Unit 3. Safety Considerations

Learning Objectives

After studying this unit, you will be able to:

• Lessen the environmental risks of chemigation.
• Understand how to avoid pollution by tailwater control and other methods.
• Protect farm workers from pesticide exposure in a chemigated area.
• Protect yourself and your coworkers from pesticide exposure while chemigating.

This unit discusses safety practices that are specific to pesticide chemigation. By reading it, you will learn how to lessen environmental threats such as drift, overspray, runoff, and deep percolation (leaching). This unit does not discuss backflow prevention and antipollution equipment. See Unit 5 (Backflow Prevention) for detailed information on those topics.

After studying this unit, you will understand the importance of field posting to keep farm workers out of recently chemigated areas. You will learn when to use protective clothing and equipment and how to report spills and other accidents. Finally, this unit describes the basics of personal safety while chemigating.

The core manual, Applying Pesticides Correctly: Guide for Private and Commercial Applicators, is a comprehensive guide to basic pesticide safety. It discusses safety issues for all applicators. See the Core Manual for more pesticide safety information.
Terms to Know

Deep Percolation—Movement of pesticide in water downward and radially through the soil profile below the target application depth. The pesticide mixture usually continues downward below the crop rooting zone to the groundwater. Also called “leaching.”

Degradation—The breakdown of a pesticide or other substance.

Diluent—Anything (usually water) used to dilute a pesticide.

Drift—The movement of a pesticide through the air as particles or vapors to nontarget areas.

End Gun—A large, high-pressure sprinkler located at the terminal of a pivot sprinkling system. It is used to extend the irrigated acreage into the corner of a field.

Furrow Damming (Dammer-Diking)—A technique to build up small earthen dams or dikes with a tillage tool. These dams, located in furrows, help reduce runoff in fields.

Overspray—A spray application that overshoots the target area into a nontarget area.

Pitting—A technique of punching holes in the soil from 6 to 10 inches in diameter and from 6 to 8 inches deep. These holes, spaced about 2 feet apart on center, help reduce runoff on steep slopes.

Restricted-Entry Interval (REI)—The length of time specified on the pesticide label between the time of the pesticide application and the time it is safe for a person to enter the treated area without label-required personal protective equipment (PPE) and/or appropriate training and certification.

Rinsate—Pesticide-containing water that results from rinsing a pesticide container, pesticide equipment, or other pesticide-containing articles.

Runoff—Movement of water, possibly containing pesticides, away from the release site flowing across the soil surface or as subsurface drainage. Runoff liquid is neither intercepted by the crop canopy nor infiltrated into the soil.

Tailwater—Water delivered to but not absorbed by a field. This excess water is often stored in a pond or redirected to another field. It is often associated with surface or flood/furrow irrigation systems.

Safety is the main concern when you apply any pesticide. Whether you use a boom sprayer, a fixed-wing aircraft, or an irrigation system, make sure that the pesticides you release attack only the target pest(s). The pesticides should not harm nontarget areas, farm workers, or your application team.
Protecting the Environment

“Environment” is another word for “nontarget areas.” When you chemigate, do your best to protect the surrounding areas from contamination caused by leaks, spills, drift, overspray, runoff, and deep percolation. Be especially sensitive to surface water nearby such as lakes and streams. If you use a center pivot system with an end gun, monitor it closely to make sure the gun does not overshoot the site. Its output should also not exceed the infiltration rate of the soil. Collect all tailwater within a storage tank or pit. Dispose of empty pesticide containers as directed on the product label. Finally, be sure you know what to do in case of a spill.

Drift

When water and pesticide are released from a sprinkler nozzle, part of the spray may evaporate. It is therefore not deposited in the target area. Spray droplets or vapors may drift in the wind out of the target area and end up on nontarget plants or soil. This nontarget application, or drift, can have the following results:

• Misapplication of a pesticide,
• illegal pesticide residues in or on a crop,
• water pollution and health hazards, and
• crop damage (ex. stunted growth) resulting in yield loss.

These actions are against the law. They can also damage your crops or a neighbor’s.

Furthermore, drift can pollute water, harm people, and injure plants.

Drift is sometimes a problem with center pivot sprinkler systems. The center pivot may dispense the spray mix at a greater height than regular ground equipment. This increases the chance of drift. Some of the newer center pivot systems have sprinkler devices placed on drop tubes. This lowers the height at which the spray mix is discharged. However, the lower sprinkler height also yields a smaller wetting pattern. Therefore, you may need more sprinkler devices to ensure good uniformity.

In general, spray nozzles or sprinkler devices with smaller droplet sizes are more likely to produce drift than those with larger droplets.

Take these steps to minimize wind drift:

• Cancel or postpone your pesticide application if winds are stronger than 10 to 15 mph. This is often a label requirement. At this point, the wind is likely to cause spray particles to drift off-target. As an applicator, you are responsible for monitoring the weather while chemigating, as directed by the label.
• Use drop nozzles on the spray boom to reduce the distance between the nozzle and the target.
• Increase the orifice (opening) size of your nozzles.
• Convert the irrigation system from high pressure to low pressure.
• Retrofit impact sprinklers with spray nozzles or devices.
• If practical, apply chemicals at night when the winds are often calmer.
• Regularly monitor your application.

Overspray

Overspray occurs when application equipment -especially end guns overshoots the target area. If you are chemigating an irregularly shaped area, turn off the end gun on your center pivot system. This will lessen the chance that you will overshoot into a nontarget area.

End Guns

End guns are a popular choice for many center pivot systems. They can add more than 5% to the irrigated area of the center pivot. However, end guns often have a high drift potential and poor distribution uniformity. They also contribute to surface runoff and overspray onto nontarget areas.

Some end guns operate continuously according to field size and layout. These cause the least problem. However, most end guns work on only part of the circle. Your application will be most uniform if you leave the end gun either on or off.
during the entire job—unless doing so will result in an off-target application. Otherwise, unless you have a variable-rate injection pump, you must recalibrate the injection system. This will allow for changes in water flow.

End-gun shutoffs that fail are frequently the cause of off-target applications. If you use an end gun, carefully check the uniformity of your application throughout. In addition, make sure environmental conditions are favorable.

**Corner Systems**

Corner systems can include hand lines or set lines. Chemicals are injected through a separate pump (usually gas powered) at the corner of the field.

A corner system on a center pivot causes a difference in application rate. This happens because of variations in flow rate. The main system slows down as the corner arm extends and speeds up as the corner arm retracts. Intermittent use of a corner system also disturbs the pressure pattern in the rest of the system. This can reduce uniformity, requiring you to recalibrate your equipment. You can use variable-rate injection pumps to compensate for changes in water flow. As with end guns, if you use a corner system, carefully check your application for uniformity.

**Surface Runoff**

Runoff will occur whenever your irrigation system applies water faster than it can infiltrate into the soil. Many factors help determine when runoff will occur:

- application rate,
- soil infiltration (intake) rate,
- topography of the field (inclination, slope length, and aspect),
- roughness of the soil surface,
- crop canopy, and
- amount and orientation of plant residue.

Runoff water can carry chemicals out of the field and harm nearby plants and animals. The tainted water may also flow into rivers and lakes.

There is much you can do to prevent or lessen surface runoff of the water-pesticide mixture. First, assess the design of your irrigation system.

**Center Pivot Design**

The design of a center pivot system greatly affects the chance of runoff. Some center pivot systems are more likely than others to produce runoff. Sprinkler systems differ according to

- pump pressure,
- water flow, and
- crop need.

Nozzle type (impact sprinklers vs. spray nozzles) and configuration (spacing on the lateral) are very important. A center pivot covers more acres in the outer spans than it does in the inner spans. This means that the density and/or size of nozzles needs to increase as you move along the center pivot lateral. In general, uniform nozzle spacing between outlets (with variable discharge rates) is most often used.

In many cases, you can reduce the risk of runoff by using spray nozzles and by dropping your release height.

**Tillage Practices**

Tillage practices can greatly reduce the chance of runoff in your fields. For example, it helps to increase the water infiltration rates of the soil. Surface treatments, such as furrow damming (dammer-diking) and pitting in crop rows, help control runoff. They do this by preventing water from flowing out of the treated area. Furrow damming involves using a tillage tool that scrapes and carries loose soil down the furrow. This tool trips at preset intervals. The effect is to build up small earthen dams or dikes. Pitting involves punching holes into the soil. These holes are 6 to 10 inches in diameter, 6 to 8 inches deep, and about 2 feet apart on center. This technique greatly reduces runoff on steep slopes.
Another tip is to chemigate at a different time than you irrigate. This allows you to apply considerably less water and reduces the chance of runoff. Sometimes, using less water produces a more effective pesticide application. Using more water may actually reduce the effectiveness of the application. This is due to excessive soil percolation.

**Buffer Zones**

You can plant field borders to act as buffer strips. These borders contain vegetation that slows runoff and traps sediments. They also allow contaminants more time to be degraded by bacteria and sunlight.

**Tailwater Control**

Tailwater, often associated with flood/ furrow irrigation systems, is a type of surface runoff. It is water delivered to but not absorbed by a field. This excess water is often stored in a pond or redirected to another field. The size of the storage area depends on two factors:

- the rate and amount of runoff, and
- the rate and timing of reuse pumping.

You need only a small storage area if the reuse is almost immediate and is at a rate equal to runoff. A large storage area gives you more flexibility in managing tailwater. However, it also increases the risk of pollution. For larger tailwater storage areas, you will need a pump. The pump will help ensure the speedy return of runoff from the sump. You may have a delay in returning the runoff. In this case, the storage area can contain the polluted water until it is pumped out.

Runoff containing pesticides is dangerous. For automated pumping, you will need electrical service and permanently installed pipes. If you must channel tailwater back into a sprinkler system, follow these steps:

1. Make sure the pressure is greater than the normal irrigation line pressure. Or, create a low-pressure zone to allow tailwater into the pipe.
2. Use an interlock to prevent pumping tailwater into the system in case the irrigation system shuts down.

**Deep Percolation**

Deep percolation can occur if too much water is applied to the soil. This is especially true with coarse-textured sandy soils. Deep percolation causes irrigation water, pesticides, and plant nutrient chemicals to leach below the crop root zone. They therefore have little effect on the crop or target pest. (In Hawaii some groundwater sources are contaminated with pesticides or nitrates which have leached from agricultural activities.) When the pesticide moves below the effective root zone, it may contaminate groundwater. You can control or prevent leaching in three ways:

- increase the travel speed of your system,
- use the least amount of water you need to
- distribute the pesticide, and
- ensure high distribution uniformity.

In addition, manage your irrigation system to allow for rainfall.

**Surface Water**

To protect groundwater as well as nontarget plants and animals, do not chemigate fields with exposed surface-water areas such as ponds or creeks.

You must also be careful that you do not overspray surface water near these fields. Avoid fields with connections to groundwater (ex. abandoned wells and subsurface drains). Check the pesticide label for any restrictions near surface water. In case of a spill, do not allow the chemical to flow into any surfacewater source. As discussed in Unit 2 (Before You Chemigate), you should always assess the target area for its closeness to sensitive areas before you begin your treatment.

NOTE: If you have surface runoff problems with your irrigation system, do not chemigate with pesticides.

For help in designing a tailwater return system, contact the Natural Resources Conservation Service (part of the U.S. Department of Agriculture) or consult an irrigation specialist or a university expert.
Container Disposal

Dispose of pesticide containers in accordance with label directions and with federal, state, tribal, and local laws and regulations. Usually, triple rinsing is adequate. A container must be triple rinsed to avoid being considered hazardous waste. Follow these steps:

1. Flush the container three times. Use a volume of diluent at least equal to 20% of the capacity of the container.
2. Use the rinsate as a diluent for the same pesticide.
3. Keep triple-rinsed containers in a locked and posted place until you send them to an approved landfill or recycling center. Crush or puncture triple-rinsed containers that you cannot return or recycle.
4. Dispose of all containers promptly to avoid unsightly buildup and health hazards.

Spills

If someone spills a pesticide during an application, you should do four things first, regardless of the size of the spill:

1. Avoid physical contact with the pesticide.
2. Keep people away from the spilled chemical and secure the area.
3. Control the spill and stop it at the source.
4. Confine the spill as much as possible.

Refer to the pesticide label for instructions about spill cleanup.

In addition, the core manual, Unit 12 (Transportation, Storage, Disposal, and Spill Cleanup), has detailed information on managing spills and how to report them.

Minor Spills

A minor spill usually involves smaller amounts of pesticide. However, even a minor spill demands special treatment if the chemical spilled may enter surface water or groundwater.

Make sure you do not get any pesticide on your skin, clothing, or shoes. Secure the area and warn people to keep out. Stop the spill and confine it as much as possible. If it starts to spread, dike it with an absorbent material such as soil, sawdust, or cat litter. If necessary, remove the contaminated soil to prevent pollution of groundwater. Take care not to disturb the gravel pack around irrigation wells when removing tainted soil.

Remember not to hose down the spill area because this will spread the chemical or cause it to leach. Do not leave the area until the spill is cleaned up or help arrives. Work carefully and do not rush.

Major Spills

The same basic steps apply for a major pesticide spill. Keep the pesticide off your skin and clothes and give first aid as necessary. Keep people out of the area, stop the spill at its source, and confine it as much as you can. For a major spill, however, you must notify certain state and local authorities. Notification is required by the Hawaii Emergency Planning and Community Right-to-Know Act (HEPCRA) for spills or leaks (“releases”) of certain quantities where the chemical could cause pollution or direct harm to people or wildlife.

Pesticide Outcome

What becomes of a pesticide after it is applied? Where will it go, how will it change, and in what form will it finally end up? Of course, the ideal outcome is absorption by the target pest(s). Plants, for example, take up herbicides with their leaves, stems, flowers, and roots.

However, plants and other organisms do not intercept all of the pesticide applied to the target site. Some of it degrades, or breaks down. The degradation of pesticides is the beneficial process that removes pesticide residues from the environment. The two major types are:

- microbial degradation and
- photodegradation.
Microorganisms in the soil such as fungi and bacteria degrade pesticides. Over time, these organisms break down the chemicals. Microbial degradation works best when the soil is warm, moist, aerated, and fertile. In photodegradation, sunlight gradually breaks down the pesticide.

When a pesticide degrades, it changes chemically. It usually—but not always quickly—breaks down into nontoxic compounds. All pesticides degrade, although some may remain in the environment for many years.

**Protecting Workers: The Worker Protection Standard**

The main way in which you can protect farm workers and others nearby is to post the chemigated area. Posting warns others that pesticides have been applied through an irrigation system. As a certified chemigator in Hawaii, you are required to know the posting requirements of any pesticides you apply through an irrigation system. The label will tell you whether posting is required. Posting is designed to discourage unauthorized entry into treated areas by workers or the public.

**Restricted-Entry intervals for the Treated Area**

In general, no one should reenter pesticide-chemigated fields until no inhalation and/or dermal exposure risk exists. The Worker Protection Standard (WPS) requires growers who employ agricultural workers and pesticide handlers to take steps to protect them from exposure to pesticides. All workers must observe the restricted-entry intervals (REIs) given on the label. For more information about WPS, see the Core Manual, Unit 7 (Harmful Effects and Emergency Response).

For Toxicity Category 1 products (those with the signal word “Danger”) that may be applied by chemigation, the EPA requires this statement to appear on the label:

“Posting of areas to be chemigated is required when 1) any part of a treated area is within 300 feet of sensitive areas such as residential areas, labor camps, businesses, daycare centers, hospitals, inpatient clinics, nursing homes, or public facilities not including public roads, or 2) when the chemigated area is open to the public, such as golf courses or retail greenhouses.”

If you need to reenter the treated area before the end of the waiting period as given on the label, you must use the personal protective equipment (PPE) specified on the label. You should also be either a licensed applicator or a trained worker or handler.

**Chemigation Posting**

The pesticide label will spell out where to post treated areas, when to post, and for how long. It may require you to list the time and date of application and how to contact the applicator. In addition, it will give specific directions on the size and appearance of the sign. Post at least one sign at each site for which posting is required. A chemigation warning sign should include the words “Keep Out” at the top. At the bottom, the words “Pesticides Being Applied in Irrigation Water” should appear underneath a stop sign.

If you are chemigating with a fumigant, you must notify workers by posting signs that contain the following information:

- Danger/Peligro.
- Area under Fumigation: Do Not Enter/No Entre.
- Name of fumigant/Soil Fumigant in Use.
- Date and time of fumigation.
- Name, address, and telephone number of applicator.

This information appears in the Agricultural Use box on the product label.
Other Concerns

Posting required for chemigation does not replace other posting and REI requirements for farmworker safety. Be sure to observe legal application days before harvest (preharvest interval). Failure to properly post a chemigated field could result in prosecution. Check with the Hawaii Department of Agriculture, Pesticide Branch, to be sure that you are complying with state laws.

Protecting the Applicator

As discussed in Unit 2 (Before You Chemigate), chemigation may pose fewer risks to the applicator than other methods. Still, pesticides can endanger human health and environmental quality. The following is a brief discussion of applicator safety when using pesticides.

For more information, consult the Core Manual, which addresses personal safety throughout. In particular, Unit 7 (Harmful Effects and Emergency Response) and Unit 8 (Personal Protective Equipment) cover human health and safety issues. Refer to these units for detailed information on pesticide injury, response to a poisoning emergency, first aid, and protective clothing. Unit 8 also has guidelines on how to clean and maintain your PPE.

Health Effects

People can be exposed to pesticides in two major ways: acute exposure and chronic exposure.

Acute exposure is a single mishap with a pesticide, such as splashing the pesticide concentrate into your mouth or eyes during mixing. It can include spilling or spraying a pesticide onto your clothing, face, or body. Usually, symptoms begin quickly (within 24 hours).

Chronic exposure is repeated contact with low levels of pesticides over a long period (usually several years). Delayed health problems may follow. Exposure usually results from inadequate protective clothing or equipment. Causes include re-wearing tainted clothes, not bathing, or working in a contaminated area without the proper PPE.

LD50

The term “LD 50 “ expresses the level of toxicity of a chemical. “LD” means lethal dose. LD 50 is the dose, based on weight, that will kill 50% of a population of test animals. The higher the LD50 value, the less acutely toxic the chemical. This value is usually expressed as milligrams/kilogram of body weight. A chemical with an LD 50 of 5,000 mg/ kg requires about 0.1 ounce of the chemical per pound of body weight to reach the LD 50 value. For a 150-pound person, this would be about 15 ounces.

The labels on pesticide products have “signal words” to convey the degree of toxicity of the product. Signal words also may tell you whether the product is caustic (burns) or is an environmental hazard. They are as follows:

- CAUTION: Slightly toxic.
- WARNING: Moderately toxic.
- DANGER: Highly toxic or hazardous in some manner. (The labels of these pesticides may or may not show the skull and crossbones symbol.)

Acute oral exposure refers to a single dose taken by mouth (ingested). Acute dermal exposure means a single dose touching the skin or eyes (skin absorption). Acute inhalation exposure is an intake of a breath of contaminated air. This type of exposure may pose a significant risk to chemigators, especially when using soil fumigants.

Cautions and Common Sense

Some pesticides have such low toxicity that it takes a large (or long) exposure to cause illness, if at all. However, some people are more sensitive than others to certain chemicals. Even low-toxicity chemicals can irritate the nose, throat, eyes, and skin of some people. Know how to protect yourself and everyone around you from exposure to all pesticides.
Route of Entry

Pesticide product labels include “route of entry” statements. These explain how the chemical(s) may enter your body. The label will also explain how to avoid pesticide exposure and what parts of the body are most at risk. For example, a route of entry statement might read, “Poisonous if swallowed, inhaled, or absorbed through the skin. Rapidly absorbed through the skin and eyes.” This tells you that the pesticide can enter your body orally, dermally, and by inhalation. It also tells you that your skin and eyes are especially at risk.

Regardless of their toxicity, use pesticides carefully. Before you buy, handle, mix, or apply any pesticide, read the label carefully. If the label tells you to use protective clothing or equipment, then do so. As a pesticide applicator, the law requires you to obtain and use the safety equipment listed on the label.

Personal Protective Equipment

The pesticide label will specify what protective clothing you need. At the minimum, follow these guidelines:

- Wear a long-sleeved shirt and long-legged trousers. Or, you can wear coveralls that fully cover your arms and legs.

- Wear shoes and socks. Avoid sandals, thongs, and cloth or canvas shoes. When working with highly toxic pesticides, wear chemical-resistant boots. Leather footwear is a poor choice since leather readily absorbs liquids. If contaminated, leather shoes and boots should be discarded.

- Wear a hat with a wide brim that is easy to clean. This will keep pesticides away from your neck, eyes, mouth, and face. Avoid hats with cloth or leather sweatbands because these will absorb pesticides.

- Wear goggles or a face shield. Goggles will help protect your eyes, but a face shield is recommended.

- Wear gloves when handling pesticides. Choose unlined, chemical-resistant (ex. neoprene or nitrile) gloves that extend well up the forearm. In most cases, wear the gloves under your shirtsleeves to keep pesticide from leaking into the glove. Avoid handling pesticides above your shoulders.

In the next unit, you will learn about the basic types of irrigation systems and equipment used for chemigation.