Applying the Correct Amount
Learning Objectives

After you complete your study of this unit, you should be able to:

- Explain why it is important to apply the correct amount of pesticide.
- Describe how to determine how much pesticide to apply.
- Identify ways that application rate is expressed.

Applying Pesticides Correctly

- Explain why it is important to calibrate some equipment.
- Describe how to figure application rate.
- Explain the importance of checking calibration often.
- Explain which types of pesticides must be diluted before application.
- Explain what information you must find in the pesticide labeling or in other recommendations before you can dilute the pesticide correctly.
- Explain what information you must know about your own situation before you can calculate how much of the dilute pesticide mixture to prepare.

Terms To Know

Active ingredients—The chemicals in a pesticide product that control the target pest.

Adjuvant—Chemical added to a pesticide formulation or tank mix to increase its effectiveness or safety.

Concentrated—Having a high percentage of active ingredient.

Diluent—Anything used to dilute a pesticide.

Dilute—To make less concentrated.

Formulation—Pesticide product as sold, usually a mixture of active and inert ingredients.

Fumigant—Pesticide that is a vapor or gas or forms a vapor or gas when applied and whose pesticidal action occurs in the gaseous state.

Labeling—The pesticide product label and other accompanying materials that contain directions that pesticide users are legally required to follow.

Target site—The site toward which control measures are being directed.

Tip-and-pour—Built-in measuring device that fills with a given amount of pesticide when the container is tilted.
One of the most important tasks for a pesticide applicator is making sure that the correct amount of pesticide is being applied to the target site. Studies indicate that only one out of four pesticide applications is applied within an acceptable range of the intended rate. Applying either too little or too much pesticide can cause problems.

For each pesticide application, take the time to determine how much you need to apply. Then be sure that you apply the correct amount.

**Underdosing is expensive.** If you apply too little pesticide, you may not fully control the pest. Sometimes you can repeat the entire application, but that can be very costly in both time and money. In other cases, a repeat application may not be possible, because it would result in an overdose.

**Overdosing is expensive** because of the high cost of pesticides. Do not use any more than the amounts listed in the “Directions for Use” section of the pesticide labeling. Using more product than the labeling recommends will not do a better job of controlling pests, and it is illegal. Overdosing may cause damage or injuries, leave illegal residues, and cause you to be fined or to be liable for damages.

### Deciding How Much To Apply

Study the “Directions for Use” section of the pesticide labeling to find out how much pesticide you should apply. If the labeling lists a range of possible amounts, use the least amount of pesticide that will achieve good control of the pest. Sometimes consultants, industry organizations, pest or pesticide specialists, Cooperative Extension agents, university specialists, or pesticide dealers provide recommendations on the appropriate amount to use.

The amount of pesticide to use is expressed in various ways. Application rates may be expressed in terms of how much **pesticide formulation** should be applied. The instructions may tell you how much pesticide formulation should be applied to each unit of area or volume in the target site.
— 5 gallons of formulation per acre, or 1 pound of formulation per 100 cubic feet of space, for example. Application rates also may be expressed in terms of how much pesticide formulation should be used per volume of mixture. Labeling might call for 3 tablespoons of product per 5 gallons of water or 1 pint of product per 100 gallons of water.

Sometimes pesticide labeling and other sources express application rates in terms of how much active ingredient should be applied per unit of area or per volume of mixture — 1 pint active ingredient per 1,000 square feet, or 1/2 pound active ingredient per 500 gallons of water, for example. When the application rate is expressed in this way, you can select different formulations and be able to figure how much to dilute each one. However, figuring the correct dilution for active ingredient recommendations is more complicated.

Occasionally the application rate is expressed in terms of a percentage of the final dilution — 1/2 percent by volume or 1 percent by weight, for example. Products that are adjuvants often express the application rate in this way. Expressing application rate as a percentage allows the user to calculate the dilution correctly for whatever dilution method is being used for the formulation.

**Mixing, Loading, and Calibration Alternatives**

Knowing what amount of the pesticide you must apply is only the first step. Next, you must determine how you will deliver the correct amount to the target site. Depending on the type of formulation you choose and the type of application equipment you will use, you may have to do some combination of three basic tasks — mixing the pesticide, loading it into your equipment, and calibrating the equipment so you will know exactly how much pesticide it is delivering.

- **Mixing** — Unless the pesticide is a ready-to-use formulation or is designed to be applied full strength, you must carefully combine the right amounts of concentrated pesticide formulation and diluent to make the needed application-strength pesticide mixture.
- **Loading** — You may need to transfer the pesticide into the equipment before it can be applied.
- **Calibrating** — For many kinds of applications, you must measure and adjust the amount of pesticide your equipment will apply to the target site.

Each different combination of formulation and equipment type requires you to do a different combination of these tasks to prepare for applying a measured amount of pesticide.

**Loading Needed, No Mixing or Calibration**

Some ready-to-use pesticides are not sold in the pesticide application equipment. The user must load them into the equipment. If the application equipment to be used is a squeeze-trigger sprayer, shaker-can duster, a vat for dipping animals or plants, a spray-dip vat, a wiper applicator, or some fumigant applicators, no calibration is necessary.

**No Calibration, Mixing, or Loading Needed**

Some pesticide formulations are sold at application strength and are already in the equipment needed for application. These include aerosol cans; squeeze-trigger sprayers; delayed-trigger foggers; baits; shaker-can dusters; impregnated collars, bars, strips, and rollers; and wiper bags. The pesticide is applied to the point of runoff, is directed at a specific target, is placed so the target contacts it, or is released to fill an enclosed space. Most of these pesticides are available for use in only a few specialized pest control situations.
Calibration and Loading Needed, No Mixing

Ready-to-use formulations sometimes must be loaded into equipment that does require calibration. These include most granular and dust formulations, some liquid formulations (especially solutions), and some fumigant formulations. The pesticide is loaded directly into application equipment without any further dilution. The equipment must be calibrated so that the correct amount of pesticide will be released per unit area.

Mixing and Loading Needed, No Calibration

Some concentrated pesticides are diluted and then loaded into equipment that does not require calibration. Many plant and animal dips or spray-dips, tree-canopy sprays, and crack and crevice treatments are applied by equipment that does not need calibration. The applicator is instructed to “cover the plant, animal, or surface thoroughly” or “apply to the point of runoff.”

Calibration, Mixing, and Loading Needed

Many concentrated pesticides are applied with equipment that must be calibrated. For many certified applicators, this is the option most commonly encountered. The concentrate must be diluted correctly and the equipment must be calibrated correctly. Both steps are crucial to applying the correct amount of pesticide to a target site. If there is an error either in dilution or in calibration, the wrong amount of pesticide will be applied.

Calibrating Your Equipment

Most pesticide applications involve equipment that must be measured and adjusted to release the correct amount of pesticide to the target site. Proper calibration is an essential but often neglected task. To be sure your equipment is...
releasing the right amount of pesticide, take time to calibrate it carefully and correctly. Recheck it regularly to detect changes caused by wear, corrosion, and aging.

Calibration often requires some simple arithmetic. Usually the equipment manufacturer, the pesticide dealer, your industry organization, or the Cooperative Extension Service will provide some standard formulas to help you. The easiest and most accurate way to do the calculations is with a calculator.

Choose equipment that you know how to use and that is:

- designed for the type of chemical being applied, and
- appropriate for the size and type of application job.

Equipment will not deliver the right amount of pesticide to the target site if it is not working correctly. Before you begin to calibrate the equipment, check it carefully to be sure that all components are clean and in good working order. Pay particular attention to the parts that regulate the amount of pesticide being released, such as nozzles and hopper openings. If they become clogged, not enough pesticide will be released. If they become worn, too much pesticide will be released.

Equipment that must be calibrated includes mechanical dusters; granule spreaders; hand, backpack, boom, hand-gun, high-pressure, airblast, and most other sprayers; and fumigant applicators. The many types of application equipment differ in the details of their operation, but if you understand the basic principles of calibration, you can apply them in any situation. Study the manufacturer's instructions carefully — they explain exactly how to adjust the equipment. They often contain suggestions on such things as the appropriate rate of travel, the range of most efficient pump pressures, approximate settings for achieving various delivery rates, and types of nozzles that can be used.

**Speed**

For some types of application equipment, the speed at which the equipment moves (or is carried) through the target site is one of the main factors in determining the rate of application. For some other types of equipment, you do not need to consider speed when calibrating.

**Equipment with gravity-flow dispersal**

If the equipment you have chosen uses gravity to maintain the flow of pesticide, calibration may be fairly simple. Some equipment, such as some granule spreaders, needs to be calibrated
Only to adjust the rate of flow or delivery. This equipment releases pesticide only when the wheels are in motion. If the speed of the equipment is kept at an even, moderate pace, the amount of pesticide being released per unit area will be uniform.

**Equipment with powered dispersal**

If your equipment has a pump or other mechanism to disperse the pesticide, you will need to determine the rate of speed best suited for the type of equipment and for the particular requirements of your application job. Such equipment may be either hand-carried or mounted on a vehicle. In either case, the speed at which the equipment moves through the target site determines the amount of pesticide applied in a given area. Keep the speed as constant as possible during the calibration process and during the actual application. For the most accurate calibration, operate the equipment at the target site or on ground (or other surface) similar to that at the target site. Whether the equipment is hand-carried or mounted on a vehicle, the condition of the ground (surface) that must be crossed is important. A rough and uneven surface will cause the equipment to be operated at a slower speed.

The equipment manufacturer's directions may offer a range of appropriate speeds. Your knowledge of conditions in the target site (including the drift hazard), plus your experience with the equipment, will help you determine an appropriate speed.

**Uniform Release**

If the application equipment you will be using has more than one nozzle (or more than 1 cluster of nozzles) or hopper, part of the calibration process is to measure the output from each to be sure that they all are releasing the correct amount of pesticide. Note whether the pesticide output from one or more nozzles (or cluster of nozzles) or hoppers is 5 percent more or less than the amount desired. Check for clogging or other obstruction in the openings that are distributing less. Check for leaks or worn parts in the openings that are distributing more. If you find no correctable problem, replace the nozzles or hoppers.

You can check for uniform output in two ways. Either method requires that you attach containers (jars) to collect the output from each nozzle, nozzle cluster, or hopper. Operate the equipment for a set period of time (1 to 5 minutes) and compare the amount of output in each jar to the amount desired. Or operate the equipment over a measured area while calibrating the equipment and, at the end of the calibration run, compare the amount of output in each jar to the amount desired. If all the nozzles or hoppers are intended to release an equal amount of pesticide, just check to see whether all the jars contain the same amount.

**Calibration Methods**

No matter what calibration method you use, you will be measuring how much pesticide is being applied in a specific area. Calibration usually requires you to operate the equipment over a pre-measured distance.

The rate of application depends partly on the particle or droplet
size, texture, and other properties of the pesticide being applied, so you will need to decide what material to use in the test. If the pesticide is a liquid with water as the major diluent, use water alone in the test. If the pesticide is a dust, granule, or fumigant, or a liquid diluted with a liquid other than water, you must use the actual pesticide in the test.

The rate of application sometimes depends also on the pressure and on the nozzle size or hopper opening. The equipment manufacturer’s directions are the best guide to these selections.

**Do a Test Application**

Calibrate your application equipment by:

- accurately measuring the amount in the tank or hopper,
- operating the equipment over the pre-measured distance while maintaining your chosen speed (if speed affects the delivery rate of the equipment you are using),
- accurately measuring the amount needed to fill the tank or hopper back up to the pre-application level.

If multiple nozzles or hoppers are used, you must add together the output of all the collection jars.

**Figure the Application Rate**

The amount of pesticide dispersed, divided by the distance covered, is the application rate. Sometimes no calculations are needed. If, for example, the label lists the application rate as “per acre” or “per 1,000 linear feet” and you measure the output for exactly 1 acre or exactly 1,000 linear feet, no calculations are necessary because the amount of output you measured is the total amount required.

However, you may not have the time to test your equipment over such a large site. Or, if you are using the actual pesticide in the test, you may not want to risk applying it over a large site without knowing the application rate. Under these conditions, you can test smaller sites and then calculate the application rate.

**Small equipment, small target sites**

If you are using application equipment that carries a relatively small load (up to a few gallons of liquid or a few pounds of dry pesticide) or if the target site is relatively small (less than an acre or 1,000 linear feet), you can choose a test site that is small.

If the use directions are for 100 linear feet, you might choose a test site of 25 linear feet. If the directions are for 1,000 square feet or for an acre, you might choose a test site of 250 square feet (a 10-by-25-foot rectangle). Measure the amount applied in this smaller site and then multiply to find the rate:

- The amount applied to 25 linear feet, multiplied by 4, equals the rate per 100 linear feet.
- The amount applied to 250 square feet, multiplied by 4, equals the rate per 1,000 square feet.
- The amount applied to 250 square feet, multiplied by 175, equals the rate per acre.

**Larger equipment, larger target sites**

If you are using application equipment that carries a larger load (more than a few gallons of liquid or a few pounds of dry pesticide) or if the target site is relatively large (greater than an acre or 1,000 linear feet), choose a larger test site. If the test site for these types of equipment or sites is too small, measurements are likely to be inaccurate. Operating a boom or other multi-nozzle or multi-hopper equipment over a site as small as 10 feet by 25 feet, for example, would not allow you to carry or drive the equipment far enough to gauge average speed accurately.

If label directions are for 1,000 square feet or for an acre, use a test site of at least 1,000 square feet (a 20-by-50-foot rectangle). The output you measure during the test will be the actual application rate for the 1,000 square feet. To find the rate per acre, multiply the test output by 43.56, which is the number of square feet in an acre (43,560) divided by 1,000.
Check Calibration Often

Once you have calibrated your equipment, do not assume that it will continue to deliver the same rate during all future applications. Clogging, corrosion, and wear may change the delivery rate, or the settings may gradually get out of adjustment. Taking the time to check the calibration of your equipment regularly is worth your while.

Be alert for possible calibration problems each time you use your application equipment. During the application, notice whether you are treating the same amount of area per load that you figured. If you find that you are covering more or less area than your figures indicated, stop application and check your figures and your equipment. If you have figured wrong or if your application equipment changes its delivery rate, you will be able to catch the mistake before you have a major problem.

Measure Accurately

When you measure pesticides or diluents, measure accurately. Inaccurate measurements can lead to underdosing, overdosing, too much pesticide mixture left in the tank, or a tankload of the wrong strength of pesticide mixture.

Use graduated utensils. If you are measuring a dry formulation, use a scale to weigh out the exact number of pounds or ounces you need. If you are measuring a liquid formulation or diluent:

- use measuring spoons or a "tip and pour" to measure teaspoons or tablespoons,
- use a graduated measuring cup or a "tip and pour" to measure from 1/4 cup to 1 pint,
- use a graduated jug or pail to measure from 1 pint to 5 gallons,
- use a flow meter to measure more than 5 gallons at a time.

Carefully measure the amount of pesticide to add. Do not guess or approximate the amount you are adding, and do not add a little extra "just to be sure." Also measure the amount of diluent carefully. Adding the correct amount of concentrate to an approximated amount of diluent can result in a whole tankful of the wrong strength of pesticide mixture. Mix only the amount you have calculated is needed for the application.

Do not assume that the tank is exactly the size of its claimed capacity. A "5 gallon" tank may hold more or less than 5 gallons. A "100 gallon" tank often holds quite a bit more than 100 gallons when totally filled. Measure the tank yourself to be sure. Even the graduated marks on some tanks or hoppers that indicate levels of partial fill are often inaccurate.

You can measure the capacity of your tank and check (or make) gauges indicating partial fill levels in two ways. You can fill the tank by hand using a container of known capacity, such as a measuring cup for small tanks and a 5-gallon pail for larger tanks. Or you can attach a flow meter to a hose and measure the quantity of water as it flows into the tank. For either method, as you fill the tank, you should check or mark measured volumes on a dip stick or sight gauge.

If water or another liquid is being used to dilute the concentrate, rinse the measuring utensils with the diluent and put the rinsate into the mix tank. Repeat this three times to be sure all of the pesticide is removed from the measuring utensil.

Measure the amount of a ready-to-use formulation carefully, too. Trying to put pesticide back into the container when you have too much left over after the applica-
tion is often a difficult task. Add only the amount you have calculated is needed to complete the application job.

Measuring utensils, such as spoons, cups, jugs, pails and scales, that you use with pesticides should never be used for other purposes. Clean them thoroughly after each use and store them with your other pesticide equipment.

**Diluting Pesticides Correctly**

Some of the pesticides you buy are dilute formulations that are sold at application strength. These often are labeled “Ready-To-Use” or “RTU.” But many pesticide formulations that you use are concentrates, which are sold at strengths many times that needed for application. These formulations must be diluted before you can apply them. They are usually powders or liquids. Granules and dusts are rarely sold as concentrates; fumigants and ultra-low-volume formulations are concentrates that are applied full strength.

The person who prepares the pesticide mixture for application must figure carefully how much concentrated pesticide to use and how much diluent to add to the concentrate. Unless the pesticide is diluted correctly, you can apply the wrong amount of pesticide in the target site.

Water is the most common diluent in pesticide mixtures.

Others that are sometimes used include other liquids, such as kerosene and oil; and dry ingredients, such as corn husks and various powders. Concentrated pesticides are either diluted in a “mix tank” and then loaded into the application equipment or loaded directly into the application equipment and diluted there.

The pesticide labeling or other recommendations will tell you:
- what to use to dilute the formulation,
- how much to dilute the formulation, and
- how much of the dilute pesticide to apply per unit of area.

After you determine how much you need to dilute the pesticide concentrate, you must calculate how much pesticide and diluent to combine to achieve the correct amount of dilute pesticide mixture in your application equipment. Depending on the situation, you may need to know:
- how much your equipment holds when full or how much mixture you will need to complete the job.
- how much mixture your equipment applies per unit of area,
- the size of the site you need to treat.

Guides that are available from many sources contain formulas and examples to help you make necessary calculations.

Pesticide labels express the desired dilution for the pesticide mixture in a variety of ways, depending on the type of product and the primary intended uses. If your application situation is not the same as those on which the labeling directions were based, you may have to use simple arithmetic to convert the quantities to different units of measure.

**Determining Size of Target Site**

If the target site is a rectangle, circle, or triangle, you can use simple measurements and formulas to determine its size. Irregularly shaped sites often can be reduced to a combination of rectangles, circles, and triangles. Calculate the area of each and add them together to obtain the total area.

To apply fumigants and a few other pesticides to fill the entire inside of a structure or other enclosed space, you must calculate the volume (cubic feet) of the building, greenhouse, truck, railroad car, or ship hold. To apply pesticides to bodies of water (not just the surface), you must calculate the volume of the water in the pond or lake. Sometimes the structures or bodies of water are regular in shape. The calculations for these are fairly simple. If the structure or body of water is irregular, you must calculate parts of the structure separately and add them together to find the total volume.
Q. Why is it so important to apply the correct amount of pesticide to the target site?
A. If you apply too little pesticide, you may not fully control the pest. Overdosing may cause damage or injuries, leave illegal residues, and cause you to be fined or to be liable for damages.

Q. Where can you find out how much pesticide to apply?
A. From the “Directions for Use” section of the pesticide labeling, and from other sources, such as consultants, industry organizations, pest or pesticide specialists, Cooperative Extension agents, university specialists, or pesticide dealers.

Q. What are some of the ways that application rates may be stated?
A. 1. Amount of formulation per unit of area or per unit of volume, such as pounds or gallons per acre, per square feet, or per cubic feet.
   2. Amount of formulation per volume of mixture, such as 3 tablespoons of product per 5 gallons of kerosene or 1 pint of product per 100 gallons of water.
   3. Amount of active ingredient per unit of area or per volume of mixture, such as 1 pint active ingredient per 1,000 square feet, or 1/2 pound active ingredient per 500 gallons of water.
   4. Percentage of the final dilution, such as 1/2 percent by volume or 1 percent by weight.

Q. Why is it important to calibrate some types of pesticide application equipment?
A. Many types of pesticide application equipment must be calibrated so that the correct amount of pesticide will be released to the target site.

Q. How do you calculate the application rate?
A. The amount of pesticide dispersed, divided by the distance covered, is the application rate.

Q. Why should you recheck equipment calibration frequently?
A. Clogging, corrosion, and wear may change the delivery rate, or the settings may gradually get out of adjustment.

Q. What pesticide formulations must be diluted before application?
A. You must dilute all formulations except those that are sold as ready-to-use products or those designed to be applied full strength.

Q. What information do you need to get from the pesticide labeling or other sources before you can dilute pesticides correctly?
A. Read the pesticide labeling or consult recommendations from other sources to find out what to use to dilute the formulation; how much to dilute the formulation; and how much of the dilute pesticide to apply per unit of area.

Q. What information do you need to know about your own situation before you can calculate how much pesticide and diluent to combine to achieve the correct amount of dilute pesticide mixture in your application equipment?
A. You must know how much your equipment holds when full or how much mixture you will need to complete the job; how much mixture your equipment applies per unit of area; and the size of the site you need to treat.