard disposable respirators as the manufacturer instructs you. Do not try to clean them.

Questions for study—Chapter 5

1. What legal responsibility do you have for wearing the personal protective equipment that the pesticide labeling lists for your handling task?
2. How can you tell when a material is not chemical-resistant to the pesticide you are handling?
3. When should you wear chemical-resistant gloves? Why are gloves so important to a pesticide handler?
4. If you need to remove your gloves during a handling task, what is the best way to remove them and put them back on?
5. When should you wear protective headgear? What type of headgear should you use?
6. When the pesticide labeling states that you must use protective eyewear, what should you wear?
7. What are the differences among dust/mist-filtering respirators, vapor-removing respirators, and air-supplying respirators?
8. What special hazards do fumigants pose for pesticide handlers?
9. What should you do with a coverall that has highly toxic pesticide concentrate spilled on it?
10. What should you tell the people who wash your clothing about how to protect themselves from pesticides?

11. What should you do when you are finished using your respirator for the day?
12. How do you know when to replace dust/mist masks, prefilters, and vapor-removing canisters and cartridges?
13. How should you clean your washing machine after washing contaminated clothing?

Chapter 6

Symptoms of Pesticide Poisoning

If you know the early signs and symptoms of pesticide poisoning, you could save yourself or your co-workers from serious harm.

To learn more about effects of specific products, see Appendix A.

Goals of this chapter

- Describe some basic signs and symptoms of pesticide poisoning.
- Describe the action and acute systemic effects (and other effects) of different kinds of pesticides.

Signs and symptoms

There are two kinds of clues to illness or harm caused by pesticides.

1. There are feelings that only the person who has been poisoned can notice. These are called **symptoms**. Symptoms could be nausea or headache.
2. There are clues that people can see. These are called **signs**. Signs could be vomiting, fainting, or the pupils of the eyes being very small ("pinpoint pupils").

Know what your own symptoms might mean. Know what the signs of poisoning are in others who might have been exposed.

Many signs and symptoms of pesticide poisoning are like signs and symptoms of flu or even a hangover. **If you have been working with pesticides and then start to have signs and symptoms that could be from poisoning, call your doctor or the Oregon Poison Center.**

Oregon Poison Center
Telephone: 800-222-1222

External irritant and allergy

The most common effect of exposure to pesticides is red, swollen, painful skin. This is called **contact dermatitis**.

There are two types of contact dermatitis. One occurs when the pesticide is an **irritant** to the skin. The signs and symptoms of irritants are:

- The skin is red and feels like it is burning.
- The skin breaks out in pimples and blisters.
- Signs and symptoms occur within minutes to hours.

The other type of contact dermatitis is **allergy** to the pesticide. The signs and symptoms of an allergic response are:

- The skin is red and breaks out in blisters, hives, and weeping sores.
- The skin feels very itchy.

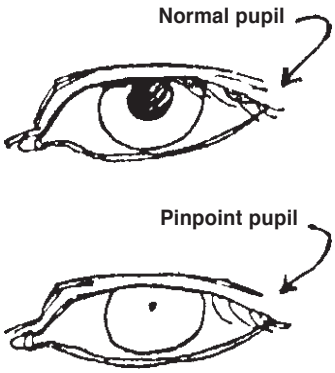
- With one kind of allergy, skin exposed to sunlight breaks out in a rash. This is called **photosensitive dermatitis**.
- Signs and symptoms occur within hours to days.

Pesticide poisoning

The signs and symptoms of pesticide poisoning vary depending on the pesticide, its dose, and the time since exposure. This makes it hard to describe signs and symptoms that could occur in any one case. But, some of the more common signs and symptoms of pesticide poisoning are:

- Nausea, vomiting, diarrhea, and/or stomach cramps
- Headache, dizziness, weakness, and/or confusion
- Heavy sweating
- Chest pains
- Trouble breathing
- Cramps in your muscles or aches all over your body

Telltale signs or symptoms



A change in pupil size is a sign of poisoning.

Pesticides in certain chemical families cause certain signs of poisoning. If you know the signs, it might help you know the kind of pesticide poisoning. For example, organophosphate and n-methyl carbamate poisoning causes pinpoint pupils in the victim's eyes. Someone poisoned by pesticides that have arsenic or phosphorus in them often has a garlic odor on his or her breath.

Be informed

For some pesticides, signs and symptom of poisoning are very like those of other kinds of sickness and poisoning. Many doctors have not been trained to know and treat pesticide poisoning or harm. They might not see such cases very often. **Know the harmful effects that the pesticides you use can cause.** Being able to tell the signs and symptoms of pesticide poisoning could be crucial for you and your co-workers.

Table 10 lists selected groups of pesticides. (It is not possible to list all the groups of pesticides here.) For each group, it tells these things:

- The action of the poison on the human system
- Acute poisoning (systemic) effects and other effects
- Type of pesticide

If you cannot tell if poisoning has occurred, let your doctor decide.

Questions for study—Chapter 6

1. What is a **symptom** (of pesticide poisoning)? What is a **sign** (of pesticide poisoning)?
2. Are the signs and symptoms of pesticide poisoning very different from the symptoms of other kinds of sickness?
3. Are the signs and symptoms for all cases of pesticide poisoning the same?
4. Name four signs or symptoms of pesticide poisoning. Name two signs or symptoms of a pesticide irritant.
5. Who should you call if you suspect that you (or a co-worker) have been poisoned by pesticides?

Table 10. Effects of pesticides on the human body.

Chemical	Action on human system	Acute systemic effects and other effects	Type of pesticide
1. organophosphates	Inhibit acetylcholinesterase enzyme in tissues	Headache, dizziness, nausea, muscle twitching, weakness, stomach cramps, diarrhea, vomiting, sweating, salivation, difficulty breathing, blurred vision, convulsions, potential loss of consciousness	Insecticides Acaricides
2. n-methyl carbamates	Inhibit acetylcholinesterase enzyme in tissues	Muscle weakness, dizziness, sweating, muscle twitching, nausea, stomach cramps, diarrhea	Insecticides Acaricides
3. organochlorines (chlorinated hydrocarbons)	Increased activity of nervous system	Increased skin sensitivity; headache, dizziness, weakness, muscle twitching, nausea, vomiting, excitability, disorientation, convulsions	Insecticides Acaricides
4. pyrethrum and pyrethrins	Allergen	Contact dermatitis and allergic respiratory reactions	Insecticides Acaricides
5. nicotine	Damages nervous system	Salivation, nausea, vomiting, diarrhea; headache, dizziness, shaking, abdominal pain, burning sensation in mouth and throat, confusion, weakness, loss of coordination, sweating; respiratory failure	Insecticide
6. rotenone	Irritant	Numbness of mucous membranes, dermatitis, respiratory tract irritation	Insecticides Acaricides Piscicide
7. *Bacillus thuringiensis*	Not known	Possible eye irritation; abdominal cramps, vomiting, diarrhea if ingested	Insecticides
8. gibberellic acid	Not known	None	Growth regulator
9. pyrethroids	Irritant	Upon contact with skin, burning and/or stinging sensation progressing to numbness; allergic respiratory reaction; dizziness, headache, fatigue, vomiting, diarrhea, salivation	Insecticides
10. fluorides	Enzyme inhibitors; corrosive to GI tract	Thirst, abdominal pain, vomiting, diarrhea; headache, weakness, salivation, dilated pupils, lethargy	Insecticides
11. boric acid	Irritant; affects mainly the stomach, intestines, blood system, and brain	Nausea, vomiting, abdominal pain, diarrhea, blood in vomit and feces; headache, weakness, tremors, restlessness; beefy red rash on palms, feet, buttocks, and scrotum	Insecticide
12. chlordimeform	Inflammation of the walls of the bladder	Blood in urine, frequent and painful urination; abdominal and back pain; hot sensation, sleepiness, skin rash, peeling skin, sweet taste, anorexia	Insecticide Miticide
13. propargite	Irritant; skin sensitizer	Dermatitis; eye irritation	Acaricide
14. diflubenzuron, teflubenzuron	Not known	Possible skin irritation	Insecticides
15. chlorobenzilate	Irritant	Skin and eye irritation; may cause tremors with extreme absorption dose	Acaricide
16. methoprene	Not known	Minimal	Insecticide
17. sulfur	Irritant	Skin, eye, and respiratory tract irritant	Acaricide Fungicide

Table 10. Effects of pesticides on the human body (continued).

Chemical	Action on human system	Acute systemic effects and other effects	Type of pesticide
18. diethyltoluamide (DEET)	Irritant	Low systemic toxicity; contact dermatitis, blistered skin, eye irritation, headache, restlessness, hypotension, irritability; suspect epileptic seizures	Insect repellents
19. alkyl phthalates	Irritant	Low systemic toxicity; irritation of the eyes and mucous membranes; gastrointestinal irritation and central nervous system depression at high ingestion rates	Insect repellents
20. benzyl benzoate	Irritant	Low systemic toxicity; occasional skin irritation	Acaricide
21. arsenicals	Damages liver, kidneys, GI tract, and nervous system; causes skin changes	Garlic odor of breath and feces, metallic taste in mouth, vomiting and bloody diarrhea; headache, dizziness, drowsiness, confusion; hyperpigmentation; muscle weakness, spasms; hypothermia, lethargy, delirium, coma, convulsion; glycosuria; shock, cyanosis, cardiac arrhythmia; jaundice	Rodenticides Insecticides Acaricides Marine antifouling compounds Desiccants Herbicides Fungicides
22. chlorophenoxy compounds	Irritant; suppresses central and peripheral nervous system. Many cause skin to discolor and damage to muscles, GI tract, liver, and kidneys.	Moderately irritating to skin, eyes, respiratory system, and GI tract; vomiting, chest pain, diarrhea, muscle weakness, headache, confusion, bizarre or aggressive behavior, peculiar odor on breath	Herbicides
23. nitrophenolic and nitrocresolic pesticides	Stimulates oxidative metabolism in cell mitochondria; damages hepatic, renal, and nervous systems	Profuse sweating, thirst, fever, headache, malaise, restlessness, apprehension, anxiety, manic behavior, tachycardia, seizures, coma; jaundice; stains skin bright yellow with contact	Herbicides
24. pentachlorophenol	Irritant to mucous membranes and skin; increases cellular oxidative metabolism rate, damages liver, kidney, and renal system	Irritation of the nose, throat, and eyes, tearing, stuffy nose; contact dermatitis; profuse sweating, nausea, weakness, dizziness; rapid breathing, intense thirst, vomiting, restlessness. Increased body temperature, muscle spasms, labored breathing, and chest tightness indicate serious poisoning.	Now registered only as a wood preservative. Formerly used in: Herbicides Defoliants Molluscicides Germicides Fungicides
25. paraquat and diquat	Corrosives; damage skin, nails, cornea, liver, kidneys, linings of stomach and intestine, and heart. **paraquat**—severe delayed damage to lungs **diquat**—damage to liver, renal, and central nervous systems	**paraquat**—burning pain in mouth, throat, and upper chest due to corrosive effect; dry, broken, blistered, and ulcerated skin; ridging or loss of fingernails **paraquat** and **diquat**—nausea, vomiting, diarrhea, giddiness, fever, burning pain in mouth, throat, stomach, and intestine. Diquat has more neurotoxicity, i.e., nervousness, irritability, restlessness, disorientation, seizures, coma.	Herbicides

Table 10. Effects of pesticides on the human body (continued).

Chemical	Action on human system	Acute systemic effects and other effects	Type of pesticide
26. acetamides	Irritant	Irritation of the skin and eyes	Herbicides
27. anilides	Irritant	Dermal irritation and sensitization; irritation of skin, eyes, and respiratory tract	Herbicides
28. aliphatic acids	Irritant	Irritation of skin, eyes, and respiratory tract	Herbicides
29. benzamide	Irritant	Moderate irritation of the eyes	Herbicides
30. benzoic acid and anisic acid derivatives	Irritant	Moderate irritation of skin and respiratory tract	Herbicides
31. benzonitriles	Irritant	Minimal irritation	Herbicides
32. benzothiadiazinone dioxide	Irritant	Irritation of eyes and respiratory tract	Herbicide
33. carbamates and thiocarbamates	Irritant; allergen. In water, metam-sodium forms methyl isothiocyanate, a gas that is extremely irritating to the respiratory system	Nausea, vomiting, diarrhea, weakness, skin rash, alcohol intolerance, irritation of eyes, skin, and respiratory tract. Interaction between alcoholic drinks and thiram can cause hyperactivity, loss of muscle tone, dyspnea, and convulsions.	Herbicides Fungicides
34. carbanilate	Irritant	Irritation of skin	Herbicides
35. chloropyridinyl	Irritant	Irritation of skin and eyes	Herbicides
36. cyclohexenone derivative	Irritant	Irritation of skin and eyes	Solvent
37. dinitroaminobenzene derivatives	Irritant	Moderate irritation of skin and eyes	Herbicides
38. fluorodinitrotoluidine compounds	Irritant	Mild irritation of skin and eyes	Herbicides
39. isoxazolidinone	Irritant	Moderate skin and eye irritation	Herbicides
40. nicotinic acid isopropylamine derivative	Irritant	Irritation of eyes and skin	Herbicides
41. oxadiazolinone	Minimal irritant	Irritation of eyes and skin	Herbicides
42. phosphonates	Irritant	Irritation of eyes, skin, and upper respiratory tract	Herbicides
43. phthalates (except endothall)	Irritant	Moderate irritation of eyes	Herbicides
44. endothall	Corrosive to GI tract; depresses cardiovas-cular system	Convulsions, shock, respiratory depression, severe burning of stomach and intestine	Herbicide Algicide
45. picolinic acid compounds	Irritant	Irritation of skin, eyes, and respiratory tract	Herbicides
46. triazines	Irritant	Low systemic toxicity; may be moderately irritating to skin, eyes, and respiratory tract	Herbicides

Table 10. Effects of pesticides on the human body (continued).

Chemical	Action on human system	Acute systemic effects and other effects	Type of pesticide
47. triazole	Slight irritant	Minimal	Herbicides
48. uracils	Irritant	Irritation of skin, eyes, and respiratory tract	Herbicides
49. urea derivatives	Irritant	Irritation of eyes, skin, and mucous membranes	Herbicides
50. thiophthalimides	Irritant	Low systematic toxicity; irritation of skin, eyes, and respiratory tract; contact dermatitis	Fungicides
51. copper	Irritant to skin, respiratory tract; corrosive to the eyes; damages liver and brain	Metallic taste in mouth; nausea, vomiting; burning pain in mouth, esophagus, and stomach; diarrhea; headache, sweating, weakness; skin, eyes, and respiratory tract irritation	Fungicides
52. organomercuric compounds	Damages nervous system, liver, and brain	Metallic taste in mouth, numbness in fingers and face, headache, fatigue, difficulty thinking; incoordination, slurred speech, hearing loss, delirium; changes in vision	Fungicides
53. organotin	Irritant; damages brain	Irritation of eyes, skin, and respiratory tract; headache, vomiting, dizziness, convulsions, stomach pain; extreme sensitivity to light; mental disturbance	Fungicides Antifouling paints
54. cadmium	Very irritating to respiratory and gastrointestinal tracts; damages renal system	Severe irritation of the respiratory tract; headache, fever, cough, labored breathing, chest pain; nausea, vomiting, diarrhea, abdominal pain; jaundice	Fungicides
55. anilazine	Irritant	Skin irritant; low systemic toxicity	Fungicides
56. cycloheximide	Not known	Low systemic toxicity	Fungicides
57. dodine	Irritant	Low systemic toxicity, irritation of the skin, eyes, and GI tract	Fungicides
58. iprodione, metalaxyl, terrazole, thiabendazole, triadimefon, triforine	Slight irritant	Irritation of the eyes and skin; dizziness, nausea, vomiting, stomachache; lethargy, fever, chills, rash, local edema	Fungicides
59. coumarins, indandiones, and other anticoagulants	Prevents blood from clotting	Bruising, bloody stools, nosebleeds, bleeding gums, blood in urine	Rodenticides
60. yellow phosphorus; also known as white phosphorus	Corrosive; highly toxic to skin and gut; damages liver	Burning pain in throat, chest, abdomen; vomiting, diarrhea; lethargy, restlessness, irritability. May impart a garlic odor to vomitus, feces, and sometimes breath. Symptoms may reoccur following a symptom-free period.	Rodenticides
61. zinc phosphide	Highly toxic, corrosive to the respiratory tract; damages liver and kidneys	Intense nausea, stomach pain, excitement, chills, cough. May impart a foul rotten-fish odor to vomitus, feces, and sometimes breath.	Rodenticides
62. thallium sulfate	Damages nervous system, lungs, heart, blood vessels, kidney, liver; may damage GI tract	Stomach pain, nausea, vomiting diarrhea, salivation; headache, lethargy, tremors, muscle weakness; convulsions, delirium, coma; fever	Rodenticides

Table 10. Effects of pesticides on the human body (continued).

Chemical	Action on human system	Acute systemic effects and other effects	Type of pesticide
63. sodium fluoroacetate	Extremely toxic, disrupts energy metabolism	Irregular heart beat; muscle and joint stiffness; spasms, convulsions, seizures	Rodenticides
64. strychnine and crimidine	Acts directly on cells in the brain and spinal cord	Severe muscle spasms, violent convulsions, seizures, depression of pulmonary/respiratory functions	Rodenticides
65. cholecalciferol	Damages liver, kidneys, and lining of the heart	Weakness, fatigue, headache, nausea; excess thirst and urination	Rodenticides
66. naphthalene	Irritant to the eyes and upper respiratory tract	Irritates eyes and respiratory tract; headache, dizziness, nausea, vomiting; red blood cell damage	Rodenticides
67. methylene chloride	Depresses central nervous system	Fatigue, weakness, drowsiness; damage to the GI tract, liver, and kidneys	Fumigants
68. methyl bromide	Corrosive; depresses central nervous system; serious damage to lungs	Disorientation; headache, dizziness, nausea, vomiting; coughing of frothy fluid, severe shortness of breath; drowsiness, shaking, weakness; causes severe burns, itching, and blisters on skin	Fumigants
69. chloroform, carbon tetra-chloride	Irritant; depresses central nervous system; damages liver and kidneys	Dizziness, loss of sensation and motor power, unconsciousness	Fumigants
70. ethylene dibromide	Severe irritant; corrosive to the eyes; depresses central nervous system	Blistering and erosion of skin; dizziness, headache, fatigue, cough; abdominal pain, damage to the GI tract, liver, and kidneys. Long-term exposure may damage testicular tissue.	Fumigants
71. dibromochloro-propane	Severe irritant; damages liver and kidneys	Irritation of skin, eyes, and respiratory tract; headache, nausea, vomiting; slurred speech, confusion, shortness of breath	Fumigants
72. dichloropropene, dichloropropane	Strong irritant; damages liver, kidneys, and heart tissue	Breathing spasms; severe irritation of skin, eyes, and respiratory tract	Fumigants
73. paradichloro-benzene	Mild irritant	Low systemic toxicity; mildly irritating to nose and eyes	Fumigants
74. ethylene oxide, propylene oxide	Irritant to all tissues contacted; damages lungs and heart	Blistering and erosion of skin; headache, nausea, vomiting, weakness; cough of frothy, bloody fluid	Fumigants
75. formaldehyde, paraformaldehyde	Irritant; damages kidneys, blood systems, and lining of stomach and intestine	Asthma and dermatitis; irritation of eyes and respiratory tract; hardens and roughens skin; abdominal pain	Fumigants
76. acrolein	Irritant; damages lungs, kidneys, blood systems, and lining of stomach and intestine	Asthma; severe eye and respiratory tract irritation, tearing; blisters on skin	Fumigants Herbicides
77. sulfur dioxide	Strong irritant to lungs and throat	Respiratory distress; severe irritation of eyes; asthma	Fumigants

Table 10. Effects of pesticides on the human body (continued).

Chemical	Action on human system	Acute systemic effects and other effects	Type of pesticide
78. chloropicrin	Irritant	Severe irritation of eyes, skin, and respiratory tract; vomiting, abdominal pain; tearing	Fumigants
79. sulfuryl fluoride	Damages lungs and kidneys	Irritation of eyes, nose, and throat; weakness, nausea, vomiting, cough, muscle twitching, convulsions, seizures	Fumigants
80. carbon disulfide	Irritant; damages central nervous system; delayed damage to kidneys and liver	Irritates eyes, nose, and throat; dizziness, headache, nausea, disorientation; coma	Fumigants
81. phosphine	Slight irritant; damages lungs, liver, kidneys, heart, and nervous system	Mildly irritating to respiratory tract; nausea, vomiting, fatigue, dizziness, weakness, shaking, cough, difficulty breathing, intense thirst	Fumigants
82. hydrogen cyanide, acrylonitrile	Inhibits energy metabolism	Headache, nausea, constriction of throat, dizziness, nervousness, sudden unconsciousness. Kills mammals quickly.	Fumigants Rodenticides
83. metaldehyde	Not known, but affects acid/base balance	Salivation, cramps, vomiting, tremors	Molluscicides
84. aminopyridine	Stimulates central nervous system	Thirst, nausea, dizziness, weakness, excessive sweating	Avicides
85. calcium cyanamide	Irritant	Severe irritation of skin and caustic to skin; flushing, headache, low blood pressure, difficulty breathing, shock	Fungicides Herbicides
86. sodium chlorate	Irritant	Nausea, abdominal pain, diarrhea, dark urine. Symptoms sometimes are delayed as much as 12 hours.	Herbicides Defoliants
87. creosote	Irritant	Severe irritation of skin, eyes, and mucous membranes; salivation, vomiting, abdominal pain; headache, dizziness, chills, convulsions	Wood preservatives Insecticides Disinfectants
88. hexachloro-benzene	Slight irritant; interferes with the synthesis of blood	Reduced hemoglobin in blood. Red-tinged urine; lesions on skin exposed to light; loss of appetite	Fungicides
89. pentachloro-nitrobenzene	Not known	Low systemic toxicity	Fungicides
90. chlorothalonil	Irritant	Irritation of the skin and mucous membranes of the eye and respiratory tract	Fungicides
91. chloroneb	Irritant	Moderate irritation of skin and mucous membranes	Fungicides
92. benomyl	Not known	Low systemic toxicity	Fungicides
93. dicloran	Irritant	Dermatitis, corneal damage; possible liver damage at very high dose.	Fungicides

Chapter 7

First Aid for Pesticide Handlers

Goals of this chapter

- Describe the right first aid to use for pesticide exposures.
- Define and describe heat stress.
- Describe the right first aid for heat stress.
- Describe a pesticide first aid kit and why you must have one.
- Explain how to get the facts quickly on types of poisonings and their treatment.
- Give a checklist for preventing pesticide accidents.

How to respond to a poisoning emergency

If you or any of your fellow workers have strange symptoms at work or later the same day, call the Oregon Poison Center or a doctor to get advice. Do not let yourself or anyone else become very sick before you decide to call your doctor or to go to a hospital. **It is better to be too cautious than too late.**

Always try to know which pesticide(s) you are using in case of exposure. Take the pesticide container (or the labeling) to the doctor. Do not carry the pesticide container in the passenger space of a car or truck.

First aid for pesticide poisoning

While you wait for medical help, there are things you can do first to help the victim. This is called **first aid**.

The best first aid in pesticide emergencies is:

1. **Get rid of the source of pesticide exposure as quickly as you can.** Remove contaminated clothes and wash the skin.
2. **Prevent the pesticide from being absorbed by the victim's body.** Do this either by washing with water, inducing vomiting if the label instructs you to do so, or adsorbing the chemical with activated charcoal.
3. If you can, call the Oregon Poison Center (1-800-222-1222) or a doctor. Tell them what pesticide is involved. This is important so the doctor can decide the best treatment for the case. Ask the poison control center or doctor if you should give the victim activated charcoal or do

anything else. You can get high-potency activated charcoal from a drug store. It adsorbs many poisons at a high rate. Mix it with water into a thick syrup for the victim to drink. Fullers earth is a kind of activated charcoal. Be sure the victim is not still exposed to the pesticide before you call for help.

Apply artificial respiration if the victim is not breathing. **Do not become exposed to the pesticide yourself while you are trying to help.**

Look at the pesticide labeling, if you can. Follow first aid instructions carefully. If you do not have label instructions, follow the basic guidelines described below.

Pesticide on skin

- Remove personal protective equipment and contaminated clothes.
- Wash skin and clothes with plenty of water. Use any source of clean water. If you can, immerse the person in a pond, creek, or other body of water. Even water in ditches or irrigation systems will do, unless you think they might have pesticides in them.
- Wash skin and hair very well with a mild liquid detergent and water. If there is a shower, it is the best way to wash and rinse the entire body surface very well.
- Dry the victim and wrap her or him in a blanket or any clean clothes at hand. Do not allow the victim to become chilled or overheated.
- If skin is burned or otherwise hurt, cover it right away with a loose, clean, dry, soft cloth or bandage.
- Do not apply ointment, grease, powder, or any other drugs in first aid treatment of burns or injured skin.

Warning: Do not allow any pesticide to get on you while you are helping the victim. Do not inhale fumes.

Pesticide in the eye

Place the water so it flows across the eye rather than directly into the eye.

- Wash the eye quickly but gently.
- Use an eyewash dispenser, if there is one. If there isn't one, hold the eyelid open and wash the eye with a gentle stream of clean running water. Place the water so it flows across the eye rather than directly into the eye. You might have to use a cup for water if you don't have a hose.
- Rinse the eye for 15 minutes or more.
- Do not use chemicals or drugs in the rinse water. They could increase the harm.

Inhaled pesticide

- Get the victim to fresh air right away. If the person is in an enclosed place, put on a respirator before you enter to rescue them.
- Loosen tight clothes on the victim that could constrict breathing.
- If breathing has stopped, or if the victim's skin is blue, apply artificial respiration. If pesticide or vomit is on the victim's mouth or face, clean it. Avoid direct contact with the victim. If you have one, use a shaped airway tube for mouth-to-mouth resuscitation.
- If other people are in or near the area, warn them of the danger.

Pesticide in the mouth or swallowed

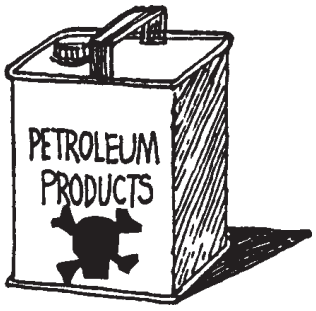
- Rinse the mouth with plenty of water.
- Induce vomiting or give the victim activated charcoal **only if the label instructs you to do so, or if a doctor or the Oregon Poison Center tells you to do so.**

When *not* to induce vomiting

When you help a person who has swallowed a pesticide, the most important choice you have to make is whether to cause him or her to throw up. This is called to **induce vomiting**. You must decide quickly and make the right choice. The victim's life might depend on it.

Most of the time, it is best to get rid of the swallowed poison quickly. But, **do NOT induce vomiting under any of these conditions**:

- The label says not to.
- The victim is unconscious or is having convulsions.
- The victim has swallowed a corrosive poison. A **corrosive poison** is a strong acid or alkali that burns the throat and mouth as badly coming up as it did going down. It could get into the lungs and burn there, too, or cause a type of pneumonia.
- The victim has swallowed an emulsifiable concentrate or oil solution. Emulsifiable concentrates and oil solutions can cause death if the victim inhales them while vomiting.



Do **not** induce vomiting!

How to induce vomiting

- Place the victim face down or kneeling forward. Do not let the victim lie face up, because the vomit could get into the lungs and do more damage.
- Put your finger or the blunt end of a spoon at the back of the victim's throat.
- Do not use salt solutions to induce vomiting.
- Collect some of the vomit for the doctor, who might need it for chemical tests.

Take the victim to the hospital

It is very important to get the victim to the hospital as fast as you can. Many towns have rescue units with ambulances staffed by Emergency Medical Technicians (EMTs). They can speak with the hospital and can start treatment on the way.

If there is no rescue unit in your area, transport the victim yourself. Call the hospital emergency room or the Oregon Poison Center for instructions. Alert them so they can prepare for the victim's arrival.

Atropine

Caution: Do not give a victim atropine tablets in a poisoning emergency. Often the victim cannot or should not swallow medicine. Also, atropine can hide or delay the early symptoms of poisoning. This fools the victim into thinking there is no problem. It can even hide the poisoning symptoms so a doctor cannot detect the poisoning.

Also, **atropine itself can be poisonous if misused.** NEVER give atropine to try to prevent poisoning.

Do NOT carry atropine for first aid. It should be given only under a doctor's direction.

Poison centers

Poison centers (formerly called Poison Control Centers) give facts and help for all types of poisonings. **Be sure you have the phone number of the Oregon Poison Center and a doctor's phone number posted near the telephone. Ask your doctor to keep the Oregon Poison Center's phone number, too.**

Oregon Poison Center
Telephone: 800-222-1222

In any poisoning emergency, think of WATER to prevent absorption. No matter where it is, your first aim is to remove or absorb the pesticide. Then, get the victim to a doctor fast.

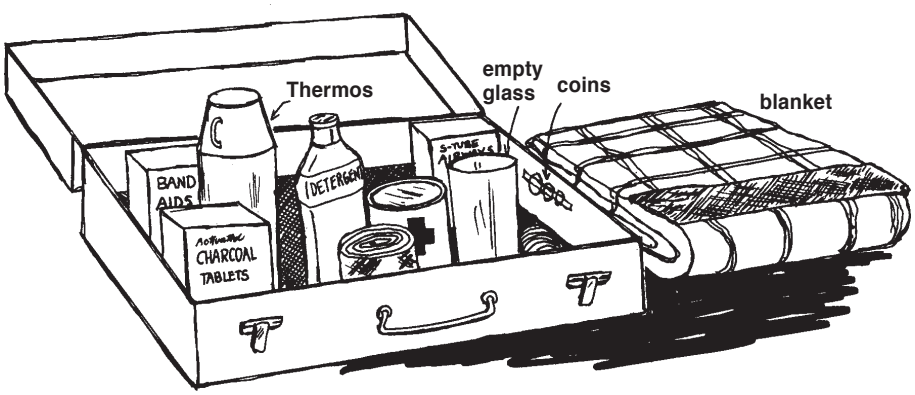
First-aid kit for field and on-the-job use

Be sure to keep a well-equipped first-aid kit always at hand. It is very important in a pesticide emergency.

You can make your own pesticide first-aid kit from a lunch pail, tool box, or a sturdy wooden box. It should have a tight-fitting cover with a latch, so it won't fall open or let pesticides leak inside. Label it clearly with paint or a marker that doesn't wash off with water.

Keep these things in your first aid kit:

- ❑ A small bottle of liquid **detergent.** You can use it to wash pesticides off the skin quickly.
- ❑ A small package of **high-potency activated charcoal.** Mix it with water and give it to the victim to swallow. High-potency activated charcoal adsorbs most pesticides.
- ❑ **A shaped plastic airway** for mouth-to-mouth resuscitation.
- ❑ A Thermos or large plastic bottle (at least 1 quart) of **clean water.** If there is no clean water in an emergency, use any pond or stream water that is there.
- ❑ An **eyewash bottle**, filled with clean water. (Replace the water every 2 or 3 months to be sure it is fresh.)
- ❑ **Bandages** and **tape.** Cover all cuts and scrapes to prevent pesticides from getting into the body easily.
- ❑ A **blanket**. Keep it in a place where it will not be contaminated by pesticides.
- ❑ Always keep **coins** taped to the inside cover of the first aid kit. You can use them to make an emergency phone call.
- ❑ A small **jar** with a lid that fits tight. You can use it as a drinking glass or to feed the victim high-potency activated charcoal. You also can use it to collect vomit to take to the doctor.



First-aid kit.

Heat stress

If your body is subjected to more heat than it can cope with, you will get sick. This sickness is called **heat stress**.

Heat stress is not caused by exposure to pesticides. But, it can affect pesticide handlers who work in hot conditions. Personal protective equipment can increase the risk of heat stress, because it makes it harder for the body to cool down.

If you are under a doctor's care, consult your doctor before you work in hot conditions.

Signs and symptoms of heat stress

Mild forms of heat stress also are called **heat exhaustion**. They make you feel ill. They make it hard for you to work well. You might get tired sooner, feel weak, be less alert, and be less able to use good judgment.

Severe heat stress is called **heat stroke**. It is a serious illness. Victims can die if they are not cooled down quickly. Severe heat stress is fatal to more than 10 percent of its victims—even young, healthy adults.

Many who do survive suffer damage for the rest of their lives. Sometimes victims are very sensitive to heat for months. They cannot return to the same work.

Learn the signs and symptoms of heat stress. Cool down fast if you feel you might have even mild heat stress. Signs and symptoms might include these things:

- Fatigue (exhaustion, muscle weakness)
- Headache, nausea, and chills
- Dizziness and faintness
- Severe thirst and dry mouth
- Clammy skin or hot, dry skin
- Heavy sweating or no sweat at all
- Change in behavior (confusion, slurred speech, arguing, or not making sense)

First aid for heat stress

It is not always easy to tell the difference between heat stress and pesticide poisoning. The signs and symptoms are alike. Don't waste time trying to decide what is causing the illness. Call a doctor.

Give first aid to a victim of heat stress by doing these things:

- Get the victim into a shaded or cool place.
- Cool the victim as fast as you can by sponging or splashing the skin with cool water. Be sure to cool the face, neck, hands, and forearms. When you can, immerse the victim in cool water.
- Carefully remove all personal protective equipment and any other clothes that could be making the victim too warm.
- If the victim is conscious, have him or her drink as much cool water as he or she can.
- Keep the victim quiet until help arrives.

Severe heat stress or heat stroke is a medical emergency! Brain damage and death can result if treatment is delayed.

Heat cramps

Heat cramps are muscle spasms in the legs, arms, or stomach. They are caused by loss of body salt through heavy sweating. They can be quite painful.

To relieve cramps, have the victim drink lightly salted water or "sports drinks" (store-bought drinks made with special salts). Stretching or kneading the muscles might relieve the cramps for a short time.

If you think that stomach cramps could be caused by pesticides rather than heat stress, call a doctor right away.

Shock

Sometimes poisoning victims go into shock. If you do not take care of the shock symptoms, the victim can die even if the poisoning would not have been fatal.

Signs and symptoms of shock

- The skin is pale, moist, cold, and clammy.
- The eyes are empty and dull, with large pupils.
- Breathing is shallow and uneven.
- The pulse is weak, rapid, and uneven.
- The victim might be in a faint.

If the victim is not vomiting, keep him or her flat on the back with the legs raised 1 to 1½ feet above the head.

Do these things to help a person who is in shock:

- Keep the victim flat on her or his back with the legs raised 1 to 1½ feet above the head. Do not do this if the victim is vomiting.
- Keep the victim warm enough so he or she does not shiver. Do not make the victim too warm.
- Keep the victim quiet. Reassure her or him often.

Warning: Never try to get a victim to swallow anything if she or he is unconscious.

Prevent pesticide accidents

All of us can improve our methods for safe handling of pesticides.

Pesticide handlers who have a lot of practice can get to know their equipment and materials very well. It is easy to become careless or take shortcuts. If you do this, it is easy for an accident to happen.

Here is a list of questions made from data that show the common causes of pesticide accidents. Answer the questions to see how safe your pesticide handling practices are. Just one "No" could be the practice that gets you in trouble!

Prevent Pesticide Accidents Checklist

Yes	No	
		Store your pesticides safely.
❑	❑	Do you store your pesticides in a space apart from other things?
❑	❑	Do you keep your storage space locked?
❑	❑	Are the windows tight, barred, or boarded over?
❑	❑	Do you keep all your pesticides in this storage, and none in the garage, feed room, basement, porch, kitchen, or refrigerator?
❑	❑	Do you store herbicides apart from other pesticides?
❑	❑	Are there signs on your storage so firemen and others are warned?
❑	❑	Do you check often for leaking containers?
❑	❑	Do you have a plan in case of fire?
		Keep the original container and label.
❑	❑	Do you always keep pesticides in the original container instead of soft drink bottles, milk cartons, or other food containers?
❑	❑	When people ask you for a little spray mix out of your tank, do you refuse?
❑	❑	Are all your containers labeled?
❑	❑	Do you always know the safeguards, antidotes, and directions for use, even though the container is not labeled?
❑	❑	Do you safely dispose of pesticides that have no labels, rather than taking a chance with your memory?
		Use the correct clothing and protective equipment.
❑	❑	Do you read the label to see what protective clothing you should wear?
❑	❑	Do you start each spraying day with clean work clothing?
❑	❑	Do you check the signal words and precautions for use on the label to see what protective equipment you need?
❑	❑	Do you wear the protective equipment stated on the label?
❑	❑	Do you clean and repair your protective equipment often?
❑	❑	Do you keep your protective equipment and clothing apart from regular clothes?
❑	❑	Do you throw away rubber gloves that have only tiny holes in them?

Spills and splashes can be hazardous.

- ❑ ❑ Do you know what to do if you spill a pesticide on yourself while mixing?
- ❑ ❑ Do you wear good footgear?
- ❑ ❑ Do you wear your pant cuffs on the outside so pesticides won't run into your footgear?
- ❑ ❑ Do you have sawdust, vermiculite, kitty litter, or some other absorbent on hand to soak up spills?
- ❑ ❑ Do you always watch your sprayer tank when you fill it so it won't run over and spill on the ground?
- ❑ ❑ Do you have a check valve or other device on your equipment to prevent back-siphoning into the water supply?
- ❑ ❑ Is your application equipment in good repair so it doesn't leak and leave puddles or piles of pesticide on the ground?
- ❑ ❑ Do you avoid draining leftover spray mix on the ground?
- ❑ ❑ Do you throw away old high-pressure hose instead of patching it?
- ❑ ❑ Do you clean nozzles with a brush or by rinsing instead of blowing them out with your mouth?

Container disposal.

- ❑ ❑ Do you multiple rinse each empty liquid container and dump the rinse water into the tank?
- ❑ ❑ Do you keep your used containers in your storage area until you throw them away?
- ❑ ❑ Do you collect every container for disposal before leaving a job, instead of leaving them in the field or at your tank filling station?
- ❑ ❑ Do you puncture, break, or crush nonburnable containers so they can't be reused?
- ❑ ❑ Do you keep, properly dispose of, or return to the manufacturer 30- and 55-gallon pesticide drums, rather than giving them away for floats or trash barrels?

Safeguard equipment!

- ❑ ❑ Do you keep your sprayer equipment where children cannot play on it?
- ❑ ❑ Do you keep your spray equipment clean so it will not contaminate someone who touches it?
- ❑ ❑ Do you always release the pressure on your equipment so spray guns won't be triggered by accident?

Yes	No	
		Use care in application.
❑	❑	Do you check the wind direction and the area downwind before you apply pesticides?
❑	❑	Do you use a safer chemical if you are spraying near a sensitive area?
❑	❑	Do you check if there might be rain and damaging runoff before you apply pesticides?
❑	❑	Do you plan your pesticide application so it will have little or no effect on bees, birds, fish, or other wildlife?
❑	❑	Do you remove, turn over, or cover up pet dishes, sand boxes, or plastic pools before you spray private property?
❑	❑	Do you make sure children and pets are out of the area and stay out until the spray dries?

Questions for study—Chapter 7

1. What is the first thing you should do when you or someone else is overexposed to pesticides?
2. Why should your doctor know which pesticides you normally use?
3. What is most important to do if poison is on the victim's skin or in his or her eyes?
4. What do you do first if the victim has inhaled poison? How do you protect yourself?
5. If a person has swallowed a poison, always make him or her vomit **except** in four cases. Name them.
6. What can you use to adsorb poisons that the victim has swallowed? How is it used?
7. Why shouldn't you carry atropine?
8. Describe shock. What can you do for it?
9. Where do you get the water you need for pesticide first aid?
10. Who should you call in Oregon if you think someone has been poisoned by pesticides?
11. What is heat stress?
12. What are some common signs and symptoms of heat stress?
13. If you are not sure whether a person is sick from heat stress or pesticide poisoning, what should you do?

Chapter 8

Integrated Pest Management

Goals of this chapter

- Define integrated pest management (IPM).
- Present the benefits of IPM.
- Describe the four major steps of IPM.
- Define "economic threshold" and "economic injury level."
- Describe types of control used in IPM.

What is integrated pest management?

There are several tactics growers can use to control pests. Integrated pest management (IPM) is a method to decide which tactics to use and how to use them. These tactics must be safe for the environment. They must make economic sense.

Integrate means to blend the parts of a system into a whole. With IPM, integration means these things:

1. Blending control methods to make the best plan for control
2. Knowing the combined impact of different pests, including animals, diseases, insects, and weeds
3. Planning how all pest control methods will work together to protect the crop or livestock

Most of all, IPM integrates facts on pest biology and control, environmental impacts, and dollar costs and benefits. Then, the grower can make the best choice and use of a pest management strategy.

Organisms that are a nuisance or cause harm to humans, plants, domestic animals, or structures are called **pests**. Pests can be animals, such as insects, mites, nematodes, slugs, snails, birds, or rodents. Pests can be microbes that cause diseases, such as viruses, bacteria, or fungi. Pests can be plants that are called **weeds**.

Management of pests means making good choices to keep the pests from reaching levels that are too high. Small numbers of pests usually do not cause too much harm. You do not always need to kill every single one.

Why practice IPM?

Chemical pesticides often control pests just fine. But, there are good reasons always to use them within an IPM program.

Keep a balanced ecosystem

Living creatures and their environment together make an ecosystem. Natural ecosystems usually are in balance (at **equilibrium**).

Humans often upset that balance. Using chemicals changes the balance, because the chemicals destroy some species and let other species increase in number.

Some insects eat pest insects. They are called **beneficial insects**. Ladybird beetles and lacewing larvae are beneficial insects. If you kill them with pesticides, you upset nature's way of pest control.

Pesticides might not work

Chemical pesticides do not always work. Pests can survive a pesticide application if the chemical does not reach them, if it is washed off, if you apply it at the wrong rate, or if you apply it at the wrong life stage of the pest.

Some pest insects, diseases, weeds, and animals have become resistant to certain pesticides.

IPM is not hard to use

Some of the terms and ideas of IPM might be new to you. But, practicing IPM is not hard. If you've found out which pest is causing the problem, found out the extent of the damage, and decided which action to take, you already have done much of the work for an IPM approach. These steps are the same ones used in IPM.

IPM saves money

IPM can save you money because it avoids crop loss from pests. You don't have to buy pesticide that you don't need. You apply pesticides only when you need them instead of by the calendar. That way, you make less applications, which saves money.

Onion growers who used IPM in 1987 saved more than $23 per acre. Apple growers who use IPM are reducing insecticide applications by up to 70 percent.

IPM helps keep the environment healthy

People are concerned about contaminated groundwater and disposal of pesticide containers. We still have much to learn about the persistence of chemicals in the environment and their effect on living creatures. But, most people agree that fewer pesticides means less risk to surface and groundwater, and less hazard to wildlife and humans.

IPM gives you a good public image

Public concern about the use of pesticides is growing. It is urgent that we use pesticides wisely and only when needed. Using integrated pest management can help soothe public concerns.

The basic steps of IPM

An IPM approach is built on four major steps.

1. Prevent pest buildup.
2. Monitor for pests.
3. Assess what you find.
4. Decide the best action to take.

1. Prevent pest buildup

To prevent or delay the buildup of pests, use IPM practices before you have a pest problem. The measures you use are different for agricultural, public health, or structural pests.

Agricultural pests

***Cultural control*—**These are actions that favor the crop and disrupt the pest's environment. Some cultural controls you can use are plowing, crop rotation, taking away infected plant material, cleaning greenhouse equipment, correct manure management (composting/aging), irrigation, and fertility management.

***Physical barriers*—**You can put nets over small fruits and screens in greenhouses. Both of these can prevent crop loss. Physical barriers are an important part of rodent control.

***Pest-resistant plants*—**Certain kinds of plants are naturally or have been bred to be more immune to some pests. These are called **resistant varieties**. If growers use resistant varieties, they often do not need to apply as many pesticides. This also is called **using host plant resistance**.

Potato growers control the golden nematode by planting resistant varieties. Apple growers can save as many as eight fungicide applications a year by growing trees that resist diseases. There are many other kinds of plants that resist pests.

***Biological controls*—**This method uses the pest's natural enemies to keep the number of pests low. The natural enemies are called **biological control agents**.

These are some kinds of biological control agents:

- Beneficial mites that feed on pest mites in orchards
- Ladybird beetles (ladybugs) that eat aphids
- The milky spore disease that kills harmful soil grubs
- *Encarsia formosa,* a wasp that kills the greenhouse whitefly

Today, you can buy many of these biological control agents to release in your fields or greenhouse.

***Pheromones*—**Natural insect scents are called **pheromones**. You can use them to attract insects to traps.

A female insect gives off a scent to attract mates. You can use that pheromone to confuse males and prevent mating. This is called **mating disruption**. You can use this method to reduce damage from the codling moth and the grape berry moth. Pheromones and mating disruption both are considered biological controls.

Structural pests

If you do structural pest control, you can suggest better cleaning (**improved sanitation**), physical barriers, or changes to the building instead of chemical control.

***Clean building site*—**Remove tree stumps and lumber scraps from building sites. These are prime food sources for termites. If you remove them, you can prevent infestations in the future.

***Physical barriers*—**Physical barriers such as screens or metal guards are an important part of termite, housefly, and rodent control.

***Changes to the building*—**When you are building, keep support timbers away from the soil. Wood absorbs moisture from soil. Carpenter ants and termites are more likely to attack it when it is touching the ground.

***Cultural control*—**You can reduce urban and industrial pest problems by doing these things:

- Improve cleaning programs (**sanitation**).
- Get rid of the sources of pest infestations.
- Pick up garbage more often.
- Install lights that do not attract insects.

Regulatory control

Pests that are not part of the natural ecosystem are called **exotic pests**. They can harm crops or products. There are laws and programs to prevent exotic pests from coming into Oregon and spreading through the state. The Oregon Department of Agriculture and the U.S. Department of Agriculture—Animal and Plant Health Inspection Service (USDA-APHIS) are in charge of these laws and programs. They include:

- Laws that make it illegal to bring certain plants or animals into Oregon.
- Special traps (used by the ODA) to detect the presence of certain introduced pests. This is called an **exotic pest detection survey**.
- Close off the area where a pest is found so it cannot spread. This is called **quarantine**.
- Kill all of the pests. This is called a **pest eradication program**. (This program is used before the pest spreads to large areas.)

To learn more about these rules and programs, you can call:

Oregon Department of Agriculture, Pesticide Division
Telephone: 503-986-4635
or
USDA—Animal and Plant Health Inspection Service
Telephone: 503-326-2814

2. Monitor for pests

Watch carefully for insects, weeds, diseases, and other pests. This is called **monitoring** or **scouting** for pests.

Check the area often to detect pests when they are just starting to infest. Check warehouses, bakeries, restaurants, fields, greenhouses, and golf courses for pests or signs of their presence.

If you find a pest, find out what it is. This is called **pest identification**. Some pests that are not the same look almost alike. If you don't know what the pest is, take some of them or the damage they leave behind to an expert. It is important to know exactly what the pest is, because the method you use for control might work only on one species and not the other. Also, you do not want to kill creatures that are not pests.

Notice the effects of biological control already in place. Find out which creatures are helping you. Find out what other kinds of biological control agents you can use. Sometimes pests are kept in check naturally. Other times, the number of pests increases sharply, and you may have to use physical controls or chemicals. If you use a pesticide, try to use one that will not harm biological control organisms.

3. Assess what you find

Crop pests

If you find a pest, and you know what it is, then you have to think over what this might mean for the grower. Do the numbers of pests threaten the crop? Is a grower likely to lose money? Is the pest likely to transmit a disease? How can you predict?

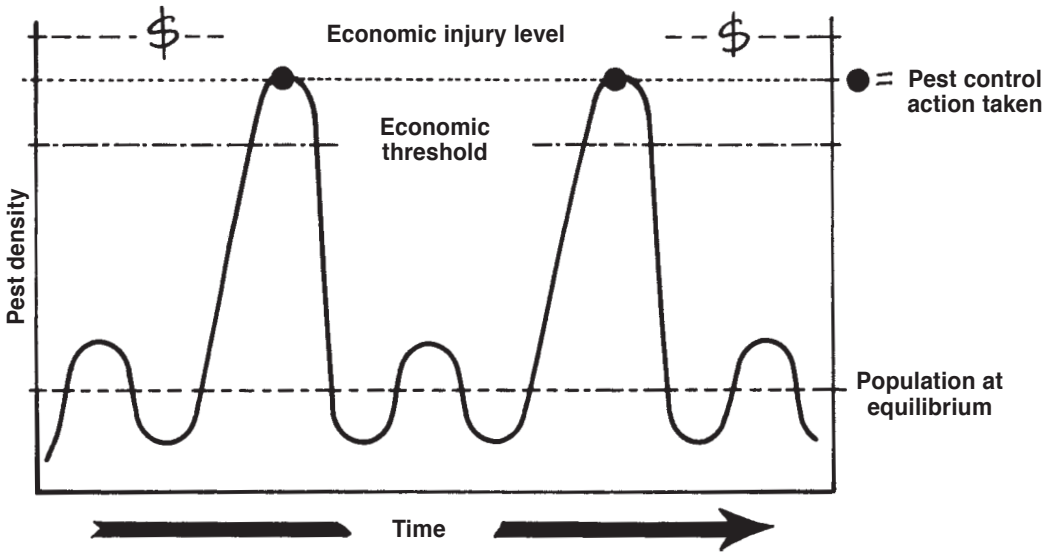
Certain weather conditions can favor outbreaks of diseases and insect pests. If you know what they are, you can spray only when conditions favor disease.

Good pest records from past years can help you decide if pest problems will recur. If you believe they will, you can apply pesticides at the proper time for early control of a problem.

Scientists measure the number of pests (**pest density**) in different ways depending on the crop or site. For example, they measure the number of insects per leaf or the number of weeds per 10 feet of row.

Sometimes, the number of pests reaches a level above which there is risk that the grower could lose money. This is called the **economic threshold**. If the number of pests goes above the economic threshold, then the cost of control is equal to the value of the yield or quality that you would lose without the control measure. This is called the **economic injury level**. If the number of pests grows above the economic injury level, then the grower loses money.

Scientists have figured out the exact thresholds for pest density for many pests and crops that will cause economic injury. If pest density has not reached the threshold, there is no need to apply control measures. Once the pest density has reached threshold, then it is time for action. The costs of control will be less than the losses that the pests would cause if they were not controlled.



Varying population densities leading to control interventions.

Urban pests

You have to assess an urban pest problem in a different way from a crop pest problem. Urban pest thresholds often apply to loss of beauty (**aesthetic threshold**) rather than loss of money.

Or, thresholds apply to human health. Only a very small number of pests may be allowed before there is a problem. This is called the **tolerable level**. Where health is a concern, the tolerable level may be zero. A zero threshold forces action, even if only one pest has been found. Zero thresholds exist in hospitals and food, warehousing, and retail buildings. Thistles or poison oak on the school playground would have a nuisance threshold of zero.

4. Decide the best action to take

If the measures you take to prevent pest buildup fail to keep pests below the economic threshold, then you have to take action. Sometimes, cultural controls are enough to destroy pests. One way is to change planting or harvest dates. For example, if you plant fall wheat before October 15 in Western Oregon, you will have problems with Hessian fly. Planting after this date avoids problems with this insect. Sometimes, early harvest can avoid pest problems and costs less than a pesticide application.

Use chemical pesticides as a control measure only when no other action will reduce the pest density below the economic threshold. If you wait until a pest reaches threshold, be sure there is a pesticide that will reduce pest numbers quickly.

Using an IPM approach means that you decide what action to take based on monitoring for pests, assessing the damage they could cause, and choosing the best control measures to keep pest density below the economic injury level. The best action could be to do nothing because nature is taking care of itself. Or, the best action could be to blend control tactics. Always keep in mind that pesticides are the last choice. Use them only when you truly need them.

Questions for study—Chapter 8

1. What is integrated pest management (IPM)?
2. What are some benefits of IPM?
3. IPM is based on preventing pest buildup, monitoring for pests, assessing what you find, and deciding what action to take. What does each of these steps involve?
4. Why is it important to know exactly what the pest is?
5. What is an economic threshold? What does it have to do with IPM?
6. Name three different types of controls used in IPM. Give an example of each.

Chapter 9

Pests

Goals of this chapter

- Teach how to know pests by their physical features and the type of damage they do.
- Describe how insect pests reproduce and grow.
- Describe how diseases affect plants.
- Describe how weeds affect crop plants.

The term **pest** refers to any organism that bothers humans or hinders their goals or activities. It refers to anything that does these things:

- Harms humans, animals, crops, structures, or other things that people value
- Competes with humans, domestic animals, or crops for food, feed, water, nutrients, space, light, beauty, or play
- Spreads disease to humans or preferred animals and plants

Humans have competed with insects, rodents, diseases, parasites, and weeds throughout their history. In recent decades, humans have added pesticides to their tactics to combat these pests.

When you know the pests you work with, you can use the right methods of control. If you need to use a pesticide, you can choose the right one and treat at the right time.

For more detail about Integrated Pest Management, see Chapter 8.

It is important to know the pest's life cycle, the type of damage it causes, and when it does damage. Then, you can do these things:

- Know the best time to control the pest.
- Use less pesticide, or use other methods of control.
- Avoid harm to the host plant or animal.
- Avoid harm to nontarget areas.

Insects

There are three times as many insects as other animals in the animal kingdom. Insects are everywhere: in snow, water, air, soil, hot springs, and in or on plants and animals. Many animals eat insects. Insects are an important part of the earth's ecosystem, and we could not survive without them.

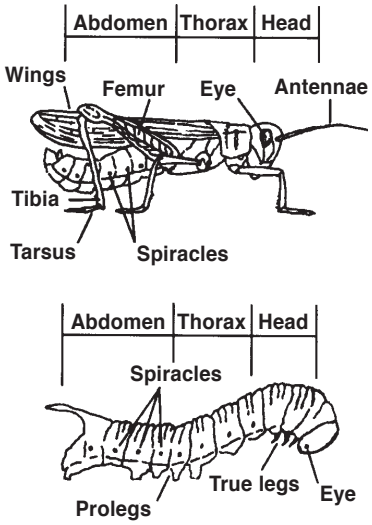
But, insects also compete with humans and other animals for food. Some insects, such as human lice, survive by feeding on humans.

You must know some basic facts about how insects live and thrive. Insects can be put in three groups by how they affect humans:

1. **Species that do not affect humans directly.** About 99 percent of all insect species are in this group. They are food for birds, fish, mammals, reptiles, and other insects. Many are beautiful and pleasant.
2. **Beneficial insects.** One important group feeds on pest insects, mites, and weeds. Good examples are ladybird beetles (ladybugs) and the praying mantis.

   Also important are insects that pollinate plants. Some of these are honeybees, bumblebees, moths, butterflies, and beetles.

   Other products we get from insects are silk and dyes for paints.
3. **Pest insects.** This group has the fewest members. These insects feed on, cause harm to, or transmit disease to humans, animals, plants, food, fiber, and structures. Only about 3 percent of insects in agricultural fields are pests.



The insect body

The insect body

All adult insects have two features in common.

1. They have three body regions—the head, thorax, and abdomen.
2. They have three pairs of jointed legs.

Head

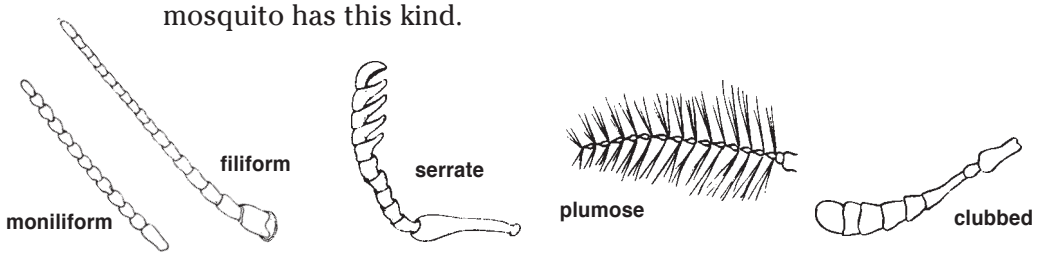
An insect has antennae, eyes, and mouthparts attached to its head. These parts vary in size and shape among species. They can help you tell some pest insects from others.

Antennae

There is a pair of body parts between or below the eyes. These are called **antennae**. Antennae vary greatly in size and form. Scientists use them to sort out insects by family and species.

Some common types of antennae are:

- **Moniliform—**like a string of beads. The segments are the same size and round in shape. Termites have this kind of antennae.
- **Filiform—**threadlike. The segments are nearly even in size. They are shaped like a cylinder. Ground beetles and cockroaches have this kind.
- **Serrate—**sawlike. The segments are more or less triangular in shape. Click beetles have this kind.
- **Clubbed—**segments increase in size away from the head. Japanese beetles have this kind.
- **Plumose—**feathery. Most segments have whorls of long hair. The male mosquito has this kind.

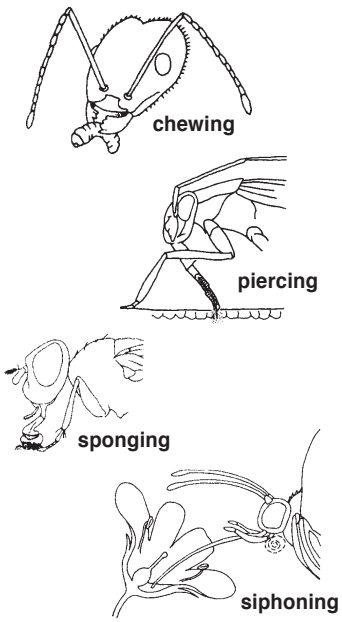


Types of insect antennae

Mouthparts

Insect groups have different **mouthparts**. Mouthparts also are used to tell insects apart. The type of mouthpart controls how the insect feeds and what sort of damage it does. These are the four main kinds of mouthparts:

- **Chewing mouthparts.** These have jaws with teeth that bite and tear the food. Beetles, cockroaches, ants, caterpillars, and grasshoppers have these.
- **Piercing-sucking mouthparts.** These are long, slender tubes that the insect forces into plant or animal tissue to suck out fluids or blood. Mosquitoes and aphids have these.
- **Sponging mouthparts.** These are like tongues that have spongy tips to suck up liquids or food. House flies and blow flies have these.
- **Siphoning mouthparts.** These are long tubes that the insect uses for sucking nectar. Butterflies and moths have these.



Insect mouthparts

Thorax

The thorax is the middle body segment. It has three pairs of legs and sometimes one or two pairs of wings (forewings and hind wings).

Legs come in many sizes, shapes, and functions. They are helpful for knowing which insect is which. Insects use them for walking, running, jumping, and climbing. The legs of some insects are made to do certain special things, such as the jumping legs of the grasshopper.

Wings also vary in size, shape, and texture. You can use the pattern of veins on the wings of an insect to know which species it is.

The forewings of some insects are hard and shell-like. Beetles have this kind. Grasshoppers have leathery forewings. The forewings of flies are thin and clear. The wings of moths, butterflies, and mosquitoes are thin and clear and covered with scales.

Abdomen

The abdomen of the insect has many segments. Along the sides of each segment are openings called spiracles. The insect breathes through the spiracles. The abdomen also contains digestive and reproductive organs.

How insects reproduce and grow

Reproduction

In most insects, males fertilize females, and then the females lay eggs. But, there are a few that are different. Some parasitic wasps produce eggs without ever mating. In some insect species, there are no males. A few insects even give birth to live young.

Some insects lay eggs one at a time. Some lay them in groups. Some lay them in floating rafts. Some insects lay eggs in capsules that contain several eggs. Then, the adult carries them until they hatch. Sometimes, insects place their eggs inside the bodies of animals, trees, or green plants.

Eggs vary in size and shape (round, oval, flat, and elongated). Sometimes, you can know which insect it is by the eggs or egg capsules.

Egg hatching is affected by temperature, humidity, and light.

Growing

Insects go through a series of changes as they grow from egg to adult. This process of growth is called **metamorphosis**.

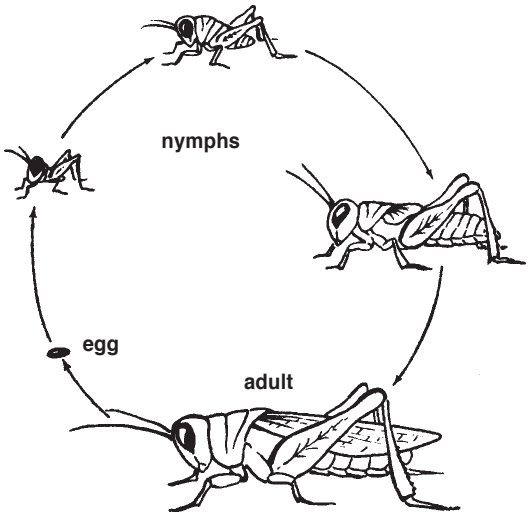
After hatching from an egg, a young insect is called either a larva, nymph, or naiad. The young insect feeds for awhile and grows. When it grows so big that its skin can stretch no further, it sheds its skin. This is called **molting**. Then, it grows a new skin.

These stages of growth and molting are called **instars**. Instars differ from insect to insect. Sometimes, they vary with the temperature, humidity, and food supply. Most of the time, the heaviest feeding occurs in the last two instars.

There are four types of metamorphosis.

1. No metamorphosis

Some insects do not change much from the time they hatch until they are adults. The insect just grows larger with each instar. The food and habitat of the nymphs are the same as those of the adult. The adults and nymphs are both wingless. Springtails, firebrats, and silverfish are in this group.



Gradual metamorphosis

2. Simple or gradual metamorphosis

Insects in this group mature through three distinct stages: egg, nymph, and adult. The nymphs are like the adults both in form and how they feed. They live in the same environment.

But, the nymph cannot reproduce or fly. Its body matures slowly. The wings and reproductive organs are full grown only in the adult stage. Cockroaches, lice, termites, scales, and aphids are in this group.

3. Incomplete metamorphosis

Insects in this group also pass through three stages: egg, naiad, and adult. Adult and naiad are alike in some ways, but mostly they are very different. The naiads live in the water and breathe through gills. The adults have wings and live near the water, but do not have gills. Stoneflies, mayflies, and dragonflies are in this group.

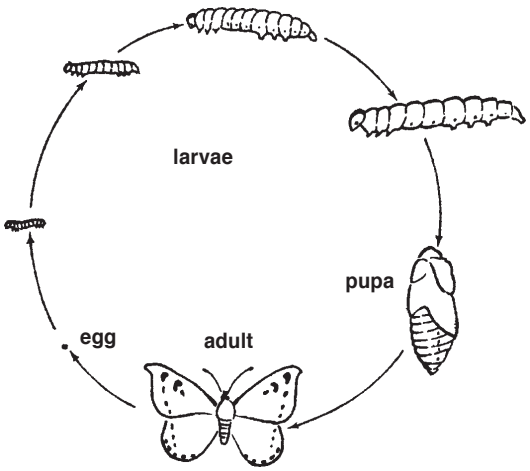
4. Complete metamorphosis

This process has four stages: first the egg, then larva, then pupa, and last adult.

The young are called **larvae**. The larvae hatch from eggs. As they grow larger, they molt and pass through several stages.

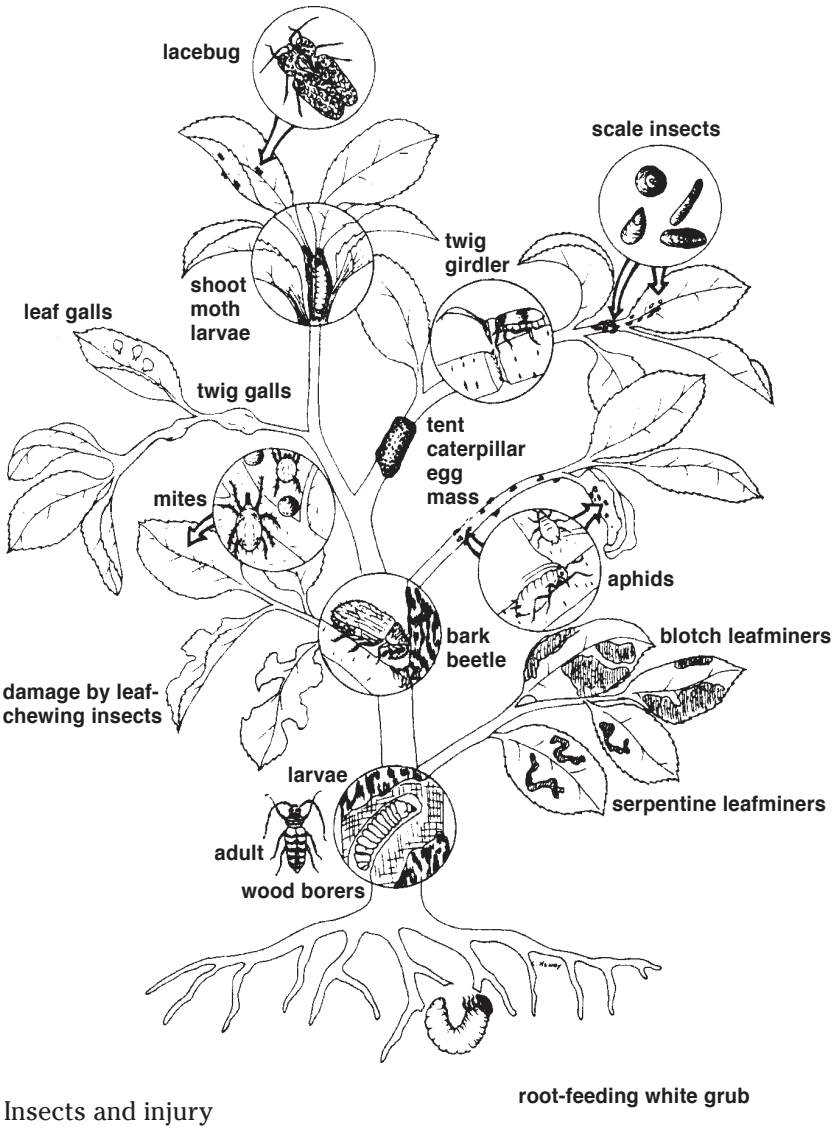
Larvae come in many forms, shapes, and sizes. We know them as caterpillars, maggots, or grubs. They are entirely different from the adults.

The larvae and the adults usually live in different habitats and eat different food. Caterpillars may live on a plant and eat leaves, while the adult butterfly flies freely, sipping nectar for food.



Complete metamorphosis

The pupa often is called the resting stage. But, the insect is not resting! While in this stage, the larvae changes



Insects and injury

into an adult with legs, wings (usually), antennae, and a full grown reproductive system.

Insect-like pests

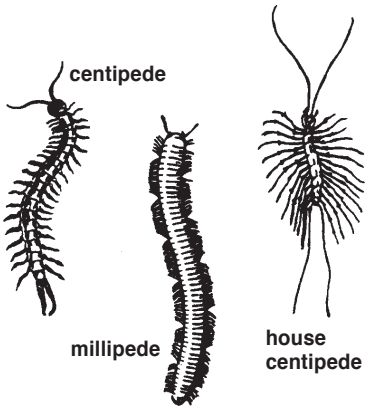
Spiders, ticks, mites, sowbugs, pillbugs, millipedes, and centipedes seem like insects, but they are not.

Arachnids

Spiders, mites, ticks, and scorpions are **arachnids**. They all have eight legs and only two body regions, the head and the abdomen. They do not have wings or antennae.

Arachnids mature through metamorphosis. The eggs hatch into larvae with six legs. Larvae molt into nymphs with eight legs. Then, the nymphs molt into adults.

Spiders and scorpions have chewing mouthparts. Ticks and mites have a kind of piercing-sucking mouthparts. Ticks sometimes transmit Lyme disease and Rocky Mountain spotted fever to humans.



Centipedes and millipedes.

Centipedes and millipedes

Centipedes are flat, long, wormlike animals. Each body segment has one pair of legs. They have chewing mouthparts. Some can give painful bites to humans.

Centipedes live in protected places under tree bark or in rotting logs. They are fast and fierce. They capture and eat insects, spiders, and small animals. All centipedes have poisonous jaws.

Millipedes are shaped like an earthworm. They have many legs—two pairs on each body segment. They feed on decaying organic material. They live in decaying leaf litter, rotting logs, and in damp debris near building foundations.

Millipedes and centipedes have no metamorphosis. They only grow larger between hatching from the egg and reaching the adult stage.


Sowbug

Crustaceans

The animals in this class nearly all live in water. Lobsters and shrimp are in this group. There are a few members that live on land. They can become pests.

Sowbugs (often called pillbugs) are black, gray, or brown. They roll up into a ball when disturbed. Sowbugs live under stones, boards, blocks, or decaying wood. Some are pests of cultivated plants, but usually they are pests in basements and garages.

Mollusks

Mollusks are a large group of land and water animals. Slugs, oysters, clams, barnacles, and snails are mollusks. They have soft, solid bodies that often are protected by a hard shell.

Snails and slugs

Land snails and slugs have two pairs of body parts that look like antennae. Their bodies are soft, smooth, and elongated.

Snails have a spiral-shaped shell. They can withdraw completely inside it to protect themselves. Slugs do not have a shell. They must look for a damp place to hide.

Snails and slugs feed on plants at night. Using their rasplike tongues, they tear holes in foliage, fruits, and soft stems. They can eat entire seedlings.

Snails and slugs leave a slimelike mucous trail that dries into silvery streaks. These streaks mar floral and ornamental crops and crops to be sold for human food.

Slugs and snails lay eggs in moist, dark places. The young mature in a year or more, depending on the species. Adults might live for several years. They overwinter in sheltered areas. They are active all year in warm climates.

Plant disease

Plant diseases are caused by biological agents called **pathogens**. Pathogens include bacteria, fungi, viruses, protozoans, and nematodes.

Plant pathogens are parasites. They live and feed on the host plant. Before an infection starts, the pathogen must get into the plant. They are spread by wind, rain, insects, birds, snails, slugs, earthworms, contaminated equipment and tools, infected seed and plants, transplanted soil, nursery grafts, vegetative propagation (bulbs, tubers, roots, stem cuttings), pollen, dust storms, irrigation water, animals, and people.

Plant diseases harm a plant's growth, beauty, or function. Plants respond to disease in three main ways:

1. The leaves curl. Tissue overdevelops, galls, and swells.
2. Tissue stunts and does not develop. The leaves do not have enough chlorophyll, and the organs do not develop completely.
3. Tissue dies and blights. The leaves spot, wilt, and get cankers.

In order for a disease to develop, you must have a **pathogen**, a **susceptible host plant**, and the **right environment**. Temperature and moisture are most important to the success of the pathogen.

Fungicides and a few antibiotics cure some diseases. Other times, fungicides only prevent pathogens from infecting plants.

Bacteria

Bacteria are one-celled organisms. You can see them only with a microscope.

Bacteria reproduce by single cell division. They multiply quickly under warm, humid conditions.

Bacteria can attack any part of a plant. They cause several of the leaf spot and rot diseases.

Phytoplasmas are a special type of one-celled organism. Unlike bacteria, they can live only inside of host cells. Yellows diseases and some stunts are caused by phytoplasmas.

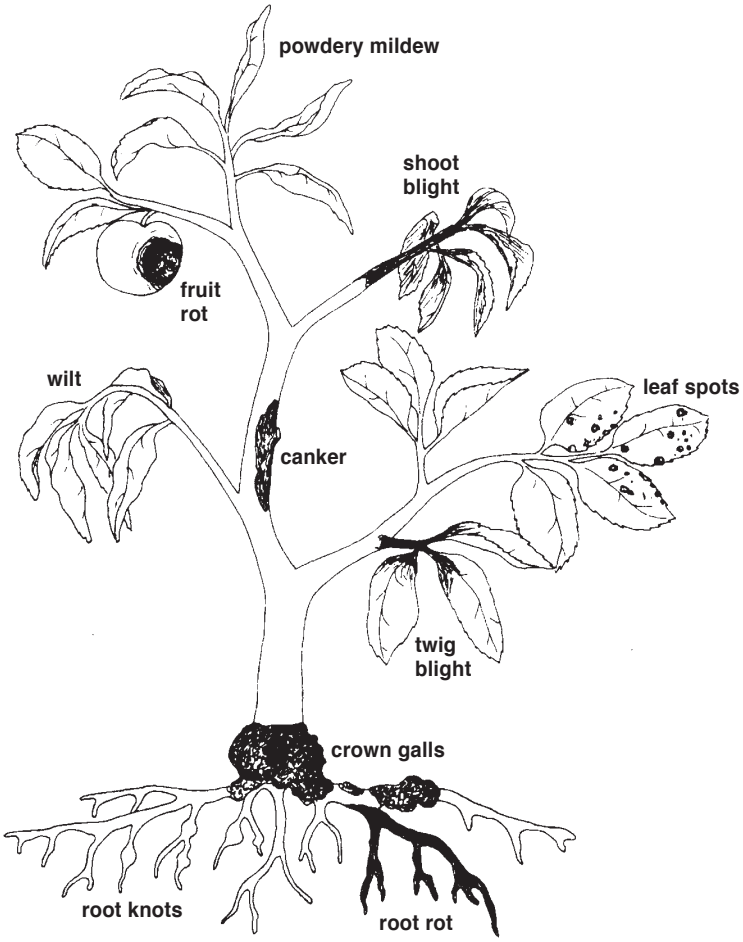
Fungi

Fungi do not have chlorophyll and cannot make their own food. They feed off other living organisms or on dead or decaying organic matter.

Most of the time, fungi are beneficial. They help release nutrients from dead plants and animals, making the soil more fertile. But, fungi are also the most common pathogens of plants.

Fungi reproduce with spores. They produce high numbers of them. Spores work about the same way seeds do. You can see fungus spores only under a microscope.

Spores need high humidity or a long period of wetness to germinate and infect plants. Mildew and smut are fungal diseases.



Disease symptoms

Viruses

Viruses are smaller than bacteria. You can see them only with a special microscope. You'll know a virus by the symptoms it causes on the infected plant, or from special lab tests.

Viruses depend on other living creatures for food. They cannot live long on their own.

Viruses invade healthy plants through wounds or during pollination. Insects that feed with piercing-sucking mouthparts and chewing insects can transmit viruses while feeding. Nematodes also can spread viruses. All plants can be infected by viruses.

Nematodes

Nematodes are tiny eel- or wormlike creatures. You can see them only with a microscope.

Nematodes feed by sucking the contents of a plant cell through their needle-like mouth. Some nematodes destroy the plant's root system. This weakens the plant, because it cannot take up enough water and minerals. Plants wilt and do not grow well when they have nematodes.

Not all nematodes feed on roots. Some nematodes attack above-ground plant parts. Triangles of brown, dried tissue appear on the leaves late in the season.

Nematodes also spread other plant diseases.

Weeds

When a plant grows where it is not wanted, it is called a **weed**. Any plant can be a weed. In fact, many weeds are plants that escaped from people's gardens.

Weeds can harm humans in these ways:

- They cause skin irritation.
- They cause allergic reactions.
- They host pests such as rodents, ticks, or insects.

Weeds can harm wanted plants in these ways:

- They contaminate the product at harvest.
- They compete for water, nutrients, light, and space.
- They host pest insects, mites, vertebrates, or plant disease agents.
- They release toxins into the soil that can harm growth.

Weeds can affect grazing animals in these ways:

- They poison animals.
- They cause an "off flavor" in milk and meat.
- They cause injury to eyes or mouth.

Weeds may be pests in water in these ways:

- They hinder fish growth and reproduction.
- They increase mosquito breeding.
- They clog irrigation ditches, drainage ditches, and channels.
- They hinder boating, fishing, and swimming.

Weeds are dangerous on rights-of-way for these reasons:

- They block vision, road signs, and crossroads.
- They increase road repair costs.

Stages of plant growth

After a plant seed has germinated, the plant goes through four stages of growth:

1. **Seedling.** Plants are very small and open to harm.
2. **Vegetative.** Roots, stem, and foliage grow fast. Nutrients and water move quickly through the plant.
3. **Seed production.** Plants use most of their energy toward reproduction. Water and nutrients go to making flowers, fruit, and seed.
4. **Maturity.** Water and nutrients move slowly in the plant. The plant produces low energy.

Weed life cycle

Annuals

Plants that grow from seed, mature, and produce seed for the next generation in 1 year or less are called **annuals**. Many grass and broadleaved weeds are annuals.

- **Summer annuals** grow from seeds that germinate in the spring. They grow, mature, produce seed, and die before winter. Foxtail, pigweed, lambsquarters, and crabgrass are summer annuals.
- **Winter annuals** germinate in the fall. They mature, produce seed, and die before the next summer. Henbit, common chickweed, and annual bluegrass are winter annuals.

Biennials

Plants that have a 2-year life cycle are called **biennials**. During the first year, they grow from seed and develop a heavy root and compact cluster of leaves called a **rosette**. During the second year, they mature, produce seed, and die. Bull thistle and burdock are biennials. Sugar beets grown for seed also are biennials.

Perennials

When plants live more than 2 years, they are called **perennials**. Perennials may mature and set seed in the first year. But, they repeat the cycle for several or maybe many years.

Some perennial plants die back each winter. Others, such as trees, may lose their leaves, but they do not die back.

Most perennials grow from seed. Many perennials produce tubers, bulbs, rhizomes, or stolons. (Rhizomes are rootlike stems that grow below the ground. Stolons are stems that produce roots.)

- **Simple perennials** such as trees, shrubs, plantain, and dandelions usually reproduce by seeds. If their root pieces are cut by cultivation, the pieces can grow into new plants.
- **Bulbous perennials** may reproduce by seed bulblets or bulbs. Wild garlic produces seed and bulblets above ground and bulbs below ground.
- **Creeping perennials** reproduce by seed, rhizomes, or stolons. Johnsongrass, field bindweed, and Bermudagrass are creeping perennials.

How to identify a weed

Arrangement of leaves

Alternate—There is one leaf at each level on the stem.

Opposite—There are two leaves opposite each other or paired.

Whorled—There are three or more leaves at each level on the stem.

Leaf structure

Simple—The leaf blade is a single piece. It is not divided into separate leaflets.

Compound—The leaf blade is divided into several leaflike parts called leaflets.

Leaf shape

Ovate—The leaf is egg-shape, oblong, and broadest at the base.

Lanceolate—The leaf is lance-shape, longer than ovate, and usually pointed at the tip.

Linear—The leaf is long and narrow with parallel sides. Grasses have linear leaves.

Arrangement of the flowers

Inflorescence—The blossoms are in a definite cluster, usually at the top of the plant.

Axillary—The blossoms grow along the stem of the plant in the angles between the leaves and the stem. (The angle between the leaf and the stem is called the **leaf axil**.)

Flower parts

Petals—The petals are the expanded (and usually colorful) parts of the flower.

Sepals—The sepals are the greenish hull surrounding the flower when it is budding.

Major classes of weeds

Grasses have round, hollow stems and narrow leaves with parallel veins. Grass seeds do not divide, so the sprouting seedlings have only one leaf. For this reason, they are called **monocotyledons** (or **monocots** for short). Because their growing point is below the soil's surface, you can mow grasses without killing the plants. Most grasses have fibrous root systems.

Grasses have both annual and perennial species.

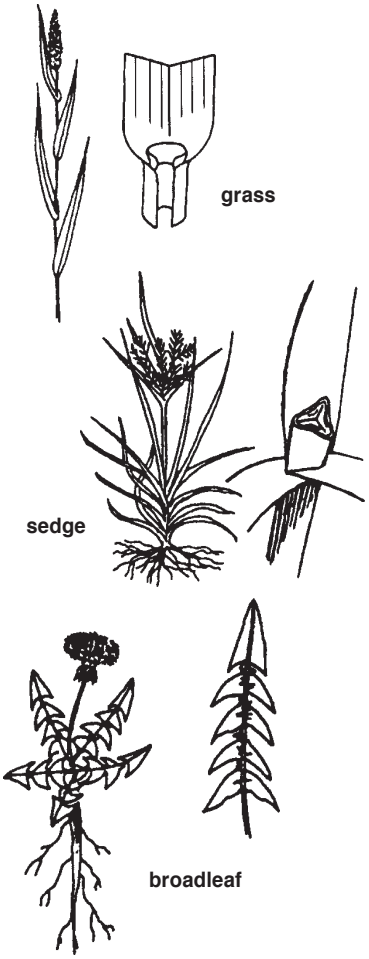
Sedges are similar to grasses, but they have triangular stems and three rows of leaves. They sometimes are listed under grasses on the pesticide label. These plants often are found in wet places. They are major pests in fertile, well-drained soils.

Yellow and purple nutsedge are perennial sedges. They produce rhizomes and tubers.

Broadleaf seeds divide into two parts, so the seedlings emerge from the seed with two leaves. For this reason, they are called **dicotyledons** (or **dicots** for short). The veins of their leaves are netlike. Broadleaves usually have a taproot. Their root system is somewhat coarse.

All broadleaf plants have exposed growing points at the end of each stem and in each leaf axil. Perennial broadleaf plants also may have growing points on roots and stems above and below the surface of the soil.

Broadleaf weeds have annual, biennial, and perennial species.



Major classes of weeds.

Vertebrate pests

Animals with a jointed backbone are called **vertebrates**. Humans are vertebrates, as are other mammals, birds, reptiles, amphibians, and fish. Most vertebrates are not pests. They are a pleasant part of our environment.

Sometimes, vertebrates can be pests. Sometimes birds, rodents, raccoons, or deer damage crops or ornamentals.

Birds and rodents eat the same food as humans. They often ruin more food than they eat.

Some mammals and birds harm livestock and poultry. They cause farmers and ranchers to lose money each year.

Flocks of roosting birds are pests when they defecate on buildings.

Rodents are a hazard to public health when they are in homes, restaurants, offices, or warehouses. Rodents, other mammals, and some birds can carry serious diseases such as rabies, plague, and tularemia.

You might need a permit or other permission before you may bait, hunt, trap, or relocate a vertebrate pest. Contact your regional office of the Oregon Department of Fish and Wildlife for details. To find out where your regional office is, or for more details, call:

Oregon Department of Fish and Wildlife
Telephone: 503-947-6000

Fact and picture sheets can help you know your vertebrate pests. They are handy and easy to use. Ask the Extension Service if they have them, or if they know where you can get them.

Questions for study—Chapter 9

1. What makes us call an organism a pest?
2. What percentage of insects in agricultural fields are pests?
3. Name the three main body parts of an insect.
4. Give three examples of pests that look like insects, but are not.
5. What causes plant disease?
6. Name five creatures associated with plant disease.
7. Give three examples of how weeds can be pests.
8. Name the three types of life cycles that plants have.
9. What does the word “vertebrate” mean?
10. Give two examples of a vertebrate pest.

Chapter 10

Types of Pesticides

FIFRA defines a **pesticide** as any substance or mixture of substances meant to prevent, destroy, repel, or reduce any insects, rodents, nematodes, fungi, weeds, or any other forms of life declared to be pests. Also, any substance or mixture of substances meant for use as a plant regulator, defoliant, or desiccant is a pesticide.

To know what a pesticide is used for, take the name of a pest and add the word "cide," which in Latin means "to kill." So, an insecticide controls insects. A fungicide controls fungi.

There are nearly 20 groups of pesticides. If you know how each pesticide affects the pest, you can decide the best way to apply it.

Goals of this chapter

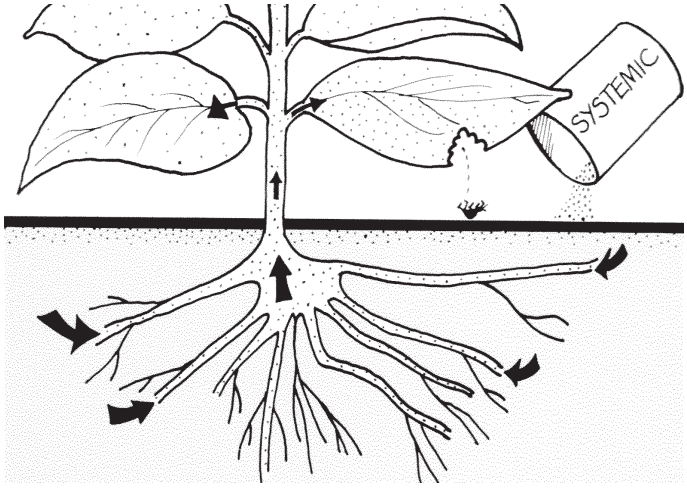
- List the different types of pesticides.
- Explain how to decide which pesticide to use to control different pests.

Insecticides

Chemicals used to control insects are called **insecticides**. Often, people think the word "insecticide" means the same as the word "pesticide." But, an insecticide is just one type of pesticide.

An insecticide can kill by coming in contact with the insect. This is called a **contact insecticide**. Or, the insect has to swallow the insecticide for it to have an effect. Sometimes these are called **stomach poisons**. Some insecticides kill both ways.

Some insecticides you place in or on one part of a plant or animal that needs protection. The insecticide then moves through the plant or animal. When an insect feeds on this plant or animal, it swallows the chemical and is affected. These are called **systemic** insecticides.



Plant uptake of a soil-systemic insecticide.

Broad-spectrum

Some kinds of insecticides can kill many different kinds of insects. These are called **broad-spectrum** insecticides. Most of the time, they attack a system common to all, such as the nervous system. There are no broad-spectrum insecticides that can kill every kind of insects.

Narrow-spectrum

Some insecticides affect a **specific system** in the **target pest**. These are called **narrow-spectrum** insecticides. They are much more **selective**. They kill only a certain species of insect or a group of insects. There are many kinds of narrow-spectrum insecticides.

Chitin synthesis inhibitors

The chemical that forms the insect's hard body is called **chitin**. **Chitin synthesis inhibitors** keep insects from making chitin. When an insect treated with a chitin inhibitor molts, it dies because it cannot make a new skin.

Insect growth regulators

Insect growth regulators (**IGRs**) mimic a young insect's growth hormone. They disrupt the insect's growth into its adult form. Growth regulators act slowly. They kill the insect at the time it molts into an adult.

IGRs only attack insects. They do not easily harm humans or other vertebrates.

Pheromones

Animals produce chemicals to send signals to each other. These chemicals are called **pheromones**.

Aggregation pheromones attract many members of the group together, such as to a site where there is a lot of food. **Sex pheromones** are used by one sex of a species to attract a mate. Walking insects, like ants, deposit **trail pheromones** so others can follow.

Laboratory science produces chemicals that copy these natural pheromones. We use them to attract pest insects into traps or to disrupt their mating.

Short-term

Some insecticides lose their potency soon after you spray them. These chemicals are called **short-term pesticides**. They are good to use when the insects do not return. Or, use them when long-term exposure could harm nontarget plants or animals.

Use short-term insecticides in homes where people and domestic animals might be exposed.

Residual

Insecticides that stay active for a long time are called **residual pesticides**. They are most useful when an insect is a constant problem, and it is in an area where the insecticide will not be a hazard to health or the environment.

Use residuals for fly control in livestock buildings or for termite control in wooden structures.

Miticides and acaricides

Chemicals used to control mites and ticks are called **miticides**. They also are called **acaricides**.

The chemical must contact the mites or ticks to have an effect. Because mites are so small, and there are always large numbers of them, you must cover the area where they live completely.

The action of miticides is like that of insecticides. Often, the same pesticide can kill both insects and mites. The terms **broad spectrum**, **short term**, and **residual** also can refer to miticides.

Fungicides

Chemicals that control fungi are called **fungicides**. Fungicides control molds, rots, and plant diseases.

Fungicides must come in contact with the fungus to have an effect. Most of the time, you have to apply them over a large surface area so the fungicide will hit every fungus.

Some fungicides are **systemic**. You spray or inject the plant with the chemical. Then, it moves throughout the plant and kills the fungi on it.

Protectant

One approach to using fungicides is to prevent a plant from getting the disease. This kind of fungicide is called **protectant**. Protectant fungicides are **fungistatic**. That means they prevent or slow fungal growth.

Protectants are useful when a certain disease or group of diseases is likely to attack a plant or crop year after year. Apply them before the disease starts.

After awhile, protectants lose their potency. The fungus might grow again or produce spores. So, to protect from infection, you might need to repeat applications of a protectant fungicide at measured times.

Eradicant

The other approach to using fungicides is to kill the disease after it appears on (or in) the plant. These fungicides are called **eradicants**. They work like antibiotics in humans, which cure sickness after it appears.

Eradicants are less common than protectants, because once the fungus grows in a plant, it is hard to destroy. You most often use eradicants when there isn't a protectant for the job, or if protectants aren't applied in time or cost too much money. You also apply eradicants when a disease appears without warning on a plant or in an area.

Herbicides

Chemicals that kill or slow the growth of plants are called **herbicides**. "Herb" comes from the Latin word for a green plant. Some herbicides kill every plant they contact. Others kill only certain kinds of plants.

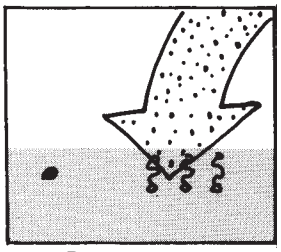
Nonselective herbicides

Chemicals that are toxic to all plants are called **nonselective herbicides**. Use these when you want no plants in an area.

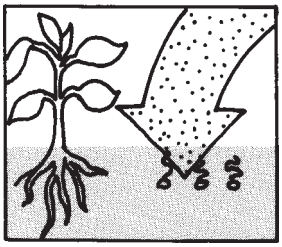
Selective herbicides

Chemicals that kill specific plants or kinds of plants are called **selective herbicides**. Use these herbicides in crops, lawns, golf courses, or in areas with trees.

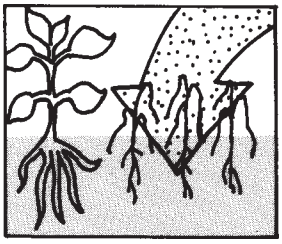
You can spray a selective broadleaf herbicide safely on grass, because it kills only the broadleaved weeds. Or, you can spray a lawn to kill the crabgrass without killing the other grasses. Some selective herbicides kill



Preemergence



Postemerged crop
Preemerged weeds



Postemerged crop
Postemerged weeds

Timing of herbicide application

certain grass weeds in broadleaf crops. Some kill grass weeds in grass crops, such as wild oats in wheat.

Spray timing

You must apply a herbicide at the right time to affect the target without harming other plants. The label tells you when to apply the herbicide.

Preplant

Apply **preplant** herbicides before the crop is planted. You apply some types to the soil surface. Some types you mix (**incorporate**) into the soil.

Preemergence

Apply a **preemergence** herbicide before the crop and weeds appear. You apply some types before both the crop and weeds appear. Apply other types after the crop appears but before the weeds appear. The label directions state, "preemergence to the crop," "preemergence to the weeds," or "preemergence to both crop and weeds."

Postemergence

When you apply a herbicide after the crop or weeds appear, it is called **postemergence**. Postemergence herbicides must be very selective in order to control the weeds but leave the crop unharmed.

Growth regulators

A **plant growth regulator** changes normal growth or reproduction in a plant. Some growth regulators advance or retard the normal harvest date for the crop. Others promote better quality and/or yield of the crop. Fertilizers and other nutrients are **not** called growth regulators.

You might use growth regulators to slow the growth of a tree that threatens power lines. That way, the tree doesn't have to be cut down.

Harvest aids

Defoliants and **desiccants** are pesticides called **harvest aids.** A defoliant causes the plant's leaves to drop off early. A desiccant draws moisture from a plant. This kills the plant's leaves.

Rodenticides

Chemicals used to control rats, mice, and other small animals are called **rodenticides**. Some regulatory agencies also include any chemicals that control other mammals, birds, and fish in this category.

Most rodenticides are stomach poisons. Most of the time, they are applied as baits.

Do not apply rodenticides to cover large ares. They are a hazard to other wildlife or domestic animals. Apply them only in certain areas such as runways or known feeding places, or as baits.

Nematicides

Chemicals used to control nematodes are called **nematicides**. Nematodes are tiny, hairlike worms. Most kinds of nematodes live in the soil and feed on plant roots. Only a few kinds live above ground.

Most of the time, soil fumigants are used to control nematodes in the soil. But, there are a few contact insecticides and fungicides that also have an effect against these tiny worms.

To learn more about using fumigants, see "Fumigants," Chapter 12.

Molluscicides

Chemicals that kill snails and slugs are called **molluscicides**. Most of the time, the slug or snail must eat the pesticide to be killed. Poisonous baits often are used to attract and kill snails or slugs.

Repellents

A repellent makes a plant or animal smell or taste bad to the pest. So, the pest doesn't feed on it.

Insect repellents come as aerosols and lotions. Apply them to skin, clothing, or plants to repel biting and nuisance insects.

Vertebrate repellents come as concentrates. You must mix them with water, powders, or granules. You can spray or paint them on nursery crops, ornamental plants, orchards, vineyards, vegetables, and seeds. They repel deer, dogs, birds, and raccoons.

Repellents are registered pesticides. You must use them according to the label.

Be sure there is a real need to use a pesticide. If there is, be sure you know which type of pesticide you need to use, and how and when to apply it to get the best effect.

Questions for study—Chapter 10

1. What is a pesticide?
2. Does the word "insecticide" mean the same as "pesticide"?
3. How does a systemic insecticide contact the pest?
4. What must you think about when you choose to use a broad-spectrum or a specific insecticide?
5. Miticides are like _____icides in action and application.
6. What pests do fungicides control?
7. What are the two basic approaches in the use of fungicides?
8. Would you choose a selective or nonselective herbicide to control weeds in a park?
9. Why is the timing of an herbicide application so important?

10. Explain preplant, preemergence, and postemergence herbicide application.
11. What types of chemicals can you use to change the crop itself?
12. Pesticides that control mammals, birds, and fish often are grouped by law along with _____icides.
13. What are nematodes?
14. What do chitin inhibitors do?
15. Are repellents subject to the provisions of FIFRA?

Chapter 11

The Pesticide Label

The pesticide label is vital for everyone who uses pesticides. The facts and instructions on it come from years of tests and studies. They tell you how to use the pesticide safely and correctly. You always must follow instructions on the label to reduce the chance of harm to yourself, the public, and the environment.

Read the label for each pesticide you use. Don't rely on your memory. Labels change often.

Goals of this chapter

- Describe the facts and instructions found on a label and why they are vital.
- Explain when and why you should read the label.
- Explain how to use what you read on the label when you apply the pesticide.

Labeling

Every pesticide product comes with a lot of written material. All of this material is called the **labeling**. Labeling includes all of these things:

- The label on the product container
- Any extra brochures, leaflets, and facts. They can be attached to the container, or your dealer or some other expert might give them to you.
- Any other text that the label tells you to read

You must comply with **all** of the labeling.

Label

The **label** is what is printed on or attached to a pesticide container.

- The label is the manufacturer's "license to sell."
- The label is a way the state or federal government controls the distribution, storage, sale, use, and disposal of the product.
- The label gives the buyer or handler instructions for safe, correct, and legal product use.
- The label gives a doctor names of chemicals and details on proper treatment for poisoning.

All labels tell you how to use the product the right way.

The label and the law

Each pesticide has a unique label that tells you how to use the product. **The label is the law**. Any use not listed on the label is forbidden.

It is against the law for consultants, salespersons, dealers, or applicators to advise you to use a pesticide in a way not listed on its label. If they give wrong advice, they can be sued.

Each statement on the label has been reviewed. The label itself—not just the pesticide product—has been approved by the EPA. **EPA registers the pesticide and the label only if the data show that handlers, the public, and the environment will not be harmed when the product is used the right way.**

For more detail on EPA registration of pesticides, see Chapter 3.

Labels vary greatly in design and order of information. It depends on what the product is for, when it was issued or reviewed, the size of the package, and the company format. Also, toxicity warnings and approved uses on labels change. So, you must read the label on each container. If you follow the label statements carefully, no illegal residues will remain on any crop.

Though labels are improved through years of research, they are not perfect. Sometimes, parts of the label are hard to understand. If you have any doubts about an application, call the pesticide dealer, the chemical company listed on the label, or your county Extension agent for help.

Directions for use by reference

Often, there is not enough room on the pesticide label to explain all the laws that might apply. There might be special rules you must follow to do these things:

- Protect groundwater
- Protect endangered species
- Transport, store, and dispose of pesticides safely
- Protect workers

EPA does not require all of the directions that apply to a pesticide product to be distributed with it. Sometimes, the labeling refers to some other text or law that you must follow in order to use the product safely. These are called **directions for use by reference**. If the labeling refers to some other text, you must by law read and obey that text also.

You might find only one short statement on the pesticide label or in the labeling that says there are other use directions and restrictions that apply to the product. There might be a statement like this one:

> "Use of this product in a manner inconsistent with the *Pesticide Use Bulletin for Protection of Endangered Species* is a violation of federal laws. Restrictions for the protection of endangered species apply to this product. If restrictions apply to the area in which this product is to be used, you must obtain the *Pesticide Use Bulletin for Protection of Endangered Species* for that county."

You are responsible to find out whether the law or other text referred to on the labeling applies to your case and your intended use of the pesticide product. You must do these things:

- Find out if the rules affect you. Some directions for use by reference apply to all pesticides. In other cases, the instructions and restrictions apply only in certain regions or to certain uses of a pesticide product.
- Find a copy of the directions for use that you need. These texts do not always come with the pesticide product when it is sold. You might have to get them from pesticide dealers or companies, industry groups, or the Extension Service.
- Comply with all the instructions and requirements.

Parts of the label

Disclosure of chemical hazards

The label **names the chemicals** in the container. It lists the contents in a standard format, so you know exactly what you are applying. If you use the wrong chemical or formulation by mistake, you can cause harm to the crop, poor control, or illegal residues. If the crop is unfit for market, you are responsible by law for any losses.

Labels display **signal words** to show the pesticide's **acute toxicity** to humans. They also list the **personal protective equipment** you must wear to use the chemical safely.

Statements about hazards to humans and domestic animals, environmental hazards, and physical or chemical hazards are not in the same place on all pesticide labels. **Search the label for statements to help you apply the pesticide safely.**

Brand, trade, or product names

The manufacturer gives the product a name that it uses to market it. This is called the **brand name** or **trade name**.

Do not choose a pesticide product by brand name alone. Products sold by different manufacturers or registrants have different brand names, even though they contain the same pesticide active ingredient. Or, many companies use nearly the same brand name for entirely different pesticide chemicals. For instance:

Tersan LSR = zinc and maneb
Tersan SP = chloroneb
Tersan 1991 = benomyl
Tersan = thiram

Always read the ingredients statement.

Ingredients statement

Each pesticide label must list plainly the contents of the product. It must show you what the active ingredients are and the amount of each ingredient. The amount of ingredient is given as a percent. The label must list the chemical names. In most cases, common names for the active ingredients are given, but they are not required by law.

Restricted use pesticide. For retail sale to and use only by Certified Applicators, or persons under their direct supervision, and only for those uses covered by the Certified Applicator's certification.

CHEMCO NO PEST INSECTICIDE

KEEP OUT OF REACH OF CHILDREN

DANGER POISON

PELIGRO

ACTIVE INGREDIENT:	**BY WEIGHT**
deltathion (1,2 phospho-(5)-4 chloromethane)	50%
INERT INGREDIENTS:	50%
TOTAL	100%

Net Contents 5 pounds.

EPA Reg. No. 999-000 EPA Est No. 000

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detaile. (If you do not understand the label, find someone to explain it to you in detail.)

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

Wear coveralls over long-sleeved clothing, eye protection, and protective gloves and chemical resistant footwear when handling. Wash hands and face before eating or using tobacco. Shower at the end of work day, washing entire body and hair with soap and water. Change clothing daily. Wash contaminated clothing thoroughly before reusing.

STATEMENT OF PRACTICAL TREATMENT

If Swallowed: Do not induce vomiting. Contains aromatic petroleum solvent. Call a physician or poison control center immediately. **If In Eyes:** Flush with plenty of water for at least 15, minutes. Get medical attention. **If On Skin:** Wash with plenty of soap and water. Get medical attention if irritation persists. **If Inhaled:** Remove to fresh air immediately. Get medical attention.

NOTE TO PHYSICIANS: "No Pest" is a cholinesterase inhibitor. Treat symptomatically. If exposed, plasma and red blood cell cholinesterase tests may indicate significance of exposure (baseline data are useful). Atropine, only by injection, is the preferable antidote. Oximes, such as 2-PAM/protopam, may be therapeutic if used early; however, use only in conjunction with atropine. In case of severe acute poisoning, use antidote immediately after establishing an open airway and respiration.

ENVIRONMENTAL HAZARDS

This pesticide is toxic to birds and extremely toxic to fish. Do not apply directly to water. Do not contaminate water by cleaning of equipment or disposal of waste. This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Avoid use when bees are actively foraging.

"No Pest" is a pesticide which can move (seep) through soil and can contaminate groundwater which may be used as drinking water. "No Pest" has been found in groundwater as a result of agricultural use. Users are advised not to apply "No Pest" where the water table (groundwater) is close to the surface and where the soils are very permeable (i.e., well drained soils such as loamy sands).

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

STORAGE: Store in original container only. Keep container closed when not in use. Store "No Pest" in a well ventilated clean dry area out of reach of children and animals. Do not store in areas where temperature averages 115°F (46°C) or greater. Do not store in or around the home or home garden. Do not store near food or feed. In case of spill or leak on floor or paved surfaces, soak up with sand, earth or synthetic absorbent. Remove to chemical waste area.

PESTICIDE DISPOSAL: Pesticide wastes are toxic. Improper disposal of excess pesticide, spray mixture or rinsate is a violation of federal law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.

CONTAINER DISPOSAL: Metal Containers: Triple rinse (or equivalent). Offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities. **Plastic Containers:** Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or, if allowed by state and local authorities, by open burning. If burned, stay out of smoke. **Glass Containers:** Triple rinse (or equivalent). Then dispose of in a sanitary landfill or by other approved procedures.

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses. and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), notification to workers, and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted entry interval (REI) of 48 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is:

- Coveralls over long-sleeved shirt and long pants
- Waterproof gloves
- Chemical resistant footwear plus socks
- Protective eyewear
- Chemical resistant headgear for overhead applications

Notify workers of the application by warning them orally and by posting warning signs at entrances to treated areas.

The label does not need to name inert ingredients. But, the label must show what percent of the total contents is inert ingredients.

Chemical name

The chemical name is complex. It names the chemical parts and describes the structure of the pesticide. For instance, the chemical name of Sevin 50% WP is 1-naphthyl N-methyl carbamate.

This name almost always is listed in the ingredients statement on the label.

Common name

Because pesticides have complex chemical names, many are given a shorter **common name**. For instance, the common name of Sevin is carbaryl.

EPA must accept a common name before it may be used in the ingredients statement on the label. In most cases, the common name might be followed by the chemical name in the list of active ingredients. A label with the trade name Sevin 50% WP would state these things:

Active ingredient:
Carbaryl (1-naphthyl N-methyl carbamate) 50%
Inert ingredients 50%

Classification

A pesticide classified by the EPA as restricted-use must carry this statement in a distinct place at the top of the label's front panel:

> **RESTRICTED-USE PESTICIDE.** For retail sale to and use only by certified applicators or persons under their direct supervision and only for those uses permitted by the applicator's certification.

The Oregon Department of Agriculture also can classify a product as restricted-use. There might be more words added if there are other rules imposed.

Only certified applicators or people working under their direct supervision may use a restricted-use pesticide (RUP). If the pesticide label does not say it is restricted-use, then anyone may apply it.

Just because there is no restricted-use statement, it does not mean that the product has a low hazard level. Judge the toxicity hazard of all pesticide products by the signal word and the precautionary statements.

Signal words and symbols

Almost every label contains a signal word that tells how hazardous the product is to humans. If you know the product's hazard, you can choose the right ways to safeguard yourself, other persons, or animals who might be exposed.

The signal word appears in large letters on the front panel of the pesticide label. It is based on the highest toxicity of the pesticide via its most sensitive route of exposure.

For more detail on signal words and pesticide toxicity, see Chapter 2.

DANGER

Any product that is highly toxic through the mouth, on the skin, or through inhalation is labeled DANGER. It also must carry the word POISON

with the skull and crossbones symbol printed in red. **Amounts of 1 teaspoonful or less taken by mouth could kill an average-sized adult.**

Any product that causes severe burning to the skin or eyes must have the signal word DANGER on the label without the word POISON.

WARNING

Any product that is moderately toxic through the mouth, on the skin, or through inhalation or causes moderate eye and skin irritation is labeled WARNING. **In some cases, 1 tablespoonful orally could kill the average-sized adult**.

CAUTION

Any product that is slightly toxic to relatively nontoxic through the mouth, on the skin, or through inhalation or causes slight eye and skin irritation is labeled CAUTION. **One ounce to more than 1 pint taken orally could kill the average adult.**

Route of entry statements

The statements that follow right after the signal word indicate the route of entry you must give most care to protect. Routes of entry are through the mouth, skin, lungs, or eyes.

Many pesticide products are hazardous by more than one route of entry. So, study the statements carefully.

DANGER label statements

- Fatal if swallowed
- Poisonous if inhaled
- Fatal if absorbed through the skin
- Corrosive—causes eye damage and severe skin burns

DANGER statements are not written the same way on all labels. More than one precaution might be stated on the same label. Sometimes, all four precautions appear on the same label.

WARNING label statements

- May be fatal if swallowed
- May be fatal if absorbed through the skin
- Causes skin and eye irritation

Some statements on a WARNING label might be like those on a DANGER label or a CAUTION label. There might be two statements combined, such as “harmful or fatal.”

CAUTION label statements

- Harmful if swallowed
- Harmful if absorbed through the skin
- Harmful if inhaled
- Avoid contact with skin and eyes

These statements can vary a lot. They usually are more moderate than the statements found on a DANGER label. They often use the word “harmful” instead of “fatal” or “poisonous,” and “irritant” instead of “corrosive.” Statements can change to reflect certain hazards of the product.

Specific action statements

Specific action statements tell you exactly what to do to prevent pesticide poisoning accidents.

These statements usually are listed below the route of entry statements. They are related to the toxicity of the pesticide product (that is, the signal word) and to the route of entry that you must protect.

DANGER labels contain statements such as these:

- Do not breathe vapors or spray mist.
- Do not get on skin or clothing.
- Do not get in eyes.

(You would not swallow the pesticide on purpose, so the "Do not swallow" statement is not needed.)

CAUTION labels contain exact action statements that are much milder than those on the DANGER label. This shows that the toxicity hazard is not as great.

- Avoid contact with skin or clothing.
- Avoid breathing dusts, vapors, or spray mists.
- Avoid getting in eyes.

Protective clothing and equipment statements

New labels describe all the personal protective equipment (PPE) that you need to use. **Follow all statements on PPE that appear on the label.**

If there isn't a statement, or if the statement mentions only one piece of equipment, **you might be wise to use more protection**. Use the signal word, the route of entry statement, the formulation, and the specific action statement to decide the correct equipment to wear. Table 11 describes the minimum PPE and work clothes you need to wear for each signal word and route of entry. A good choice of PPE depends on knowing the pesticide,

For more detail on choosing the correct personal protective equipment for the job, see Chapter 5.

Table 11. Minimum personal protective equipment (PPE) and work clothing for handling activities.

Route of exposure	Toxicity category of end-use product			
	I (DANGER!)	II (WARNING!)	III (CAUTION!)	IV (CAUTION!)
Dermal toxicity or skin irritation potential[1]	Coveralls worn over long-sleeved shirt and long pants	Coveralls worn over short-sleeved shirt and short pants	Long-sleeved shirt and long pants	Long-sleeved shirt and long pants
	Socks	Socks	Socks	Socks
	Chemical-resistant footwear	Chemical-resistant footwear	Shoes	Shoes
	Chemical-resistant gloves	Chemical-resistant gloves	Chemical-resistant gloves	No minimum[2]
Inhalation toxicity	Respiratory protection device	Respiration protection device	No minimum[2]	No minimum[2]
Eye irritation potential	Protective eyewear	Protective eyewear	No minimum[2]	No minimum[2]

[1]If dermal toxicity and skin irritation potential are in different toxicity categories, protection shall be based on the more toxic (lower numbered) category.
[2]Although no minimum PPE is required by the Worker Protection Standards for this toxicity category and route of exposure, EPA may require PPE on a product-specific basis.

the task you need to do, the weather, the handler, and how these factors interact.

For instance, a WARNING label might state, "Causes skin and eye irritation. Do not get in eyes, on skin, or on clothing. Wear goggles while handling." Even though the label does not require them, also wear coveralls over regular work clothing, chemical-resistant gloves, and footwear. If you will be in contact with the chemical for a long time, or if you are spraying above your head, also wear a chemical-resistant protective suit and hat.

The Worker Protection Standards (WPS) might require more PPE for mixers and loaders than for applicators! Or, the reverse might be true. Read the label carefully.

The safe use of pesticides depends on knowing the risk, choosing the right protective equipment, handling equipment and pesticides with skill, cleaning yourself with care, and seeing your doctor. **Read the label for exact instructions about personal protective equipment and clothing!**

Other precautionary statements

All pesticide labels list other safeguards to protect yourself, your helpers, and other persons or animals that might be exposed. But, **even if they are not on the label, always do these things**:

- Do not contaminate food or feed.
- Remove and wash contaminated clothing before reuse.
- Wash your hands and arms thoroughly after handling and before eating, smoking, drinking, chewing gum, or using the toilet.
- Wash your clothes daily.
- Do not use or store pesticides in or around a house.
- Do not allow children or domestic animals into the treated area.

Part of the pesticide label might be written in other languages, also, for people who don't speak English. The same label requirements apply in every language.

First aid

For more detail on first aid for pesticide poisoning, see Chapter 7.

This section tells you the first aid treatments to give in case of poisoning. It also is called **statement of practical treatment**. Examples are:

- In case of contact with skin, wash immediately with plenty of soap and water.
- In case of contact with eyes, flush with water for 15 minutes and get medical attention.
- In case of inhalation exposure, move from contaminated area and give artificial respiration if necessary.
- If swallowed, drink large quantities of water—do not induce vomiting.

All DANGER labels have a section called First Aid Treatment, Signs or Symptoms of Poisoning, Note to Physicians, or Antidote. They also have an Emergency Assistance telephone number.

Most of the time, WARNING and CAUTION labels do not have this kind of section. Some might give an emergency assistance telephone number near the signal word or precautionary statements.

If you are having poisoning symptoms, go to the doctor. Take the pesticide label with you. The doctor can find the names of the chemicals on the label.

Environmental hazards

Pesticides can be harmful to the environment. Some products are classified as restricted-use because of their hazard to the environment. Label warnings might state that you must protect groundwater and suggest how to do it. Look for special warning statements on the label about hazards to the environment.

Hazards to wildlife

The label states if a certain pesticide is very hazardous to wildlife.

- This product is highly toxic to bees.
- This product is toxic to fish.
- This product is toxic to birds and other wildlife.

The label might tell you not to spray in the morning, near beehives, or near water. It also might tell you where you can get more facts.

These statements help you choose the safest product for a job. They remind you to take extra precautions.

General environmental statements

These statements remind you of the common-sense actions you can follow to avoid contaminating the environment. They list what to do to avoid harm to wildlife. They appear on almost every pesticide label. Sometimes they follow a toxicity statement.

- Do not apply when runoff is likely to occur.
- Do not apply when weather conditions favor drift from treated areas.
- Do not contaminate water when you clean equipment or dispose of wastes.
- Keep out of any body of water.
- Do not allow drift on desirable plants or trees.
- Do not apply when bees are likely to be in the area.
- Do not apply where the water table is close to the surface.

If any or all of these statements do not appear on the label, you still must take good precautions.

Physical or chemical hazards

This section of the label tells you about any special fire, explosion, or chemical hazards the product might pose.

- Flammable—Do not use, pour, spill, or store near heat or an open flame. Do not cut or weld container.
- Corrosive—Store only in a corrosion-resistant tank.
- This product reacts with aluminum to form highly explosive hydrogen gas.

Reentry statement

Some pesticide labels tell you how much time must pass before you can go into a treated area without the correct PPE. These are called **reentry intervals** or **restricted-entry intervals** (REI). Reentry intervals are set by the EPA and by some states.

Reentry intervals set by states are not always listed on the label. Your pesticide dealer should know what they are. If they are listed, use the one stated on the label.

It is against the law to ignore reentry intervals.

WPS has strict rules for PPE that you must wear for early reentry. Follow the statements on the pesticide label!

The reentry statement might appear under the sections titled General Information or Directions for Use. If there is no reentry statement on the label, and if none has been set by the State of Oregon, then you must wait at least until sprays have dried or dusts have settled before you reenter an area.

The reentry statement might include worker safety statements for persons who will be working near or in treated areas. The label might require written and/or oral statements and posting of treated areas.

Storage and disposal

All pesticide labels contain general instructions for the storage and disposal of the pesticide and its container. Common statements include:

- Not for use or storage in or around the home.
- Store away from fertilizers, insecticides, fungicides, and seeds (for herbicides).
- Store at temperatures above 32˚F (0˚C).
- Do not reuse container.
- Do not contaminate water, food, or feed by storage and disposal.
- Multiple rinse and offer this container for recycling or reconditioning. Or, dispose of it in an approved landfill.

These statements might appear in a special section of the label titled Storage and Disposal or under General Instructions. State and local laws vary a lot, so their instructions usually are not on the label.

For more detail on how to store and dispose of pesticides and containers, see Chapter 17.

Choose the best ways to store and dispose of pesticides and containers for what and where your business is. Call the Oregon Department of Environmental Quality or the Department of Agriculture for details on proper pesticide disposal and storage.

Registered uses

The label **lists the uses** the Environmental Protection Agency has approved for the pesticide. If your intended use is not on the label, do not use the product. It is against the law to use a formulation for anything that is not listed on the label. You are responsible by law if there is any accident or crop loss because you used materials in a way that was not approved.

The same active ingredient can be found in many pesticide products. But, each can be registered for a different use. So, you must read each label carefully.

It is against the law in Oregon to apply a product by chemigation unless the label states that you may apply the product in that way.

Type of pesticide

The type of pest the product controls is listed on the front panel of the pesticide label. For instance, the label might state one of these things:

- Insecticide for control of certain insects on fruits, nuts, and ornamentals
- Soil fungicide

- Herbicide for the control of trees, brush, and weeds
- Algicide

Product identification

Net contents

The front panel of the pesticide label states how much is in the container.

Name and address of manufacturer

The law requires the producer or registrant of a product to put the name and address of the company on the label.

Registration and establishment numbers

You need these numbers in case of poisoning, claims of misuse, faulty product, or other lawsuits.

Registration numbers

An EPA registration number must appear on all pesticide labels. The number is proof that the pesticide label has been registered by the federal government.

Most registration numbers have two sets of numbers, such as EPA Reg. No. 3120-280. The first set of numbers—3120—is the registrant's identification number. The second set—280—is the product identification number. Sometimes there are more letters and numbers in the EPA registration number.

In some cases, a state might approve a pesticide product for special local needs. For instance, a registration number might be EPA, SLN No. OR-7709. In this case, SLN means Special Local Need. OR means that the product is registered for use in Oregon.

SLN numbers might not appear on the package label. They might be part of the labeling.

Establishment numbers

The establishment number appears on either the pesticide label or the container. It shows the place that produced or repackaged the product. An establishment number might look like this: EPA Est. No. 5840-AZ-l.

Directions for use

To apply a pesticide product the right way, follow the label's directions for use. They tell you these things:

- The pests that the manufacturer claims the product will control
- The crop, animal, or site the product is meant to protect
- The proper equipment to use
- How much to use. **Approved doses and ways of applying the product** appear on every label. These directions state the largest dosage allowed by law. In some cases, you might not need to use the largest dose to achieve good pest control. Use no more pesticide than you need.
- Mixing directions

To learn more about compatibility of pesticides with other chemicals, see Chapter 15.

- Compatibility with other products. Most of the time, the label states whether you can mix other chemicals with the pesticide. As long as one of the labels does not forbid tank mixing, you can combine other pesticides or fertilizers with the product.

  Some chemicals lose their effect when you combine them. Check that chemicals will work well together **before** you mix.
- Phytotoxicity and other possible injury problems. If the pesticide is likely to injure plants, the label tells you that it is **phytotoxic**. The harm to plants can range from slight damage to death of the plant. Choose a pesticide that is not phytotoxic to the plants you want to protect.
- Corrosion and oxidation of equipment
- When and where to apply the material

Preharvest interval

Labels for agricultural pesticides often list the **preharvest interval** (PHI). This is the least number of days that must pass between the last pesticide application and crop harvest, slaughter, or grazing. EPA sets the PHI for these reasons:

- To allow time for the pesticide to break down in the environment
- To prevent illegal residues on food, feed, or animal products
- To prevent poisoning of grazing animals

Uses inconsistent with the labeling

It is against the law to use a pesticide in any way not permitted by the labeling. You may use a pesticide only on the plants, animals, or sites named in the directions for use. You may not use higher dosages, higher concentrations, or more frequent applications.

You must follow all directions for safety, mixing, diluting, storage, and disposal. You must wear the stated PPE. **The directions and instructions are not advice. They are the law.**

Federal law **does** allow you to use pesticides in some ways not stated in the labeling. Unless you would be breaking the laws of Oregon or your tribe, you may do these things:

- You may apply a pesticide at any dosage, concentration, or frequency **less** than that listed on the labeling.
- You may apply a pesticide against a target pest not listed on the labeling if the application is to a plant, animal, or site that is listed.
- You may use any proper equipment or method of application that is not forbidden by the labeling. In Oregon, no pesticide may be applied through irrigation water (**chemigation**) unless the label permits it.
- You may mix a pesticide or pesticides with a fertilizer if the labeling does not forbid the mixture.
- If they are compatible, you may mix two or more pesticides if all of the dosages are at or below the stated rate.

Special Local Needs and Emergency Exemptions are also legal uses not found on the original EPA label.

Read the label

Before you buy a pesticide, read the label to find out these things:

- Whether it is the right pesticide
- Whether you can use the pesticide safely under your conditions
- Where you can use the pesticide (on livestock, crops, or structures)
- Whether there are any use restrictions for the pesticide
- How much product you need

Before you mix the pesticide, read the label to find out these things:

- What protective equipment you need
- With what you can mix the pesticide (with what it is compatible)
- How much pesticide to use
- How to mix it

Before you apply the pesticide, read the label to find out these things:

- What safety measures you need to follow
- When to apply the pesticide
- What the waiting period is for crops and animals
- How to apply the pesticide

Before you store or dispose of the pesticide or pesticide container, read the label to find out these things:

- Where and how to store the pesticide
- How to decontaminate and dispose of the pesticide container
- What to do with surplus pesticide

Questions for study—Chapter 11

1. Does the label state which protective equipment you need for cautious use of each pesticide?
2. If the intended use is not listed on the label, but you are pretty sure it works, should you go ahead and use it anyway?
3. If you use a material in a way that is not registered and problems arise, are you liable?
4. Is the label something the manufacturer invents just to help sell a product?
5. What are the toxicity warnings on the label based on?
6. EPA registers the pesticide and the label only when there is proof that what things will not be harmed?
7. Do all labels give the official common names for the pesticides in the container?
8. What two words must appear on all labels for highly toxic products?
9. What labels must carry an Antidote or Note to Physician statement?
10. Is the signal word WARNING required on labels for moderately toxic products?

11. All labels for slightly toxic materials must carry the word _____ .
12. What are some other recommendations on the label?
13. Name the four times you need to read the label.
14. Where can you find details on the disposal of unused pesticides and containers?

Chapter 12

Formulations

A pesticide chemical rarely can be used as it was first manufactured. Instead, it must be diluted with water, oil, air, or chemically inactive (**inert**) solids, so it can be handled by application equipment and spread evenly over the area to be treated.

In most cases, the basic chemical cannot be added directly to water or mixed in the field with solids. Manufacturers must add other materials to their products such as solvents, wetting agents, stickers, powders, or granules. The final product is called a **pesticide formulation** or the **formulated product** or the **commercial product**. It is ready for use either as packaged or after it is diluted with water, liquid fertilizers, or other carriers.

Goals of this chapter

- Define the types of formulations and list their abbreviations.
- Show what you must think about to choose the best formulation and when to use it.
- Present the dangers of these formulations and the steps you must take to protect yourself.

Types of formulations

A single pesticide often is sold in more than one type of formulation. The applicator must choose the formulation that best meets the requirements for the job.

To decide on a pesticide formulation, think about all the factors listed below:

- The habits of the pest
- The plant, animal, or surface you must protect
- Application equipment
- The danger of drift and runoff
- Possible harm to the protected surface
- Whether the formulation is effective against the pest

There are three types of formulations. They are:

1. Liquid
2. Dry
3. Fumigants

Abbreviations often are used to describe the type of formulation. These abbreviations are used on labels and in recommendations. Some common ones are listed on the next page.

Liquid	
S	solution
EC or **E**	emulsifiable concentrate
Dry	
WP	wettable powder
G	granules or granular
D	dusts
P	pellets
M	microencapsulated
F	flowable
WDG	water-dispersible granules
DF	dry flowable
SP	soluble powder

Liquid formulations

Emulsifiable concentrates (EC or E)

ECs usually contain from 25 to 75 percent (2 to 8 pounds per gallon) active ingredient. The active ingredient of most ECs is not soluble in water. So, the manufacturer dissolves it in an organic solvent. Most organic solvents are soluble in oil (**lipophilic**).

Most ECs are applied in oil or in water. To be able to mix the EC in water for application, an emulsifying agent (**emulsifier**) must be added to the mixture of the organic solvent with dissolved active ingredient (**ai**). An emulsifying agent makes it possible for us to mix oil in water. Often, other additives (**adjuvants**) such as wetting agents, spreaders, and stickers (see page 143) are added as well.

Advantages

- Because they are oil-soluble, EC formulations tend to penetrate plant surfaces (leaf waxes) better than other formulations.
- They need only moderate agitation in the tank, so they work very well for low-pressure, low-volume sprayers; mist blowers; and small (home) sprayers.
- They are not abrasive.
- They do not settle out when the sprayer is not running.
- There is little visible residue on the treated surface.
- They can be measured by volume, so scales are not needed to measure them, like you need for dry formulations.

Drawbacks

- These pesticides are highly concentrated. So, it is easy to make a mistake when mixing them.
- Mixtures of emulsifiable concentrates may be **phytotoxic** (toxic to plants).
- Because they are oil-soluble, they are absorbed easily through the skin and may be a hazard to pesticide handlers. Mix these carefully.

- Emulsifiable concentrates contain solvents that quickly damage rubber hoses, gaskets, and pump parts unless they are made of neoprene rubber. Some formulations even cause pitting of car finishes.

Main uses

Emulsifiable concentrates can be diluted and used on fruit, vegetables, shade trees, farm animals, and to control structural pests. Household sprayers, hydraulic sprayers, low-volume ground sprayers, mist blowers, low-volume agricultural aircraft sprayers, and ultralow-volume sprayers all can spray EC formulations.

To learn more about pesticide application equipment, see Chapter 13.

Solutions (S)

Some pesticide active ingredients dissolve readily in a petroleum-based or water solvent. When mixed with the solvent, they form a **solution** that does not settle out or separate. **Formulations of these pesticides usually contain the active ingredient, the solvent, and one or more other ingredients.**

Solutions may be used in various types of sprayers indoors or outdoors.

Ready-to-use (RTU)

These are solutions of highly refined oils and low concentrations of pesticide. In most cases, they are used as purchased.

Advantages

- Low-concentrate solutions are designed to be sprayed as purchased. They do not need mixing, so there is less chance to make a mistake.
- Household formulations do not have a bad smell. In most cases, the liquid evaporates quickly and does not stain fabrics and furniture.

Drawbacks

- Low-concentrate formulations are fairly costly for the amount of active ingredient bought.
- There are few uses for low-concentrate formulations.

Main uses

Low-concentrate solutions may be used in the home for flying or crawling insects and for mothproofing clothes. In barns, they may be used as space sprays and fly sprays for livestock. They also are used as prepared sprays for mosquito control and shade tree insect control.

Concentrate solutions (C or LC)

Some solutions are sold as concentrates that must be diluted further with a liquid carrier (**diluent**) before they are applied. Sometimes the carrier is water, but more often it is specially refined oil or petroleum.

Advantages

- These do not need agitation.
- Other advantages vary depending on the solvent used, the concentration of the active ingredient, and the type of application.

Drawbacks

There are few formulations of this type for sale.

Main uses

Concentrate solutions are used for structural and institutional pest control, control of some household pests, livestock and poultry pest control, space sprays in barns and warehouses, shade tree pest control, and mosquito control.

Ultralow-volume (ULV)

These concentrates can be almost 100 percent active ingredient. They are designed to be used as purchased or to be diluted with only small amounts of certain solvents.

Advantages

- They are fairly easy to handle, transport, and store.
- They require little agitation.
- They are not abrasive to equipment.
- They do not plug screens and nozzles.
- They leave little visible residue on treated surfaces.

Drawbacks

- ULV formulations have a high drift hazard. It is hard to keep them in the target site.
- Specialized, precisely metered equipment is required.
- Solvents used in the formulations—or the concentrated form of the active ingredient itself—damage rubber or plastic hoses, gaskets, and pump parts and surfaces.
- There is a lot of hazard to the handler, because the concentrated pesticide in these formulations is absorbed easily through the skin.

Main uses

ULV formulations are for special uses mostly outdoors, such as in agriculture, forestry, ornamental, and mosquito control programs.

Aerosols (A)

Aerosols are sold in small, pressurized cans that contain a small amount of pesticide or a combination of pesticides. Sometimes they are called "bug bombs." When the nozzle is triggered, the mixture is driven through a fine opening by a chemically inactive gas under pressure.

Advantages

- Aerosols are always ready to use.
- They are a way to buy small amounts of a pesticide.
- They are easy to store, and the pesticides do not lose their strength while in storage.

Drawbacks

- Aerosols are only practical for use in small areas.
- A can contains little active ingredient, so this is a costly way to buy pesticides.
- Small children are tempted to play with aerosol cans. If cans are left in reach, they are a hazard.
- Aerosols can be dangerous if cans are punctured or overheated. They could explode and hurt someone. **Never** burn aerosol cans.

Main uses

Aerosols are used most often in homes, backyards, tents, and other small areas. They may be used either as space sprays for flying insects or as residual sprays. In most cases, they are used against insects, but some are designed for plant diseases or weeds.

There are commercial models for use in greenhouses, barns, and other large indoor areas. These hold 5 to 10 pounds of pesticide, and most of them are refillable.

Dry formulations

Dusts (D)

A prepared dust is a finely ground, dry mixture combining a low concentration of pesticide with a carrier such as talc, clay, or volcanic ash. There is a wide range in size of the dust particles in any one formulation.

Advantages

- Dusts are ready to use as purchased and need no mixing.
- Even for commercial use, they can be applied with simple, lightweight equipment.

Drawbacks

- Because dust particles are so fine, they can drift long distances from the treated area and contaminate off-target areas. Never apply dust formulations on a windy day.
- When used outside, they easily can be dislodged from the treated surface by wind and rain and soon become inactive.
- Dust can drift into the handler's face and be inhaled.

To learn more about weather conditions and pesticide application, see Chapter 16.

Main uses

Inside, dusts are used in cracks and crevices to control roaches and other domestic insects. Dusts also are used to control lice, fleas, and other parasites on the skin of pets and livestock.

Because of drift, dusts are not recommended for large-scale outdoor use. Outside, they are used mostly for spot treatments and home gardens, and they work best when applied to dewy surfaces in the early morning.

Poisonous baits

A poisonous bait is a pesticide mixed with a food or other substance that attracts pests to eat it. After a while, it causes their death.

Advantages

- Baits are used to control flies, rats, and other pests that range over a large area. Often the whole area need not be covered, just the spots where the pests gather.
- In most cases, only small amounts of pesticide are used compared to the total area treated, so environmental pollution is low.

Drawbacks

- Baits must be set in just the right places in homes, gardens, granaries, and other agricultural buildings, so they do not contaminate food or feed and can be removed after use. They must be used with care. Within the home, baits often attract children or pets and cause them danger. Outdoors, baits can kill domestic animals and wildlife.
- When you kill larger pests with baits, you must dispose of their bodies so they do not cause an odor or a sanitation problem. There also is the problem that other animals feeding on the poisoned pests can be poisoned as well.
- Often, pests prefer the protected crop or food rather than the bait, so the bait can be ineffective.

Main uses

Baits are used inside buildings for ants, roaches, flies, rats, and mice. Outdoors, they may be used in gardens to control slugs; in dumps to control rats; and in fields to control gophers, orchard mice (voles), slugs, and insects.

Granules (G)

Like dusts, pesticide granules are dry, ready-to-use, low-concentrate mixtures of pesticide and inert carriers. But, unlike dusts, almost all of the particles in a granular formulation are about the same size, and they are larger than those making up a dust. A fine granular pesticide pours like salt or sugar.

Advantages

- Granules are ready to use as purchased and need no further mixing.
- Because the particles are large, heavy compared to dust, and more or less the same size, they drift less than most other formulations. Little toxic dust will drift into the handler's face, so there is less chance that he or she will inhale it.
- Granules often can be applied with simple, multipurpose equipment such as seeders or fertilizer spreaders.
- Granules will work their way through dense foliage to a target underneath.

Drawbacks

- In most cases, granular formulations do not work for treating foliage because they do not stick to it.
- They might need moisture to start the pesticidal action.
- Granules can be hazardous to nontarget species, especially waterfowl and other birds that feed on the grain- or seedlike granules by mistake.

Main uses

- Granular pesticides often are used for soil treatments to control pests living at ground level or underground.
- They may be used as **soil systemics** (formulations applied to soil that a plant absorbs through the roots and carries throughout its system).

- Granular herbicides and insecticides often are applied with fertilizers on turf, thereby saving labor.
- Granular formulations may be the choice for application by aircraft where drift is a problem, or when treating water for mosquitoes where the water has heavy foliage covering it.

Pellets (P or PS)

Most pellet formulations are like granular formulations, but larger. In fact, both terms sometimes are used to mean the same thing. But, in a pellet formulation, all the particles are about the same weight and shape. Because the particles are all the same, they can be applied by precision applicators such as those that are used for planting pelleted seed.

A few fumigants are formulated as pellets which dissolve with moisture and form a gas. These are labeled clearly as fumigants, and you must not confuse them with pellets that are not fumigants.

Wettable or soluble powders (WP or SP)

Wettable powders and soluble powders are dry preparations that contain a highly varying percent of active ingredient. The amount of pesticide in these powders varies from 15 to 95 percent.

Wettable powders are mixed with water to form **suspensions**. Soluble powders dissolve in water to form **solutions**.

Advantages

- They are easy to store, transport, and handle.
- They are safer to use on tender foliage.
- In most cases, they do not absorb through the skin as fast as liquid formulations.
- They are easy to measure and mix when preparing the spray mix.

Drawbacks

- Wettable powders can be hazardous if the handler inhales their concentrated dust while mixing.
- They require good agitation (mechanical, in most cases) in the sprayer tank.
- They settle quickly if the sprayer is turned off.
- They are abrasive and cause some pumps and nozzles to wear out quickly.
- Because their residue is more visible, they can soil cars, windows, and other finished surfaces.

Main uses

Liquid concentrates and wettable powders are the formulations used most by commercial applicators. Like liquid concentrates, wettable powders can be used for most pest problems and in most spray machinery.

Where toxicity to the plant or absorption through the skin of an animal is a problem, use a wettable powder suspension rather than a liquid emulsion or solution of the pesticide.

Microencapsulated pesticides (M)

Microencapsulated formulations are small amounts of pesticide (liquid or dry) surrounded by a kind of plastic coating to form a very small (micro) capsule. The formulated product is mixed with water and then applied as a spray. Once applied, the capsule slowly releases the pesticide. This process can prolong the life of the pesticide because there is a timed release of the active ingredient.

Advantages

- Most of the time, these formulations are safer for the handler.
- They are easy to mix, handle, and apply.
- The timed release extends the useful life of the pesticide.

Drawbacks

- Constant agitation of the spray in the tank is needed to prevent settling.
- Bees often pick up the capsules and carry them back to their hive, where the released pesticide can poison the entire hive.

Water-dispersible granules (dry flowables) (WDG or DF)

Dry flowables and **dispersible granules** are both names for formulations made of small granules that disperse into a suspension, just like a wettable powder, when added to water. In fact, these formulations are modified wettable powders with more adjuvants that reduce "dust" and allow them to flow much like a liquid. They are becoming very popular because of ease of handling.

When WDG or DF formulations are mixed with water, they act like wettable powders. Once in water, the granules break apart into fine particles. The formulation requires constant agitation to keep it suspended in water.

Water-dispersible granules have the same advantages and drawbacks of wettable powders, plus the advantages listed below:

- They are even easier to measure and mix.
- The handler is less likely to inhale them during pouring and mixing.

Fumigants

Fumigants are pesticides in the form of poisonous gases that kill when absorbed or inhaled.

Advantages

- A single fumigant can be toxic to many forms and types of pests. So, a single treatment with one fumigant could kill insects, weed seeds, nematodes, and fungi.
- Fumigants penetrate into cracks, crevices, burrows, soil, and other places that are not gas tight. So, they expose hidden pests to the killing action of the pesticide.

Drawbacks

- In most cases, the area to be fumigated must be enclosed. Even in outdoor treatments, the area either must be covered by a tarp, or the fumigant must be incorporated into the soil so it doesn't escape.
- Fumigants are highly toxic. You must use proper techniques and all recommended protective gear when applying them. Most fumigants burn the skin.

Main uses

- Fumigants are used inside buildings to control vermin that cannot be reached by other pesticide formulations.
- They are used in ports of entry and at state borders for treatment of plants and other materials to prevent new pests coming into an area.
- Stored grain pests often are controlled with fumigants.
- Soil is fumigated to kill all pests before planting.

Adjuvants

An **adjuvant** is a chemical added to a pesticide formulation or mixture to improve its action and safety. Most pesticide formulations contain at least a small amount of one or more adjuvants.

Some of the most common adjuvants are **surfactants** (**sur**face **act**ive **a**ge**nts**)—that change the dispersing, spreading, and/or wetting action of spray droplets. Surfactants include these listed below:

- **Wetting agents** allow wettable powders to mix with water.
- **Spreaders** allow the pesticide to spread out more, thus coating the treated surface better.
- **Penetrants** allow the pesticide to get through the outer surface to the inside of the treated target.

Here are some other common adjuvants:

- **Emulsifiers** allow petroleum-based pesticides (ECs) to mix with water.
- **Invert emulsifiers** allow water-based pesticides to mix with a petroleum carrier.
- **Stickers** allow pesticides to stay on the treated surface for a longer time without being dislodged.
- **Foaming agents** keep pesticides moist for a longer time on leaf surfaces and reduce drift.
- **Thickeners** reduce drift by increasing droplet size.
- **Safeners** reduce the toxicity of certain herbicides to some crop plants.
- **Compatibility agents** aid in combining pesticides effectively.
- **Buffers** allow pesticides to mix with diluents or with other pesticides or water of different acidity or alkalinity.
- **Antifoaming agents** reduce foaming of spray mixtures that require vigorous agitation.

Take care before using adjuvants. Some labels very clearly prohibit their use. Others clearly state the type of adjuvant that can be used and when it should be added to a spray mixture.

The right formulation can be the factor that makes an effective control job instead of a failed application that does more harm than good. Choose wisely.

Questions for study—Chapter 12

1. When a pesticide active ingredient is mixed with solvents, wetting agents, stickers, powders, or granules, the final product is called a _____ .
2. What are the common abbreviations for these types of formulations?
   Wettable powder _____
   emulsifiable concentrate _____
   dust _____
   granules _____
3. What must you think about when choosing the best formulation for your job? (Name six items.)
4. Which pesticide formulation is used most often in homes, backyards, and other small areas?
5. Which pesticide formulation can be dangerous if the container is punctured or overheated?
6. Why, in most cases, are dust formulations not used outdoors on a large-scale basis?
7. For what types of pests are poisonous bait formulations used?
8. Why are poisonous baits often used in small amounts?
9. How do granule formulations differ from dust formulations?
10. What advantages do granules have over dusts and sprays?
11. Why wouldn't you choose a granular formulation if you were going to treat a tree or lettuce leaf?
12. Why would you choose a low-concentrate liquid formulation if you wanted to be sure of getting the right mixture?
13. Which formulation would you choose if you wanted little visible residue and only moderate agitation?
14. Which formulation is more hazardous to the handler than most, because it is absorbed easily by the skin?
15. What is the difference between emulsifiable concentrates and flowables?
16. Would you choose an EC or a WP if phytotoxicity might be a problem?
17. Why should a handler wear a dust mask or respirator when mixing soluble or wettable powders?

18. Which formulation would you choose if you wanted to penetrate cracks, crevices, soil, burrows, and other unexposed areas?
19. Name two drawbacks of fumigants.

Chapter 13

Equipment

Goals of this chapter

- Give the names and uses of different application equipment.
- Explain how to choose the best application equipment for the job.
- Explain how each kind of equipment works.

Choose your equipment wisely

There are many kinds of **pesticide application equipment**. Some is simple, like a paintbrush, plunger duster, pressurized can, or aerosol bomb. Some is very complex, like an airplane equipped with liquid spray systems or granule spreaders.

What kind of equipment to use depends on your working conditions, the pesticide formulation, and where you want to apply the pesticide. If you choose the best type of equipment for the job, you can save time and money.

There are mainly two kinds of application equipment.

- **Dry formulation equipment**, for applying dry pesticide formulations
- **Liquid formulation equipment**, for applying liquid pesticides

Dry formulation equipment

Dusters

Dusters blow fine particles of pesticide dust onto the target surface. They can be built simply. Often the pesticide package is the duster, such as a plastic squeeze bottle with a spout.

Home gardeners, pest control operators, and truck gardeners mostly use dusters. They use them for spot treatment of plants or for small areas.

Sometimes you might apply dusts to large areas with an airplane.

Advantages

- Dusters are lightweight, fairly cheap, and fast acting.
- They do not need water.

Drawbacks

- Dusters are not the best choice for most crops or large outdoor jobs. Dusts are easy to see in the air. They drift easily. They are hard to control.

Granule spreaders

Granule spreaders apply same-sized, coarse, dry particles to soil, water, and leaves of plants.

Some spreaders are small. You can use them on home lawns. Some spreaders are big enough to cover large fields.

These are some kinds of spreaders:

- **Multiple gravity feed outlets**. These are called **lawn spreaders** and **grain drills**.
- **Soil injectors**. These are for placing pesticides in the soil.
- **Ram-air**. These are for airplanes.
- **Whirling discs**. These are called **seeders** and **fertilizer spreaders**. You can use seeders and fertilizer spreaders to apply pesticide granules.

Advantages

- Granule spreaders are light, simple to use, easy to calibrate, and need no water.
- Granules flow easily.

Drawbacks

- You can use granular formulations only a few ways.
- Granules may poison wildlife if they are left uncovered.

Liquid formulation equipment

Sprayers that apply liquids are called **hydraulic** sprayers. "Hydraulic" comes from the Greek word *hydros,* which means "water."

Sprayers

Hand sprayers

Hand sprayers use compressed air to force the spray solution through a nozzle.

People use hand sprayers for small pest problems or for small jobs that do not need large power equipment. You also can use them for hard-to-reach places where you must carry in the spray equipment.

Advantages

- Hand sprayers are simple and lightweight. You can use them for many pest problems.
- Drift usually is not a problem with hand sprayers. This is because they use small amounts of spray at low pressures.
- If you need to spray in a sensitive area, you attract less attention when you use a hand sprayer.

Drawbacks

- Hand sprayers are not best for large jobs nor are they good for applying wettable powders. It is too hard to keep the mixture blended.
- With small tanks, you have to pump them often or pressure drops quickly.

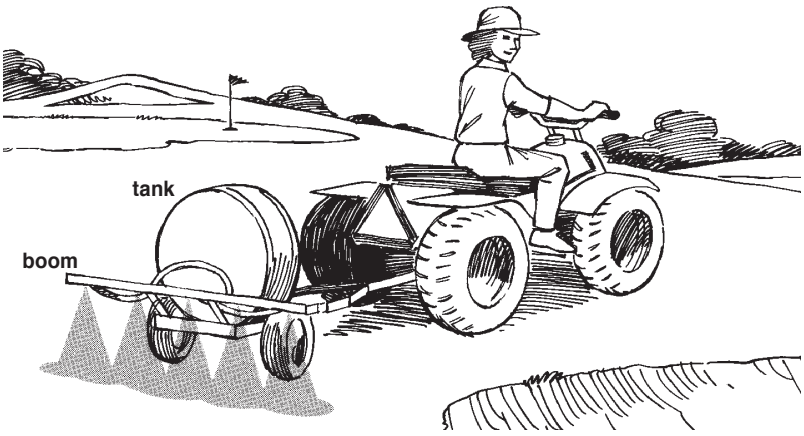
Low-pressure boom sprayers

Common low-pressure sprayers are made of:

- A roller or centrifugal pump
- A tank
- An agitation system
- Flow control valves
- Nozzles along a pipe or other structure called a **boom**

Low-pressure sprayers usually are mounted on tractors, trucks, or trailers. You can use them to spray field crops or large fields of turfgrass.

Low-pressure sprayers generally use 10 to 40 gallons per acre of dilute spray solution applied at about 20 to 60 psi.



Low-pressure sprayer for turfgrass.

Advantages

- Low-pressure sprayers don't cost a lot of money.
- They are lightweight and can cover large areas fast.
- You can use them for many kinds of applications.
- They apply at a fairly low volume, so one tankful covers a large area.

Drawbacks

- Low-pressure sprayers do not penetrate thick layers of leaves or cover them well.
- Many low-pressure sprayers use hydraulic agitators. These do not keep wettable powder formulations mixed well in the tank. (You can use mechanical agitators to solve this problem.)

High-pressure sprayers

High-pressure sprayers are like low-pressure sprayers, but they are built to work with high pressures (from 250 psi to several hundred psi). They can do the work of a low-pressure boom sprayer if you put a boom on them. You also can put a handgun or long hose on a high-pressure sprayer. With these you can spray shade trees and ornamentals, livestock, orchards, buildings, unwanted brush, rights-of-way, and commercial crops.

Advantages

- High-pressure sprayers can force spray through heavy brush, thick cow hair, or to the tops of tall shade trees.
- High-pressure sprayers use piston pumps. These pumps resist wear from abrasive materials.
- High-pressure sprayers also use mechanical agitators. These keep wettable powders well mixed in the tank.

Drawbacks

- High-pressure hydraulic sprayers must be strongly built. They can be heavy and costly.
- They use large amounts of water, so you need to fill them often.
- Spraying at high pressure makes it easier for pesticides to drift.

Air-blast sprayers

Air-blast sprayers use air and water to apply the pesticide to the target. First, they pump the pesticide mixture through a nozzle. Then, a high-speed fan blows the pesticide away from the spraying nozzle. The rushing air shatters the stream of spray into tiny droplets and carries them to the target. The droplets can go from 10 to 40 feet, depending on the fan speed.

Air-blast sprayers mostly are used for spraying trees. They also are used on field crops. The air blast helps the spray go through the layers of leaves and cover all plant parts.

Advantages

- Air-blast sprayers apply a fairly low volume per acre. So, you spend less time refilling the tank.
- You can apply pesticide easily to hard-to-reach places under thick layers of leaves.

Drawbacks

- Air-blast sprayers are expensive.
- You can use them only when the weather is calm. Wind changes the normal application pattern of the blower. Wind also can cause the small spray particles to drift away from the target.

Low- and ultralow-volume sprayers (ULVs and mist blowers)

Mist blowers apply low volumes of pesticide in the form of a mist. A fan or whirling disk breaks up and blows tiny droplets of spray toward the target. The mist is often hard to see.

Low-volume mist blowers use a diluted pesticide mixture. ULV mist blowers use undiluted concentrate.

Advantages

- Low-volume sprayers save time and work.
- They are lightweight and easy to use.
- They carry small amounts of spray mixture and get good pest control with a small amount of spray.

Drawbacks

- Concentrated pesticides cause the greatest risk to you, the applicator.
- It is easy to apply too much pesticide if your sprayer is not calibrated exactly.
- The air must be calm to use this equipment safely. Drifting concentrates can harm people, animals, or other crops.
- Low-volume spraying may not control some pests.
- Only a few pesticides are labeled for ULV application at this time.

Aerosol generators (foggers)

Foggers break certain pesticide formulations into a fog of tiny droplets. The fog is called an **aerosol**.

Some foggers heat the pesticide to turn it into a fog. These are called **thermal aerosol generators**. Other foggers break the pesticide into tiny

particles using whirling discs, air blast, or extremely fine nozzles. A single droplet is so small that it cannot be seen with the naked eye.

You mostly would use a fogger to cover a whole area such as a greenhouse, warehouse, or open recreational grounds. The fog kills insects and other pests that come in contact with it.

Advantages

- The droplets made by foggers are so small they do not leave ugly residues. So, you can use foggers in the home for flying insects, in commercial buildings for pests, or outdoors for blackflies and mosquitoes.
- The droplets can go through tiny cracks in furniture. They can go through thick layers of leaves.
- Because foggers blanket an area, it is difficult for pests to escape.

Drawbacks

- Most of the droplets made by foggers do not stick to surfaces. As soon as the aerosol moves out of a place, other pests can move back in. (This can be an advantage if you need to move back into a treated area as soon as possible.)
- The droplets are so small that they drift for long distances. The drift can cause problems.
- Most foggers need special pesticide formulations. You cannot use a general-purpose formulation.
- The weather must be just right to use a fogger outside. There must be little or no wind, or the pesticide may blow away before it can kill the target pests. For example, if you are spraying for mosquitoes, rising air currents could carry the aerosol over the pests and out of the area.
- After you spray a building or an area, be sure to air it out well before people move back in.

Pumps

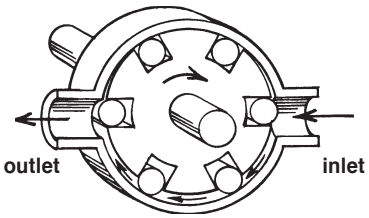
Flexible-impeller pumps

Flexible-impeller pumps have a series of rubber paddles attached to a rotating hub. The inside of the pump is not round, and it squeezes the paddles as the hub turns. The spray mixture is trapped between the paddles and squeezed out of a hole in the side of the pump.

Some of the mixture leaks around the paddles as they turn. This gives an automatic pressure relief. In most cases, these pumps do not reach more than 50 psi. They cannot work with abrasive materials.

Roller pumps

The rollers in a roller pump fit into slots of a rotating hub. The slots allow the rollers to follow the oval shape of the inside of the pump. Spray mixture trapped between the rollers is pushed out a hole in the side of the pump.



Roller pump.

Because the rollers let mixture leak around them, the output from a roller pump goes down as pressure rises.

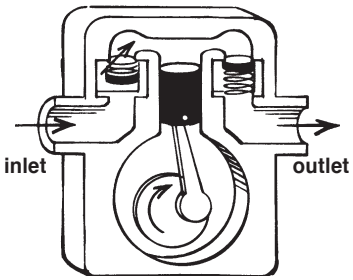
Applicators use roller pumps the most because they work well, are flexible, and are fairly inexpensive. Worn roller pumps can be rebuilt easily without costing a lot of money.

Centrifugal pumps

Centrifugal pumps handle abrasive materials well. Their high volume capacity gives a lot of hydraulic agitation.

These pumps do not make high pressures. They must rotate at high speed. You must use belt, gear, or hydraulic drives to gear up the pump to high speed.

Centrifugal pumps require priming, unless they are below the level of the supply tank. You can adjust pump output easily with a relief valve on the output line. But, relief valves sometimes cause uneven output.



Piston pump

Piston pumps

Piston pumps are positive displacement pumps. This means that every time the piston moves, liquid must pump out.

These pumps do not "leak" as roller pumps do, so high pressure builds up. They put out a low volume, so they may not agitate well.

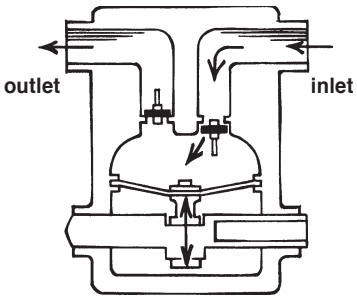
These are the most expensive pumps. They are good for abrasive mixtures such as wettable powders.

Gear pumps

The gear pump is another type of positive displacement pump. Applicators rarely use gear pumps now, because they wear out fast when they pump abrasive mixtures.

Gear pumps are good for pumping oil suspensions or emulsions at high volumes and pressures.

The pump housing and gears are made of bronze. The shaft is stainless steel. The pump cannot be rebuilt. You must throw it away when it wears out.



Diaphragm pump

Diaphragm pumps

The motion of a flexible diaphragm makes the pumping action. Liquid is drawn in on the downstroke and forced out on the upstroke.

These pumps also are positive displacement pumps. They are built with one or two diaphragms that resist wear from abrasives. But, certain chemicals can damage them.

Diaphragm pumps don't cost a lot of money. They are easy to repair.

Ground-driven pumps

Ground driven pumps are powered by a ground wheel. They also are called **metering pumps**. When speed changes, the rate of pumping

changes with it. The big advantage of these pumps is that the application rate holds fairly constant as you drive over changing ground.

Two types of pumps normally are used on sprayers with ground drives.

1. The **variable-stroke piston pump**. With this pump, you can change the length of the piston stroke to adjust the application rate. Increasing piston stroke increases flow. Reducing stroke cuts flow. The application rate stays fairly even whether the sprayer is traveling at 1 mph or 5 mph.
2. The **hose pump**. This pump is a series of rollers on a reel with a flexible hose stretched over the reel. As the ground wheel drives the reel, the rollers roll over the hose and push fluid out. You cannot change the flow from this pump.

Sprayer nozzles

Nozzles, especially the **spray tips**, can be the most important part in a steady, even application. They do three things:

1. Meter or adjust the flow of the liquid
2. Turn the liquid stream into droplets (**atomize** it)
3. Spread the droplets in a certain pattern

Adjust flow

The size of the nozzle's orifice plus the pressure of the liquid affect the flow of liquid. With most nozzles, flow rate increases as pressure increases.

Doubling the pressure **does not** double the flow rate. You must increase pressure by four to double the flow rate.

Atomize stream

The nozzle spreads the liquid into a thin layer. The tearing action of air breaks the layer of liquid into tiny droplets. This is called **atomization**.

If you make the pressure stronger, you increase the tearing action. This makes smaller droplets.

Think about droplet size when you choose nozzles. If the droplets are too small, drift becomes a problem. If droplets are too large, they do not stick to the target surface. They roll off.

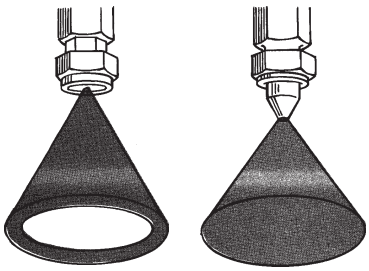
Each nozzle makes a range of droplet sizes. Droplet size is measured in **microns**.

A micron is one millionth of a meter. There are about 25,400 microns in an inch. A drop of water dripping from a faucet is about 5,500 microns. Fog droplets are from 25 to 50 microns.

Most nozzle makers give details on droplet size in their catalogs. Ask your dealer for information.

The pesticide industry is working to help applicators reduce pesticide drift. New national and international standards are being adopted

which classify nozzles as very fine, fine, medium, coarse, very coarse, and extremely coarse. A standard color-code is proposed for each classification. Pesticide labels will suggest which droplet-size nozzle you should use.



Hollow-cone and solid-cone spray patterns.

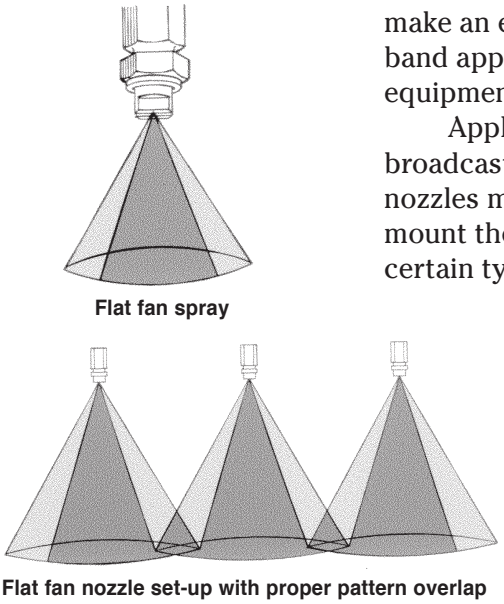
Nozzle spray patterns

Hollow-cone and **solid-cone** nozzles make a pattern shaped like a circle. Hollow-cone nozzles make smaller droplets than the solid cone. These nozzles are used on handgun sprayers and row crop sprayers, usually at pressure above 50 psi. They go through thick layers of leaves well. You can use them to apply fungicides, insecticides, and sometimes herbicides.

You can use **flat-fan spray** nozzles to broadcast most types of pesticides. The pattern they make is fan shaped, with gradually tapered edges. You get an even application across the sprayer width by overlapping the tapered part of the pattern.

Even flat-fan spray nozzles make a narrow, rectangular pattern. They make an even application across the entire width. You can use them for band applications of chemicals. Applicators often use them with planting equipment.

Applicators often use **flooding-fan** nozzles (impact nozzles) for broadcast application of fertilizers, herbicides, and defoliants. These nozzles make a wide, flat spray pattern with large droplets. You can mount them on a boom in different positions. You sometimes can use certain types of flooding nozzles for boomless broadcast spraying.



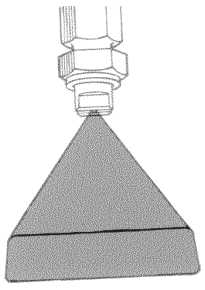
Flat fan spray pattern.

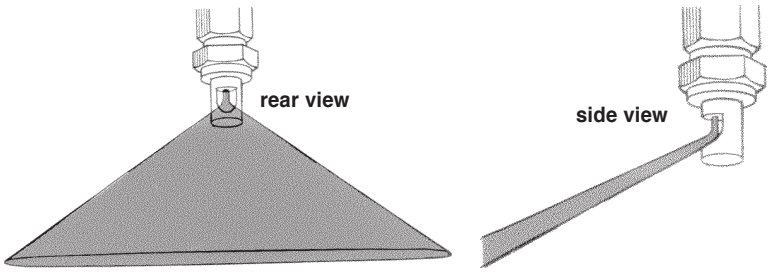
Multipattern spray nozzles usually have different spray tips built into one nozzle. You choose the pattern by turning the nozzle body to the spray tip you want.

Usually, there are two flat-fan patterns. One makes small droplets and low-volume patterns. One has a large-volume fan that makes large droplets.

Another pattern is the variable stream. This makes a range of stream patterns. The pin stream can apply the pesticide into a hole or crevice. The solid stream can spray trees or distant objects.

You also can attach a crack and crevice tool.


Even flat-fan spray pattern.



Flooding flat spray pattern.

Nozzle materials

Applicators choose spray nozzles of different materials for how much they cost and how long they last. Here is a list of most common nozzle materials. **RL** stands for **relative wear life**. This means how long the nozzle should last.

- **Brass** is used the most. It wears out most easily. It does not cost a lot. RL = 1
- **Plastic or nylon** is used for formulations that are not abrasive. It does not corrode easily. It does not cost a lot. It is not good for high pressure. RL = 1–1.5
- **Stainless steel** does not corrode or wear easily. It costs more money than brass or plastic. RL = 3–4
- **Hardened stainless steel** is useful for highly abrasive formulations. It costs more than brass, plastic, or stainless steel. RL = 4–6
- **Ceramic** lasts longest using highly abrasive and corrosive chemicals. It costs four to five times more than brass. It comes in only a few sizes. RL = 10–40

Maintain the nozzle

The edges of nozzle **orifices** (holes) are finely machined. They control the spray pattern. They can be damaged by dirt and abrasive spray mixtures.

You must protect nozzles from grit and dirt with good screens. Make sure there is a filter in each nozzle.

Clean clogged tips only with a soft-bristled brush. A metal object can damage the orifice. **Never put a clogged nozzle to your mouth to clean it!**

Nozzles wear out

Worn nozzles have uneven spray patterns and higher flow rates than new nozzles. Test spray tip wear by comparing the flow rate of a used tip to the flow rate of a new one. To compare the flow rate, collect liquid from each tip for a measured length of time. Collect the liquid in a container that measures the liquid correctly.

If the flow rate of the used tip is 10 percent greater than a new one, replace it.

To learn about calibration of equipment, see Chapter 14.

Care of equipment

Whether equipment is simple or complex, it needs proper care so it will work well and safely. You always must clean equipment, including hoses, nozzles, pumps, tanks, and hoppers.

Put antifreeze or alcohol through pumps and other equipment that you store in below-freezing weather. Remove and clean nozzles before you store them.

Cleaning sprayers

Wear the right protective clothing when you clean any piece of application equipment.

Clean the sprayer after each day's use. Flush the equipment with clean water inside and out. This helps prevent corrosion and buildup of chemicals.

When you are finished for the season, or when you change chemicals, clean the sprayer very well with a cleaning agent. Be careful not to pollute water supplies. Do not harm plants or animals.

Follow these steps for cleaning a sprayer:

1. Wash the inside of the tank and fill it part way with water. Flush this water through the nozzles. When the tank is empty, repeat these steps. Give the tank two complete rinses.
2. Remove the nozzle tips and screens. Clean them with a soft brush and a strong detergent or kerosene.
3. Add water to the tank a third time, adding a cleaning agent. Agitate and flush this through the system.

Table 12 lists cleaning agents. It tells how to use them to clean certain pesticides from equipment.

Table 12. Cleaning agents and amounts for cleaning sprayers.

Pesticide used	2½ gallons cleaning solution	Instructions
Insecticides* and/or fungicides	1 tbsp powdered detergent**	Agitate, flush, and rinse.
Hormone herbicides, salt or amine formulations (2,4-D, dicamba, MCPA, etc.)***	½ cup household ammonia	Thoroughly agitate, flush small amount through system, and let the rest stand in sprayer overnight. Flush and rinse.
	or 3 tbsp washing soda (sal soda)	Same as above, except let stand for at least 2 hours.
	or ¼ lb trisodium phosphate	Same as above, except let stand for at least 2 hours.
	or 2 tbsp fine activated charcoal and 1 to 2 oz powdered detergent**	Agitate, run the sprayer for 2 minutes, let stand for at least 10 minutes, then flush through sprayer. Rinse.
Hormone herbicides, ester formulations (2,4-D, brush killers, MCPA, etc.)*	4 oz washing soda (sal soda) + 1½ cup kerosene + 1 tbsp powdered detergent**	Rinse inside of tank and flush small amount through system. Let stand at least 2 hours. Flush and rinse.
Other herbicides (atrazine, simazine, alachlor, etc.)	1 tbsp powdered detergent**	Rinse with clean water before and after using sudsy solution.

* You can detoxify some organophosphate and carbamate insecticides by adding household ammonia to the cleaning solution (½ cup per 2½ gallons).

** You may substitute liquid detergent for powdered detergent; mix enough to make a sudsy solution.

*** Caution: Since only a trace of herbicide can damage sensitive plants, it may be risky to use an insecticide or fungicide in a sprayer that has been used to apply 2,4-D or other herbicides.

You can buy other kinds of cleaning agents. Ask your dealer about them.

Cleaning granular and dust application equipment

You must clean this equipment after each use. Here are the steps for cleaning:

1. Remove all pesticide from the device. You may need to take it apart.
2. Clean the inside of the hopper.
3. Use sandpaper or a wire brush to clean rusted parts. Paint the cleaned parts.
4. Coat the inside with oil. Oil or grease the bearings.
5. Clean and oil the flow control slides or valves very well.
6. Wipe off the excess oil if it will contact the chemical during the next use.

You can expect to do a good job of pest control if you:

- Use common sense
- Choose the right formulation
- Choose the right pesticide
- Choose the right machine to apply it

Questions for study—Chapter 13

1. When you choose pesticide application equipment for a job, what do you have to think about?
2. Can you use seeders and fertilizer spreaders to apply granules?
3. What type of pesticide equipment might you choose if you wanted to reach pests in hard-to-reach places and then go into the area soon afterwards?
4. Would a fogger be a good choice if there is a sensitive area nearby and the wind is blowing softly?
5. Are hand sprayers only good for using at home? Explain your answer.
6. What type of sprayer would you probably choose to apply a wettable powder formulation to an oak tree in a backyard? Why?
7. When cleaning a sprayer, how many times should you put water into the tank and flush it out?
8. How much higher does the pressure need to be to double the flow rate?
9. Name four nozzle materials. Describe how they wear.
10. Name a pump that has automatic pressure relief.
11. What is a big advantage of ground-driven pumps?
12. List the three functions of a sprayer nozzle.

13. How do you find out if a nozzle tip is worn?
14. When is a nozzle tip worn too much to use?
15. Which nozzle delivers a wide, flat spray pattern made of large droplets?
16. When should you clean a sprayer?

Chapter 14

Calibration and Calculations for Mixing Pesticides

Goals of this chapter

- Explain why calibration of application equipment is important.
- Show how to calibrate different types of sprayers.
- Show some of the calculations to use when mixing.
- Explain why it is important to add the correct amount of concentrate to a mixture.

Calibration

The **delivery rate** (output) is the total amount of pesticide mixture your equipment applies to a given area. You must measure and adjust the delivery rate of your application equipment so you can apply a precise amount of pesticide to that given area. This is called **calibration**.

If you apply too little pesticide, you will not get good pest control. If you apply too much, you can damage crops and harm the environment. You can cause pesticide residues to be too high on crops and produce. And, it costs more money.

Up to 70 percent of all pesticide failures happen because calibration wasn't right or application equipment wasn't working right.

Be sure to calibrate at the start of every application season. Calibrate often during the season.

Before you start

Before you calibrate your application equipment, check it for any problems. Check for leaky hoses and connections. Be sure that all controls are working well.

For liquid sprayers:

- Clean all nozzles, screens, and filters.
- Find the right speed of application for your working conditions and equipment.
- Always calibrate at the same speed you will use when you make the application.
- If you can, always calibrate in the same place where you will apply the pesticide. This helps you make less mistakes from changes in speed as you drive or walk over different ground conditions.

- Find the correct application height. Follow the manufacturer's suggestions. Or, spray on a dry surface. Adjust height until you have from 25 to 30 percent overlap with a flat fan nozzle; or, until you have the desired band width for band applications.

Factors that affect output

There are four main factors that affect the output of hydraulic sprayers. They are:

1. Speed
2. The size of the hole (**orifice**) in the nozzle tip
3. Pressure
4. The number of nozzles on the boom

If you double your speed, you reduce the sprayer output by half. If you go four times faster, the sprayer output goes down to one fourth. See Table 13.

Table 13. Relationship between speed and output of a sprayer.

Speed (mph)	Output (gal/a)
2	100
4	50
8	25

Find the ground speed

In some cases, it is important to know your ground speed. Your equipment sprays more pesticide on the target as you move slower and less as you move faster. **Never measure speed with your speedometer.** When wheels slip in mud or loose dirt, or when tires wear down and get smaller, you can be traveling up to 30 percent slower than your speedometer reads. This can cause you to apply 30 percent too much pesticide.

To find your ground speed, follow these steps.

1. In the area where you will spray, mark off a test course.
2. With the spray tank at least half full of water, get your vehicle up to your normal spraying speed. Then, record how many seconds it takes to drive the test course.
3. Multiply your distance in feet by 60 (seconds in a minute) and divide by the time it took to cover your test course, multiplied by 88 (at 1 mph, you travel 88 feet per minute). This tells you your speed in miles per hour. This can be written as:

$$\frac{\text{distance (ft)} \times 60}{\text{time (sec)} \times 88} = \frac{\text{distance}}{\text{time}} \times 0.682$$

Example:
You record 30 seconds to drive 176 feet. Thus,

$$\frac{176}{30} \times 0.682 = 4 \text{ mph}$$

Size of nozzle orifice and pressure

The larger the **nozzle orifice**, the more output you get. More **pressure** also increases output. But, doubling the pressure does not double the flow rate. Doubling the pressure increases nozzle output by only 43 percent. So, if you want to double output by only increasing pressure, you would need to increase the pressure 4.6 times. See Table 14.

Table 14. Effect of nozzle orifice size and pressure on sprayer output.

If the TeeJet nozzle size is:	then the output in gallons per minute is:		the % change in output is:	
	at 20 psi	at 40 psi	due to pressure	due to size
8001	0.07	0.10	43	—
8002	0.14	0.20	43	100
8003	0.21	0.30	43	100
8004	0.28	0.40	43	100

To make big changes in output of motorized sprayers, change your speed and/or the size of the nozzle tip. Use pressure only for small changes.

There are many ways to calibrate sprayers. The ones we show here are simple to use. You also can use charts based on speed, nozzle type, and nozzle spacing.

How you calibrate is not important. **Making your application exactly right is important**. Use the method that gives you the greatest accuracy.

Hand sprayers

It is best to walk at an easy pace when you calibrate a knapsack sprayer. If you start at a pace that is not easy, you will settle into an easy pace as you go along. The change in your walking speed changes the calibration measurement.

Adjust the output by changing the nozzle.

Each sprayer can give a different output. Each person walks and pumps the sprayer at a different speed. So, you must calibrate with each sprayer that you use.

How to do the calibration

1. Add only water to the sprayer. Fill it to a certain marked level.
2. Mark out and measure a test area in the site you are going to treat.
   Length x width = square feet. The symbol for "square feet" is **ft²**.
   Or, length x effective swath width = square feet.
   Effective swath width = Number of nozzles x spacing between nozzles.
3. Spray the test area, keeping pressure, speed, and nozzle height always the same.

4. Refill the sprayer. Measure how much water you need to refill to the starting level. This is how much water you used in the test area.
5. Calculate gallons per acre (gal/a):

Formula 1

Multiply the amount of water you used (in gallons) by 43,560 ft^2/a. Then, divide by the size of the test area (in square feet).

$$\text{gal/a} = \frac{\text{water used (gal)} \times 43{,}560\ ft^2/a}{\text{area sprayed}}$$

Example:

1. You sprayed an area 6 feet wide and 100 feet long.

   $6\ ft \times 100\ ft = 600\ ft^2$

2. You used 0.25 gal of water.
3. Calculate:

$$\frac{0.25\ gal \times 43{,}560\ ft^2/a}{600\ ft^2} = 18.2\ gal/a$$

How much water do you need to cover a certain site?

Always mix up only the amount of spray solution you need. You do not want to have pesticide solution left over.

After you calibrate the sprayer output in gallons per acre, you can find out how much water you need in your sprayer for a certain area.

Formula 2

Multiply the area you want to spray (ft^2) by sprayer output (gal/a). Then, divide by 43,560 ft^2/a.

$$\frac{\text{area to spray } (ft^2) \times \text{sprayer output (gal/a)}}{43{,}560\ ft^2/a}$$

Example:

1. You want to spray an area measuring 42 ft x 55 ft.
2. Your sprayer output was 18.2 gallons per acre.
3. How much water will you need? Calculate:

   $42\ ft \times 55\ ft = 2{,}310\ ft^2$

$$\frac{2{,}310\ ft^2 \times 18.2\ gal/a}{43{,}560\ ft^2/a} = 0.97\ gal \text{ to spray } 2{,}310\ ft^2$$

If you need to know the amount in fluid ounces (fl oz), multiply:

$0.97\ gal \times 128\ fl\ oz/gal = 124.2\ fl\ oz$

How much pesticide do you add to the sprayer tank?

You need to find out how much pesticide to add per gallon of water (or other carrier) in the spray tank. Divide the rate of pesticide recommended on the label by the sprayer output in gallons per acre.

Formula 3

Amount of commercial product **per gallon of spray solution** =

$$\frac{\text{Recommended rate/a}}{\text{Sprayer output (gal/a)}}$$

Example:

1. The label recommends you apply 4 lb/a of WeGo 70 WP.
2. Your sprayer output is 20 gal/a.
3. Calculate:

$$\frac{\text{4 lb WeGo 70 WP/a}}{\text{20 gal/a}} = \text{0.2 lb WeGo 70 WP per gallon of water}$$

If you need to know the amount in ounces (oz), multiply:

0.2 lb x 16 oz/lb = 3.2 oz

How much WeGo 70 WP do you add to a 3-gallon spray tank?

3.2 oz of WeGo 70 WP per gallon of water x 3 gal = 9.6 oz of WeGo 70 WP

Calibrating mechanized sprayers for broadcast spraying

The "refill method"

1. Fill the sprayer tank. Use water only.
2. Spray the area you are going to treat. Keep an even pressure and speed.
3. Measure the area you sprayed (length x width = square feet).

   If you use a boom sprayer, you must measure the **effective swath width**. The effective swath width is the number of nozzles x the spacing between the nozzles.
4. Measure the amount of water you need to refill the tank using a measuring container of known capacity or one with markings. This is how much water you used in the test area.
5. Calculate gallons/acre:

Formula 1

$$\text{gal/a} = \frac{\text{water used (gal)} \times 43{,}560\ \text{ft}^2/\text{a}}{\text{area sprayed (ft}^2\text{)}}$$

Example:

1. You sprayed an area 12 feet wide and 300 feet long.

   12 ft x 300 ft = 3,600 ft^2
2. You used 2 gal of water.
3. Calculate:

$$\frac{\text{2 gal} \times 43{,}560\ \text{ft}^2/\text{a}}{\text{3,600 ft}^2} = \text{24.2 gal/a}$$

Calibrating by time

This is the best method to use with larger sprayers.

1. Fill the sprayer tank. Use water only.
2. Set marks to measure a certain length of the field. Use a part of the field that you are going to spray.
3. Measure how long (**time** in seconds) it takes you to drive over the length of field you marked. This is called the **test run**.
4. Calculate the size of the **test area** (length of test run x effective swath width).
5. Now, leave the sprayer stopped in one place. Lower the boom and spray at the same pressure you will use in the field. Collect the output from each nozzle for the same length of **time** it took you to drive the test run. Replace any nozzle that varies 10 percent from the average.
6. Add the output of all nozzles to find the total amount of water you used.
7. Calculate gal/a using ***Formula 1***.

Example:

1. It takes you 45 seconds to travel 330 feet.
2. There are 12 nozzles. They are 20 inches apart.

   12 x 20 in = 240 in
   240 in ÷ 12 in = 20 ft

3. The test area is 330 feet long and 20 feet wide.

   330 ft x 20 ft = 6,600 ft^2

4. You used 30 fl oz of water per nozzle in 45 seconds.

   30 fl oz/nozzle x 12 nozzles = 360 fl oz

   360 fl oz ÷ 128 fl oz/gal = 2.81 gal

5. Calculate:

$$\frac{2.81 \text{ gal} \times 43{,}560 \text{ ft}^2/\text{a}}{6{,}600 \text{ ft}^2} = 18.5 \text{ gal/a}$$

The "1/128 acre method"

This is a simple method that more and more applicators are using.

There are 128 ounces in a gallon. If we divide 1 acre (43,560 ft^2) by 128, we have 340 ft^2 (43,560 ft^2 ÷ 128 = 340 ft^2). So, if you find out how many ounces of water you need in order to spray 1/128 of an acre, you can equate this to gallons per acre.

1. Inspect your application equipment to be sure all parts are working properly (see "Before you start," page 159.)
2. Figure the distance you need to travel for the test. The distance of travel varies according to nozzle spacing. Divide 340 ft^2 by the spacing (in feet) between the nozzles on your boom (or use the actual **band width** for band spraying). For example, if your nozzles are spaced 12 inches apart (1 ft), divide 340 ft^2 by 1 foot.

   340 ft^2 ÷ 1 ft = 340 ft

   So, 340 feet is the distance of travel for the test.

3. Measure how long (**time** in seconds) it takes you to drive 340 feet (the test run).
4. Collect liquid from your nozzles for this amount of time and at the same pressure you will use in the field. Use the average volume per nozzle (not total volume from all nozzles) as ounces collected. The average ounces collected per nozzle are equal to gallons per acre.

   Example:

   1. You have nozzles spaced 22 inches apart. Divide 22 inches by 12 in/ft.

      $$\frac{22 \text{ in}}{12 \text{ in/ft}} = 1.83 \text{ ft}$$

   2. Divide 340 ft by 1.83 ft.

      $$\frac{340 \text{ ft}}{1.83 \text{ ft}} = 185.8 \text{ ft}$$

      You need to find out how long it takes you to travel 185.8 ft.

   3. The amount of water (in ounces) that you collect from a nozzle in this amount of time is equal to the gallons of water you will apply to an acre.

Be sure to collect from as many nozzles as possible, and use the average flow rate (add the amount each nozzle discharges in the test time and divide by the number of nozzles). Remember, you should replace any nozzle that varies by more than 10 percent from the average.

The chart below shows the distance you need to travel for each nozzle spacing to spray 1/128 of an acre.

Nozzle spacing or band width (in)	Row travel distance (ft)
6	681
8	511
10	408
12	340
14	292
16	255
18	227
20	204
22	186
24	170

You also can calculate for other spacing that is not shown here.

How much pesticide do you add to the sprayer tank?

Formula 3

Amount of commercial product **per gallon of spray solution** =

$$\frac{\text{Recommended rate/a}}{\text{Sprayer output (gal/a)}}$$

Example:

1. The label recommends you apply 2 lb/a of ByBy 80 WP.

2. Your sprayer output is 10 gal/a.
3. The spray tank holds 60 gallons.
4. Calculate:

$$\frac{\text{2 lb ByBy 80 WP/a}}{\text{10 gal/a}} = \text{0.2 lb ByBy 80 WP per gallon of water}$$

How much do you add to the 60-gallon spray tank?

0.2 lb of ByBy 80 WP per gallon of water x 60 gal = 12 lb

Sometimes the recommended rate is given as **active ingredient** (**ai**). To find out how much commercial product (also called **formulated product**) you need per gallon of water, divide the final result in ***Formula 3*** by the percent active ingredient (%ai).

Percent ai is expressed as a decimal for dry formulations. It is expressed as actual pounds active ingredient per gallon (lb ai/gal) for liquids.

Example:

1. The label recommends you apply 3 lb/a atrazine. Atrazine is the ai in BeGone.
   BeGone 80 WP contains 80% atrazine.
2. Your sprayer output is 20 gal/a.
3. The sprayer tank capacity is 200 gallons.
4. Calculate:

$$\frac{\text{3 lb ai/a}}{\text{20 gal/a}} = 0.15$$

$$\frac{0.15}{0.80} = \text{0.188 lb BeGone 80 WP per gallon of spray solution}$$

How much do you add to a 200-gallon tank?

0.188 lb/gal x 200 gal = 37.6 lb of BeGone 80 WP

Adjust for changes in density

Water with pesticides added is thicker than water alone. This is called a **change in density**. A change in density changes the sprayer's flow rate. This happens most with wettable powder formulations and fertilizers.

After you add the pesticide or fertilizer to the tank, spray the solution into a container. Spray for the same amount of time you used in the test area. Then, return the spray solution to the tank.

Calculate gallons per acre again, using ***Formula 1***. Then, correct the amount of pesticide per gallon of water, using ***Formula 3***.

Some nozzle manufacturers provide conversion tables to correct for change in density of the spray solution.

Band spraying

Sometimes, to reduce the total amount of pesticide you use, you apply pesticide only over a strip down the row crop. This is called **band spraying** or **band application**.

To figure the gallons per acre in the bands (sprayed strips), we need to figure the area of the bands and the amount of water used in a given

length of bands. Multiply the band width by the number of bands by their length and measure the amount of water used in the test run. Divide the amount of water used by the area sprayed to get gallons per acre.

Example:

Assume you planted corn in rows that are 30 inches apart, and you will apply a herbicide at 3 lb/a in bands 12 inches (1 ft) wide over the corn rows. In a 600-ft test run with an 8-row corn planter/sprayer, you used 1.2 gallons of water.

$$\text{acres} = \frac{\text{band width x number of bands x length}}{43{,}560\ \text{ft}^2/\text{a}} = \frac{1\ \text{ft} \times 8 \times 600\ \text{ft}}{43{,}560\ \text{ft}^2/\text{a}} = 0.11\ \text{acre}$$

$$\text{gallons per acre} = \frac{\text{gallons used}}{\text{area sprayed}} = \frac{1.2\ \text{gal}}{0.11\ \text{acre}} = 10.9\ \text{gal/a}$$

How much herbicide would you put in a 150-gallon spray tank for this application?

First, figure how many acres you can spray with 150 gallons.

$$\frac{150\ \text{gal}}{10.9\ \text{gal/a}} = 13.8\ \text{acres can be sprayed with one tankful}$$

Since you will apply 3 pounds of the formulated herbicide product per acre, and the full tank will spray 13.8 acres, you need a total of 3 pounds x 13.8 acres, for a total of 41.4 pounds of herbicide per tankful.

You can verify this result by using ***Formula 3***: pesticide rate divided by sprayer output gives us the amount of commercial product per gallon of carrier. This is:

$$\frac{3\ \text{lb/a}}{10.9\ \text{gal/a}} = 0.275\ \text{lb/gal} \times 150\ \text{gal} = 41.3\ \text{lb herbicide}$$

Air-blast sprayers

Air-blast sprayers normally are used to spray orchards. The text below tells how to calibrate an air-blast sprayer in an orchard.

Figure size of test area

Just as with broadcast spraying, you need to know the size of the test area and how much water you use in the test area. To figure the size of your test area, take the distance between the orchard rows and multiply by the length of your test run. When running through your test run, drive with at least half a tank of water at the same speed you will use to spray the orchard. Be sure to record the amount of time this takes.

Figure the amount of water used

One way to figure the amount of water you used in your test run is to fill the sprayer tank to a certain level, then spray your test area. You then

can measure carefully the amount of water needed to refill the tank to the exact level. Remember, the sprayer must be sitting in the same position for both measurements. If the sprayer sits tilted at a different angle when you refill the tank, then you will get the wrong measurement of how much water was used. Also, in a large tank, it is often hard to figure exactly how much water was used. And, you should check each nozzle for flow rate.

But, because of the way the nozzles are spaced around an air-blast sprayer, the high volume, and the pressure of the air blast, it is hard to catch spray from air-blast nozzles. So, we suggest you follow the method below.

1. Put one end of a hose over a nozzle and put the other end into a measuring container.
2. With the machine at a stop, measure how much water is in the container after spraying **for the same amount of time it took for your test run**.
3. Repeat this same thing with each nozzle.
4. Find the average flow rate. (Add the amounts that each nozzle discharges in the test time and divide by the number of nozzles.)
5. Replace any nozzle that has an output differing more than 10 percent from the average of *identical* nozzles. (Some air-blast sprayers have different-sized nozzles at different positions on the sprayer shroud in order to apply the same amount in different parts of the trees. In such cases, make sure that the respective nozzles on each side of the sprayer are discharging the same amount. Read your manual carefully.)

Again, take the total amount of water you used in the test time, and then use ***Formula 1*** to calculate gallons per acre.

Example:

Assume that the rows are 18 feet apart in your orchard, and that you traveled 176 feet in 30 seconds, and that you used a total of 10.5 gallons of water.

$$176 \text{ ft} \times 18 \text{ ft} = 3{,}168 \text{ ft}^2 \text{ area sprayed}$$

Calculate with ***Formula 1***:

$$\frac{10.5 \text{ gal} \times 43{,}560 \text{ ft}^2/\text{a}}{3{,}168 \text{ ft}^2} = 144.3 \text{ gal/a}$$

Account for tree size and foliage

Because of the great difference in tree size and the amount of foliage on some trees, you might need to slow down where the volume of tree foliage (called **tree row volume** or **TRV**) is greater. Where trees are smaller, you may be able to speed up. Some new sprayers have electronic eyes that regulate sprayer output by TRV or even shut off the sprayer if trees are missing.

Get water-sensitive paper from your pesticide dealer. Place the paper in different parts of the trees to see if your application is even. You might have to change the angle of some nozzles for the spray solution to go through different heights in the trees. Take your time to test your sprayer, using water only. You do not want to be sloppy when you apply pesticides.

Granular application

To find your application rate, measure the amount of granules you spread over a test area. Measure the test area to know how large it is.

Run the test over a tarp or concrete driveway, so you can sweep up the granules easily to weigh them.

When you calibrate, use the granule you plan to apply to the target site. Any other granule may flow through the hopper at a different rate. Be sure to calibrate again if you change to a different kind of granule.

A spreader driven by a gear connected to the wheels generally does not need to be pulled at a certain speed during calibration. However, make sure to pull it fast enough so the granules flow out evenly.

Measure the area

The size of the test area you use to calibrate depends on the type of granular application equipment you use. It's best to use at least 1,000 square feet for a drop spreader. Use at least 5,000 square feet for a large rotary spreader.

Do not contaminate the place that you are planning to treat.

If you cannot spread over a test area, then place a bag or catch pan under your spreader to catch the chemical. The bag or pan must not get in the way of the granules as they flow out.

Calculate the application rate

Collect and weigh the amount of chemical you spread over the test area.

Then calculate:

Application **area** = width x distance traveled

$$\text{Application } \textbf{rate} = \frac{\text{amount of chemical collected x 43,560 ft}^2\text{/acre}}{\text{the area you covered}}$$

Example 1:

1. You are applying insecticide from a chemical box on a corn planter, using a 12-inch band. Place a bag under the drop tube to collect the granules.
2. You drive the planter a total of 500 feet.
3. You collect 0.5 ounce of insecticide in the bag.
4. Calculate: What was the application rate in pounds per treated acre?

Application area = 1 ft x 500 ft = 500 ft^2

$$\text{Application rate} = \frac{0.5 \text{ oz x } 43{,}560 \text{ ft}^2}{500 \text{ ft}^2} = 43.56 \text{ oz}$$

$$\frac{43.56 \text{ oz}}{16 \text{ oz/lb}} = 2.7 \text{ lb}$$

Application rate = 2.7 lb/treated acre

Example 2:

You wish to apply turf chemicals using a push-type drop spreader.

1. Measure a 1,000-square-foot area (20 feet by 50 feet) on smooth concrete. Or, to avoid sweeping such a large area, you can make more passes over a smaller area. For example, five passes over an area 4 feet wide and 50 feet long:

   $4 \text{ ft} \times 50 \text{ ft} = 200 \text{ ft}^2 \times 5 \text{ passes} = 1{,}000 \text{ ft}$

2. Add the chemical to the spreader and spread it over the measured area.
3. When you sweep up the chemical from the test area, you find that it weighs 6 ounces.
4. Calculate: What was the application rate?

$$\text{Application rate} = \frac{6 \text{ oz} \times 43{,}560 \text{ ft}^2/\text{acre}}{1{,}000 \text{ ft}^2} = 261.4 \text{ oz/acre}$$

$$\frac{261.4 \text{ oz}}{16 \text{ oz/lb}} = 16.34 \text{ lb/acre}$$

Check for mistakes

After you calibrate your application equipment, check it often. Be sure you are treating an equal area (in acres or square feet) with each tankful. If you find you are applying either more or less than you calculated for each area, stop the application right away. Calibrate again. If you have calculated wrong or your application equipment changes its delivery rate, you can correct the problem before you make a major mistake.

Remember the facts about calibration, and it will become simple and easy. Calibrate your sprayer well, and you will do a good, safe job. Also, you will save materials and money.

Useful conversion factors for calibration

area = length x width
area of a circle = 3.14 x r^2
1 acre = 43,560 square feet (ft^2) (208.71 ft x 208.71 ft)
1 gallon = 128 fluid ounces (fl oz)
1 quart = 32 fluid ounces
1 pint = 16 fluid ounces
1 pound = 16 oz
1 mile per hour (mph) = 88 feet per minute (ft/min)
1 tablespoon = 0.5 fluid ounce

Calculations when pesticide rates are given as a concentration or percentage

It is very important to add the correct amount of pesticide to mix a finished spray. If you add too little pesticide, you will get poor control. If you add too much, you could harm the treated surface and leave too much residue on plants or produce. You could waste a lot of money.

The label tells how to mix the product. You only need to make some simple calculations.

Wettable powder (and other dry formulations)

1. The label tells you to use 2 pounds of pesticide per 100 gallons of water.
2. You want to fill a 300-gallon tank.
3. Calculate:

$$\frac{300 \text{ gal}}{100 \text{ gal}} = 3$$

3 (hundreds) x 2 lb (per hundred) = 6 lb

Add 6 lb pesticide in 300 gallons of water.

What if you want to mix just 20 gallons of spray?

1. Find how many 20s are in 100 gallons.

$$\frac{100 \text{ gal}}{20 \text{ gal}} = 5$$

There are five 20s in 100. In other words, 20 is ⅕ of 100.

2. Find ⅕ of 2 pounds.

⅕ x 2 lb = ⅖ lb

⅖ lb = 0.4 lb

If you need to know the amount in ounces (oz), multiply:

0.4 lb x 16 oz = 6.4 oz

Add 0.4 lb (6.4 oz) of the pesticide to 20 gallons of water.

Here is another way to work this problem.

1. Find how many pounds of the pesticide go into 1 gallon.

If 2 pounds go into 100 gallons,
0.2 pound goes into 10 gallons, and
0.02 pound goes into 1 gallon.

2. Find how many pounds of the pesticide you need for 20 gallons of spray.

20 x 0.02 lb = 0.4 lb

Add 0.4 lb to 20 gal of water.

Liquid concentrates

1. The label says to mix 3 pints of pesticide per 100 gallons.
2. You want to mix 300 gallons.
3. Calculate:

   300 gal = 3 x 100 gal

   3 x 3 pt = 9 pt

   Add 9 pt pesticide to 300 gal water.

To mix only 20 gallons:

20 gal = ⅕ of 100 gal

⅕ x 3 pt = ⅗ pt = 0.6 pt

If you need to know the amount in fluid ounces (fl oz), multiply:

0.6 x 16 fl oz = 9.6 fl oz

Percentage mixing

How to calculate percentage mixing for liquids

The pesticide label often tells you to mix up a certain concentration or **percentage** of the commercial product in water.

1. The label tells you to make a 1 percent mixture.
2. To do this, mix 1 part commercial product and 99 parts water.
3. There are 128 fluid ounces in 1 gallon.

   1.28 = 1% of 128

   Mix 1.28 fl oz of the commercial product with 1 gallon of water to make *close to* a 1 percent mixture.

Sometimes the label tells you to make a spray solution with a certain **percentage of active ingredient** (**ai**).

1. You need a 1 percent active ingredient (1% ai) spray for ants.
2. The pesticide is an emulsifiable concentrate (EC) that has 57 percent active ingredient.
3. To make a 1% ai spray solution, add 1 part EC to 56 parts water.

One gallon of water weighs 8.3 pounds, so 100 gallons weigh 830 pounds. To make a 1 percent mix of pesticide active ingredient in 100 gallons of water, add 8.3 pounds of active ingredient of pesticide to 100 gallons of water.

Some pesticides mix in kerosene instead of water. One gallon of kerosene weighs 6.6 pounds, so 100 gallons weigh 660 pounds.

You must know how much emulsifiable concentrate you need for the correct percentage of active ingredient in the tank. Use the **weight** (pounds) of active ingredient per gallon. Do not use the percent active ingredient. (See the Ingredient Statement on the label.) This is because the density of many formulations is not the same as pure water.

Liquid formulation percentage calculation

$$\frac{\text{gal wanted} \times \%\text{ai wanted} \times 8.3\ \text{lb/gal}}{\text{lb ai/gal concentrate} \times 100}$$

Example:

You want to use a 25 percent emulsifiable concentrate that has 2 pounds active ingredient per gallon. How many gallons of this EC do you need to make 100 gallons of 1 percent spray?

$$\frac{100 \text{ gal} \times 1\% \times 8.3 \text{ lb/gal}}{2 \text{ lb ai/gal concentrate} \times 100} = \frac{830 \text{ gal}}{200} = 4.15 \text{ gal of 25\% EC}$$

How to calculate percentage mixing for dry formulations

You need to know how much wettable powder to add to water for the correct percentage of active ingredient in the tank.

Dry formulation percentage calculation

$$\frac{\text{gal wanted} \times \%\text{ai wanted} \times 8.3 \text{ lb/gal}}{\%\text{ai in wettable powder you are using}}$$

Example:

You want to apply a mixture using a mist blower. How many pounds of an 80 percent wettable powder do you need to make 50 gallons of 3.5 percent active ingredient spray?

$$\frac{50 \text{ gal} \times 3.5\%\text{ai} \times 8.3 \text{ lb/gal}}{80\% \text{ ai WP}} = \frac{1{,}452.2 \text{ lb}}{80} = 18.1 \text{ lb of 80\% WP}$$

Square feet mixing

Often the label tells you to mix an amount of pesticide to use per 1,000 square feet or per acre. You calculate this by calibrating your equipment. Then you can add the right amount of pesticide for the rate of application stated on the label.

Other useful conversion factors

- 1 pound wettable powder per 100 gallons = 1 tablespoon per gallon (nearly)
- 1 pint emulsifiable concentrate per 100 gallons = 1 teaspoon per gallon
- 1 ppm (part per million) = 1 teaspoon per 10,000 gallons

See Appendix B, "Conversions and Calculations," for more conversion factors.

Questions for study—Chapter 14

1. When you have the right mixture in your spray tank, can you still apply the wrong amount of pesticide?
2. What is "delivery rate"?
3. If your sprayer is applying less spray to each acre than you want it to, how would you change the rate?
4. Must you calibrate granular application equipment each time you change granules? Why?

5. You are using a 10-foot sprayer with six nozzles on 20-inch centers to apply herbicides on a golf course. At the speed you want, the sprayer travels across a 204-foot course in 40 seconds. How do you calculate the application rate from these facts?
6. You collect a total of 32 ounces of water from one spray nozzle in 30 seconds. What is the nozzle delivery rate in gallons per minute (gpm)?
7. What is the purpose of calibration?
8. List three items on your equipment that you need to check before you start to calibrate.
9. To reduce the output of a sprayer by half, how would you adjust the speed? By how much?
10. To double the output, how much do you need to increase pressure?
11. What is the best way to make major changes in output? Minor changes?

You have a sprayer with a piston pump that runs at 30 psi. There are 20 nozzles on a boom, spaced at 1.5 feet. It takes you 0.68 minutes to drive 300 feet. Each nozzle delivers 0.31 gallons in 0.68 minutes. The tank holds 300 gallons. The field size is 1,000 feet long and 523 feet wide.

12. How many acres are in the field?
13. How many gallons per acre is the sprayer applying?
14. How many acres will one full tank spray?

Continue the same story above. You want to apply 3 pounds of active ingredient per acre, formulated either as (1) an 80 percent wettable powder, or (2) a 4 lb/gal emulsifiable concentrate.

15. How many pounds of active ingredient do you need to add to each full tank?
16. How many pounds of the wettable powder do you need to add to each full tank?
17. How many gallons of the EC do you need to add to each full tank?
18. If the label tells you to use 3 pounds of wettable powder per 100 gallons of finished spray, how much do you put in a 450 gallon tank? Show your calculations.
19. How much do you put in an 80 gallon tank at 3 pounds per 100 gallons?
20. If the label says to mix 3 pints of an emulsifiable concentrate per 100 gallons, how much do you put in a 300-gallon tank? How much do you put in a 50-gallon tank?
21. If the label says to mix 1 pound of WP per 100 gallons of water, how many tablespoons of WP would you add to 1 gallon?
22. If the label says to mix 2 pints of EC per 100 gallons of water, how many teaspoons of EC would you add to 1 gallon?
23. How much does 100 gallons of water weigh? How much does 100 gallons of kerosene weigh?

Chapter 15

Mixing, Loading, and Application

Goals of this chapter

- Describe how to protect the water source at the mixing site.
- Name types of protection you might need while mixing or loading pesticides.
- Name the types of empty containers that you can rinse. Describe the rinsing methods.
- Describe ways to test whether two pesticides can be mixed together safely.
- Name some of the pesticide application jobs for which you might need to wear more personal protective equipment than the labeling requires.
- Describe what you must do after you finish mixing, loading, and application work.
- Explain closed system mixing and loading and enclosed application systems.
- Describe what to do with rinsates from equipment cleanup.

You can use some pesticides just as you buy them. Baits, dusts, dry granules, aerosols, and some liquid sprays are ready to use from the package.

Other pesticides must be diluted with liquids. These are called **concentrated pesticides**. Wettable powders or emulsifiable concentrates are concentrated pesticides.

Water is the most common liquid used for diluting pesticides.

Mixing, loading, and application are the main pesticide handling tasks. They are also some of the most dangerous parts of a handler's job. Never try to save time or money where safety is concerned. Always expect the unexpected. Even though you have used a pesticide many times, take time to read the labeling each time you buy the product. Often, the label has new instructions and rules on it.

Mixing and loading safely

Pesticide handlers may be exposed to harmful amounts of pesticides when they mix or load concentrated pesticides. **Handlers who mix and load concentrated pesticides with high acute toxicity are at high risk of accidental poisoning, especially through the skin. Inhalation risks**

are high when handling powder formulations or pesticides with organic vapors. By using some simple safeguards, you can lower these risks.

When to mix

It usually is best to add the pesticide to the tank or the granules to the hopper just before you are ready to apply. This is very true when you go to a job that you have not checked first. If the pest is different than you thought it would be, you may have a full tank of the wrong pesticide.

If you are a pest control operator treating an apartment, never carry any concentrate into the apartment. You have to mix the pesticide before you go inside.

How to mix wettable powders

Always mix wettable powders in a small container first. Add water and stir until you make a **slurry**. This helps wet all the particles. After you transfer the slurry to the spray tank, rinse the small container and add the rinsate to the spray tank.

Choose the right place to mix

Choose the pesticide mixing and loading place carefully. It should be outdoors or in a building with lots of fresh air. It should be in a place away from people, animals, food, other pesticides, fertilizer, and anything else that could be contaminated.

Choose a place with good light, especially if you are working at night. Be very careful not to mix or load pesticides indoors if you do not have enough light and fresh air.

Protect your water source

When you fill a sprayer tank with water, keep the hose above the level of the pesticide mixture. This keeps pesticide off the hose and keeps the pesticide from back-siphoning into the water source.

If you pump directly from the water source into a mix tank, you must use a check valve (called an **antisiphoning device**) or backflow preventer. You must keep the pesticide from back-siphoning into the water source in case the pump fails. Oregon law requires that you use backflow prevention tools.

Do not mix or load pesticides in places where a spill, leak, or overflow could contaminate water supplies. Place your mixing equipment where spills, leaks, and overflows cannot flow toward a drain or into the water supply. Install dikes or other barriers, or grade the soil if you need to divert the flow.

If you mix or load at the site often, consider putting in a collection pad or tray (see “Pesticide containment systems,” page 188). **Read the pesticide label for any special precautions**.

Personal protective equipment

Before you open a pesticide container, put on the right personal protective equipment (PPE). **By law, you must use all the PPE that the pesticide label requires**. Use more PPE for certain mixing and loading jobs.

Protect your front

Wear a bib-top apron made of butyl, nitrile, or foil-laminate material to guard you from splashes or contact with equipment. An apron with built-in gloves and sleeves protects you very well.

These are good reasons to wear an apron:

- It keeps pesticides off the front of your clothing.
- It is cooler than a chemical-resistant protective suit.
- You can take it off easily when you're done with the job.

Protect your face

If you pour liquid pesticide or add dry pesticide to a liquid, wear a face shield. A face shield keeps splashes and drifting dusts off your face and out of your nose and mouth.

If you also need to wear a respirator, goggles or shielded safety glasses will fit better than a face shield.

Protect from dusts

When you pour dusts or work where dust might swirl up into your face, wear a dust/mist filtering respirator. The respirator keeps you from inhaling the dust. Choose a dust/mist respirator that is approved by NIOSH/MSHA.

Keep the dust out of your eyes, too. Wear shielded safety glasses, goggles, or a face shield.

Protect from vapors

Some pesticides you handle give off vapors that could harm your eyes, nose, throat, or lungs. Wear eye protection and a vapor-removing respirator approved by NIOSH/MSHA.

Opening containers

Do not tear open paper or cardboard containers. Use a sharp knife. Clean the knife after you use it, and do not use it for any other purpose.

Open pesticide containers only when they are sitting on a flat, stable surface. If they are sitting on an angle or off balance, they can spill or leak easily when you break the seal.

Transferring pesticides

When you pour any pesticide from its container, keep the container and pesticide below face level. This keeps splashes, spills, or dust from getting onto your face, eyes, or mouth.

If a breeze is blowing, stand so the pesticide blows away from you.

If you siphon the pesticide from the container to the tank, **never** use your mouth to get the siphon started.

Spills

Close containers after each use. Even if you plan to mix more pesticide soon, close the container tightly each time.

Always watch the tank while you fill it. If you leave, it might overflow and contaminate the site.

If a pesticide splashes or spills on you, stop right away. Take off all your contaminated clothing. Wash very well with soap and water as fast as you can. Put on clean PPE. Then clean up the spill.

To learn how to manage spills, see Chapter 18.

For major spills, or spills that may contaminate water, there are special safeguards and work that you must do.

Empty pesticide containers

Even if it seems that you have used all the pesticide product from a container, it isn't truly empty. The pesticide that clings to the inside of the container can be dangerous to people and to the environment. Take care of empty containers at once.

Rinse containers as soon as they are empty, if the label says you may.

Return all pesticide containers to the pesticide storage site or the container holding area when you finish your job. Do not leave them at the mixing, loading, or application site. Never give pesticide containers to children to play with or to adults to use.

Oregon has an active pesticide container collection program. But, some empty pesticide containers cannot be refilled, reconditioned, recycled, or returned to the manufacturer. Clean them thoroughly, and then crush, break, or puncture them. This way, no one can use the containers. It also might save storage space.

To learn how to dispose of pesticide containers, see Chapter 17.

To dispose of containers, you must follow label directions and federal, state, tribal, and local laws.

Rinsable containers

You can rinse glass, metal, and plastic containers, plastic-lined paper or cardboard containers, and even unlined paper or cardboard containers. Rinse them as soon as they are empty. Residues can dry fast, and they are hard to remove.

The liquid you use for rinsing should be the same as the diluent listed on the pesticide labeling for the pesticide application. After you rinse, add the rinsate to your pesticide mixture. This can save you money.

If you rinse empty pesticide containers very well, usually you can give them to the container collection program. Or, you can dispose of them as nonhazardous waste.

Clearly mark rinsed containers that you store to dispose of later. You want to know which containers you have rinsed. There are labels you can buy for this purpose.

Do not rinse a container if the labeling directs you not to.

Multiple rinsing

You must rinse containers many times to get them clean. Some people call this "triple rinsing." But, some containers may not be clean enough after only three rinses. So, it is better to call the rinsing process **multiple rinsing**.

To multiple rinse a container, follow these steps:

1. Empty the container into the tank. Let it drain at least 60 seconds.
2. Fill it one-fifth to one-fourth full of water (or the correct diluent).
3. Close the container again and shake or rotate it for about 30 seconds. Turn the container upside down so the rinse cleans all the inside surfaces.
4. Drain the rinse water from the container into the tank. Let the container drain for 30 seconds.
5. Repeat steps 2 through 4 at least two more times. **Repeat the rinsing process until you can see no more residue in the container**.

Pressure rinsing

You can use pressure rinsing instead of multiple rinsing. Some pesticide equipment has a way to pressure rinse pesticide containers when they are empty. This is how you pressure rinse a container:

1. Put a high-pressure nozzle into the container.
2. Turn the nozzle and rinse for at least 30 seconds.
3. Drain the container very well into the spray tank.

Sometimes, you need to puncture the base or side of the container to put in the nozzle. Sometimes, you put the nozzle into the container's regular opening.

Nonrinsable containers

You may not be able to rinse bags, boxes, and other containers of dry pesticides, because the container will fall apart. You also may not be able to rinse containers of ready-to-use pesticides because there is no place to put the rinsate.

The pesticide labeling may tell you not to rinse certain types of containers. These containers may be designed to be returned to the pesticide dealer or manufacturer for rinsing.

If you cannot or should not rinse a container, then you must empty it as well as you can. Shake or tap the container to remove as much of the pesticide product as you can. Drain containers of liquid pesticides for at least 60 seconds.

Combining pesticides

Pesticide applicators often like to combine two or more pesticides and apply them at the same time. Doing this can save time, labor, and fuel. (Pesticide manufacturers sometimes combine pesticides for sale. This is called a **premix**.) Under federal law, you may combine pesticides unless the label on any of the pesticides tells you not to combine them.

When you combine more than one chemical, the **mixing order** is very important. Use the order listed below (called the **W-A-L-E** plan):

1. Add some of the diluent (water, liquid fertilizer, or diesel) first.
2. Add **W**ettable and other powders and **W**ater-dispersible granules.
3. **A**gitate thoroughly. Then, add the rest of the diluent.
4. Add the **L**iquid products, such as solutions, surfactants, and flowables.
5. Add **E**mulsifiable concentrates last.

Not all pesticides work well when you mix them together. They must be **compatible**. This means that they must be just as safe and potent when you mix them as they are by themselves. The more pesticides you add to the mix, the greater the chance of a result you do not want.

Some pesticide mixtures are **physically incompatible**. They are hard or impossible to apply. They may clog equipment, pumps, and tanks. Mixtures that are physically incompatible might show these results:

- The pesticide forms lumps or gels.
- The pesticide turns into solids that fall to the bottom of the mix tank.
- The mixture separates into layers that you cannot remix.

Sometimes the combined pesticides are **chemically incompatible**. They may cause a chemical reaction that **you cannot see** by looking at the mixture. But, the chemical change can cause these things to happen:

- The pesticide is less effective against the target pests.
- The pesticide is more toxic to the pesticide handler.
- The pesticide harms the treated surface.

Some pesticide labels list pesticides and other chemicals that are compatible or incompatible with that formulation. There are charts that show you which pesticides you can combine with others. They are called **compatibility charts**. Ask your Extension Service or pesticide industry agent where you can find compatibility charts.

Compatibility testing

If you cannot find a chart that lists the compatibility of the chemicals you wish to mix, you can test a small amount before you mix a large amount.

First, put on PPE. Wear **at least** the equipment required by the labeling of any of the pesticides. Also wear protective eyewear and chemical-resistant gloves and apron.

Get a large, clean, clear glass container, such as a quart jar. Use the same diluent (such as water, fertilizer, or diesel) you will use when you make up the larger mixture. Add the diluent and each of the products in the same proportions you will use for the larger mixture. Unless the pesticide labeling tells you to do something else, add pesticides to the diluent using the **W-A-L-E** plan.

Shake the jar briskly. **Right away, break the seal to prevent any pressure buildup**. Touch the sides of the jar to feel if the mixture is getting hot. If it is, the mixture may be chemically incompatible. If so, do not combine the pesticides.

Let the mixture stand for about 15 minutes and feel again for unusual heat. The chemical reaction could be slow to occur.

The mixture probably is not compatible if any of these things happen:

- Scum forms on the surface.
- The mixture clumps.
- Any solids settle to the bottom, except for wettable powders. Wettable powders form a fine deposit on the bottom.
- The mixture heats up.

If you see no sign that the chemicals are incompatible, it is probably safe to use the mixture. But, if you have enough time, it would be good to test the mixture on a small area of the site where you plan to apply it.

Water pH

A pH in the range of 4 to 6 is best for most pesticide sprays. Water with a pH above 7 is called **alkaline**.

Alkaline spray water can cause many organophosphates and carbamates to break down. Use adjuvants called **buffering agents** to adjust the pH of the spray solution to a 4- to 6-pH range. Use buffering agents, especially if the pH is 8 or higher and you are using a pesticide that is sensitive to high pH.

Your chemical dealer can sell you special paper strips that you can use to test the pH of your water.

Adjuvants

Most pesticide formulations have a small amount of adjuvants in them. But, sometimes an applicator adds more adjuvant to a pesticide mixture to improve the success of the active ingredient.

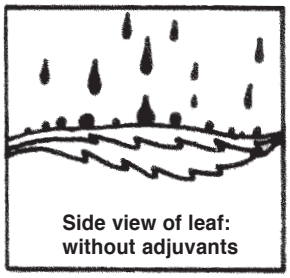
- Wetting agents and emulsifiers help the pesticide mix with water.
- Spreaders and stickers help the mixture spread evenly over the treated surface. They help the mixture resist the effects of rain and wind. When you treat waxy surfaces such as cabbage or onion leaves, you might need a spreader-sticker.
- Herbicides must be absorbed by the target plant to be effective. Penetrants help the pesticide get through the outer surface (leaf, root, skin) and into the plant. Some other kinds of pesticides need penetrants, also.

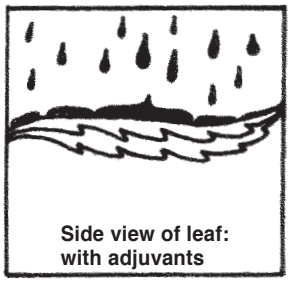
Other types of additives include thickeners, emulsifiers, buffering agents, and anti-foaming agents.

Note: Using too much additive can cause less of the pesticide to stick to the target.

Careful mixing saves pesticide, saves money, and reduces human and environmental exposure.

For more detail on adjuvants, see Chapter 12.





Applying pesticides safely

Every time you apply pesticides, you have two major responsibilities:

- To protect yourself, others, and the environment
- To make sure you apply the pesticide correctly

Protect yourself

By law, you must wear the personal protective equipment and other clothing the pesticide labeling requires. Use more protection for some types of pesticide application tasks. Think about the application job you have to do. Then, decide which PPE would be best for you to wear.

For more detail on personal protective equipment, see Chapter 5.

Hand-carried application equipment

When you carry hand-held sprayers, shake cans, or knapsack sprayers, you risk getting pesticide onto your skin. A dripping or partly clogged nozzle, an unfastened lid, a leaky hose, or a loose connection are very

likely to expose you to the pesticide. Wear extra PPE to protect the parts of your body that are in contact with the equipment.

If you carry the application equipment in front, wear a sleeved apron, an apron with built-in gloves and sleeves, or an apron plus gloves that cover your arms to protect your front from leaks, drift, and splashes.

If you carry pesticide on your back with a knapsack (backpack) or trombone-style sprayer or duster, wear a cape to protect your back and shoulders from leaks.

If you carry only the nozzle, wear gloves that cover your arms. Or, wear elbow-length gloves with the cuffs taped or sealed some other way to your coverall sleeve.

Entering the path of the released pesticide

Sometimes while you make an application, you have to walk or drive into the path of the pesticide.

Whenever you can, walk backwards into the untreated area, away from where you are releasing the pesticide. Sometimes, though, it is unsafe to walk backwards in an application site. If you must walk into the path of the released pesticide, wear chemical-resistant boots that come up to your shin or your knee. Wear chemical-resistant pants also, if the sprayed plants are taller than your boots.

If you spray a thick coating of fabric starch or fabric stain protectant on the lower legs of your coveralls, you can make them a barrier for low toxicity pesticides for a short time. Also, you make the coveralls easier to clean.

When you apply pesticides from a vehicle, it is best to use equipment that releases the pesticide to the rear. That way, you are in front of and above the release area, and you are moving away from it. Sometimes, though, you may have to use a vehicle with equipment that requires you to drive into the path of the pesticide application.

Whether you are walking or riding, if the pesticide is not aimed down away from you, or if it stays in the air long enough to cause exposure to any part of your body, wear the right PPE. Remember, you are responsible for your safety!

Walking into a just-treated area

While you are making an application, you might need to repair or adjust the equipment. Or, you might need to check the pesticide dispersal. You might have to climb over contaminated equipment and walk through an area that you treated only moments before. Put on more PPE for this.

If the pesticide has a reentry time on the labeling, it is against the law for you to enter the sprayed area without wearing the right PPE while the reentry time is in effect. Reentry time also is called the **restricted-entry interval** (**REI**). The REI is how much time you must wait between the application and when people may enter a sprayed area without PPE.

If the plants in the treated area are covered with pesticide spray or dust, and they are fairly short, wear protective footwear.

If the plants in the treated area are tall, wear a chemical-resistant suit with the footwear. If you cannot wear a chemical-resistant suit because of the heat, wear a cape or an apron to protect your legs and front. It may help to apply spray starch or fabric stain protectant to your pants legs.

If spray is dripping or dust is falling from overhead, wear a hood or wide-brimmed hat with the body protection and footwear. You might need a dust/mist respirator and protective eyewear, too.

High-exposure applications

These types of pesticide applications put you at more risk of exposure:

- Mist blower or air-blast applications
- Aerosol and fog applications (especially indoors)
- Some applications using high-pressure sprayers and power dusters
- Applications directed upward over your head, such as to tree canopies or roof eaves
- Aerial applications with human flaggers

Whenever you work with these kinds of applications, large amounts of pesticide might fall onto your skin and clothing. Unless you are in an enclosed cab, you cannot avoid this exposure, even if you make the application when the air is still.

If you do this kind of work, you should wear more PPE than the pesticide labeling requires for other types of applications. You must wear a chemical-resistant suit with a hood, gloves, and footwear. You also need a full-face respirator or half-face respirator with sealed goggles. Only these give you enough protection for these high-exposure applications.

Applications in enclosed spaces

Sometimes you have to apply pesticides in enclosed spaces. Some kinds of enclosed spaces could be:

- Warehouses
- Factories
- Homes
- Railcar, ship, and truck cargo areas
- Silos, elevators, and other grain storage areas
- Greenhouses

When you use pesticides in enclosed spaces, you are more at risk of being exposed by inhalation. You might need to use a respirator that supplies you with air. You might need it even if you would not need one for the same application outdoors. Wear a vapor-removing respirator, even outdoors, if you must adjust fumigation equipment.

Immersing hands and forearms

Some kinds of applications require you to put your hands and forearms into the pesticide liquid or dust. You might need to do this with animal, plant, or seed dipping vats and spray-dip machines.

With this exposure, wear a sleeved apron for full front and arm protection. Also wear protective footwear. Wear a face shield to protect you against splashes or drifting dusts.

Applying in air currents

If you need to apply pesticides into or across wind or air currents, wear extra PPE. Because pesticide might blow onto you, you need more body protection, protective eyewear, and a dust/mist filtering respirator.

Applying concentrates

You might be exposed to highly concentrated pesticides during some applications. Ultralow-volume concentrates and fumigant formulations often are highly toxic. They may contain almost 100 percent active ingredient. When you apply concentrates, use the same extra PPE that you would wear when mixing and loading them.

Protect others and the environment

Avoid nontarget plants and animals

Before you apply a pesticide, clear all unprotected people from the area. It is against the law for you to expose them to a pesticide application, either directly or through drift.

Also, remove any pets or livestock that you are not treating with the pesticide. Even when the pesticide application is narrowly aimed, such as for a crack and crevice treatment, keep people and animals out of the area while you are working.

Check the pesticide labeling to find out when people and nontarget animals can go back into the application area. Some pesticide labels restrict reentry from a few hours to many days. Even if the pesticide labeling does not restrict reentry, do not let anyone enter the treated area at least until dusts and mists have settled, vapors are gone, and spray has dried.

After indoor treatments, air out the space with fans, vents, or open windows before you let anyone return. Keep people out of the treated area until the restricted-entry interval is over.

Avoid nontarget surfaces

When you can, take anything that should not be contaminated with pesticides out of the application site. Cover or protect anything that you cannot take out of the area (anything you don't need for the handling activity). Take away or cover food and food utensils; bedding; toys; seed; pet or livestock feed, water, or supplies. Take away anything that could transfer pesticides to people, pets, or livestock.

Use equipment safely

Turn off your equipment whenever you stop for any reason. Take special care to turn it off before you make any adjustments or repairs. Depressurize any pressurized tanks. Turn off the main pressure valve on the tank and release any pressure remaining at the nozzles.

If you are applying pesticides at a distance from your equipment (for example, at the end of a long hose), make sure unprotected people and pets stay away from the equipment. You might need a helper to stay near it.

Check hoses, valves, nozzles, hoppers, and other equipment parts from time to time while you are applying. If you notice a problem, stop right away and fix it.

Do not use bare hands or your mouth to clear nozzles, hoses, or hopper openings. Carry a small nylon brush for such jobs. Be sure that any tool you use for this kind of job is never used for any other purpose.

Use correct application methods

Every time you apply a pesticide, use these basic methods. Be sure you are using the pesticide safely and effectively.

Deliver the pesticide to the target

Take time to be sure the pesticide is reaching the surface or space that you want it to cover.

Check the delivery rate

Check to be sure you are applying the pesticide evenly and in the right amounts. Be very careful in places where you turn or pause. Many types of application equipment continue to release pesticide even when they are not moving.

When you begin an application, first apply only to a small area. Then, check that area or space. If you haven't applied the correct amount, make any adjustments or repairs that you need to make.

Safety systems

If you handle large amounts of pesticides or pesticides that are highly hazardous to humans or to the environment, there are three kinds of safety systems that are worth the money to you.

1. Closed mixing and loading systems
2. Enclosed application systems
3. Pesticide containment systems

Sometimes, you must use one of these systems for handling certain pesticides. Or, you must use one of these systems when you use pesticides in or near sensitive areas.

Closed mixing and loading systems

Closed mixing and loading systems are made to keep the pesticide from contacting handlers or other persons during mixing and loading. You must use a closed system for some pesticide products.

There are two main types of closed mixing and loading systems. One uses mechanical tools to transfer the pesticide from the container to the equipment. The other type uses containers that dissolve in the tank. This is called **soluble packaging**.

Mechanical systems

Mechanical systems are often several pieces of equipment connected to each other. You can remove a pesticide from its original container, rinse the empty container, and transfer the pesticide and rinse solution to the application equipment without being exposed to the pesticide.

The most common mechanical closed systems use only liquid formulations.

Closed mixing and loading systems often are custom made. Mechanical systems remove the pesticide concentrate from the original container in one of two ways: by gravity or by suction.

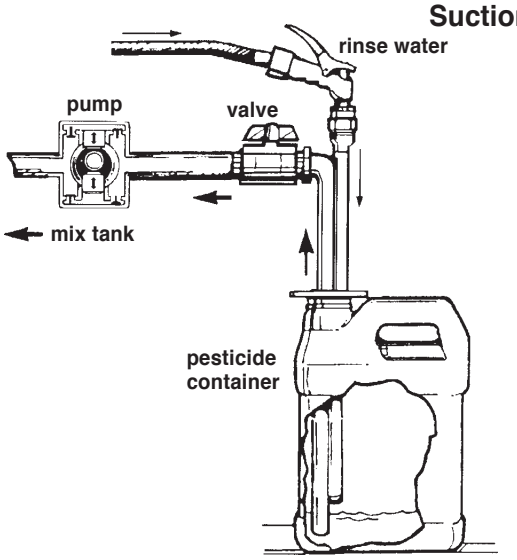
Gravity systems

Gravity systems can work with both liquid and dry concentrates that use water as a diluent. A gravity system sometimes is called a "punch and drain system."

The unopened pesticide container is put into a chamber which then is sealed. A punch cuts a large opening in the container, allowing all the material to drain into the mixing tank. A water nozzle attached to the punch sprays the inside of the container to rinse it thoroughly. The rinse water drains into the mixing tank. The rinsed container then is removed for disposal.

One problem with this system is that you cannot use part of the pesticide in a container and store the rest.

Suction systems



Closed-loading (suction)/rinse system.

This system uses a pump to remove the pesticide through a probe put into the container. (Some containers are made with built-in probes.) Hose and pipe transfer the pesticide to the mixing tank. The machine rinses the empty container and the transfer system with water. Then, it adds the rinse water to the mixing tank.

Some systems have a way to measure the amount of pesticide suctioned into the mixing tank. They let the probe stay in the container until all the pesticide is used and the container and probe are rinsed. To do this, some probes have a breakaway head that stays in the container. This lets you take the probe out and reuse it.

With some suction systems, you cannot reseal a partly empty container. Another disadvantage of suction systems is that very thick pesticide mixtures are hard to move by suction.

Soluble packaging

Soluble bags or containers are a less complex type of closed mixing and loading system. You place the sealed pesticide package into the mixing tank, where it dissolves in the solvent (usually water).

One disadvantage of soluble packaging is that the concentrate accidentally could release if the package were exposed to water or other solvents during shipping or storage. Another disadvantage is the risk that a container could splash when you add it to the tank.

Personal protective equipment requirements

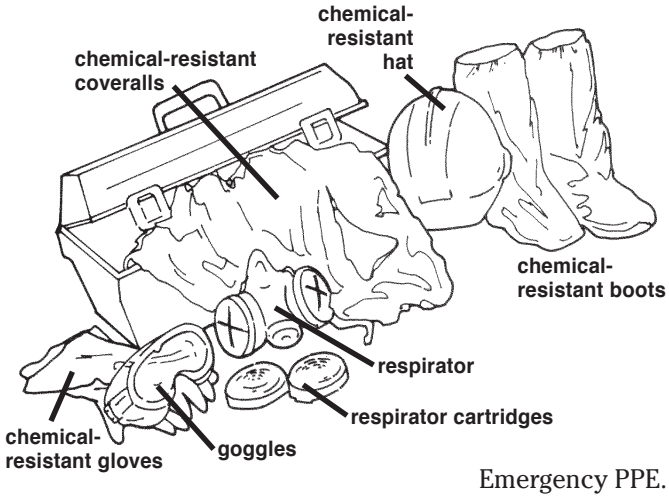
The PPE that you must wear to work with many pesticides may be less if you use a closed system.

- You may be allowed to use a long-sleeved shirt, long-legged pants, shoes, and socks instead of the PPE listed on the pesticide label.
- If you are mixing or loading concentrated pesticides using the closed system, you may be required to wear a chemical-resistant apron and chemical-resistant gloves.
- If the system runs under pressure, you may be required to wear protective eyewear.

Even if you wear less PPE because you are using a closed system, keep a set of the PPE that the pesticide labeling requires for regular mixing and loading. Store the PPE at the mixing and loading site. Then you are ready in case the closed system equipment breaks down or there is an accidental spill.

Advantages of closed mixing and loading systems

- Handlers are less exposed to the pesticides.
- You need less personal protective equipment.
- There are fewer spills.
- Measurements are more accurate. So, you use the right amount of pesticide for the job. This saves you money.



Emergency PPE.

Disadvantages of closed mixing and loading systems

- Some systems cost a lot of money or are hard to find.
- Some systems are massive and clumsy.
- Some systems are not right for certain pesticides and for some handling activities.

Enclosed application systems

An enclosed application system is a tractor or sprayer cab. The applicator stays inside the cab. This keeps you from coming in contact with pesticides during applications. An airplane cockpit also is an enclosed application system.

When you work in an enclosed application system, pesticide labeling directions and current pesticide rules may allow you to wear less PPE than they require for regular application. But, you must store the required PPE inside the cab. You must wear it any time you get out of the cab in the treated area.

Take off the contaminated PPE before you get back into the cab. Store it outside the cab. Or, put it in a chemical-resistant container, such as a plastic canister or trash bag, that you can close tightly and take inside the cab.

These are some types of enclosed application systems:

- An enclosed cab. It protects skin and eyes.
- An enclosed cab with an air-filtering ventilation system. It protects you from inhaling dusts and mists. It protects skin and eyes.
- An enclosed cab with a vapor-removing ventilation system. It protects you from inhaling pesticide vapors. It protects skin and eyes.
- An enclosed cockpit. It protects skin and eyes, and protects you from inhaling pesticides.

Pesticide containment systems

If you often mix and load pesticides in one place, or if you often clean equipment at one place, a pesticide collection pad or tray is a good investment. These pads and trays are made to catch spills, leaks, overflows, and wash water so you can throw them away properly or reuse them. You can install larger pads that stay in one place. You can move smaller pads and trays to use in different places.

These systems can save you time and money. They make spill cleanup easier. They reduce pesticide waste by letting you reuse the rinse water and spill cleanup water. They also help prevent the harm that spills and runoff can cause to the environment or to people.

Collection trays

You can use a collection tray at mixing, loading, and equipment cleaning sites where you handle only small amounts of pesticide at a time. You can use a collection tray on a counter or bench.

The tray can be made of sturdy, chemical-resistant rubber or plastic, like a boot or shoe mat. It must have a rim around it to collect spills and leaks. It should have a spout for pouring off the contents.

Collection pads

A collection pad is for mixing, loading, and equipment cleaning sites where you handle large quantities of pesticides and clean large equipment. These sites usually are outdoors or in a large, open space in a warehouse or barn. **Do not use the collection pad to collect leftover or excess spray from the spray tank**.

The collection pad should be made of waterproof material. Good materials are sealed, smooth concrete; glazed ceramic tile; or no-wax sheet flooring. Do not use porous surfaces, such as wood, asphalt, soil, or carpeting. Your local fire marshal or county Extension agent should have design plans or suggestions for collection pads.

The pad must be concave. Or, it must have curbs or walls high enough to hold the largest amount of spill, leak, or equipment wash water that could be created at the site.

The pad also must have a way to remove and recover spilled, leaked, or released material. It must have either an automatic sump system or a hand pump.

Place the collection pad where rainwater, irrigation water, and flood water cannot flow over it. Wash the pad at the end of each day's use to prevent possible harm to animals and unprotected people. A good way to dispose of this collected water is to spray it along fence rows or field roadways to which people and animals do not have access.

After mixing and loading

As soon as you finish mixing, loading, or applying a pesticide, you must clean up. Take time to clean up properly. Wash your pesticide equipment. Return equipment to its place. Safely store or dispose of all pesticides and other chemicals you have used. Be sure your work site

presents no hazard to people or to the environment. Never leave the site unattended until everything has been cleaned up and put away. After you finish, wash yourself well.

Make a record in writing of what you applied and the conditions at the application site while the facts are fresh in your memory.

To learn more about keeping records, see Chapter 19.

Clean your equipment

Always clean mixing, loading, and application equipment as soon as you finish using it. Do not leave equipment with pesticides on or in it at the mixing and loading site or at the application site.

Do not wash equipment over and over in the same place, unless you use a containment pad or tray. Over time, the floor or soil can become contaminated with small amounts of pesticides. This contamination increases the chances of harmful effects to people and animals who might contact the site. It increases the chances of runoff or leaching into water systems.

Do not tell a worker to clean contaminated equipment unless that person knows the basic rules of pesticide safety. Equipment cleaning can present a real risk of exposure to pesticides.

All parts of the equipment can have pesticides or pesticide residues on them. When you clean contaminated equipment, wear the PPE that the labeling requires for handlers, plus a chemical-resistant apron.

Consequences of poor cleanup

Sloppy cleanup is one of the main causes of pesticide cross-contamination and equipment failure. Never keep excess pesticides in your equipment for more than a short time. Even small amounts of pesticide residues can damage equipment.

Liquid pesticides quickly can corrode the equipment. They can cause the equipment to leak. They can speed up nozzle wear or clog the hole.

Some liquid pesticides change if you store them after they have been diluted. You cannot use them for application at a later time. Some settle out and form a solid clump at the bottom of the tank that even mechanical agitation cannot remix. Others separate into two or more separate liquids that you cannot remix easily. Liquid pesticides that stay in the equipment until they are totally dry may be impossible to remove completely at a later time.

Dry pesticides that become wet through humidity, rain, dew, or other moisture tend to clump and stick to the sides and hopper openings. You cannot apply them at a later time. You cannot remove them easily from the equipment.

Correct cleaning methods

After the equipment is empty, clean both the inside and outside very well. Clean nozzles or hopper openings. Sometimes you might need to use the diluent for the pesticide mixture (kerosene or high-grade oil), special cleaning agents, or water under pressure. At other times, plain water might be enough.

Collect the rinsate (the liquid that results from the washing process).

Use special care when you wash any vehicle that unprotected workers or family members might use later. People can be poisoned by riding in vehicles that have pesticide residues on them.

Rinsates

Remember, the rinsates you make when you clean your equipment have pesticides in them. They can harm people and the environment. **Do not let rinsates flow into water systems, including sink or floor drains, rainwater culverts, wells, streams, lakes, and rivers. Do not make puddles that children, other unprotected persons, or animals could get into**.

You may use equipment rinsate as a diluent for future mixtures of pesticides, if:

- The pesticide in the rinsate is labeled for use on the target site where you want to apply the new mixture.
- The amount of pesticide in the rinsate plus the amount of pesticide product in the mixture is not more than the labeling rate for the target site.
- You use the rinsate to dilute a mixture that contains the same pesticide or a compatible pesticide.
- You comply with other application instructions stated on the labeling.

You cannot add the rinsate to a pesticide mixture if:

- The pesticide labeling does not list the rinsate as an acceptable diluent. For example, the rinsate contains a strongly acidic or alkaline neutralizing agent.
- The rinsate contains strong cleaning agents, such as bleach or ammonia, that might harm the plant, animal, or surface to which you want to apply the pesticide.
- The rinsate would change the pesticide mixture so you could not use it. For example, the pesticides are physically or chemically incompatible.

To learn how to dispose of excess pesticides, see Chapter 17.

If you have any rinsates that you cannot use, dispose of them as you would excess pesticides.

Clean yourself

When you finish working with pesticides or contaminated equipment, take time to clean yourself.

Wash the outside of your gloves. Then, grasp the cuff and “roll” them off. Then carefully take off your PPE so you won’t get pesticides on your skin. Take off any other clothing that has pesticide on it.

Use a mild liquid detergent and warm water to wash your face, hands, forearms, and any other place that might have pesticides on it. As soon as you can, wash your whole body and your hair. Use soap and shampoo and plenty of warm water. Be sure to wash by the end of the work day.

When you take off your PPE and work clothes, put them in a plastic bag or box until you can wash them. Do not let children or pets play with them. Do not wash work clothes and PPE in the same wash water with other clothes.

Questions for study—Chapter 15

1. Which pesticide formulations must you dilute before you apply them?
2. When is the best time to add the pesticide to the spray tank? Why?
3. Why is mixing the time when you are most likely to be dangerously exposed to pesticide poisoning?
4. Through which route(s) of entry are you most likely to be exposed during mixing?
5. Why are antisiphoning devices important to protect the environment?
6. After you empty a pesticide container, why must you rinse it out?
7. How many times should you rinse an empty pesticide container?
8. Can you mix all types of pesticides together without any problem? Why?
9. What does compatibility mean when talking about pesticides?
10. Where can you find out if two pesticides are compatible?
11. What is an adjuvant?
12. For what kind of job would you use a spreader-sticker?
13. Why is it important to measure out the correct amount of adjuvant to add to the spray tank?
14. Should a pesticide applicator wear protective clothing while mixing or loading pesticides? Why?
15. For most pesticide sprays, what is the recommended pH level?
16. Describe how to multiple rinse pesticide containers.

Chapter 16

Weather-wise Application

Goals of this chapter

- Explain how weather conditions can both help and hinder the applicator.
- Explain the hazards of applying on a windy day.
- Tell who is responsible by law for damage caused by drift.
- Explain the advantage of early morning and evening application.
- Show how humidity affects pesticide application.
- Show how temperature inversions affect pesticide application.

Weather-wise means checking the weather forecasts and conditions before you apply pesticides. Weather-wise application can reduce pesticide hazard to the environment. If rain washes the pesticides away, or wind blows them away, you'll need more pesticide, time, and money to treat again.

Hot day and dry air

A hot day and low relative humidity make the pesticide evaporate faster. When droplets evaporate before hitting the target, pesticide stays in the air. The vapor can be carried miles from the treatment area. This is called **vapor drift**.

On a hot day with low relative humidity, spray droplets evaporate so fast that the pesticide might not have time to penetrate the leaf surface. The pesticide might stay on the leaf surface.

Windy days

High winds increase drift. They move the pesticide out of treated areas. Drifting pesticides can contaminate air, water, soil, plants, animals, and buildings.

Apply pesticides when there is little wind. You can reduce the chance of harm to sensitive sites. Also, you reduce the chance of harm to yourself.

You are responsible by law for any harm due to pesticide drift. **Don't take a chance by spraying when it is windy.**

Turbulence

Sometimes the air is disturbed by air currents. This is called **turbulence**.

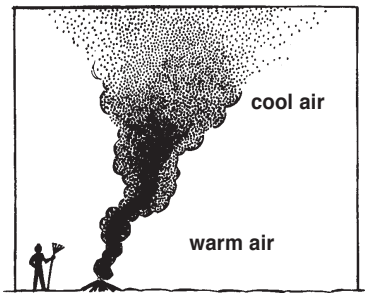
Air turbulence is caused by the difference between the temperature at ground level and the temperature of the air just above it. During the day, sunlight and warm air heat the soil. When the air near the soil's surface is warmer than the air above, air currents move upwards towards

the sky. The larger the temperature difference between the air near the soil surface and the air above, the stronger the air currents.

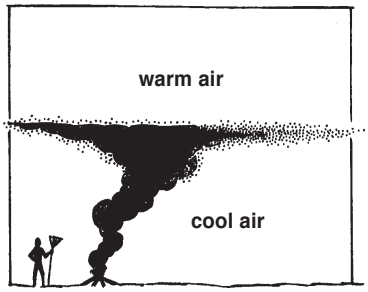
Air currents can carry spray vapors and droplets away from the treatment area. Small twisters (also called **wind devils**) and currents that you can see rising are signs of turbulence.

Do not apply pesticides when the air is turbulent.

Inversions



Normal conditions: Smoke rises and disperses.



Inversion condition: Smoke concentrates.

Sometimes the air near the soil surface is cooler than the air above it. This is called an **inversion.** The warm air on top blocks the air near the soil from moving up. Air moving up would help disperse any pesticide that is still in the air above.

Wind can help mix the air. This reduces inversion conditions. But, a light breeze during inversion conditions could cause small spray drops to stay in the air. These droplets then move out of the treatment area with the slightest breeze.

You can use smoke to test for an inversion condition. Burn rags or straw, and watch the smoke rise. If it rises no more than 15 or 20 feet before it spreads out, you most likely have an inversion condition. **Do not apply pesticides when there is an inversion.**

Application before rain

Do not spray just before it rains. The pesticide might wash off and not control target pests.

Rain also can wash the pesticide away from the target area. The runoff can carry the pesticide into crops, ponds, ornamental plants, and streams. This might cause pollution and harm.

Apply in the morning or the evening

Wind speed is usually lowest and air has most moisture in the evening and early morning. If you spray at these times, you reduce the risk of drift.

Children, farm animals, and pets are less likely to be nearby during these hours. There is less danger to birds, mammals, and bees, who often visit crop lands during the day.

Questions for study—Chapter 16

1. Can weather-wise application save you money?
2. Why should you avoid applying pesticides on windy days?
3. Why are drifting pesticides hazardous?
4. Is windy day application more hazardous for the applicator and others nearby?

5. If a pesticide drifts onto nontarget areas and causes harm, who is responsible by law?
6. Why must spray applications dry onto a surface before a rain?
7. What harm can pesticide runoff do?
8. What are two advantages of early morning or evening application?
9. Which weather factors affect drift?
10. When does an inversion occur?

Chapter 17

Transportation, Storage, and Disposal

Goals of this chapter

- Discuss safeguards for transporting pesticides in a vehicle.
- Describe how to protect pesticide containers during transport.
- Explain how to make a safe storage site and keep it safe.
- Describe what to do when a pesticide container leaks.
- Explain what to do with excess pesticides that you still can use.
- List legal ways to dispose of pesticide wastes.
- Tell how to avoid throwing away pesticide containers.

When you move, store, or dispose of extra pesticides and their containers, you must use safety measures. If you are prepared, you can prevent many pesticide accidents—and make the ones that happen less severe.

Proper pesticide storage helps chemicals stay potent longer. Proper storage reduces risk to people, animals, and the environment.

Careless disposal practices are a common cause of environmental contamination. Dispose of excess pesticides and empty containers carefully and legally.

Read the pesticide product label for details on storage and disposal.

Transporting pesticides

You are responsible for safety when you haul pesticides. If you are careless, containers can break or spill. This can contaminate the environment and harm you and others.

Do all you can to prevent a mishap, but be prepared in case it happens.

Before you haul pesticides, know what to do if there is a spill. If any pesticide spills in or from the vehicle, act fast to make sure the spill is cleaned up correctly.

Report the spill to the **Oregon Emergency Response System (OERS)**. If the amount of hazardous substance that spilled is more than the reportable quantity, OERS will tell you if you also must report the spill to the **National Response Center**.

OERS
Telephone: 800-452-0311

National Response Center
Telephone: 800-424-8802

To learn what to do if there is a spill, see Chapter 18.

For details on the reportable quantity, see "SARA Title III" in Chapter 1.

The National Response Center Web site: www.nrc.uscg.mil

Vehicle safety

NEVER carry pesticides in the part of your vehicle where people ride. The pesticides can release hazardous vapors. The vapors can make the driver and other passengers ill. Pesticides also can cause sickness or harm if they spill on you or people or pets riding with you. Even vapors from pesticide spilled on the outside of the container can be hazardous. NEVER let people or pets ride with pesticides.

There really is no way to remove spills completely from the fabric of seats and floor mats. They can cause harm later.

NEVER transport pesticides with food, clothes, or other things that come in contact with people or animals. Even small amounts of pesticide could harm them.

NEVER leave your vehicle without someone to watch it when pesticides are in an unlocked trunk or an open-bed truck. You are responsible by law (not your company) if children or careless adults are poisoned by chance. Whenever you can, transport pesticides in a locked compartment.

DO NOT transport highly volatile pesticides with other chemicals. Spills or fumes from opened containers can contaminate the other chemicals. Transport them by themselves.

Protect pesticide containers

The safest way to haul pesticides is in the back of a truck. Flatbed trucks should have side and tail racks. Beds lined with steel or plastic are best, because you can clean them more easily if there is a spill. But, containers placed on steel or plastic slide more easily than containers resting on wood. **In all cases, you must tie down the containers so they do not move.**

Carry the shipping papers and signs that you need for each pesticide. Read the Materials Safety Data Sheet for details.

Move pesticides only in containers whose labels are not damaged and that you can read. Inspect containers before you load them to be sure all caps, plugs, and other openings are closed tightly. Handle containers carefully to avoid rips or punctures.

Tie down all containers firmly to keep them from rolling or sliding. Packing or shipping containers have extra padding. Protect paper and cardboard containers from moisture. They get soggy and split easily when they are wet.

Protect pesticides from extreme heat or cold during transport. Extreme heat can cause pesticide containers to melt. Extreme cold can cause containers to crack or break easily. Extreme heat or cold also might make the pesticides less potent.

Always carry a spill kit.

For details about a spill kit, see Chapter 18.

Pesticide storage

Make a storage site

Many pesticide handlers store pesticides in buildings that already exist. Or, they use part of a building. If you need to store large amounts of pesticides, it is best to build a special storage building just for the pesticides.

Your pesticide storage should be apart from offices, workshops, livestock areas, food, and feed. It should be far from wells, streams, lakes, ponds, and wildlife.

Plan your building

There are no national standards for storage buildings. Call or write your local Fire Marshal for help with your design. You can get some kinds of plans from your Extension office.

It is best to use fireproof building materials.

Most plans call for liquid spill containment walls. These are called **berms**. The berms must be able to hold 100 percent of all liquids stored there plus another 25 percent. That way, they can contain the pesticides plus water if there is a fire.

Secure the site

Keep people out of the storage site who should not be there. No matter what size your storage space, keep it securely locked.

You also might want to put a fence around the storage area.

Put up signs on all doors and windows to alert people that pesticides are stored there. Be sure the signs will last through rain and sun. Put up "no smoking" signs, too.

Prevent water damage

Choose a storage site where water from excess rain, irrigation, or flooding streams cannot cause damage. Also, beware of water from burst pipes, spills, and overflows. Water or excess moisture can cause these things to happen:

- Metal containers can rust.
- Paper and cardboard containers can split or crumble.
- Pesticide labeling can peel, smear, run, or become too damaged to read.
- Dry pesticides can clump, degrade, or dissolve.
- Slow-release products can release their pesticide.
- Pesticides can move with runoff from the storage site into other places.

Store containers off the floor. If the storage site is not protected from the weather or if it is damp, place metal, cardboard, and paper containers in sturdy plastic bags or cans. Large metal containers can rust when they get damp. You can put them on pallets inside the storage site.

Control the ventilation

The storage area must have enough fresh air. You can use either well-designed passive ventilation or a fan. **Passive ventilation** means that fresh air flows through the building without fans or other force.

If you use a fan, place the switch outside so you can air out the storage space before you enter. Design either system so the air flow is away from the door.

It also may be a good idea to put in an exhaust hood. Use it when you measure pesticides for mixing and loading.

Control the temperature

Store pesticides indoors, whenever you can. The storage room or building should be cool and have plenty of fresh air. It should be insulated or have a way to keep the inside from extreme heat or cold.

The pesticide labeling might tell you at what temperatures to store the product.

Freezing cold can cause glass, metal, and plastic containers to break. High heat can cause liquids to expand. This puts containers under pressure. High heat also can cause some glass containers to explode. It can cause some pesticides to vaporize and drift away from the storage site.

Extreme heat or cold can destroy the potency of some pesticides. They cause the chemical to degrade in the container.

Have enough light

The storage site should have lots of light. Pesticide handlers working there must have enough light to do these things:

- Read pesticide container labeling
- See whether containers are leaking, corroding, or coming apart some other way
- Clean up spills or leaks completely

It is best to use anti-spark electrical parts for pesticide storage sites.

Use nonporous materials

The floor of the storage site should be made of sealed cement, glazed ceramic tile, no-wax sheet flooring, or some other material that is easy to clean. Do not use carpet, wood, soil, or other floors that absorb liquid. They are very hard or impossible to clean.

To make cleanup easy, build shelves and pallets from plastic or metal. If you use wood or fiberboard, cover it with plastic or polyurethane or paint it with epoxy paint.

Prevent runoff

Inspect the storage site to trace the pesticide's likely path in case of spills, leaks, drainage of equipment wash water, and heavy pesticide runoff from firefighting or floods. Pesticides could move away from the storage site and into surface water or groundwater.

For more detail on collection pads, see Chapter 15.

If you store large amounts of pesticides at your site, you might need to use a collection pad to hold pesticide runoff.

Provide clean water

Each storage site must have a ready supply of clean water. The best is running water that is pure enough to drink.

If you cannot supply running water, fill with clean water a large container that you can seal. Change the water in the container at least once a month to be sure it stays safe to use on skin and eyes.

Keep a supply of detergent, soap, and hand cleanser in the storage area. Keep an eyewash dispenser ready for emergencies. If you can, have a shower to use in an emergency.

Prepare for emergencies

Keep a list of emergency telephone numbers handy. Keep a copy of the list inside **and** outside the storage area. If there is a fire or major leak or spill, you can find the list away from where the danger is. Keep a spill kit, first aid kit, and a fire extinguisher approved for chemical fires.

For contents of a spill kit, see Chapter 18.

For contents of a first-aid kit, see Chapter 7.

Keep the storage site safe

Prevent contamination

At the storage site, store only pesticides, pesticide containers, pesticide equipment, and a spill cleanup kit. Do not keep food, drink, tobacco, feed, medical supplies or medicine for people or animals, seeds, clothing, or personal protective equipment (other than what you need for emergency response) at the site. Vapors, dusts, or spills could contaminate these and cause exposure to people or animals.

Protect labels

Moisture, dripping pesticide, diluents, or dirt can damage or destroy labels. You can use clear tape or a coating of lacquer or polyurethane to protect the label. If the label is destroyed or damaged, ask for another one from the pesticide dealer or the pesticide formulator **right away**.

Keep containers closed

Keep pesticide containers tightly closed while you store them. Tightly closed containers help protect against these things:

- Spills
- Cross-contamination with other stored products
- Evaporation of liquid pesticides or the solvent
- Clumping or caking of dry pesticides when the air is humid
- Contamination by dust or dirt

Use original containers

Store pesticides in the containers in which you bought them. Never put pesticides in a bottle, bag, or box that children and other people might mistake for food or drink. You are responsible by law if any harm comes from pesticides you have put in the wrong containers or containers without labels.

Watch for damage

Inspect containers often for tears, splits, breaks, leaks, rust, or corrosion. When a container is damaged, put on the correct personal protective equipment and act fast.

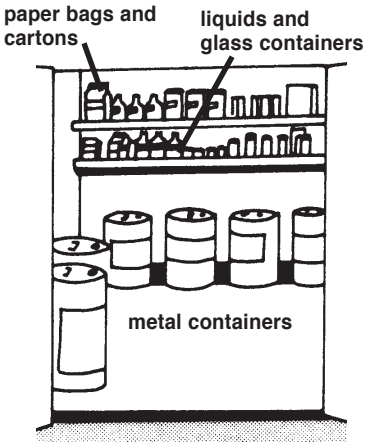
- Use the pesticide right away on a site and at a rate allowed by the label. **Or**
- Put the pesticide into a pesticide container that held the same pesticide and has the same label still intact. **Or**
- Put the pesticide in a sturdy container that you can close tightly. If you can, remove the label from the damaged container and use it on the new container. If you cannot do that, then mark the new container with the name of the pesticide and the EPA registration number. Get a copy of the label from the pesticide dealer or formulator as soon as you can. The telephone number is usually on the label. **Or**
- Place the entire damaged container and its contents into a larger container that is right for storing it. This might not be the best choice, though. Often, a leaking container ruins the label so you cannot read it. You must not use a pesticide unless you know the name and registration number and can get a copy of the label. It also is a disposal problem.

If the damaged container is an aerosol can or fumigant tank that holds pesticides under pressure, use special care not to release the pesticide into the air.

Store pesticide containers correctly

Store all pesticide containers with the label in plain sight. Store containers off the floor, especially if the damp ground can damage them. Set containers upright.

Place all containers in straight rows with enough room for you and your helpers to walk between them. Store paper bags and cartons on shelves above liquids. Store glass containers below bags and cartons. Store metal containers on lower shelves.



Correct storage of pesticide containers.

Store volatile products apart from others

Store volatile pesticides, such as some formulations of 2,4-D, apart from other types of pesticides and other chemicals. Vapors from opened containers of these pesticide can move into other pesticides and chemicals and make them useless. A separate room is best.

The labeling of volatile herbicides usually tells you to store them apart from seeds, fertilizers, and other types of pesticides.

Store waste products safely

Sometimes, you might hold pesticides and pesticide containers to dispose of them later. Store them in a section of the storage site apart from other containers. If you use a pesticide by mistake that was meant for disposal, it can cost you a lot.

Clearly mark all containers of stored waste. Be sure they are safe from moisture and extreme heat or cold. Be sure the place you store them gets a lot of fresh air. This way, harmful vapors cannot build up there.

Be sure the storage space is closed and locked to keep out animals and people who should not be there.

Clearly mark containers that you have multiple rinsed or cleaned in some other correct way. **You can recycle them.**

For details on cleaning pesticide containers, see Chapter 15.

Know your inventory

Keep an up-to-date list of the pesticides you have in storage. This is called your **inventory**. Each time you add or remove a pesticide from the storage site, update the inventory list.

The list helps you keep track of your stock. It is a must in a fire or flood emergency. The list aids in insurance settlements. It helps you decide which pesticides and how much to buy in the future.

Buy and store only as much pesticide as you need for 1 year at most.

Keep product shelf life in mind

Before you store it, mark each pesticide container with the date you bought it. If the product label lists a shelf life, your purchase date will show you whether you still can use it. Use older products first. Some pesticides have a short shelf life.

Pesticides break down from age or poor storage conditions. A lot of clumping, poor suspension, layering, or the wrong color might mean that the pesticide has broken down. But, sometimes you can't tell that pesticides have broken down. The result can be poor pest control or damage to the treated site.

If you have doubts about the shelf life of a pesticide, call the dealer or manufacturer for advice.

Prevent pesticide fires

Some pesticides catch fire very easily. They are **highly flammable**.

Pesticides that need extra safeguards often have a warning statement in either the Physical/Chemical Hazards section or the Storage and Disposal section of the label. Pesticides that contain oils or petroleum-based solvents are the ones most likely to have these warning statements.

Store flammable pesticides away from open flames and other heat sources. Do not store them near steam lines, heating systems, kerosene heaters or other space heaters, gas-powered equipment, or incinerators.

Do not store glass containers in sunlight. The glass can focus the heat rays and might explode or ignite the pesticide.

Install fire detection systems in large storage sites. Equip each storage site with a fire extinguisher that works. The fire extinguisher must be approved for all types of fires, including chemical fires.

If you store highly toxic pesticides or large amounts of any pesticides, you must tell your local fire department and police where your pesticide storage building is. It is the law. Do this before there is a fire emergency.

Tell the fire department what types of pesticides you store at the site. Give them a floor plan. Work with them to make an emergency response plan.

Know the law

There are three sections under SARA Title III that relate to pesticide storage. They refer to these things:

1. You must report where your storage site is and the amount of hazardous chemicals you keep there.
2. You must keep a Material Safety Data Sheet (MSDS) for each chemical that requires it.
3. You must report your inventory each year.

For details on SARA Title III, see Chapter 1.

Storage Facility Checklist

Yes	No	
❑	❑	Apart from offices, workshops, livestock areas
❑	❑	Far from wells, streams, lakes, ponds, wildlife
❑	❑	Apart from food and feed
❑	❑	Fire-resistant building materials
❑	❑	Floor made of material that does not absorb liquids
❑	❑	Liquid spill containment (berms, 125 percent of liquid storage)
❑	❑	Anti-spark electrical parts
❑	❑	Heating system
❑	❑	Ventilation system with an outside switch
❑	❑	Plenty of light
❑	❑	Locked doors
❑	❑	Fenced
❑	❑	Warning signs posted
❑	❑	Racks for off-floor storage
❑	❑	Emergency eyewash and shower ready to use
❑	❑	Clean water and soaps for routine wash-up nearby
❑	❑	Spill kit and fire extinguishers ready
❑	❑	Personal protective equipment
❑	❑	First aid kit
❑	❑	Prepared emergency response plan on file
❑	❑	Pesticide inventory on file

Make it a habit! Store your pesticides and equipment correctly before you clean up and go home or on to the next job.

Disposal

Be sure that you dispose of these things correctly:

- Empty pesticide containers
- Excess pesticides
- Any waste that contains pesticides or their residues

If you dispose of them the wrong way, you could cause serious harm to humans and the environment.

The Oregon Department of Environmental Quality (DEQ) makes the rules for disposing of excess pesticides and empty pesticide containers. Contact them for details on what ways you can dispose of pesticides in your local area.

Using excess pesticides

The best answer to the question of what to do with excess pesticides is to not have any.

- Buy only the amount you need for 1 year or season.
- Calculate carefully how much diluted pesticide you need for a job. Mix only that amount.
- Use **all** the mixed pesticide as the labeling instructs.

If you have excess pesticides that you can use, first try to find a way to use them as the label directs. The best way is to apply the pesticide on a site listed on the label, under these conditions:

- The total amount of pesticide active ingredient that you apply to the site must not be more than the rate and frequency allowed on the label. This includes all the applications you have made already.
- You must comply with other application instructions listed on the label.

If you have pesticide products that you cannot use, try to return them to a dealer, formulator, or manufacturer. The pesticides must be in their original, unopened containers.

Container rinsates should not become excess pesticides, because you can add them into the tank during mixing. You can add rinsates from equipment cleaning and spill cleanup. Add them to a tank mixture that contains the same pesticide, as long as doing so is not against labeling instructions.

You can save rinsate to add to the spray tank the next time you apply this same pesticide. Rinsate and other pesticide waste must be stored in a clearly marked container. It is illegal to store them in the original container.

Some rinsates have other chemicals in them, so you cannot use them. If you cannot add rinse water to the spray tank, spray it on a fencerow or other site at the normal use rate. Be sure it is a place where humans and animals will not enter. Soil microbes and sunlight should break down any pesticide present.

Pesticide wastes

Whenever you can, avoid making pesticide wastes that you need to dispose of. Pesticide wastes include excess pesticides, rinsates, and spill cleanup materials that you cannot use. They also include personal protective equipment that you cannot clean and reuse.

Most of the time, pesticide wastes are hazardous wastes. You must dispose of them in a landfill that has an EPA or State (DEQ) permit for hazardous wastes. Some landfills may accept wastes in very small amounts. Most normal landfills are not right for pesticide wastes. Contact the landfill near you for details.

NEVER burn, bury, or dump excess pesticides. Never dispose of them in a way that will pollute groundwater, surface water, or sewage treatment water.

If you have wastes that you cannot dispose of right away, clearly mark the containers. Store them safely until you can dispose of them the correct way. See "Store waste products safely," page 202, for details on how to store pesticide wastes.

Containers

You may have other choices than to dispose of empty pesticide containers as waste.

- Use containers that the pesticide dealer or the chemical company can reuse.
- Recycle multiple-rinsed containers.

Reuse

Refilled containers

Some types of containers are meant to be refilled with pesticide many times while they last. **Minibulks** are 15- to 30-gallon tanks. **Small-volume returnables** are containers that hold less than 15 gallons.

Most of the time, you do not need to multiple rinse or pressure rinse them. The pesticide dealer or chemical company cleans them before refilling.

Reconditioned containers

You can return some 30- and 55-gallon drums to the dealer, manufacturer, or formulator. They will recondition and reuse them.

Recycle

Oregon's Pesticide Container Management Program

The public is getting more concerned about the disposal of used pesticide containers. Because of this, the Oregon Agricultural Chemicals and Fertilizer Association and the Oregon Farm Bureau Federation created a program to collect and recycle **multiple-rinsed metal and plastic** containers safely.

The program began in 1984. Since then, Oregon's Pesticide Container Management Program has become known and copied by many other states.

The program lets people who use pesticides dispose of used pesticide containers in a way that protects the environment.

This program works well because pesticide users prepare pesticide containers correctly for recycling:

1. Multiple rinse glass, plastic, and metal pesticide containers. Pour the rinsate into the spray tank.
2. Multiple rinse and crush metal containers. Puncture 1- and 5-gallon containers with at least three 1-inch holes in the top and bottom before you crush them. You must cut out both the top and bottom of 30- and 55-gallon containers. Then crush them.
3. Multiple rinse plastic containers. Pour the rinsate into the spray tank. Remove plastic caps and plastic label sleeves. You don't need to remove paper labels from the plastic containers. You do not need to cut plastic containers in half or crush them.
4. After you prepare them, store metal and plastic containers in a dry place. All containers need to be clean on the outside for a collection site to accept them.
5. Plastic and metal pesticide containers that have not been multiple rinsed are hazardous waste. You cannot recycle them.

For more details on the container recycling program, call:
Oregon Agricultural Chemicals and Fertilizer Association
Telephone: 503-370-7024

Send to the landfill

Multiple-rinsed or pressure-rinsed containers

Most of the time, you can dispose of clean containers that you have multiple rinsed or pressure rinsed in a normal landfill. Sometimes the pesticide labeling or the person who runs the landfill tells you that you cannot. Contact the person who runs the landfill before you dispose of your decontaminated containers there. **You can recycle multiple-rinsed plastic and metal containers**.

Never leave rinsed containers lying around carelessly where they could be used for the wrong purpose or where children may play with them. Store them properly until you can recycle or dispose of them.

Unrinsed containers

If you do not rinse metal and plastic containers, you cannot recycle them. They are hazardous waste.

Take unrinsed containers to a landfill that has an EPA or Oregon State permit for hazardous waste disposal. If you cannot do this, check with the DEQ to find out what to do. You might need to store the containers until you have a way to dispose of them that is legal.

Hazardous waste disposal is expensive. That might give you more reason to decontaminate and recycle your containers.

Burning containers

The labeling of some paper and cardboard containers lists "burning, if allowed by state and local authorities" as a way to dispose of them.

But, open burning of pesticide containers and waste pesticides is a hazardous practice. You also might break federal or state laws that come first before the instructions on the pesticide labeling. Because of the risks

of air pollution and breaking the law, it is best to dispose of these containers some other way.

It is against Oregon law to burn plastics. Many pesticide bags have plastic liners. Do not burn these bags.

Know the law

For more detail on RCRA, see Chapter 1.

The U.S. Environmental Protection Agency makes laws for hazardous wastes under the **Resource Conservation and Recovery Act (RCRA)**. The EPA keeps a list of hazardous materials. Some pesticide wastes are on this list.

RCRA also applies to certain wastes that are flammable, corrosive, reactive, or toxic, even if they are not on the list. Some pesticides could be "regulated hazardous wastes" under RCRA if they have one of those dangers.

Oregon Department of Environmental Quality (DEQ) Web site: www.deq.state.or.us/

Call DEQ to find out if a pesticide is listed in RCRA. Or, call DEQ to find out how to take care of pesticide waste.

Oregon Department of Environmental Quality
Telephone: 503-229-6753 or
503-229-5913

Questions for study—Chapter 17

1. What safeguards should you use when you transport pesticides in a vehicle?
2. What should you do to protect pesticide containers during transport?
3. List four things you should do to make a safe storage site.
4. List four things you should do to keep the storage site safe.
5. When a pesticide container is damaged, what can you do?
6. If you have excess pesticides that you still can use, how can you use them?
7. If you have pesticide wastes (other than empty containers), what can you do with them?
8. List three ways to dispose of empty pesticide containers other than as wastes.
9. Why do you need to store volatile herbicides in a special place apart from other pesticides?
10. Why is it important to take the time to dispose of surplus pesticides and empty containers correctly?
11. What problems can result if you buy more pesticides than you can use?
12. What are the proper ways to dispose of surplus concentrated pesticides that are still in their original containers?

13. If you have rinsed out a container, can you toss it away or give it to children to play with?
14. What should you do with the rinse water if you can't add it to the tank mix?
15. What should you do to prepare empty metal, glass, or plastic containers for disposal or recycling?
16. Name the ways to prevent pesticide waste surplus.
17. Which groups in Oregon have a program for recycling metal and plastic containers?
18. What agency in Oregon is most responsible for pesticide disposal?

Chapter 18

Spill Management

Goals of this chapter

- Explain the Three C's of spill management and the steps to take in each.
- List where to get help for managing a spill.
- Explain when a spill kit should be at hand.

Spill response

A spill is any accidental release of a pesticide. As careful as you may be, pesticide spills can and do occur. You must know how to respond the right way when a spill occurs. You must have the proper cleanup equipment in place and ready.

Stopping large leaks or spills is often not simple. If you cannot manage a spill by yourself, get help. If not handled correctly, even a spill that appears to be minor can put you, other people, and the environment in danger.

Never leave a spill unguarded.

Clean up spills right away. The faster you can contain, absorb, and dispose of a spill, the less chance there is that it will cause harm. Clean up even minor dribbles or spills right away to keep other people or animals from being exposed.

A good way to remember the steps for a spill emergency is with the **Three C's:**

Control
Contain
Clean up

You can get help from the Chemical Transportation Emergency Center by calling:

Chemtrec
Telephone: 800-424-9300—Emergencies only

You also can get help from the Oregon Emergency Response System by calling:

OERS
Telephone: 800-452-0311

Control the spill situation

Protect yourself

Put on appropriate personal protective equipment to avoid contact with the spill or breathing its fumes. If you do not know how toxic the pesticide is or what type of PPE to wear, don't take a chance! Wear a foil-laminate apron, footwear, and gloves; eye protection; and a respirator.

Stop the source

If a small container is leaking, place it into a larger chemical-resistant container such as a plastic drum or bag. If a spray tank is overflowing, stop the inflow and try to cap off the tank. If a tank, hopper, or container has burst, or if it has tipped over and is too heavy for you to right, get help.

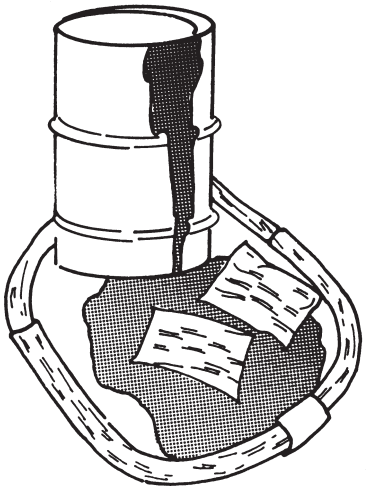
Protect others

Isolate the spill site by keeping children, other people, and animals well back. Rope off the site if you need to. If you think the spill contains a highly volatile or explosive pesticide, keep people back even farther. Warn people to keep out of reach of any drift or fumes. Do not use road flares or let anyone smoke if you think the leaking material is flammable.

Stay at the site

Do not leave the spill site until someone who is trained and wearing the right PPE arrives. Someone trained and protected must be at the spill site at all times until the spill is cleaned up.

Contain the spill



Containment "snakes" and absorbent pads.

Confine the spilled material

As soon as the source of the leak is under control, move quickly to keep the spill from spreading or getting worse. Use containment "snakes" to surround a small spill and keep it confined. For larger spills, use a shovel, a rake, or other tool or equipment to make a dike of soil, sod, or absorbent material.

Protect water sources

Block or redirect a spill that is flowing toward any body of water or any pathway that leads to water, such as a ditch, floor drain, well, or sinkhole.

Absorb liquids

You can contain liquid pesticide spills further by covering the entire spill site with absorbent materials, such as spill pillows, fine sand, dry peat moss, vermiculite, sawdust, clay, kitty litter, shredded newspaper, or absorbent pads. Keep at the storage site a supply of absorbent material that is enough for the size of the storage facility and the amount of product stored there.

Cover dry materials

Prevent dry pesticide spills such as dusts, powders, or granules from becoming airborne. Cover them with a sweeping compound or a plastic cover, or lightly mist the material with water. Do not mist too much, because water could release the pesticidal action or cause the pesticide to form clumps, so you could not use it.

Clean up

After you have contained the spill, pick up the spilled material.

Sweep up the material that has absorbed spilled liquid pesticide. Place it into a heavy-duty plastic drum or bag. Keep adding absorbent material until the spilled liquid is soaked up and removed. Dispose of it as excess pesticide or hazardous waste.

Pick up spills of dry pesticides carefully. You might be able to reuse them. Avoid contaminating the spilled material with soil or other debris, so you can use it in the usual application equipment. Do not sweep with a broom if this will raise dust.

If you cannot reuse the spilled dry pesticide because it is wet or full of debris, cover it with absorbent material. Mist it lightly so you can sweep it up without raising a dust cloud. Place it in a heavy-duty plastic drum or bag for disposal as hazardous waste.

Decontaminate the spill site

Once you have collected as much of the spilled material as you can, decontaminate the spill site as well as you can. **Do not hose down the site with water** unless the spill is on a containment tray or pad.

If the pesticide has spilled on a nonporous surface, such as sealed concrete, glazed ceramic tile, or no-wax sheet flooring, **first remove as much of the pesticide as you can, in the ways described above**. Then, use water (or the liquid listed on the label to dilute the pesticide) and a strong detergent to remove the spill residues from the surface. Do not let any of the wash solution run off the site.

Place fresh absorbent material over the wash solution until it is all soaked up. Then, sweep up the absorbent material. Place it in a plastic drum or bag for disposal as excess pesticide or hazardous waste.

If the pesticide has spilled on a porous surface, such as soil, unsealed wood, or carpet, you might have to remove the contaminated surface and dispose of it as excess pesticide or hazardous waste.

Neutralize the spill site

Sometimes, if the spill is not too large and the pesticide not highly toxic, you can counter the toxic effect of the pesticide by adding another substance to it. This is called to **neutralize** the site.

The labeling of a few pesticides instructs you to neutralize a spill of that pesticide. Sometimes the pesticide manufacturer, Chemtrec, or OERS also will instruct you to neutralize the spill site. Follow the instructions carefully.

Often, you follow these steps to neutralize a spill:

1. Mix full-strength bleach with hydrated lime and work the mixture into the spill site with a coarse broom.
2. Spread fresh absorbent material over the spill site to soak up the neutralizing liquid.
3. Sweep up this material and place it in a plastic drum or bag for disposal.

You might need to repeat the process several times to make sure the site is neutralized very well.

If the spill is on soil, sometimes with DEQ's guidance you can remove and dispose of the top 2 to 3 inches. Then, neutralize the soil that is left. The instructions might tell you to mix activated charcoal into the soil. Or, they might tell you to cover the spill site with 2 or more inches of lime and cover the lime with fresh topsoil.

Sometimes, the instructions might tell you to cover minor spills with activated charcoal. Large spills would need so much activated charcoal that it would cost too much money to neutralize them that way.

Decontaminate equipment

Clean any vehicles, equipment, and PPE that were contaminated by the spill or during containment and cleanup. Use a strong mixture of chlorine bleach, dishwasher detergent, and water to clean the vehicles and equipment. Wash PPE very well. Follow the manufacturer's instructions and the guidelines in Chapter 5 of this manual.

You cannot clean porous things, such as brooms, leather shoes, and clothing, well enough when they are soaked with pesticide. Throw them away.

Decontaminate yourself

As soon as you are done cleaning up the spill and equipment, wash yourself very well with detergent and water. Wash any part of your skin that might have been exposed. Always wash your face, neck, hands, and forearms.

Spill kit

Keep a spill cleanup kit at hand and ready every time you handle pesticides or their containers. If a spill occurs, you will not have time to look for all the things you need.

Keep in the kit all the things in the Spill Cleanup Kit Checklist. Store them in a plastic container. Keep them clean and in working order so they are ready when a spill occurs.

Spill Cleanup Kit Checklist

- ❑ Telephone numbers for emergency help
- ❑ Sturdy gloves, footwear, and apron that are chemical-resistant to most pesticides, such as foil-laminate gear
- ❑ Protective eyewear
- ❑ A good respirator, if any of the pesticides require that you use one during handling activities or for spill cleanup
- ❑ Containment "snakes" to confine the leak or spill to a small area
- ❑ Absorbent materials, such as spill pillows, absorbent clay, dry peat moss, sawdust, pet litter, activated charcoal, vermiculite, or paper, to soak up liquid spills
- ❑ Sweeping compound to cover dry spills
- ❑ A shovel, broom, and dustpan. Store brooms and shovels that fold up. They are easy to carry. Be sure they are made from nonsparking and nonreactive material, such as fiberglass.
- ❑ Heavy-duty detergent
- ❑ A fire extinguisher rated for all types of fires
- ❑ Any other spill cleanup items listed on the labels of any products you use often.
- ❑ A sturdy plastic container big enough to hold the amount of pesticide from the largest pesticide container you are handling. Be sure it can close tightly.

Spill follow-up

Keep records of containment and cleanup for all large spills, and for any spills that take place off your property. Keep records of your talks with officials and the public about the spill.

Take photos. They help show if there was any damage. They also show how you cleaned up the spill.

Report the spill to the OERS. They will assign an **incident number** to the spill. This number shows that you reported the spill.

Whom to call in case of a spill

Call the OERS as soon as you can after a spill. People there give details and expert advice on how to handle hazardous materials accidents and spills. They will help you alert the proper officials.

OERS
Telephone: 800-452-0311

You also can get advice what to do with a spill from Chemtrec, a public service of the Chemical Manufacturing Association in Washington, D.C. There are trained people at Chemtrec 24 hours a day who can advise you how to manage chemical **emergencies**. They can put you in contact with the pesticide manufacturer.

Chemtrec
Telephone: 800-424-9300—Emergencies only

When you ask for help from the OERS, Chemtrec, or any other source, have the product label in front of you if possible. Many pesticide labels list an emergency telephone number to call people who know how to manage emergencies for that product. Also, be sure there is an emergency phone number on all shipping papers for hazardous materials and hazardous substances.

If the spill occurs on a highway, call the OERS right away. If the spill occurs on a county road or city street, call the county sheriff, city police, or fire department. These officials are trained for emergencies. They can help you clean up.

If you think that a large spill is flammable, call the fire department for help. But, **do not let them hose down the spill** unless someone from the Department of Environmental Quality directs them to do so.

If the spill could expose the public to pesticides or pesticide residues, call OERS. They will call public health officials or tell you who to call. If anyone is poisoned by the spill, or if you think that an exposure could lead to poisoning, call the hospital emergency room. Tell them the brand name, active ingredients, and any other labeling facts about human health hazards, signs and symptoms of poisoning, and antidotes.

Know the law

If you are involved in a pesticide spill, you might need to comply with two federal laws.

Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) requires you to report any accidental release (such as a spill)

For details on SARA Title III, see Chapter 1.

of any extremely hazardous substance. **You must report if all of these things occur:**

- The pesticide was spilled.
- The pesticide is covered under SARA Title III.
- The spill amount was larger than the reportable quantity stated in the law.
- The spill caused offsite exposure.

If such an accident occurs, you must:

- Tell the OERS. Since you probably will not know if a pesticide is covered under SARA Title III, tell OERS of **all** spills. OERS will tell SERC and LEPC for you. OERS should assign an incident number to the spill. **Be sure you ask OERS if your spilled product requires a Title III spill report.**
- **Write down the time and date of the call and the person you talked to. Keep this for your records.**
- If OERS tells you to do so, report the release to:

National Response Center
Telephone: 800-424-8802

You must report to EPA any spill that could get into groundwater or surface water. This is a law under the Clean Water Act.

If you still have doubts after calling OERS, call one of the offices listed below for help:

Oregon Department of Environmental Quality
Telephone: 503-229-5913 or
503-229-6753

EPA regional office
Telephone: 206-553-1091 or
800-424-4372

Questions for study—Chapter 18

1. What do the Three C's of spill management stand for?
2. What should you do to control a spill?
3. How should you contain a spill?
4. What should cleanup include?
5. Who can you call when you need help to manage a spill?
6. When should you have a spill kit at hand and ready?
7. After controlling and containing a pesticide spill, describe how you would clean up.
8. Do materials that absorb a spill need to be treated as pesticide waste?
9. What agency or group must you call as soon as you can about spills occurring in Oregon?

Chapter 19

Keeping Records and Reporting

Goals of this chapter

- Learn how pesticide application records can be helpful to you.
- Know who must keep record information.
- Know what record information you must maintain.

In addition to being a law, keeping records of pesticide usage is a wise practice. Records can be proof of proper use. They can be helpful in finding the cause of an error, if one has been made. Records also can provide information to help trace residue and/or damage problems. They can protect you in case of false damage claims.

Your records can save you money. They can improve your pest control practices. By keeping careful records from year to year, you can compare the results you got from different pesticides. And, you can use records to predict how much pesticide you will need for the next season. That helps you avoid seasonal carryover.

The more detail you write down, the more useful the records will be to you. Carry a notebook with you in the field to record extra details.

What are the requirements?

You can find details on Oregon pesticide recordkeeping requirements in Oregon Pesticide Control Law (Oregon Revised Statutes—Chapter 634). Or, contact the Department of Agriculture, Pesticide Division.

Listed below are the types of licenses required by law to keep pesticide records and the record information required.

You can access ORS-634 at:

http://www.leg.state.or.us/ors/

http://landru.leg.state.or.us/ors/634.html

Commercial pesticide operators (and independent commercial applicators)

Each Oregon commercial pesticide operator must make and keep records of all pesticide applications. Commercial applicators not employed by a commercial operator (those who apply restricted-use pesticides [RUPs] to their own property) also are subject to these requirements.

Facts you must include in these records are listed in Oregon Revised Statutes—Chapter 634 (ORS 634.146). Failure to make and keep the required records is against the law [ORS 634.372(5)].

Records must include these things:

1. The name of the person for whom you applied the pesticide

2. Where the land or property is on which you made the application
3. The date and time of the application. Record both the time you begin and end.
4. The person who supplied the pesticide(s)
5. The trade name and the strength of these pesticides
6. The amount you applied. Use pounds, ounces, or gallons of actual product per acre or concentration (pounds or ounces product per gallon) and total gallons applied
7. The exact property, crop, or crops to which you applied the pesticide
8. A report of the equipment, device, or apparatus you used (such as a backpack, boom, or airblast sprayer). If you applied pesticide by aircraft, list the F.A.A. number.
9. The names of the pesticide applicators or pesticide trainees who did the actual application or spraying

You must keep your records for at least 3 years from the date of application of the pesticide. You must keep them where Department of Agriculture officials can review and inspect them during business hours.

Sometimes an owner asks to see the record of the application you made on his or her field crops. You must give the owner who asks for one a copy of the pesticide application record within 40 days after the application.

Commercial applicators must give certain facts to the person for whom they applied a restricted-use pesticide. You must give them within 30 days of the restricted-use pesticide application. See requirements under "Private pesticide applicators," below.

Public pesticide applicators

Each Oregon public pesticide applicator must make and keep the same records required of commercial pesticide operators (ORS 634.146).

Pesticide dealers

Each Oregon pesticide dealer must make and keep records of sales of restricted-use and highly toxic pesticide products. Details are listed in Oregon Administrative Rules—Chapter 603, Division 57 (OAR 603-57-40). Failure to make and keep records is against the law [ORS 634.372(5)].

Records must include these things:

1. Name, address, and license number of the pesticide buyers
2. Date of sale
3. Trade name (and formulation, if there is one) of the pesticides
4. Quantity of each sale of the pesticide

Private pesticide applicators

The U.S. Department of Agriculture/Agricultural Marketing Service (USDA/AMS) is in charge of the 1990 Food, Agriculture, Conservation, and Trade Act (FACT) (also known as the **1990 Farm Bill**). The 1990 Farm Bill states what records commercial and private applicators must keep.

But, the Oregon Department of Agriculture recordkeeping rules for commercial, public, and private applicators are stricter than the USDA rules. And, the Oregon Pesticide Use Reporting System (PURS), which took effect January 31, 2002, requires applicators to report more details than the federal law requires. Contact ODA to find out how PURS applies to you before you make an application.

The USDA/AMS recordkeeping law says that all private applicators must record these facts when they use restricted-use pesticides:

1. The brand or product name and the EPA registration number of the RUP that you applied
2. The total amount of the RUP you applied
3. Where you made the application, the size of the area treated, and the crop, commodity, stored product, or site to which you applied a RUP
4. The month, day, and year that you made the RUP application
5. The name and certification number (if there is one) of the certified applicator who applied or who supervised the application of the RUP
6. If you make applications of RUP to a total area of less than ⅒ of an acre on the same day, you must record these things:
   - Brand or product name
   - EPA registration number
   - Total amount applied
   - Sometimes you do not treat a whole field, but only certain spots throughout the field. These are called **spot applications**. List where in the field you made them.
   - Date of application

   This does not apply to nursery and greenhouse applications.

You must write these details down within 30 days after you apply the pesticide. You must keep all records for 2 years from the date of application.

Records required for forest applications

Under the Oregon Forest Practices Act, pesticide operators must keep certain pesticide application records when they apply pesticides or fertilizers in forests. The rules apply to private, commercial, and public applicators and trainees.

The facts you must record differ slightly from those required by ORS 634 or USDA. You must record the same facts required by ODA or USDA, plus these things:

1. The legal location of the area you treated with chemicals
2. The acreage you actually treated with chemicals
3. Brand name or EPA registration number of the chemicals you used, the carrier you used, and the application rate
4. Date and time of application
5. Air temperature*
6. Humidity*
7. Wind speed and direction*
8. The name of the person making the application. Include the contractor's name and/or pilot's name when you apply pesticide by airplane. Include the contractor's name and/or employee's name for ground application.

*Measure within the operation area. Record at least hourly for applications made by airplane. Record at least at the beginning and end of each day's application for ground applications. You do not need to record the weather for spot treatment with non-motorized equipment (backpack sprayers).

Table 15. Pesticide Application Records.

Pesticide Operators shall prepare and maintain records containing specific information. (ORS 634.146)

Public Pesticide Applicators shall prepare and maintain the records required of pesticide operators. (OAR 603-57-130)

Commercial Pesticide Applicators not employed by an operator (groundskeeper, etc.) shall prepare and maintain the records required of pesticide operators. (OAR 603-57-130)

Record information required	Explanation
1. The firm or person for whom the pesticide application was made	The full name, address, and phone number of the business, firm, or person who owns or controls the crop/property sprayed. Do not use initials, nicknames, or partial names.
2. The location of the land or property where application was made	The address of the site or a geographic description of the application site (such as circle number, map number, or township/section/range) and the size of the area treated (acres, square feet, linear feet, etc.)
3. The date and approximate time of application	The month/day/year of application and the beginning and ending time of application
4. The supplier of pesticide product(s) applied	The full name of the person or business that supplied the pesticide to you. Do not use initials, nicknames, or partial names.
5. The trade name and the strength of pesticides applied	The EPA registration number of each pesticide product applied or the manufacturer, product name, and formulation type of each product applied
6. The amount or concentration (pounds or gallons per acre of active ingredient or concentration per approximately 100 gallons)	A. The amount of each pesticide product applied (ounces, pounds, pints, quarts, etc.) per unit of measure B. The type and amount of carrier applied per unit of measure (acre, square feet, etc.); or, where a specific unit of measure is not applicable, the total amount applied to the site C. The amount and type of other material applied (such as spreader/sticker, wetting agent, or drift retardant)
7. The specific property, crop, or crops to which the pesticide was applied	For each pesticide product applied, the specific crop or site of application: Agricultural applications: the specific crop PCO General and PCO Structural applications: the specific area (exterior wall voids, kitchen cabinets, interior foundation, living room baseboards, etc.) Ornamental applications: the general area (front yard, hedge, fruit tree, etc.) Other applications: descriptions similar to the examples above
8. The summary information of equipment, device, or apparatus used and, if applied by aircraft, the F.A.A. number	Identification of the application equipment used (aerosol can, speed sprayer, backpack sprayer, fogger, etc.) and, if applied aerially, the "N" number of the aircraft.
9. Name of applicator(s) or trainee(s) who made application	The full name of the applicator(s) or trainee(s) who applied the pesticides.
10. Records kept for 3 years	Records shall be maintained for at least 3 years from the date of application.

Release of information

All pesticide applicators must release pesticide application records to these people:

- A doctor, nurse, or other licensed health worker, if he or she needs the records to give medical treatment or first aid to someone who might have been exposed to the pesticide you applied
- An official working for the USDA, who wants to make sure you have complied with the rules

Pesticide use reporting

From January 31, 2002, all applicators are required to record and report more information on all pesticide applications they make. The State of Oregon has designed the Pesticide Use Reporting System (PURS) to collect data on all pesticide use throughout the state. All applicators, trainees, and even non-licensed pesticide users must report information on their pesticide use. Contact ODA to find out what information PURS requires before you make an application.

Questions for study—Chapter 19

1. What information does state law require pesticide operators to record?
2. Who must keep pesticide application records?
3. How long must you keep pesticide application records?
4. Why should you keep pesticide application records?
5. What information does state law require pesticide dealers to record?

Chapter 20

Liability

Goals of this chapter

- Know and understand when you could be liable for making an application the wrong way.
- Learn the steps you should take to protect yourself against lawsuits for pesticide misuse.
- Understand why you must have insurance.

This chapter is not a substitute for legal advice from a qualified person. To obtain legal advice, consult a qualified legal professional.

Even the most careful applicators sometimes have damage claims brought against them. The usual claims are for making the application the wrong way, harm to the crop, property damage, contamination of nontarget areas, or a lack of pest control. It is important that you know the most common claims that could be brought against you.

You need to know when you could be liable for damage. This means that the court holds you responsible by law to pay for it.

Drift

Drifting pesticides are a major cause of environmental contamination and damage to nontarget areas. In general, the courts have held the pesticide applicator and the customer who hired the applicator **both liable** in drift cases. The customer is responsible when he or she hires or contracts for a hazardous act such as the application of pesticides.

Don't depend on your customers to share costs. They may file another lawsuit against you. Even if no damage is observed, people may sue you for drift onto their property.

Sometimes, the manufacturer of the pesticide also can be held liable. If the label does not clearly warn that the pesticide could drift, the manufacturer could share liability.

Target site

Claims of injury to the target site (such as crop, turf, or shrub) or claims that the pesticide did not perform as expected involve the dealer, the manufacturer, and the applicator. A consultant who gives the wrong advice also is liable.

The courts must decide which of the four gave advice or guaranteed the product for that exact use on that certain target. The party in error must accept the blame and pay for the damage. **You must make sure you use pesticides only for the purposes stated on the label**.

If you keep detailed records of all pesticide applications you make, you can use them to support your claim of proper pesticide use. Then—and only then—might the blame be placed on others.

If the injured target site was not large and the harm was not great or total, the customer or applicator must show how much damage was caused by the pesticide and how much was caused by other conditions such as weather or disease. You don't need to divide up the causes in cases of great or total injury.

Both the applicator and customer could be held liable for harm resulting from careless application.

Personal injury

Applying pesticides can be very dangerous. In legal terms, it is called an **ultrahazardous activity**.

The pesticide applicator is liable for any human harm caused by the pesticide.

Wrong site

If you apply the pesticide on a field, crop, or area other than the one it was intended for, serious problems can result. If there is damage or excess residue (**overtolerance**), or if the owner didn't want the area treated, you could be charged with **negligent application**.

Defense against this charge is very hard. Double check addresses, site locations, and all landmarks before you treat an area. Applying pesticides to the wrong site can be costly.

Bees

Honeybees can be harmed or killed by many pesticides. Honeybees are important to farmers and beekeepers. If the bees in hives are killed as the result of drift from nearby application sites, the applicator can be held legally responsible. The applicator must pay for the damage.

In some states, an applicator is liable only if he or she did not tell landowners next to the application site before applying the pesticide. Some states require the applicator to tell registered beekeepers before making applications near beehives.

At this time, applicators in Oregon do not need to tell landowners or beekeepers before applying pesticides. But, it is wise and proper to let beekeepers know before you make an application. Know where beehives are in your area.

If bees are exposed to pesticides while they are in the sprayed site, the applicator is not usually liable. The courts have ruled that the bee is trespassing and that the area doesn't need to be safe to uninvited animals. But, be sure you have not ignored a label direction that tells you to protect the bees. Then, you could be liable.

Attractive nuisance

In some cases, children are attracted to ground equipment or aircraft and hurt themselves on it. This is called **attractive nuisance**.

The owner or applicator or both are held liable for harm to children when the landowner has failed to find a way to prevent children from hurting themselves on dangerous equipment. Even if the children are not

supposed to be on the land, the owner or applicator still can be liable. But, children must come to the area often so there is a reason for the landowner to guard the equipment.

You must watch ground equipment with exposed drive belts, drive wheels, gears, or any moving parts when you are in places where children can get to them. Never park aircraft where curious children can find them. Never leave pesticides in unlocked or open vehicles. Empty containers and aerosol cans also attract children. They are dangerous. Store and dispose of them properly!

Noise

Recently, homeowners and others have made claims against applicators for noise damage. They claim that the noise of aircraft and ground equipment above or near their property has caused damage or loss of property value. But, they must prove they lost property because the noise was from machines run in a careless or wrong way.

In some cases, an owner has claimed that an applicator flew an airplane over his or her property without the owner's consent. This is important in aerial applications when you need to make pull-ups over nearby property.

Applicators and farm owners are legally liable only if the noise is too loud or more than normal. Some noise is normal and not legally a nuisance, even though it could be unpleasant.

The applicator can show that the noise did not cause harm or damage. This is a good defense.

Cross-contamination

Every year, there are reports of pesticide **cross-contamination** that could cause damage at the sites being treated. This contamination can occur in one of three ways:

- The applicator can make an error in mixing or loading in the spray tank. Or, the applicator might not have removed all the pesticide left over from the last application. In this case, both the applicator and equipment owner might be liable.
- Open containers of herbicides—such as 2,4-D—can volatilize and penetrate other pesticides stored nearby. When these other pesticides are applied, a 2,4-D contamination can cause serious harm to sensitive plants.
- The manufacturer can make a mistake in labeling, formulating, or refilling a container.

You must be sure you know which container of pesticide you used on the site. Lab tests can show whether the contamination occurred during mixing and loading or earlier. In cases of herbicide contamination, it is hard to prove whether contamination occurred because a volatile pesticide vaporized during storage or the manufacturer made a mistake. The courts must decide who is to blame.

Note: In case of cross-contamination, look for the EPA Establishment No. on the label. Also, you should record the lot number. In most cases, lot numbers are stamped directly on the pesticide container, or sometimes

on the label. In some cases, the lot number is on the original packing that the pesticide was shipped in. If this is not available, contact the dealer where you purchased the pesticide to see if they have any record of the lot number or other identifying information.

What to do when you are involved

If you become involved in any legal problem, **act carefully** and promptly. Always be friendly and helpful. Offer to look into the matter right away.

Never admit you might be liable. Be careful to whom you give details about your spray operation.

Take action as follows:

- Look at your records to make sure you really were working in the area at the time of the alleged harm.
- Make sure all of your records are up-to-date. Be sure you have the details on which equipment you used, air temperatures, wind direction and speed, and all other data that you need.
- Go to the scene right away. Make notes of any adverse condition, such as swarms of insects, disease, water stress, late planting, and carry-over effect from any other chemicals that may have been used there.
- Carefully take photos of any adverse condition you find, so an expert can study the symptoms. Use color film.
- Save the containers that you used for the job. If you cannot save the whole container, save the label. Or, take a close-up color photo of the label.
- Tell your insurance company right away.
- If you do not have insurance for the loss, ask if you may have an expert look at the site or the property. That way, you have the benefit of the expert's opinions.
- If a chemical company is involved, tell them right away. They probably will want to send their experts to the site.
- Get the names and addresses of all witnesses who might give their word about how the application was made and the conditions of the site before and after.
- If the application site is a perennial crop, look at USDA aerial photos to find out the condition of the orchard or other perennial plantings in years before the year of alleged harm.

Insurance

To protect yourself and your business, be sure you have insurance in case of pesticide mishaps. In Oregon, and in some other states, a pesticide operator **must** show proof of **financial responsibility**, that is, insurance. This is the law (ORS 634.116). In some states, your pesticide certification application is not valid unless your insurance company is listed on it.

There are many different types of insurance plans. They can include bodily injury, property damage, restricted chemical liability, and comprehensive chemical. Choose a plan that fits your needs and your business. An insurance agent who works with pesticide insurance is the best person to advise you on your individual insurance needs.

Public relations

It is always important to keep a good public image as a pesticide applicator. Here are some things to practice.

- **Always be polite**. The way you first impress a customer can last a long time. Calm words help people listen to you.
- **Listen to the question**. Let the person know that you understand his or her concern.
- **Be prepared**. Be sure you know which materials you are applying, why you are applying them, and what their basic properties are. Keep exact records.
- **Have an answer**. Know as much as you can. Do not give facts you are not sure of.
- **Take notes**. Include name, place, date, time, and details of the complaint or request for information.
- **Be prompt**. Problems may come up during the busiest times. Deal with them as quickly as you can. How fast you act could make the difference between an easy way to fix the problem or a hard, costly one.
- **Keep good records**. A simple file that includes business questions from customers and your course of action could turn out to be important proof.

No matter how careful you are, accidents happen. You must be prepared for any emergency. Above all, keep calm.

Questions for study—Chapter 20

1. If you apply a pesticide and the wind carries it off target, are you liable even though you tried to be careful?
2. If the site to which you applied a pesticide is harmed even though you followed the directions and dosages on the label, who could be liable?
3. Is the application of pesticides an ultrahazardous activity by law?
4. Can you be sued for applying pesticides to the wrong target area even though there is no damage?
5. What is the legal standing of bees killed while they are “visiting” in a sprayed field?
6. From a legal standpoint, why should you never leave pesticide equipment or empty pesticide containers where children could be attracted to them?
7. If someone accuses you of pesticide misuse, what steps should you take to protect yourself?
8. List at least three practices that are important for a good public image.
9. Who can advise you best on your insurance needs?

Answers to Study Questions

Chapter 1—Pesticide Laws

1. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).
2. The U.S. Environmental Protection Agency (EPA).
3. A pesticide tolerance is the maximum amount of a pesticide residue that is allowed on food or feed crops.
4. EPA sets pesticide tolerances. FDA enforces pesticide tolerances.
5. FIFRA provides civil penalties when the violation of a regulation was unintentional, and criminal penalties when the law was violated knowingly.
6. The Resource Conservation and Recovery Act of 1976.
7. The Federal Aviation Administration and the Oregon Forest Practices Act.
8. Oregon OSHA.
9. Oregon OSHA.
10. Oregon Water Resources Department.
11. The Endangered Species Act (ESA) of 1973.
12. An endangered species is closest to extinction.
13. Yes.
14. No.

Chapter 2—Toxicity of Pesticides

1. Toxicity is how poisonous a substance is to a living system, such as a human being, an animal, a lake, or a forest.
2. Through the skin (dermally), by ingestion (orally), by getting them in the eyes (ocular), or by breathing them (inhalation).
3. True. Some pesticides are just as dangerous when they contact the skin as when they are taken orally. Dermal exposure to pesticides can actually become oral exposure if you do not wash up carefully between pesticide work and eating or smoking.
4. Oil-soluble pesticide solutions are absorbed more easily through the skin.
5. The eyes, ears, forehead, scalp, and groin absorb pesticides more quickly than other areas.
6. Dermal and inhalation are the most common routes of entry.
7. Wash hands properly after applying pesticides, especially before eating or smoking. Never store pesticides in any food or drink container.

8. Pesticide exposure is when a chemical contacts a body surface.
9. **Acute exposure**: a one-time or limited contact with a pesticide.
   Chronic exposure: contact with a pesticide again and again.
10. Acute effects are easier to detect and study.
11. Exposure is when a chemical contacts a body surface (skin, eyes, gut, or lungs). The dose is how much chemical actually is absorbed into the bloodstream.
12. Acute toxicity is how poisonous a substance is after an acute exposure. Chronic toxicity is how poisonous a substance is after chronic exposure at low doses over a long period of time.
13. LD_{50} means Lethal Dose Fifty. It is the dose of a chemical that kills half, or 50 percent, of the animals in a dose-response study.

    LC_{50} means Lethal Concentration Fifty. It is the amount of chemical in the air that causes half, or 50 percent, of the test animals to die when they inhale it.
14. False. The higher the LD_{50}, the less toxic the pesticide.
15. Six milligrams per kilogram (mg/kg) is the same as 6 parts per million (ppm). (A milligram is 1 millionth of a kilogram.)
16. Pesticides can cause deformities in unborn offspring (teratogenic effects), cause cancer (carcinogenic effects), cause mutations (mutagenic effects), poison the nervous system (neurotoxicity), or block the natural defenses of the immune system (immunotoxicity). Pesticides can also have local or systemic effects; immediate or delayed effects; reversible or irreversible effects; singular, additive, or synergistic effects.
17. Signal words and warning statements are based on a pesticide's acute oral or dermal toxicity (LD_{50}); acute inhalation toxicity (LC_{50}); and eye and skin irritation effects.
18. Relatively nontoxic: CAUTION!
    Highly toxic: DANGER—POISON!
    Slightly toxic: CAUTION!
    Moderately toxic: WARNING!
19. Yes, there is a difference between toxicity and hazard. The toxicity of a substance is how poisonous it is to a living system. Hazard is the chance or risk that danger or harm will result from the use of a pesticide.
20. No. A highly toxic pesticide can pose a lower risk or hazard if you handle it properly.
21. Some factors that make a chemical hazardous: (a) toxicity; (b) the skill of the handler; (c) the type of pesticide; (d) the health of the exposed person; (e) the formulation; (f) the concentration and dosage used.

Chapter 3—Residue, Tolerance, and Registration

1. The pesticide found on leaves, skin, or other surfaces just after application is called the deposit. The deposit that remains in or on the crop after a certain length of time is the residue.
2. A long-lasting residue can mean that the pesticide will be effective for a longer time. But, a long-lasting residue on food or feed could be a hazard to those who eat it. Residues that remain in the soil might affect crops planted at a later date. Residues can poison anyone who enters a treated area.
3. Tolerance is the maximum amount of residue allowed to remain on a harvested food or feed crop. A tolerance must be set before a pesticide is registered.
4. No. The crop could be condemned and seized by federal or state regulatory agencies.
5. No. Most of the time, pesticide residues are at a level far below the tolerance.
6. Minor-use pesticides are those used on small-acreage crops. They do not make much profit for their manufacturers compared to the high cost of registration.
7. NOEL stands for No Observed Effect Level. It is the highest dose in a dose-response study that does not cause an adverse effect that scientists can observe.
8. At least 100 times lower than the NOEL.
9. The law defines **safe** as "reasonable certainty that no harm will result from aggregate exposure."
10. The law defines **aggregate exposure** as "all possible residue exposure from all foods (and water), residential (non-occupational), and occupational uses for which tolerances have been granted for the same pesticide, **and all pesticides with a similar mechanism of toxicity**."
11. It is the least number of days allowed between the last pesticide application and the harvest or slaughter day.
12. The reference dose (RfD) is the dose of chemical that a person can be exposed to daily without being likely to suffer an adverse effect over a lifetime. To figure the RfD, the EPA divides the NOEL by a safety factor (or uncertainty factor) of at least 100. In other words, the RfD is at least 100 times lower than the NOEL.
13. To cancel a pesticide use means that all products to which the judgment applies no longer may be sold or distributed in the U.S. In most cases, the pesticide remains on the market during the cancellation process.

    If the EPA thinks that leaving the product on the market would pose too high a risk, the EPA can issue a suspension order. The suspension order bans the sale or use of the pesticide until the pesticide's status is decided.

Chapter 4—Ecology and the Environment

1. Vapor drift.
2. Evaporation; particle size; nozzle design and placement; pressure; height of nozzle; air movement; temperature; humidity.
3. Wind direction and speed, temperature, and humidity.
4. Apply the right pesticide the right way. Do not apply to crops, trees, or weeds in bloom. Make applications in the evening. Use a pesticide that breaks down in a few hours. Do not treat near hives.
5. Pesticides can affect breeding and birth. Pesticide applications also can alter habitat or reduce food supply, which harms wildlife.
6. A steady diet of plants or animals that have pesticides in them can result in the buildup of some pesticides in the bodies of animals (including humans).
7. Pesticides applied to a site can move downward with rain or irrigation water and reach the water table below. Pesticides can enter a well from a spill or back-siphon and enter the groundwater directly.
8. Pesticides are dangerous when they drift off-target or are applied in amounts greater than the rate recommended on the label. Carelessness contributes to pollution of the environment.
9. Runoff of polluted water and soil erosion carry pesticides to water sources.
10. Reduce pressure and increase the droplet size. Larger droplets drift less.
11. People, pets, wildlife, and sensitive plants can be injured by pesticide exposure. Pasture grasses can be destroyed. Milk or meat can contain illegal pesticide residues if cattle eat contaminated forage. Water can become too contaminated to drink, aquatic organisms can be destroyed, and the cost of cleaning will be very high.
12. An aquifer is a geologic formation of permeable rock, sand, or gravel that stores large amounts of water. Many people use water from aquifers for drinking.
13. Food chain.
14. Prevention.
15. Near the top of the food chain.
16. Nonaccumulative pesticides do not build up in the bodies of animals or in the tissues of plants.
17. Accumulative pesticides slowly build up in the bodies of animals or plants. Persistent pesticides remain in the environment without breaking down.
18. No. Persistent pesticides remain in the environment without breaking down. This does not mean they also have the necessary characteristics to accumulate in animals or plants.

19. They can, but sometimes persistence is helpful. For example, long-lasting or persistent pesticides protect wood in structures from termites. There are persistent pesticides that stay on target, control specific pests, and cause no adverse environmental impact.
20. Water falls to the earth as rain, snow, or hail. The runoff that remains on the earth's surface is called surface water (lakes, streams, rivers). The water that seeps through the soil and collects underneath the earth's surface is called groundwater. Water returns to the sky by evaporation from plants, soil, and surface water.
21. It is a species at risk of extinction throughout all or a large portion of its range.
22. Microbial, chemical, and photodegradation.

Chapter 5—Personal Protective Equipment

1. By law, you must wear at least the personal protective equipment listed on the label for the handling task you will be performing. You are allowed to wear more protective equipment.
2. The material may change color, become soft or spongy, swell or bubble up, dissolve or become like jelly, crack or get holes, or become stiff or brittle.
3. Wear chemical-resistant gloves any time pesticide could get on your hands, except when you are handling fumigants whose labeling may direct you not to wear gloves. The hands get more exposure to pesticides than other body parts do.
4. If you need to remove and put your gloves back on:
   - Wash your gloves well before you take them off.
   - Wash and dry your hands very well.
   - Then, put the gloves on again.
5. Whenever you could be exposed to pesticides from above, wear protective headgear to help keep the pesticide off your head, neck, eyes, mouth, and face. Wear a chemical-resistant hood or wide-brimmed hat.
6. You must wear chemical-resistant goggles or safety glasses with a full-face shield.
7. Dust/mist-filtering respirators are masks or cartridges that filter dust, mists, and powders. Vapor-removing respirators use a cartridge or canister to remove pesticide gases and vapors from the air. Air-supplying respirators provide you with clean air either from an air tank or from a location where the air is not contaminated with pesticides.
8. Fumigants pose a serious inhalation hazard to pesticide handlers. Some fumigants also can cause severe skin irritation or poisoning if they are trapped next to the skin by tight clothing or chemical-resistant personal protective equipment.

9. Discard the coverall. It cannot be cleaned well enough.
10. Tell the people washing your clothes to:
    - Wear chemical-resistant gloves and apron (especially if they handle contaminated items regularly or handle items contaminated with highly toxic pesticides).
    - Work in an area where there is lots of fresh air and avoid inhaling steam from the washer and dryer.
11. When you finish using your respirator, you should:
    - Discard any masks, filters, or respirators that cannot be reused.
    - Take off the prefilters and cartridges or canisters. Discard them. Or, if you can still use them, wipe them with a clean cloth, replace filters and caps, and seal them in an airtight container. A zip-close plastic bag works well.
    - Wash the respirator body and facepiece, and wipe the exterior of any reusable filters. Soak them for at least 2 minutes in a mixture of 2 tablespoons of chlorine bleach in 1 gallon of hot water. Rinse well. Dry well or hang them in a clean area to dry.
    - Store the respirator and any reusable cartridges, canisters, filters, and prefilters in an airtight container in a place where they will be protected from dust, sunlight, extreme temperatures, too much moisture, and pesticides or other chemicals.
12. Change dust/mist masks, cartridges, and prefilters immediately if you have trouble breathing. They usually need to be changed at least every 8 hours.

    Change vapor-removing canisters or cartridges immediately if you smell, taste, or feel irritation or dizziness from pesticide vapors. Change them whenever any service-life indicator tells you to, or change them after the time limit set by the manufacturer. Otherwise, replace them after about 8 hours of use.
13. Run one more complete but empty cycle. Use hot water and detergent.

Chapter 6—Symptoms of Pesticide Poisoning

1. A **symptom** is a feeling or other effect that only the person who has been poisoned can notice.

   A **sign** of poisoning is a clue that others can see.
2. No. Many signs and symptoms of pesticide poisoning are like sickness or other types of poisoning.
3. No. Signs and symptoms vary depending on the pesticide, dose, and time since exposure.
4. **Pesticide poisoning**: nausea, vomiting, diarrhea, stomach cramps; headache, dizziness, weakness, confusion; excessive sweating, chills, thirst; chest pains; difficult breathing; muscle cramps or aches all over your body.

Pesticide irritants: redness, blisters, rash, burns on the skin; swelling, a stinging sensation, burns in the eyes, nose, mouth, and throat.

5. Call your doctor or the Oregon Poison Center at 800-222-1222.

Chapter 7—First Aid for Pesticide Handlers

1. Call the Oregon Poison Center or a doctor.
2. So that he or she will better be able to treat you if you are poisoned by pesticides.
3. Wash with plenty of running water.
4. Carry the patient to fresh air right away. Wear a respirator if the victim is in an enclosed space.
5. Exceptions: The label says not to. The victim is unconscious or in convulsions. The victim has swallowed corrosive poison. The victim has swallowed petroleum products.
6. High-potency activated charcoal is used to absorb many poisons. Mix it with water to make a thick syrup for the victim to drink.
7. Atropine can be poisonous if misused. Use it only under a doctor's direction.
8. The skin is pale, moist, cold, and clammy. The eyes are empty and dull with dilated pupils. Breathing is shallow and uneven. The pulse is very weak, rapid, and uneven. The victim might be in a faint.

   Raise the victim's legs 1 to 1½ feet above the head. Keep the victim warm and quiet. Reassure him or her often.
9. Keep a Thermos or large plastic bottle (at least 1 quart) of clean water in a first-aid kit. Use ponds, hoses, or running streams, if they are there.
10. The Oregon Poison Center or a doctor.
11. Heat stress is the illness that occurs when the body is subjected to more heat than it can cope with.
12. Heat stress may cause fatigue (exhaustion, muscle weakness); headache, nausea, and chills; dizziness and fainting; severe thirst and dry mouth; clammy skin or hot, dry skin; heavy sweating or no sweat at all; change in behavior (confusion, slurred speech, arguing, or not making sense).
13. Call a doctor. In the meantime, give first aid: Move the person to a cooler place that is away from pesticides. Remove the victim's personal protective equipment or other clothing that could be contaminating her skin or making her too warm. Use water to clean and cool her skin. Give her plenty of cool water to drink. Keep her quiet until help arrives.

Chapter 8—Integrated Pest Management

1. IPM is a method to decide which pest-control tactics to use and how to use them. The tactics must be safe for the environment. They must make economic sense.
2. IPM keeps a balanced ecosystem, is not hard to use, saves money, promotes a healthy environment, and maintains a good public image.
3. Preventing pest buildup can include using cultural and biological controls, and physical barriers.

   Monitoring involves checking an area often, proper and early identification of pests, and identification of the effectiveness of biological control agents.

   Assessment involves determining the potential for pest populations to reach an economic threshold or economic injury level.

   Deciding the best action to take involves using the aspects of integrated pest management to prevent loss or damage.
4. Proper identification of a pest is important because the control method you use might work on one species but not another. Also, you do not want to kill creatures that are not pests.
5. An economic threshold is the highest number of pests beyond which there is risk of economic loss. The economic threshold is a major factor in preventing loss of yield or quality.
6. Cultural controls disrupt the pest's environment. An example is crop rotation. Biological controls use a pest's natural enemies to keep the number of pests low. An example is mites that feed on pest mites. Physical barriers are materials such as nets over fruits and screens in greenhouses.

Chapter 9—Pests

1. Anything that harms, spreads disease, or competes with humans, domestic animals, or feed crops.
2. About 3 percent of insects in agricultural fields are considered pests.
3. Head, thorax, and abdomen.
4. Arachnids, centipedes and millipedes, and crustaceans.
5. Diseases are caused by biological agents called pathogens.
6. Bacteria, fungi, viruses, protozoans, and nematodes.
7. Weeds can cause skin irritation, cause poisoning, hinder fishing, clog drainage areas, etc.
8. Annuals, biennials, and perennials.
9. Animals with a jointed backbone.
10. Rodents, some birds, deer, and raccoons.

Chapter 10—Types of Pesticides

1. A pesticide is any substance that is used to prevent, destroy, or repel any form of life declared to be a pest.
2. No. An insecticide kills insects. It is just one of many types of pesticides.
3. A systemic moves inside the plant or animal to all its parts. When an insect feeds on the plant or animal, it swallows the chemical.
4. Will beneficial insects die? Do I really need to use an insecticide that kills more than one species?
5. Insecticides.
6. Molds, rots, and plant diseases.
7. To protect against disease or to kill the disease organism after it appears.
8. A selective herbicide.
9. To affect the target without harming other plants.
10. **Preplant** is before the crop is planted. **Preemergence** is before the crop and weed appear. **Postemergence** is after both the crop and the weed appear.
11. Growth regulators.
12. Rodenticides.
13. Nematodes are tiny, hairlike worms.
14. Chitin inhibitors keep insects from making the substance that forms their hard body. When the insect molts, it dies because it cannot make a new hard skin.
15. Yes. Repellents are registered pesticides.

Chapter 11—The Pesticide Label

1. Yes. The label states the personal protective equipment.
2. No. If the intended use is not on the label, do not use it. Use of a pesticide on a site not listed on the label is against the law.
3. Yes. The pesticide applicator is liable for the misuse of a pesticide.
4. No. The label itself is approved and registered by the EPA.
5. Toxicity warnings on labels are based on the highest toxicity of the pesticide via its most sensitive route of exposure.
6. The applicator, the public, and the environment are protected.
7. No. Only common names accepted by the EPA are on the label. The common name is not required by law to be listed.
8. The words POISON and DANGER.
9. DANGER labels.
10. Yes. The word WARNING is required on labels for moderately toxic pesticides.

11. The word CAUTION.
12. The recommended crop and the site to be protected; the equipment; the quantity of pesticide; mixing directions; compatibility with other products; health precautions; and the location and timing of applications.
13. (1) Before you buy, (2) before you mix, (3) before you apply, and (4) before you store or dispose of pesticides.
14. The label specifies disposal steps for both the pesticide and the container.

Chapter 12—Formulations

1. Formulation.
2. WP, EC, D, G.
3. The habits of the pest; the plant, animal, or surface you must protect; application equipment; danger of drift and runoff; possible harm to the protected surface; whether the formulation is effective against the pest.
4. Aerosols.
5. Aerosols.
6. They can drift long distances from the treated area.
7. Ants, roaches, flies, rats, mice, slugs, gophers, and voles.
8. Baits are needed only where pests gather.
9. Almost all particles in a granular formulation are the same size and are larger than those in a dust.
10. Granules drift less. They are applied with simple equipment that is often multipurpose. They can work their way through dense foliage to a target underneath.
11. They will not stick to the foliage surface.
12. They are designed to be sprayed as purchased (no mixing needed).
13. Emulsifiable concentrate.
14. Emulsifiable concentrate.
15. Flowables are modified wettable powders that are suspended in liquid. Emulsifiable concentrates begin as liquids and are formulated to mix with water or oil.
16. WP.
17. They can be hazardous to the handler if he or she inhales their concentrated dust while mixing them.
18. Fumigants.
19. (1) They must be applied in an enclosed area or incorporated into the soil. (2) They are highly toxic. You must use all recommended protective gear when applying them.

Chapter 13—Equipment

1. Working conditions, pesticide formulation, and where you want to apply the pesticide.
2. Yes.
3. Aerosol generators or foggers.
4. No.
5. No. A custom applicator can use a hand-operated sprayer for small jobs that do not require large, powered equipment.
6. High-pressure sprayer. They use mechanical agitators, which keep wettable powders well mixed in the tank.
7. Flush water out a minimum of three times to clean a sprayer the right way.
8. You must increase pressure by four to double the flow rate.
9. Brass—wears out easiest.

   Plastic and nylon—not good for high pressure. Does not corrode easily.

   Stainless steel—does not corrode or wear easily.

   Hardened stainless steel—useful for highly abrasive formulations.

   Ceramic—resists wear and corrosion the longest.
10. Flexible-impeller pumps.
11. The application rate holds constant as the speed changes.
12. (1) Meter or adjust the flow of the liquid. (2) Atomize the liquid stream into droplets. (3) Spread droplets in a certain pattern.
13. Worn nozzles spray uneven patterns and have higher flow rates than new nozzles. Find out if a spray tip is worn by comparing the flow rate of the used tip to the flow rate of a new one.
14. If the flow rate of the used tip is 10 percent greater than a new one, replace it.
15. Flooding-fan nozzles.
16. Clean your sprayer after each day's use.

Chapter 14—Calibration and Calculations for Mixing Pesticides

1. Yes. Application equipment that is not calibrated applies the pesticide at an unknown rate. If equipment is not calibrated, it could be under- or overapplying the pesticide.
2. Delivery rate is the total amount of pesticide mixture your equipment applies to a given area.
3. Change pump pressure, speed, or nozzles.
4. Yes, because each granule flows through the hopper at a different rate.

5. Catch the spray from one nozzle in a container for 40 seconds (time it takes to travel speed course). The amount (ounces) of water collected represents the application rate in gallons per acre.
6. 0.5 gal/min

$$\text{Delivery rate} = \frac{32 \text{ oz (wet)}}{30 \text{ sec}} \times \frac{1 \text{ gal}}{128 \text{ oz}} \times \frac{60 \text{ sec}}{1 \text{ min}}$$

Delivery rate = 0.5 gal/min

7. To get good pest control without damaging crops or the environment. To save materials and money.
8. Nozzle tips, pump, all connections, screens, and filters.
9. Double the speed.
10. Four times.
11. For major changes: change nozzle tips, change speed.
    For minor changes: change pressure.
12. 12 acres

$1{,}000 \text{ ft} \times 523 \text{ ft} = 523{,}000 \text{ ft}^2$

$43{,}560 \text{ ft}^2\text{/acre}$

$$\frac{523{,}000 \text{ ft}^2}{43{,}560 \text{ ft}^2\text{/acre}} = 12 \text{ acres}$$

13. 30 gal/acre

$$\frac{0.31 \text{ gal} \times 20 \text{ nozzles}}{20 \text{ nozzles} \times 1.5 \text{ ft/nozzle} \times 300 \text{ ft}} = \frac{X}{43{,}560 \text{ ft}^2\text{/acre}}$$

$$\frac{6.2 \text{ gal}}{9{,}000 \text{ ft}^2} = \frac{X}{43{,}560 \text{ ft}^2\text{/acre}}$$

X = 30 gal/acre

14. 10 acres

$$\frac{300 \text{ gal/tank}}{30 \text{ gal/acre}} = 10 \text{ acre/tank}$$

15. 30 pounds

Each tankful sprays 10 acres.
Rate = 3 pounds active ingredient per acre.
3 lb/acre x 10 acres = 30 lb

16. 37.5 pounds

$$\frac{30 \text{ lb ai}}{0.8 \text{ lb ai/lb WP (80\%)}} = 37.5 \text{ lb WP/tank}$$

(Note: Divide by percentage; don't multiply.)

17. 7.5 gallons

$$\frac{30 \text{ lb ai/tank}}{4 \text{ lb ai/gal EC}} = 7.5 \text{ gal EC/tank}$$

18. 13.5 pounds

$$\frac{3 \text{ lb}}{100 \text{ gal}} = \frac{X \text{ lb}}{450 \text{ gal}}$$

$100X = 1{,}350$
$X = 13.5$

19. 2.4 pounds in 80 gallons.

3 pounds = 3 x 16 ounces = 48 ounces
80 gallons is $^{80}/_{100}$ of 100 gallons = $^{4}/_{5}$

$$\frac{4}{5} \times \frac{48}{1} = \frac{192}{5} = 38.4 \text{ oz}$$

38.4 ounces = 2.4 pounds in 80 gallons
(16 ounces in a pound)

20. 9 pints or 1 gallon plus 1 pint in 100 gallons. 1½ pints in 50 gallons.
21. 1 tablespoon
22. 2 teaspoons
23. 100 gallons of water weigh 830 pounds.
    100 gallons of kerosene weigh 660 pounds.

Chapter 15—Mixing, Loading, and Application

1. Concentrated pesticides (wettable powders or emulsifiable concentrates).
2. Add pesticides to the spray tank just before you are ready to apply them. You can estimate the amount of pesticide needed, and you can be sure you are using the correct pesticide.
3. Because when mixing, you are handling the concentrated form of the pesticide, and you are more likely to be exposed to liquid splashing on clothing and skin.
4. Through the skin (dermal) and inhalation.
5. They keep the spray mixture in the tank from back-siphoning down the hose into the water source (stream, pond, or well).
6. The pesticide that clings to the inside of the container can be dangerous to people and the environment.
7. Rinse containers until you can see no more residue inside (at least three times).
8. No. Pesticides can be chemically or physically incompatible. If you mix them, they might become impossible to agitate or spray. Or, they might be less effective or more toxic.
9. Compatible means pesticides must be just as safe and potent when you mix them as they are by themselves.
10. The pesticide label or a compatibility chart.

11. An adjuvant is a chemical that, when added to the pesticide mixture, helps an active ingredient do a better job.
12. A spreader-sticker is used to treat waxy surfaces such as cabbage or onion leaves.
13. Too much adjuvant can cause less of the pesticide to stick to the target, and the pest control will be reduced.
14. Yes. Mixing and loading concentrates are the most hazardous activities involving pesticides. Wearing protective clothing reduces the risk to the handler.
15. 4 to 6
16. (1) Empty the container into the tank. Let it drain at least 60 seconds. (2) Fill it one-fifth to one-fourth full of water (or the correct diluent). (3) Close the container again and shake or rotate it for about 30 seconds. Turn the container upside down so the rinse cleans all the inside surfaces. (4) Drain the rinse water from the container into the tank. Let the container drain for 30 seconds. (5) Repeat steps 2 through 4 at least two more times. Repeat the rinsing process until you can see no more residue in the container.

Chapter 16—Weather-wise Application

1. Yes. Rain and wind waste pesticides and money.
2. Wind increases drift. Drifting pesticides move out of the treated area.
3. Drifting pesticides can contaminate the environment and harm plants, animals, and people.
4. Yes. Application on a windy day increases the inhalation and contact hazard to the applicator and others nearby.
5. The applicator is responsible by law for any harm or money loss due to pesticide drift.
6. The pesticide might wash off and fail to control pests on leaves.
7. Pesticide runoff can harm crops and wild areas and contaminate surface waters.
8. Wind speed is lowest and air has most moisture. Children, farm animals, and pets are less likely to be nearby.
9. Wind, air temperature, and humidity.
10. When the air near the soil surface is cooler than the air above it.

Chapter 17—Transportation, Storage, and Disposal

1.
   - Never carry pesticides in the part of your vehicle where people ride.
   - Never transport pesticides with food, clothes, or other things that come in contact with people or animals.
   - Never leave your vehicle without someone to watch it when pesticides are in an unlocked trunk or open-bed truck.
   - Do not transport highly volatile pesticides with other chemicals.
2.
   - Be sure flatbed trucks have side and tail racks.
   - Tie down containers so they cannot move.
   - Carry only containers with labels that are not damaged and that you can read.
   - Inspect the containers to be sure all their openings are closed tightly and no pesticides are on the outside of the containers.
   - Handle the containers carefully.
   - Protect paper and cardboard containers from moisture.
   - Protect pesticides from extreme temperatures (heat and cold).
3. Use fireproof building materials; build berms; keep people out who should not be there; put up a fence; prevent water damage; control the temperature; have enough light; use nonporous materials; prevent runoff; provide clean water.
4. Prevent contamination; protect labels; keep containers closed; use original containers; watch for damage; store containers the right way; store volatile products apart from others; store waste products safely; know your inventory; keep product shelf life in mind; prevent fires.
5.
   - Put on PPE.
   - Use the pesticide right away on a site and at a rate allowed by the labeling.
   - Put the pesticide into a pesticide container that held the same pesticide and has the same label still intact.
   - Put the pesticide in a sturdy container that you can close tightly. Take the label from the old container and attach it to the outside of the new container. Or, mark the container with the pesticide name and EPA registration number. Get a copy of the label as soon as you can.
   - Place the entire damaged container and its contents into a larger container that is right for storing it.
6. Apply them to a site listed on the labeling, if:
   - The total amount of pesticide active ingredient that you apply to the site is not more than the rate and frequency allowed on the label. This includes all the applications you have made already.
   - You comply with other application instructions listed on the label.
7. Dispose of in a hazardous waste landfill, or store safely until you can use them in a legal application or dispose of them the correct way.

8. Use refilled or reconditioned containers that you can return for reuse; recycle multiple-rinsed plastic and metal containers; send multiple-rinsed containers to the landfill.
9. They can vaporize and spread into seeds, fertilizers, and other types of pesticides.
10. They can cause serious harm to humans and the environment. A buildup of pesticide waste allows chemicals to accumulate in the soil; from the soil, the chemicals might leach into groundwater.
11. There is a limit to how long some pesticides can be stored (called **limited shelf-life**), especially once the container is opened. If you buy more pesticide than you can use in one or two seasons, you increase the risk that it will become less effective over time. You also increase the risk that the container will deteriorate and result in leaks or spills.
12. If the container has never been opened, try to return it to a dealer, manufacturer, or formulator.
13. No.
14. Save it to apply later on sites that have the same pest control problem. You may be able to spray it on a fence-row or other site where people or animals will not enter.
15. Multiple rinse the container.
16. • Buy only the amount of pesticide you need for 1 year or season.
    • Calculate carefully how much diluted pesticide you need for a job. Mix only that amount.
    • Use **all** the mixed pesticide as the labeling instructs.
17. Oregon Agricultural Chemicals and Fertilizer Association, and Oregon Farm Bureau Federation.
18. Oregon Department of Environmental Quality.

Chapter 18—Spill Management

1. Control, Contain, Clean up.
2. Protect yourself, stop the source of the spill, protect others, and stay at the site.
3. Confine the spilled material, protect water sources, absorb liquids, and cover dry materials.
4. Pick up the spilled material; decontaminate the spill site; neutralize the spill site; decontaminate equipment; decontaminate yourself.
5. OERS (Oregon Emergency Response System); Chemtrec; emergency telephone numbers on pesticide labeling; police department or county sheriff; fire department; public health department.
6. Every time you handle a pesticide or pesticide container.
7. • If pesticide has been spilled on a person, he or she should wash it off, then change into dry clothes. The person might need to see a doctor.

- Clean the storage area with the help of a crew wearing the proper PPE.
- If liquid has been spilled, throw an absorbent material over it to soak up as much as possible. Collect this contaminated material in plastic bags and place in a large drum.
- If dry material has been spilled, cover it with absorbent material, then sweep it without raising dust. Place the spilled pesticide in plastic bags or a drum.
- Neutralize the pesticide with bleach and hydrated lime.
- Rinse the entire area with water. Dispose of the rinsewater as excess pesticide or hazardous waste.

8. Yes. These materials contain pesticides. Dispose of them as excess pesticide or hazardous waste.
9. Oregon Emergency Response System (OERS).

Chapter 19—Keeping Records and Reporting

1. Pesticide operators' records must include these things:
   (1) The name of the person for whom you applied the pesticide
   (2) Where the land or property is on which you made the application
   (3) The date and time of the application. Record both the time you begin and end.
   (4) The person who supplied the pesticide(s)
   (5) The trade name and the strength of these pesticides
   (6) The amount you applied. Use pounds, ounces, or gallons of actual product per acre or concentration (pounds or ounces product per gallon) and total gallons applied
   (7) The exact property, crop, or crops to which you applied the pesticide
   (8) A report of the equipment, device, or apparatus you used (such as a backpack, boom, or airblast sprayer). If you applied pesticide by aircraft, list the F.A.A. number.
   (9) The names of the pesticide applicators or pesticide trainees who did the actual application or spraying
2. - Commercial pesticide operators
   - Independent commercial applicators
   - Public pesticide applicators
   - Private pesticide applicators, when they use restricted-use pesticides
3. Two years for private pesticide applicators; 3 years for commercial and independent commercial applicators.

4. Records can be proof of proper use. They can help to find the cause of an error, if one has been made. They can provide information to help trace residue and/or damage problems. They can protect you in case of false damage claims. They can save you money. They can improve your pest control practices. You can compare the results you got from different pesticides from year to year. You can predict how much pesticide you will need for the next season.
5. State law requires pesticide dealers to record these things:
   (1) Name, address, and license number of the pesticide buyers
   (2) Date of sale
   (3) Trade name (and formulation, if there is one) of the pesticides
   (4) Quantity of each sale of the pesticide

Chapter 20—Liability

1. Yes. The applicator and the customer are responsible.
2. The dealer, manufacturer, and applicator. A consultant who gives wrong advice also is liable.
3. Yes. It is an ultrahazardous activity in legal terms.
4. Yes. It is the applicator's responsibility to apply the pesticide to the proper target area.
5. The courts say the bees are trespassing, so the applicator is not liable. But, if the label says you must protect bees, then you could be liable.
6. The owner or applicator or both are held liable if children harm themselves. This is called attractive nuisance.
7. Some steps to protect yourself are:
   - Check your records.
   - Make notes of the scene.
   - Record conditions at the scene.
   - Take color photos.
   - Save the pesticide containers you used for the job.
   - Tell your insurance company and the chemical company right away.
   - Get names and addresses of all witnesses.
   - If the site is perennial, look at USDA aerial photos from before the alleged harm.
8. Always be polite, listen to the question, be prepared, have an answer, take notes, be prompt, keep good records.
9. An insurance agent who works with pesticide insurance.

Index for Pesticide Effects
Chapter 6, Table 10

The list below relates to Table 10: "Effects of Pesticides on the Human Body" in Chapter 6. The number after each pesticide in the list refers to the pesticide family number in the Table.

It is not possible to include every registered pesticide here. This is a representative list.

Conversions and Calculations

Effective application of agricultural chemicals depends on many factors. One of the more important is to calculate correctly the amount of material you need. Even a correctly calibrated sprayer can apply the wrong rate if you do not have the correct amount of pesticide in your tank mix.

Manufacturers provide application rate instructions on every pesticide label. These can be stated in many ways, such as pounds of active ingredient per acre (lb ai/a), pounds of formulation per 100 gallons of spray (lb formulation/100 gal spray), or ounces of ai per l,000 square feet (oz ai/1,000 ft^2). So, often you must adapt the application rate instructions to different areas and volumes, or even other units of measure.

Sometimes, the amount of active ingredient must be converted to the amount of actual product. This process can be very confusing. The table of conversion factors below and Chapter 14 can help you make these calculations.

Multiply	By	To get
acres	43,560	square feet
acres	4,840	square yards
acres	0.405	hectares
bushels	64	pints
bushels	32	quarts
cubic feet	1,728	cubic inches
cubic feet	0.037	cubic yards
cubic feet	7.481	gallons
cubic feet	59.84	pints (liquid)
cubic feet	29.92	quarts (liquid)
cups	8	ounces (liquid)
cups	16	tablespoons
feet	30.48	centimeters
feet	12	inches
feet	0.305	meters
feet	⅓ or 0.333	yards
gallons	3.785	liters
gallons	128	ounces (liquid)
gallons	8	pints (liquid)
gallons	4	quarts (liquid)
gallons, H_2O	8.345	pounds of water
grams	0.001	kilograms
grams	1,000	milligrams
grams	0.035	ounces
grams per liter	1,000	parts per million
hectares	2.47	acres
inches	2.54	centimeters
kilograms	1,000	grams
kilograms	2.205	pounds
kilometers	3,281	feet
kilometers	0.621	miles
liters	0.264	gallons
liters	2.113	pints (liquid)
liters	1.057	quarts (liquid)
meters	100	centimeters
meters	3.281	feet
meters	39.37	inches
meters	0.001	kilometers
meters	1,000	millimeters
meters	1.094	yards

Multiply	By	To get
miles	5,280	feet
miles	1,760	yards
miles per hour	88	feet per minute
miles per hour	1.467	feet per second
miles per minute	88	feet per second
miles per minute	60	miles per hour
ounces (dry)	28.35	grams
ounces (dry)	0.063	pounds
ounces (liquid)	0.063	pints (liquid)
ounces (liquid)	0.031	quarts (liquid)
parts per million	0.001	grams per liter
pecks	16	pints (dry)
pecks	8	quarts (dry)
pints	0.125	gallons
pints	0.473	liters
pints	2	cups
pints (liquid)	16	ounces (liquid)
pints (liquid)	0.5	quarts (liquid)
pounds	453.392	grams
pounds	16	ounces
pounds	0.0005	tons
quarts	2	pints
quarts	0.25	gallons
quarts	0.946	liters
quarts (liquid)	32	ounces (liquid)
quarts (liquid)	2	pints (liquid)
rods	16.5	feet
square miles	640	acres
square yards	9	square feet
square yards	1,296	square inches
tablespoons	3	teaspoons
temperature (degrees C + 17.98)	1.8	temperature (degrees F)
temperature (degrees F - 32)	0.555	temperature (degrees C)
tons	907.185	kilograms
tons	2,000	pounds
yards	3	feet
yards	36	inches
yards	0.914	meters

Glossary of Pesticide Terms

2-PAM, protopam chloride
An antidote used for organophosphate poisoning, but not for carbamate poisoning.

abrasion
A scrape, scratch, sore, or cut that breaks the skin.

abrasive
Something that grinds down or wears away an object. For example, wettable powders are abrasive: they wear out nozzle tips by enlarging the orifice.

absorb
To take in and incorporate. Example: to take a pesticide into a plant or animal.

absorption
The entrance of a pesticide into the body through the skin, eyes, gut, or lungs. May also refer to the entrance of water, minerals, or a pesticide into a plant or microorganism.

absorptive clay
A special type of clay powder that can take up chemicals and hold them. It sometimes is used to clean up pesticide spills.

acaricide
A pesticide used to control mites and ticks (from the order Acari). Same as miticide.

Acceptable Daily Intake (ADI)
(See *reference dose.)*

accumulate
Build up, pile up, store.

accumulative pesticides
Chemicals that tend to build up in animals or the environment.

acid
A sharp, sour liquid that is usually dangerous in concentrated form.

acre
An area of land measuring about 209 feet long by 209 feet wide (43,560 square feet).

activated charcoal
Finely ground, high quality charcoal that absorbs liquids and gases easily.

active ingredient (ai)
The part of the pesticide that kills pests or prevents damage by them. In most cases, it is the same as the technical material in the formulated product.

actual dosage
The amount of active ingredient (not formulated product) that is applied to an area or other target.

acute dermal toxicity
How poisonous a single or limited dose of a chemical is when absorbed through the skin.

acute inhalation toxicity
How poisonous a single or limited dose of a chemical is when it is inhaled.

acute oral toxicity
How poisonous a single or limited dose of a chemical is when taken into the mouth and swallowed.

acute poisoning
Severe poisoning that occurs after a single or limited exposure to a pesticide.

acute toxicity
Refers to how poisonous a material is to a human, animal, or plant after a single or limited exposure.

adhesive
An adjuvant that helps the pesticide stick to the treated surface.

ADI
Acceptable Daily Intake. (See *reference dose.)*

adjuvant or additive
A relatively nontoxic ingredient added to the pesticide mixture to help the active ingredient do a better job. Examples: wetting agent, spreader, adhesive, emulsifying agent, penetrant.

adsorption
The binding of a pesticide to the outside surface of soil particles or to plant parts in such a way that the chemical is only available slowly.

adverse effect
An unwanted result such as sickness or environmental damage.

aerosol
Pesticide chemical stored in a container under pressure. The pesticide is driven through a fine opening by an inactive gas under pressure when the nozzle is triggered.

agitate
To keep a pesticide chemical mixed in a liquid carrier; to keep it from settling or separating in the spray tank.

agricultural commodity
An animal, animal product, plant, or plant product meant to be bought or sold.

air-blast sprayer
A sprayer that uses a high-speed fan to help shatter and disperse spray from nozzles.

algae
Simple, chlorophyll-containing plants that grow in water.

algicide
A pesticide used to kill or control algae.

alkali
The opposite of an acid. Most of the time, it is hazardous in concentrated form.

annual
A plant that grows from seed, produces seed, and dies the same year.

antagonistic effect
Reduced toxicity or effectiveness as a result of combining one pesticide with another.

anticoagulant
A chemical that keeps blood from clotting. If it is fed to rodent pests, the pests bleed to death.

antidote
A treatment given by a doctor to reduce the effects of pesticide poisoning.

antisiphoning device
A small piece of equipment attached to the filling hose or irrigation equipment to prevent fill water from draining back into the water source. Example: check valve.

apiary
Place where people keep colonies of bees.

application
Putting a pesticide on or in plants, animals, buildings, soil, air, water, or other targets to kill pests or prevent damage by them.

application rate
The amount of pesticide applied to a certain area.

apply uniformly
To spread a pesticide evenly over an area.

aquatic weeds
Weeds that grow in water, either on top or under the surface.

arachnid
A wingless arthropod with two body regions and four pairs of jointed legs. Spiders, ticks, and mites are arachnids.

arthropod
An invertebrate animal that has a jointed body and limbs and often a hard body covering that it molts. Examples: insects, mites, spiders, crayfish.

artificial respiration
First aid to revive someone who has stopped breathing. This is done by blowing air into the person's lungs or applying pressure from the outside to his or her chest cavity.

atropine
An antidote for organophosphate and carbamate poisoning. Full name is atropine sulfate.

attractant
A substance or device made to lure insects or other pests to a trap or poison bait.

attractive nuisance
A legal term for any object that attracts children or other persons but that might harm them as a result. Examples: sprayers, empty pesticide containers.

avicide
A pesticide used to kill or repel birds.

backpack sprayer
See *knapsack sprayer.*

back-siphoning
When a spray mixture flows back to the well or other water source from the spray tank.

bacteria
Microscopic organisms. Some cause diseases in plants and animals.

bait
A food or other substance that attracts a pest to a pesticide or to a trap where it will be killed.

band application
Application made in a strip over or parallel to a crop row.

base
Alkali (opposite of an acid). (See *alkali.*)

beetle
A hard-shelled insect. Lady beetles and June bugs are beetles.

beneficial
This refers to organisms that help humans. A lady beetle is beneficial because it eats aphids and other insects that damage plants.

biennial
A plant that lives 2 years. During the first year, it makes leaves and stores food. During the second year, it produces fruits and seeds.

bioaccumulation
When organisms build up and store chemicals in their tissues.

biological control
When living organisms are used to control pests. Examples: Parasites, predators, or diseases are used to control pests.

blanket application
Applying pesticide over the whole area.

blight
Spotting, discoloration, wilting, or death of leaves, fruit, flowers, stems, or the entire plant.

boom
See *spray boom*.

boom sprayer
A pesticide sprayer with many nozzles mounted along a long boom.

brand name
The name, number, or designation of a specific pesticide product or device made by a manufacturer or formulator.

broadcast application
Application made evenly over an entire area rather than only on rows, beds, or the middle of an area.

broadleaf plants
Plants with wide, flat leaves and netted veins. Example: dandelion, rose.

broad-spectrum pesticides
Pesticides that kill a wide range of pests. They are effective when many different pests are a problem.

buffers
Adjuvants used to slow chemical degradation of some pesticides by controlling the pH of water (for example, lowering the pH).

buildup
Refers to a pesticide accumulating in soil, animals, or in the food chain.

calculate
Do some math; work with numbers, determine, figure out.

calibrate, calibration
To figure or measure how much pesticide will be applied by the equipment to the target.

canceled
A pesticide use that no longer is registered as a legal use by the Environmental Protection Agency. Remaining stocks usually can be used by order of the Administrator, EPA.

canister
Small plastic or metal cartridge attached to a respirator. It filters out pesticides from the air you are breathing.

carbamate pesticide
A family of pesticides that are chemically alike. In most cases, they have the same mode of action. Common ones are carbaryl (Sevin), carbofuran (Furadan), and methomyl (Lannate).

carcinogen
A substance or other agent that causes cancer.

carrier
(1) The liquid or solid that is used to dilute the active ingredient when a pesticide formulation is manufactured. Examples: talc, petroleum solvents. (2) The substance used to carry the pesticide to the target. Examples: water in a hydraulic sprayer, air in a mist blower.

cartridge
The cylinder-shaped part of a respirator that absorbs the fumes and vapors from the air before you breathe them. You should replace it often.

caustic
A chemical that burns the skin.

CAUTION
A signal word used on labels of pesticides to alert users that the pesticide is slightly toxic.

Celsius
A temperature scale in which water freezes at 0°C and boils at 100°C.

centigrade
Same as Celsius. (See *Celsius.)*

certification
The process in which the applicator shows that he or she has the knowledge and skills to apply pesticides safely without endangering the environment, him- or herself, or others.

chemical
All matter is composed of chemical elements. So, everything in the physical world is chemical. In this manual, chemical often is used to mean a pesticide chemical.

chemical control
Using a pesticide to kill or control a pest.

chemical name
Scientific name telling the contents or formula of the active ingredients of the poison. Example: 2,4-dichlorophenoxy acetic acid.

chemical reaction
When two or more substances are combined and then undergo a complete change to make new substances or materials.

chemical resistant
In the Worker Protection Standards for agricultural pesticides, the EPA defines a material as chemical resistant if it shows no measurable movement of pesticide through the material during use.

chemically inactive
Will not react easily with any other chemical or object. Examples: talc, clay.

chemigation
Applying fertilizers or pesticides to soil or plants by including them in irrigation water.

CHEMTREC
The Chemical Transportation Emergency Center. It has a toll-free number that gives 24-hour help for chemical emergencies such as a spill, leak, fire, or accident: 1-800-424-9300.

chlorinated hydrocarbons
A family of pesticides that contain chlorine. They tend to be more persistent than most carbamate or organophosphate pesticides. Examples: chlordane, lindane, methoxychlor.

cholinesterase
An enzyme found in humans and many other animals. It regulates the activity of nerve impulses.

cholinesterase inhibitor
A pesticide or other chemical that disrupts cholinesterase in the human nervous system.

chronic poisoning
Poisoning that occurs as a result of small, repeated doses of pesticide over time.

chronic toxicity
How poisonous a pesticide is to an animal or human after small, repeated doses over a period of time.

circulate
To move all the way through something in a path that returns to the starting point.

commercial
A job or business whose purpose is to make money or earn a profit.

commercial applicator
In Oregon, a licensed commercial pesticide applicator, as an employee of a commercial pesticide operator, can apply or supervise the application of pesticides by a commercial trainee, or can apply restricted-use pesticides on property owned by someone else, as a means of earning money.

common name
A well-known, simple name of a pesticide accepted by the Pesticide Registration Division of the Environmental Protection Agency. Examples: carbaryl, atrazine, benomyl.

compatibility
When two or more pesticides can be mixed together without reducing their effectiveness or harming the target.

concentrate
A pesticide as it is sold, before it is diluted. In most cases, it contains a lot of the active ingredient.

concentration
The amount of active ingredient of pesticide in a formulation or mixture.

condemnation
The act of removing a crop or product that does not meet legal standards for tolerances on food and thus is not to be sold.

conifers
Trees or shrubs that have needlelike leaves. Examples: pine, cedar, spruce, fir, and hemlock.

contact
To touch or be touched by.

contaminate
Adding an unwanted material (often a pesticide) where it could do harm or damage.

contract
An agreement with someone to do a job or perform a service.

control
To reduce damage or keep down the number of pests in an area.

corrosion
The effect of being worn down or eaten away.

corrosive poison
A type of poison that burns the skin, mouth, stomach, etc.

coverage
How well a pesticide spreads over a surface. Also used to indicate the number of spray droplets per square inch.

cross-contamination
When one pesticide gets into or mixes with another pesticide by accident. In most cases, this occurs in a pesticide container or in a poorly cleaned sprayer.

cultural controls
Control measures that change planting, growing, cultivating, and harvesting of crops to favor the crop and disrupt the pest's environment. They are aimed at preventing or delaying the buildup of pests.

cumulative effect
When poisons build up or are stored in the body over time until the person or animal suffers an effect.

cumulative pesticide
Chemicals that tend to accumulate or build up in the tissues of animals or in the environment (soil, water).

cuticle
The outermost layer of skin or surface of an animal or plant.

deciduous
Plants that live from year to year but lose their leaves during the winter.

decontaminate
To remove or break down the unwanted material (usually pesticide) so it cannot do any harm or damage.

defoliant
A type of pesticide that causes the leaves of a plant to drop off.

degrade
Break down, decompose.

degree of exposure
The extent to which a person has been in contact with a toxic pesticide.

density
When talking about organisms, the number of them within a given area.

depleted
Exhausted. Used up completely.

deposit
The pesticide found on the leaves, skin, or other surface right after a pesticide application.

dermal toxicity
How poisonous a pesticide is when it is absorbed through the skin.

desiccant
A type of pesticide that draws moisture (liquids) from a plant or plant part causing it to dry out and die.

detergent
A chemical used to clean, that is not made from fat and lye like soap. Detergents are used as surfactants in some pesticide sprays. (See *surfactant*.)

deteriorate
To decay, to wear away, to break down.

detoxify
To make a poison harmless.

diagnosis
Identification of the nature and cause of a problem.

diluent
A liquid or dust used to make a pesticide less concentrated.

dilute
To make a pesticide less concentrated by adding water, oil, or other material.

disease
When part of a living organism is harmed as the result of an infectious agent.

disinfectant
A pesticide or other chemical that kills or inactivates a disease-producing microorganism such as bacteria.

dispersants
These are added during the formulation process of wettable powders to keep individual particles of the product from clumping together when it is added to water.

disposal
The act or process of discarding a pesticide. Should be done carefully, safely, and legally.

dissipate
To scatter or spread out. Gases and vapors dissipate through the air.

dissolve
Completely mixing solids with a liquid to form a solution.

dormant spray
Pesticide application made before trees and other plant life begin to leaf out in the spring. Such sprays, if applied during active growth, would cause damage to the plant.

dose, dosage
(1) The amount of pesticide that is applied to the target. (See *rate*.) (2) The amount of chemical absorbed through the surface into the body.

downwind
On the side toward which the wind is blowing.

drift
The movement by wind and air currents of droplets or particles of a pesticide away from the target area.

dry flowable (DF)
A dry, granular pesticide formulation that forms a suspension when added to water. (Same as *water dispersible granule*.)

dust (D)
A finely ground, dry mixture containing a small amount of pesticide and an inert carrier such as talc or clay. The dust particles are of many different sizes.

ecology
Study of the relationship between a plant or animal and its surroundings.

economic injury level
The point of pest infestation at which the cost to control the pest is equal to the value you would lose if you don't control it.

economic threshold
The lowest pest density that will cause economic damage.

ecosystem
A natural community of plants, animals, and their environment.

emergence
When a young plant breaks through the surface of the soil, or an insect comes out of its egg or pupa.

emetic
Something that makes people or animals vomit.

emulsifiable concentrate (EC)
A pesticide formulation with the active ingredient dissolved in a liquid (usually an organic solvent). An emulsifier is used also so the pesticide can be diluted, usually with water.

emulsifier
A chemical that helps suspend one liquid in another liquid that would not mix without it. Example: oil in water.

emulsion
A mixture in which one liquid is suspended in another. Example: oil in water.

encapsulated pesticide
(1) A pesticide formulation with the active ingredient enclosed in capsules of polyvinyl or other synthetic materials. It mostly is used for slow release. (2) A method of disposal of pesticides and pesticide containers by sealing them in a sturdy, waterproof container to prevent leakage of contents.

endangered species
A plant or animal that is in danger of extinction throughout all or most of its range.

environment
Surroundings. Most of the time, refers to water, air, soil, plants, and wildlife.

Environmental Protection Agency (EPA)
The federal agency responsible for implementing pesticide rules and regulations and registering pesticides.

EPA establishment number
A number assigned by the EPA to each pesticide production facility. The number indicates the plant where the pesticide product was produced. It must appear on all labels of that product.

EPA registration number
A number assigned by the EPA to a product when it is registered. It must appear on all labels for that product. It appears as "EPA Reg. No." or "EPA Registration No." followed by the company number and product number.

epidemic
A sudden increase in a disease or disease organism.

eradicant fungicide
A type of fungicide that kills the disease after it appears on or in a plant.

evaporate
To turn into a gas (vapor).

evergreens
Plants that have green leaves throughout the year.

exemption
That which frees one from something that others must do.

exoskeleton
The outer supportive covering of an animal (such as an insect).

expose, exposure
Not shielded or protected. To come in contact with the pesticide.

face shield
A transparent piece of protective equipment used by a pesticide handler to protect the face from exposure to pesticides.

Fahrenheit (F)
A temperature scale in which water freezes at 32°F and boils at 212°F.

fatal
Deadly.

FDA
Food and Drug Administration, U.S. Department of Health, Education, and Welfare.

feed
Food used for feeding livestock and domestic animals.

FEPCA
Federal Environmental Pesticide Control Act of 1972.

FIFRA
The Federal Insecticide, Fungicide, and Rodenticide Act. It is a federal law dealing with pesticide regulations and use.

filler
A powdered diluent.

filter
To screen out unwanted material; to clean by straining out undesirable parts; or a piece of equipment for doing this.

flowable (F)
A pesticide formulation in which a finely ground solid particle is suspended in a liquid carrier. Flowables require only moderate agitation and seldom clog spray nozzles.

fluid
Liquid.

foam retardant
An adjuvant used to reduce the foaming of a spray mixture during agitation.

foaming agent
Chemical substance that causes the pesticide mixture to form a thick foam.

fogger
An application machine that sprays liquid solutions in the form of a fine mist or fog. It also might use a low-speed air supply or some other device to help disperse the fog.

foliage
Leaves, needles, or blades of a plant.

foliar sprays
Pesticides that are applied on the stems, leaves, needles, or blades of a plant.

food chain
A sequence of species in which each species is consumed by the species next higher. It is a link between plant eaters, plant and meat eaters, and meat eaters.

forecasting
To predict pest numbers (populations) using weather, host, and pest characteristics.

formula
A brief way of writing a complicated idea using abbreviations and symbols.

formulation
The pesticide product as purchased consisting of a mixture of one or more active ingredients, carriers or diluents (inert ingredients), plus other additives to make it safe and easy to store, dilute, and apply.

fume
Unpleasant or irritating smoke, vapor, or gas.

fumigant
A pesticide in the form of a poisonous gas that kills destructive microorganisms, animals, and plants when they absorb or inhale it.

fumigation
The use of a fumigant to destroy a pest.

fungi, fungus
Non-chlorophyll-bearing plants, living on decaying organic matter or as parasites. They cause rots, molds, and plant diseases. Some are beneficial and serve as a food source.

fungicide
Pesticide used to control organisms that cause molds, rots, and plant diseases (fungi).

gall
An unnatural growth of plant tissue caused by mites, insects, bacteria, nematodes, viruses, fungi, or chemicals.

gas mask
A type of respirator that covers the face and protects the eyes, nose, and mouth. Gas masks contain better filters and more absorbing material to cleanse the air than cartridge respirators.

gpa
Gallons per acre.

gpm
Gallons per minute.

gram
A metric weight that equals 1/1,000 kilogram; 1 ounce equals about 28.5 grams.

granary
A storage place for threshed grain.

granular pesticide (G)
A pesticide whose active ingredient is mixed with or coats an inert carrier to form small pellets. These pellets are applied with seeders, spreaders, or special equipment.

ground driven
Power supplied to a pump, auger, or spinning disc from one of the wheels as the machine is towed.

groundwater
Water in a layer of soil or rock below the ground.

growth regulator
A pesticide chemical that changes the normal growth or reproduction of a plant or insect.

habitat
Where an organism lives.

hand sprayer
Portable sprayers that can be carried and operated by one person.

harvest aid chemical
A chemical that makes the leaves fall from plants or kills vines, to make machine harvesting easier. (See *defoliant*, *desiccant*.)

harvest interval
(See *preharvest interval*.)

hazard
The chance that danger or harm will result from an activity. Whether or not a pesticide is a hazard depends on both its toxicity and exposure to the pesticide. (See also *risk*.)

herbicide
Pesticide used to control unwanted plants. A weed or grass killer.

high-pressure sprayer
Same as *hydraulic sprayer*.

hormone
A substance found in plants and animals that controls growth and other body processes. There are synthetic chemicals that also regulate growth.

host
A plant or animal on which another plant or animal lives as a parasite. (See *parasite*.)

humidity
How damp or moist the air is.

hydraulic agitator
A device that keeps the tank mix from settling out using water flow under pressure.

hydraulic sprayer
A machine that applies pesticides by using water under pressure to deliver the pesticide to the target.

IGR
(See *insect growth regulator*.)

illegal residue
An amount of pesticide found on the crop at harvest that is either above the set tolerance or that is not allowed on the crop at all.

immune
A state of not being affected by disease or poison; exempt from or protected against.

inactive
Will not react chemically with anything; not involved in the pesticide action.

incinerator
A high-heat furnace or burner that reduces everything to ashes and vapors or nonharmful residues.

incompatible
Two or more materials or chemicals that cannot be mixed or used together to produce a desired effect.

incorporate
To work or blend a pesticide into the soil.

induce vomiting
To make a person or animal throw up.

inert ingredients
Inactive part of a pesticide or formulation. Any material in a pesticide mixture that would not prevent damage or destroy pests if used by itself.

ingest
To eat or swallow.

ingredient statement
The part of the label on a pesticide container that gives the name and amount of

each pesticide chemical and the amount of inactive material in the mixture.

inhalation
To take air into the lungs, to breathe in.

inhalation toxicity
How poisonous a pesticide is to humans or animals when breathed in through the lungs.

inhibitor
A chemical that prevents or suppresses growth or other processes in plants or animals.

inject
To force a pesticide chemical into a plant, animal, building, or the soil.

injurious
Harmful.

injury
Harm; hurt.

insect
An arthropod that has a body with three segments and three pairs of legs.

insect growth regulator (IGR)
A synthetic hormone used as a pesticide. It mimics insect hormones so the exposed insect cannot develop normally and dies without becoming an adult.

insecticide
A pesticide used to kill insects or prevent damage caused by insects.

instar
The time between an insect's molts. Each of these stages has a number. Example: the first instar is a stage between the egg and the first molt.

integrated pest management (IPM)
The use of all proper pest control methods to keep the number of pests below the economic injury level. Methods include cultural practices; use of biological, physical, and genetic control agents; and the selective use of pesticides.

integument
The skin or membrane covering an organism.

interval
Length of time. The length of time between two pesticide applications or between the last pesticide application and harvest.

inversion
When the temperature at ground level is lower than that of the air above.

invert emulsifier
An agent or additive that allows water to remain suspended in oil. The usual emulsifier allows suspension of oil in water.

IPM
(See *integrated pest management*.)

irritating
Annoying. Example: making an animal (or person) uncomfortable by burning, stinging, itching, or making the eyes water.

kilogram (kg)
A unit of weight in the metric system equal to 2.2 pounds.

knapsack sprayer
A small sprayer with a hose, hand nozzle, and a tank that can be worn like a backpack. Also called a backpack sprayer.

label
The printed material attached to or part of a pesticide container.

larva (plural: larvae)
The immature form of an insect or other animal that goes through metamorphosis.

larvicide
An insecticide used to kill larvae of insects.

LC_{50}
(See *Lethal Concentration Fifty*.)

LD_{50}
(See *Lethal Dose Fifty*.)

leaching
The movement of a substance through soil with water.

lesion
A diseased area on a plant or an animal. It can be a spot, scab, canker, or blister.

lethal
Deadly.

Lethal Concentration Fifty (LC_{50})
The amount of a pesticide in air that kills half of the test animals exposed to it. The lower the LC_{50} value, the more poisonous the pesticide is. It is used to measure acute inhalation toxicity.

Lethal Dose Fifty (LD_{50})
The dose or amount of a pesticide that kills half the test animals in a dose-response study when eaten or absorbed through the skin. The lower the LD_{50} value, the more poisonous the pesticide. LD_{50} values are used to measure acute oral and acute dermal toxicity.

liable, liability
Legal responsibility for.

licensing
The process of giving the proper application form and fees required to get the Pesticide Applicator or Consultant License.

life cycle
What an organism completes when it has passed through all of its developmental stages.

liter
A unit of volume in the metric system equal to a little more than 1 quart.

low-concentrate solution
A low concentration of active ingredient mixed in a highly refined oil or other liquid.

low-volume spray
A spray application using 0.5 to 5 gallons per acre.

mammals
Warm-blooded animals that feed their young with milk. Most mammals have hair.

marine
Having to do with animals and plants that live in the ocean.

mechanical agitator
A physical device that keeps the pesticide and any additives well mixed in the spray tank by paddling, swirling, or stirring.

metabolite
In the case of pesticides, a compound derived from changes in the active ingredient through chemical, biological, or physical reactions. The metabolite can be simpler or more complex and can be more poisonous than the original chemical.

metamorphosis
A change in the shape, size, and/or form of an animal.

metric system
A system of measurement that uses meters, grams, and liters as units. It is used by most of the world except the United States and Canada. It is used in scientific work.

mg
(See *milligram*.)

mg/kg
Milligrams per kilogram. Used to express the milligrams of chemical per kilogram of animal weight that are necessary to cause an effect in the animal.

microbial degradation
Breakdown of a chemical by microorganisms.

microgram (μg)
A unit of weight in the metric system equal to $\frac{1}{1,000,000}$ of a gram. There are about 28,500,000 micrograms in 1 ounce.

micron (μ)
A unit of length equal to $\frac{1}{1,000,000}$ of a meter. Droplet sizes are measured in microns.

microorganism
An organism so small it cannot be seen without the aid of a microscope.

milligram (mg)
A unit of weight in the metric system equal to $\frac{1}{1,000}$ of a gram. There are about 28,500 mg in 1 ounce.

misdiagnose
To make a mistake in deciding which pest has caused the problem.

mist application
A spray that has droplets between 50 and 100 microns in size.

mist blower
An application machine that uses an air stream to help disperse (and, in some cases, break up) spray leaving a nozzle. They use low volumes of water.

mite
A tiny animal that is like an insect but has eight legs rather than six. Its body is divided into two parts, and it has no antennae (feelers).

miticide
Acaricide; a pesticide used to control mites and ticks.

mode of action
The way in which a pesticide has a toxic effect on the target plant, animal, or microorganism.

mold
A growth caused by a fungus that often is found in damp or decaying areas or on living things.

molluscicide
A pesticide used to control snails and slugs.

molting
The process of shedding and renewing the exoskeleton.

monitoring system
A system of keeping track of and checking up on whether pesticides are escaping into the environment.

mortality
Death. Often used to mean death rate.

multipurpose
Doing more than one job; a pesticide that kills more than one pest.

mutagen
A substance or agent able to cause genetic changes in living cells.

mutagenic
Produces genetic changes.

narrow-leaf plants
Plants that have narrow leaves and parallel veins. Grasses, sedges, rushes, and onions are all narrow-leaf plants. Compare to *broadleaf plants.*

natural control
The control of unwanted pests by natural forces. Examples: predators and parasites, pathogens, or physical means.

natural enemies
The predators and parasites that exist in the environment and attack pest species.

negligence
Failure to do your job or duty; to be neglectful.

nematicide
A pesticide used to control nematodes.

nematode
A tiny, hairlike worm that causes damage by feeding on roots or other plant parts.

neoprene
Synthetic rubber used to make gloves and boots that protect against pesticides.

nervous system
The brain, spinal cord, and nerves of animals.

neurotoxicity
Poisonous to the nervous system (brain, spinal cord, and nerves).

neurotoxin
A substance or agent able to cause disorders of the nervous system.

neutralize
To destroy the effectiveness of, to counteract.

NIOSH
National Institute for Occupational Safety and Health.

NOEL
No Observable Effect Level. The highest dose level at which a pesticide shows no effect that scientists can observe in test animals.

nonaccumulative
Will not build up in an animal's body or in the environment.

nonlabeled
A use or method that is not written on the pesticide label and therefore is not legal.

nonpersistent
Only lasts a short time (a few weeks or less) after being applied; breaks down quickly in the environment.

nonselective pesticide
A chemical that is toxic to plants or animals without regard to species. Example: a nonselective insecticide can kill or harm beneficial insects.

nontarget
Any plant, animal, or other organism that a pesticide application is not aimed at, but that might be injured by the chemical by mistake.

nontoxic
Not poisonous.

nonvolatile
A pesticide chemical that does not evaporate (turn into a gas or vapor) at normal temperatures.

noxious weed
A plant defined by law as troublesome, not wanted, and hard to control.

nozzle
A device that controls the flow of the liquid, droplet size, and the pattern of the spray of a pesticide application.

nymph
The immature stage of an insect that passes through three stages (egg, nymph, and adult) in its development.

off-target
An area where the pesticide is not meant to be applied.

oils
Paraffinic and other oils used to dilute and act as carriers of pesticides.

oral
Through the mouth.

oral toxicity
How poisonous a pesticide is if taken by mouth.

organism
Any living thing. Examples: plant, animal, fungus, bacteria, insect.

organophosphate pesticides
A family of pesticides that are chemically alike in that they all contain phosphorous. In most cases, they are less persistent than the chlorinated hydrocarbon family. They act by inhibiting an enzyme called cholinesterase. Examples: malathion, Diazinon, parathion.

orifice
An opening. The hole in a nozzle tip. It regulates the flow rate of liquid solutions.

original container
The package (bag, can, bottle) that a pesticide is sold in. The package must have a label telling what the pesticide is and how to use it correctly and safely.

ornamentals
Plants used to add beauty to homes, lawns, gardens, and parks.

overlap
To apply pesticide over part of a swath that has already been sprayed.

2-PAM, protopam chloride
An antidote used for organophosphate poisoning, but not for carbamate poisoning.

parasite
A plant or animal that harms another living plant or animal (called the *host*) by living or feeding on or in it. Sometimes parasites attack and control pests that could injure crops or animals. These parasites are forms of biological control.

parts per billion (ppb)
One part per billion equals 1 pound in 500,000 tons.

parts per million (ppm)
One part per million equals 1 pound in 500 tons, or 1 cubic centimeter in 1,000 liters.

parts per trillion (ppt)
One part per trillion equals 1 pound in 500,000,000 tons.

pathogen
A disease-causing organism.

penetrant
An adjuvant added to a spray mixture to enhance the absorption of a pesticide.

percent by weight
The amount of actual pesticide chemical in a mixture based on its weight compared to the weight of the whole mixture. Example: One pound of actual pesticide plus 3 pounds of other material gives you a mixture with 25 percent pesticide by weight.

perennial
A plant that normally lives for more than 2 years. Trees and shrubs are perennials.

persist
To stay for a length of time; to remain.

persistent pesticide
A pesticide chemical (or its metabolites) that remains active in the environment more than one growing season. Some compounds can accumulate in animal and plant tissues or remain in soil for years.

personal protective equipment (PPE)
See *protective equipment*.

pest
An unwanted organism (animal, plant, bacteria, fungus, virus, or other).

pesticide
A chemical or other agent that destroys a pest or protects something from a pest.

pesticide chemical
Used to describe a pesticide that is a chemical rather than a parasite, virus, or some other type of pest killer.

pesticide kill
When careless or wrong use of a pesticide results in the death of large numbers of nontarget organisms.

pesticide resistance
The ability of an organism to suppress or resist the harmful effects of a pesticide.

pesticide tolerance
(See *tolerance*.)

pesticide waste
The concentrate, rinsate, spill, mix water, wash water, and containers that have no further use after a pesticide application job is done.

petroleum products
Anything that contains gasoline, kerosene, oil, or similar products.

pH
A measure of acidity or alkalinity. Acid is below pH 7; basic or alkaline is above pH 7.

phenoxy
A chemical class of herbicides including 2,4-D.

pheromones
Chemicals produced by insects and other animals to communicate with each other. Synthetic pheromones are used to attract, monitor, and control pests.

photodegradation
Breakdown of chemicals by the action of sunlight.

phytotoxicity
Injury to plants.

plant disease
Any sickness that affects plant life. In most cases, it is caused by fungi, bacteria, or a virus.

plant growth regulator
A chemical that changes the normal growth or reproduction of a plant.

pneumatic
Moves or worked by air.

point of runoff
When a spray is applied until it starts to run or drip off the ends of the leaves and down the stems of plants, or off the hair or feathers of animals.

poison
Any chemical or substance that can cause illness or death when eaten, absorbed through the skin, inhaled, or otherwise absorbed by humans, animals, or plants.

poison control center
An agency with current information on the proper first aid and antidotes for poisoning emergencies, including pesticide poisoning.

pollinators
Bees, flies, and other insects that visit flowers and carry pollen from flower to flower on many plants to produce fruit, vegetables, nuts, and seeds.

pollute
To make unclean or unsafe. See also *contaminate*.

port of entry
Place where goods from other countries (plants, animals, crops, and others) enter the United States.

postemergence
After a plant has germinated and pushed up (emerged) through the soil.

potency
Strength of something. Example: How deadly a poison is.

ppb
(See *parts per billion*.)

PPE
Personal protective equipment. See *protective equipment*.

ppm
(See *parts per million*.)

ppt
(See *parts per trillion*.)

precautions
Safeguards; safety measures; warnings.

precipitate
A solid substance that forms in a liquid and settles to the bottom of the container. A material that no longer remains in suspension.

predator
Any animal or insect that attacks, kills, and eats other animals or insects. Predators are important in the food chain, and some help to reduce pests that cause disease, damage, or harm.

preemergence
The time between planting seeds and when the seedlings push up through the soil.

preharvest interval
The least number of days between the last pesticide application and the harvest date, as set by law.

preplant
Incorporation of pesticides into the soil before planting crop seeds to control weeds, insects, and soil-borne diseases.

pressure
The amount of force on a given area. The pressure of a liquid pesticide forced out of a nozzle to form a spray is measured in pounds per square inch (psi).

private applicator
In Oregon, a pesticide applicator who can buy and use restricted-use pesticides on land he owns or controls or on land owned and controlled by his employer for the purpose of producing agricultural crops or commodities.

product
A term used to describe the pesticide as it is sold. In most cases, it contains the pesticide chemical plus a number of additives.

propellant
The inert ingredient in self-pressurized products that forces the active ingredient from the container. (See *aerosol*.)

properties
The characteristics or traits that describe a certain chemical or other matter.

protectant
A pesticide applied before pests are found but where they are expected. The pests are unable to develop, so they cannot cause damage or destroy desirable crops or animals.

protective equipment
Clothing and other gear that protect a person against harm when using poisonous pesticides. They include gloves, apron, shoes, coveralls, hat, cartridge, respirator, and gas mask.

public applicator
In Oregon, a licensed public pesticide applicator, as an employee of a utility, school district, or other publicly owned and/or operated entity, can apply or supervise the application of pesticides on property of that public agency.

pupa (plural: pupae)
The resting stage of an insect that passes through four stages (egg, larva, pupa, and adult) in its development.

pyrethrin
A pesticide obtained from plants in the chrysanthemum family. The active ingredient of pyrethrum.

pyrethroids
Synthetic chemicals that are like pyrethrin. (See *pyrethrin*.)

pyrethrum
An insecticide containing pyrethrin. (See *pyrethrin*.)

quarantine
Regulatory method that closes off the area where a pest (animal, insect, weed, or disease-causing organism) is found so it cannot spread. Involves inspections, treatments, and destruction of contaminated plants or animals or their parts.

rate
The amount of material that is delivered to a plant, animal, or surface. In most cases, it is measured as per acre, per 1,000 square feet, or per hour.

RCRA
The Resource Conservation and Recovery Act. It is the federal law regulating the transport, storage, treatment, and disposal of hazardous wastes.

recommended dosage
Advice from a county agency, Extension specialist, other authority, or written on the label regarding how much pesticide should be used to prevent damage by or to destroy a pest. Same as **recommended rate**.

reentry interval
See *restricted-entry interval*.

reference dose (RfD)
The dose of pesticide a person can be exposed to daily without being likely to suffer an adverse effect over a lifetime. It used to be called the Acceptable Daily Intake (ADI).

registered pesticides
Pesticide products that have been registered by the Environmental Protection Agency for the uses listed on the label.

registration
Approval by the Environmental Protection Agency of a pesticide for uses as stated on its label.

regulatory officials
The persons working for the federal or state government who enforce the rules and laws.

repellent
A pesticide that keeps insects or other pests away from the treated plant, animal, or surface.

residual pesticide
A pesticide that can destroy pests or keep them from causing damage for a long time after it is applied (days, weeks, months).

residue
The pesticide that remains on a crop, animal, or surface for a while after it has been treated. Not the same as *deposit*.

resistance
The genetic ability developed by some pests to resist the effects of certain types of pesticides that are toxic to other members of that species.

respirator
A face mask that filters out poisonous gases and particles from the air so that a person can breathe and work safely.

restricted-entry interval (REI)
The time between pesticide application and when workers safely can go back into an area without protective clothing. Also called reentry interval.

restricted-use pesticide (RUP)
A pesticide that can be purchased only by certified pesticide applicators and used only by certified applicators or persons directly under their supervision. The public may not use it because of the high toxicity and/or environmental hazard.

restrictions
Limitations.

RfD
(See *reference dose*.)

rinsate
Rinsewater or dilute pesticide from cleaning pesticide equipment.

risk
The chance that a substance or some activity will cause harm under certain conditions.

rodent
Animals of the order Rodentia. Examples: rats, mice, gophers, woodchucks, and squirrels.

rodenticide
A pesticide used to control rats, mice, rabbits, and other rodents.

runoff
The movement of water on the soil surface.

RUP
See *restricted-use pesticide*.

russetting
Rough, brownish marks on leaves, fruit, or tubers.

scientific name
The one name used throughout the world by scientists for each plant and animal. The names are based on Latin or Greek languages.

scouting
Checking and identifying pests and beneficial organisms and the effects of biological control.

seed treatment
Applying a pesticide to seeds before planting in order to protect them from harm or destruction by soil pests.

segment
A ring or subdivision of the body, leg, or antennae of an arthropod.

seizure
The taking of a crop or animal if it contains more than the allowable pesticide residue.

selective pesticide (specific pesticide)
A pesticide that controls only certain pest species and not other plants and animals.

sensitive areas
Places where pesticides could cause great harm if not used with special care and caution. Examples: houses, barns, parks, ponds, streams.

sensitive crops
Crops that are injured easily by pesticide chemicals. Even slight drift could cause major damage.

sensitivity
How susceptible an organism is to the effects of a poison at a low dosage.

shock
The severe reaction of the human body to an injury; can result in death if not treated, even if the injury itself would not be fatal.

short-term pesticide
A pesticide that breaks down into nontoxic by-products soon after application.

sign
Evidence of poisoning in a plant, animal, or human that can be seen by another person. Compare to *symptom*.

signal word
A word that must appear on pesticide labels to show how toxic the pesticide is. The signal words used are DANGER—POISON or WARNING or CAUTION.

silvicide
Herbicide used to control unwanted brush and trees, as in wooded areas.

site
An area, building, plant, animal, or other organism to be treated with a pesticide to protect it from the target pest.

slurry
A thick suspension of a pesticide made from a wettable powder and water.

soil fumigant
A pesticide that is added to the soil in the form of a gas or vapor to kill many pests. Often a tarpaulin (tarp), plastic sheet, or layer of water is used to trap the gas in the soil until it does its job.

soil injection
Placing a pesticide below the soil surface with little or no soil mixing. Example: forcing a pesticide into the ground through a tube.

soil sterilant
A pesticide used to kill nearly every organism in the soil. This often depends on the dose.

soluble powder (SP)
A finely ground, solid pesticide that dissolves in water or other liquid when ready for application.

solution
A mixture made by dissolving a solid, liquid, or gas in a liquid. The mixture will not separate or settle out in normal use. Example: sugar dissolved in water.

solvent
A liquid such as water, kerosene, or alcohol that a pesticide or other substance dissolves in to form a solution.

space spray
A pesticide that is applied in the form of tiny droplets that fill the air to destroy insects and other pests, either inside or outdoors.

species
A group of living organisms that are very nearly alike, are called by the same common name, and can interbreed successfully.

spiders
Arachnids. Small animals like insects. They have eight jointed legs, two body regions, no antennae, and no wings.

spot treatment
Application to a restricted or small area.

spray
A mixture of a pesticide with water or other liquid that is applied as tiny droplets.

spray boom
A section of pipe or tubing with two or more nozzles for applying pesticides.

spray concentrate
A liquid formulation of pesticide that is diluted with another liquid (usually water or oil) before using.

spray drift
(See *drift*.)

spreader
A machine made for applying granular pesticides or fertilizers.

spreader-sticker
A chemical added to the pesticide mixture to make the spray droplets spread out and stick better to the animal, plant, or other surface being treated.

stage of development
A certain time during growth from newborn or egg to adulthood. Example: An insect goes through many changes from egg to adult. Any one of these changes is a stage of development.

sterilize
Treat with a chemical or in some other way to kill every living thing in a certain area.

structural pests
Insects, rodents, and other pests that attack and harm barns, houses, and other buildings. Examples: termites, carpenter ants.

suction hoses
The hose through which water is pulled from a pond or stream, or spray solution from the spray tank, into the pump.

surface spray
A pesticide spray that is applied to cover the entire outside of the object to be protected.

surface water
Water that is above ground. Examples: rivers, lakes, ponds, streams.

surfactant (from **Surf**ace **Act**ive Age**nt**)
A chemical or other substance used in a pesticide formulation to make mixing easier and help the pesticide to spread over and completely wet the sprayed surface. Example: detergent, emulsifiers, wetting agents, spreaders and stickers.

susceptible
Can be killed or harmed by the pesticide at the rates used.

suspended
A pesticide that is no longer legal, and remaining stocks cannot be used. More severe than *canceled*.

suspension
A mixture in which fine particles of a pesticide chemical are floating in a liquid.

swath
The width of the area covered by a sprayer making one sweep or one trip across the field or other treated area.

symptom
A warning that something is wrong. Feelings that only the person who has been poisoned can notice. (Compare to *sign*.)

synergism
The action of two pesticides that has a greater effect when the pesticides are used together than when they each are used alone.

synthetic rubber
A material that looks like natural rubber but is made by a chemical process in a laboratory. Latex is not used in its formation. Examples: neoprene and butyl, used in boots and gloves.

systemic
A pesticide that is taken in by one part of a plant or animal and moves through it. When a pest feeds on this plant or animal, the pesticide acts on it. A systemic herbicide affects the plant itself.

tank mix
When two or more chemicals are added together in the same spray tank.

target
The area, buildings, plants, animals, or pests meant to be treated with a pesticide application.

technical material or pesticide
The pesticide as it is first manufactured by the company before formulation. In most cases, it is almost pure. (Also called *active ingredient*.)

temperature inversion
When the temperature at ground level is lower than that of the air above.

termiticide
An insecticide used to control termites.

test animals
Animals—mostly rats, fish, birds, mice, or rabbits—used in the laboratory to determine the toxicity and hazards of different pesticides.

thermal
Related to heat.

thorax
The second or middle segment of the insect body. This segment is where the legs and wings attach.

threatened species
A plant or animal that is likely to be endangered.

tick
A small, eight-legged, blood-sucking, insectlike organism often found on dogs, cows, or wild animals.

tolerance
The maximum amount of a pesticide that is allowed to remain on any food or feed (plant or animal) that is to be eaten by livestock or humans. The tolerance is set by the Environmental Protection Agency.

tolerant
Not susceptible to (harmed by) a pesticide application.

toxic
Poisonous; harmful to plants, animals, or humans.

toxicant
A poison. The chemical in a pesticide formulation that can injure or kill the pest as well as humans, animals, or plants.

toxicity
How poisonous a pesticide is to a living organism.

toxin
A natural poison produced by plants, animals, or microorganisms. Examples: the poison produced by the black widow spider, the venom produced by snakes, the botulism toxin.

trade name
A brand name. The name given to a pesticide by a manufacturing company to identify it as their product.

transport
To carry from one place to another, usually in a car or truck.

treated area
A building, field, forest, garden, or other place where a pesticide is applied.

ultrahazardous
A job or activity that is very dangerous.

ultralow volume (ULV)
The application of a pesticide that is almost pure toxicant or technical material by spraying it in extremely small amounts over a large area (in most cases, only a few ounces per acre).

ULV
(See *ultralow volume*.)

unauthorized persons
People who have no right to be doing something because they have not been told or trained to do it.

uncontaminated
Does not contain hazardous pesticide residues.

underground water
Water beneath the soil surface. Where wells get their water. Also called *groundwater*.

uniform coverage
The even application of a pesticide over a whole area, plant, or animal.

uniformly
Done exactly the same way each time or over each area. Done evenly.

uninformed persons
People who are not trained to use and handle pesticides safely.

unintentionally
Accidentally; not done on purpose.

USDA
United States Department of Agriculture.

vapor
Gas; steam.

vapor drift
When chemical vapors move away from the area of application.

vapor pressure
That which causes a chemical to evaporate. The higher the vapor pressure, the more volatile the chemical or the easier it will evaporate.

vaporize
Evaporate; become a gas.

vermin
Pests. Most of the time, this means rats, mice, or insects.

vertebrate
Animal that has a segmented backbone or spinal column.

victim
Someone who is injured, poisoned, or hurt in any way.

virus
Very tiny parasites that can be seen only with a powerful microscope. Viruses can only multiply in living tissues. They cause many animal and plant diseases.

viscosity
How thick a liquid is or how easily it flows. When temperature goes down, most liquids become more viscous.

volatility
The rate of evaporation of a pesticide.

volatilize
To become vapor.

volume
The amount, mass, or bulk.

vomitus
The matter that is vomited.

water dispersible granule (WDG)
(See *dry flowable*.)

water table
The upper level of the water-saturated zone in the ground.

weathering
The action of wind, snow, rain, ice, and heat to wear away. Pesticides weather from the surfaces to which they were applied.

weed
Any plant growing in a place where it is not wanted.

wettable powder (WP)
A pesticide formulation in the form of powder that is mixed with water to be applied. It does not dissolve in the water but forms a suspension.

wetting agent
An additive that helps the pesticide spread out and coat a surface more evenly. It helps sprays to remain on and spread evenly on waxy or hairy leaves.

wildlife
All living things that are not human or domesticated. (Pests are not considered to be wildlife.)

woody plants
Perennials that have a tough, thick stem or trunk covered with bark.

References

Farm Chemicals Handbook, 2001. Meister Publishing Co., Willoughby, OH.

Federal Hazardous Substances Act (codified at 15 U.S.C. 1261_1278) (Public Law 86-613, 74 Stat. 372, July 12, 1960, as amended), Public Law 100-695, 102 Stat. 4568, Nov. 18, 1988; at **http://www.herc.org/library/fhsa.pdf**

Meister Pro Crop Protection Handbook. 2003. Meister Publishing Co. Willoughby, OH.

Morgan, D.P. 1989. *Recognition and Management of Pesticide Poisonings.* Fourth edition. U.S. Environmental Protection Agency.

O'Connor-Marer, Patrick J. (ed.). *The Safe and Effective Use of Pesticides.* 2000. Pesticide Application Compendium, Volume 1. Second edition. University of California, Davis. Publication 3324.

Ottoboni, M. Alice. 1991. *The Dose Makes the Poison: A Plain-language Guide to Toxicology.* Second edition. Van Nostrand Reinhold. New York.

Ramsay, C.A. and G.L. Thomasson (eds.) *Private Applicator Pesticide Education Manual; A Guide to Safe Use and Handling.* 1995. Washington State University, Pullman, WA.

Reigart, Routt and James Roberts (eds.). *Recognition and Management of Pesticide Poisonings.* 1999. EPA Office of Pesticide Programs. Washington, DC.

Ware, George W. 2000. *The Pesticide Book.* Thompson Publications, Fresno, CA.