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Federal Laws

The primary focus of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was to provide federal control of pesticide distribution, sale, and use. The Environmental Protection Agency (EPA) was given authority under FIFRA not only to study the consequences of pesticide usage but also to require users (farmers, utility companies, and others) to register when purchasing pesticides.

Through later amendments to the law, users also must take exams for certification as applicators of pesticides. All pesticides used in the U.S. must be registered (licensed) by EPA. This assures that pesticides will be properly labeled and that if in accordance with specifications, will not cause unreasonable harm to the environment.

Penalties Under FIFRA

If you violate FIFRA, or regulations issued under it, you are subject to civil penalties. Penalties can be as much as $1,000 for each offense for private applicators ($5,000 for commercial applicators). Before EPA can fine you, you have the right to ask for a hearing in your own city or county.

Some violations of the law also may subject you to criminal penalties. These can be as much as $1,000 and/or 30 days in prison for private applicators ($25,000 or 1 year in prison, or both, for commercial applicators). States may establish higher penalties.

Residues and Tolerances

Any pesticide that remains in or on food or feed is called a **residue**. A long-lasting residue is sometimes desirable for long-term pest control. Residues that remain in food or feed at harvest or slaughter, however, are carefully monitored to avoid hazards to the humans and domestic animals that will eat them.

A **tolerance** is the maximum amount of pesticide residue that may legally remain on or in treated crops and animals (and animal products, such as milk or eggs) that are to be sold for food or feed. The Federal government sets residue tolerances for all pesticides used in the production of crop and animal products intended for food or feed, and for pesticides applied after harvest.

Federal agencies monitor food and feed products for tolerance violations. Any products that exceed the tolerances may be condemned and seized, and violators may be prosecuted.

A pesticide applicator cannot measure residues on crops and livestock, because such measurements require highly specialized equipment and techniques. **Only by following labeling instructions** can you be sure that treated products will have residues well below tolerance level when marketed. Especially important are instructions on correct application rate and on minimum days between the pesticide application and harvest, slaughter, freshening, or grazing.

Worker Protection Standard

The EPA's Worker Protection Standard (WPS) (as revised in 1992) must be complied with when pesticide products are used on agricultural establishments (farms, forests, nurseries, and greenhouses) for the commercial or research production of agricultural plants. The Worker Protection Standard (WPS) requires employers to provide agricultural workers and pesticide handlers with protections against possible harm from pesticides.

Persons who must comply with these instructions include owners/operators of the agricultural establishment and owners/operators of commercial businesses that are hired to apply pesticides on the

agricultural establishment or to perform crop-advising tasks on such establishments.

You and any family members who work on your agricultural or commercial pesticide establishment are considered "employees" in many situations and must receive some of the required protections.

Some of the basic requirements the WPS establishes for employers include:

Displaying information about pesticide safety, emergency procedures, and recent pesticide applications on an agricultural establishment.

Training workers and handlers about pesticide safety.

Helping employees get **medical assistance** in case of a work-related pesticide emergency.

Setting up **decontamination sites** for washing pesticide residues off hands and body.

Compliance with **restricted-entry intervals** – the time immediately after a pesticide application when workers may not enter the treated area.

Notifying workers (through posted and/or oral warnings) about areas where applications are taking place and areas where restricted-entry intervals are in effect.

Allowing only trained and equipped pesticide handlers to be present during a pesticide application.

Providing **personal protective equipment** for pesticide handlers, and also for workers who enter pesticide-treated areas before expiration of the restricted-entry interval (in the few very limited circumstances permitted by the WPS).

Protecting pesticide handlers by giving them safety instructions about the correct use of personal protective equipment and mixing, loading, and application equipment; inspecting and maintaining equipment they will be using; and monitoring them in hazardous situations.

For detailed information about your responsibilities under the WPS, get a copy of EPA's manual "Worker Protection Standard for Agricultural Pesticides – How To Comply." It will tell you what you need to do to be in compliance with the Federal worker protection requirements.

Kentucky Laws and Regulations

The Kentucky Fertilizer and Pesticides Storage, Pesticide Use and Application Act of 1996 (KRS 217b) and appropriate administrative regulations are administered by the Kentucky Department of Agriculture (KDA), Division of Environmental Services, Pesticide Regulation

107 Corporate Drive
Frankfort, KY. 40601
Toll Free (866) 289-0001

Web Page – Pesticide Regulation
www.kyagr.com/enviro_out/pesticide/index.htm

Definitions (From KRS 217b – Kentucky Fertilizer and Pesticide Use and Application Act 1996)

Pest – any insect, snail, slug rodent, nematode, fungus, weed; or any other form of plant or animal life or virus, bacteria, or other microorganism, except viruses, bacteria, or other microorganisms on or in living man or other living animals, which is normally considered to be a pest, or which the department declares to be a pest.

Pesticide – any substance or mixture of substances intended to prevent, destroy, control, repel, attract, or mitigate any insect pest; OR any substance or mixture of substances intended to be used as a plant regulator, defoliant, or desiccant; OR any substance or mixture of substances intended to

be used as a spray adjuvant, once they have been mixed with an EPA-registered product.

Commercial pesticide applicator – any individual employed by a pesticide operator to apply pesticides.

Commercial pesticide operator – any individual who owns or manages a pesticide application business that is engaged in the business of applying pesticides on the lands of another.

Non-commercial applicator - any individual employed by golf courses, municipal corporations, public utilities, or other governmental agencies making applications of pesticides to lands owned, occupied or managed by his or her employer.

Private pesticide applicator is a person certified to use any pesticide for purposes of producing any agricultural commodity on property owned or rented by him/her or an employer, or to the lands of a farmer-neighbor, if applied without compensation other than trading of personal services between producers of agricultural commodities.

Dealer – any person that engages in the storage of bulk fertilizer or a restricted use pesticide for the purpose of redistribution or direct resale, or engages in the business of applying any pesticide to the lands of others. A dealer shall not include a manufacturer of a restricted use pesticide or a fertilizer who distributes his or her product solely to a dealer.

Pesticide sales agent - an individual who sells or distributes restricted use pesticides or an individual who sells and makes recommendations for the use or applications pesticides to the final user.

Training for Certified Pesticide Applicators

The Kentucky Cooperative Extension Service provides training materials and educational programs for certification of private and commercial applicators through the Pesticide Safety Education Program.

This manual is provided as a reference for pesticide applicators because all of the information cannot be provided in a single training program.

Certified Private Pesticide Applicator

Private applicators are certified through training programs conducted at the county extension office. Certification is valid for 3 years and expires on December 31 of the final year. Applicators attend a training session to become certified again. Trained applicators receive a yellow card with a unique number. This card must be shown to a dealer when purchasing Restricted Use pesticides.

Minimum Standards for Applicators

(Taken from Code of Federal Regulations Part 40 Protection of Environment)

- Have a practical knowledge of common pests to be controlled and the damage caused by them.
- Be able to read and understand the label and labeling information including- common name of the pesticide applied, pests to be controlled, timing and methods of application, safety precautions, any pre-harvest or re-entry restrictions and any specific disposal procedures.
- Know how to apply pesticides in accordance with the label instructions and warnings, be able to prepare proper concentrations and calibrate application equipment.
- Recognize local environmental situations that must be considered during application to avoid contamination.
- Be able to recognize poisoning symptoms and procedure to follow in case of a pesticide accident.

Testing of Certified Commercial and Non-Commercial Pesticide Applicators

Commercial and non-commercial pesticide applicators **must be both certified and licensed**. This is accomplished by passing (70%) a written competency / licensing examination administered by the KDA. The examination includes general information from this manual and questions from the appropriate category specific manual.

There is a certification examination fee of twenty-five dollars ($25). For persons testing in multiple categories, there is a fee of ten dollars ($10) for each additional category.

After passing an examination, you have ninety (90) days from the date of testing to activate the license(s) requested. Otherwise, you will have to take the test again.

C**ommercial and non-commercial certifications** are **valid for 3 years**. Certification expires on December 31 of the final year.

The **license**, which expires on December 31, is **valid for one year** and must be renewed annually. Applicators who do not renew the licenses must take the examination again.

Categories of Commercial and Non-commercial applicators

Category 1. Agricultural pest control. This category has two subcategories:

1a Plant and animal. – applying pesticides in production of agricultural commodities including, but not limited to, tobacco, feed grains, soybeans and forage, vegetables, small fruits, tree fruits and nuts, as well as on grasslands, non-crop agricultural lands, and greenhouses, and the application of pesticides on animals and to places on or in which animals are confined.

1b Agricultural fumigation – applying pesticide gases or fumigants in an enclosed area used for the production, storage, or transportation of agricultural commodities, or to the contents of any structure used for the production, storage, or transportation of agricultural commodities; and any other application of a pesticide gas or fumigant in preparing land for production or in controlling pests in growing agricultural commodities, whether agricultural commodities are indoors or outdoors.

Category 2. Forest pest control - applying pesticides in forests, forest nurseries, and forest seed-producing areas.

Category 3. Ornamental and lawn care - applying pesticides or fertilizer to control insects, weeds, and diseases in residential and commercial lawns, and maintenance of ornamental trees, shrubs and flowers, including the control of pests that do not normally invade structures, such as bagworms, grubs, and moles. Certification in this category does not qualify an applicator to make applications to sports turf or golf courses.

Category 4. Seed treatment - applying pesticides on seeds.

Category 5. Aquatic pest control - applying pesticides to standing or running water, excluding applicators engaged in public health-related activities.

Category 6. Right-of-way pest control - applying pesticides in the maintenance of public roads, electric powerlines, pipelines, railway rights-of-way, or other similar areas.

Category 7. Industrial, institutional, structural, and health-related pest control – applying pesticides for structural pests only, in, on, or around food-handling establishments, human dwellings, educational facilities, health care centers, industrial establishments, including warehouses and grain elevators and any other structures and adjacent areas, public or private; and for the protection of stored, processed, or manufactured products.

Industrial, institutional, structural, and health-related pest control certification shall be divided into the following subcategories:

7a Structural pest control covers the use of pesticides to control general pests and wood-destroying organisms by all means other than fumigation.

7b Integrated pest management covers an environmentally- sound approach to pest management in schools and health care facilities with the goal of the judicious use of pesticides.

7c Structural fumigation covers the use of pesticides in the form of poisonous gases.

Category 8. Public health pest control – for state, federal, or other government employees using pesticides in management and control of pests in public health programs.

Category 9. Regulatory pest control - for state, federal, or other government employees who apply pesticides to control regulated pests.

Category 10. Demonstration and research pest control – those who demonstrate to the public the proper uses and techniques of applying pesticides. Includes extension specialists and agents, individuals demonstrating methods used in public programs, and persons conducting field research with pesticides, and in so doing, apply or supervise the application of pesticides. This group includes state and federal employees and other persons conducting field research on pesticides.

Category 11 – Aerial applicator - applying pesticides to lands of another using aircraft.

Category 12 - Pesticide sales agent – persons who sell or distribute restricted use pesticides or any individuals who sell and makes recommendations for the use and application of pesticides to the final user. Persons taking orders or explaining service programs without naming or making recommendations shall be excluded from certification, if the person selling or distributing pesticides is licensed as a pesticide sales agent.

Category 13 - Antifouling marine paint – applying paint mixed with a pesticide to prevent the growth of pests, both plant and animal, to a product to be used in lakes, rivers, and waterways.

Category 14 - Pest control consultant - persons, who for a fee, offer or supply technical advice, supervision, or aid, or recommend the use of specific pesticides for the purpose of controlling insect pest, plant diseases, weeds, and other pests.

Category 15. Antimicrobial pest control - applying pesticides to control bacteria, mold, or fungi to or through any medium. Water and waste water treatment plant operators shall be included in this category. Homeowners applying pesticides to personal swimming pools, and persons certified in Category 1 of this chapter are excluded from this category.

Category 16. Sewer root control - applying pesticides into the sewer or sewer system to control the ingress of roots or any other blockage of the system.

Category 17. Wood preservatives - applying pesticides to wood and wood products to protect from wood-destroying organisms. Excluded from this category are persons engaged in structural pest control.

Category 18. Golf course pest control - applying pesticides or fertilizer to land on which turf and ornamental care is done for the purpose of preparing the land for use in the game of golf.

Category 19. Interior Plantscape Pest Control - using pesticides to control insects, weeds, and diseases in or on interior plantscapes, regardless of who owns the plants.

Category 20 Sports turf pest control - applying pesticides to control insects, weeds, and diseases to or on turf on which sports activities occur. Certification in this category does not qualify an applicator to make applications to golf courses.

How Commercial / Non-commercial Applicators Stay Certified

1) Renew your license annually.

2) Commercial and non-commercial applicators maintain their certification by earning 12 Continuing Education Units (CEUs) during the 3-year certification period. A unit is 50 minutes of training approved by the Division of Environmental Services. The 12 CEU credits must include 9 general units and 3 category specific units.

A list of approved training meetings for all categories can be seen from the **Division of Environmental Services – Pesticides** web page at

www.kyagr.com/enviro_out/pesticide/index.htm

The **UK Pesticide Safety Education Program** web page provides important information for all applicators:

www.uky.edu/Agriculture/PAT/welcome.htm

The **KY Pest News** newsletter is written by UK College of Agriculture Entomology, Plant Pathology and Weed Science Cooperative Extension Specialists. It provides information on a variety of pests including insects, diseases and weeds. The newsletter is published weekly during the peak growing season and bi-weekly the remainder of the year. It is available at:

www.uky.edu/Agriculture/kpn/kpnhome.htm

Pest management information is accessible from the **UK IPM Program** web page at:

www.uky.edu/Agriculture/IPM/ipm.htm

1 - Principles of Pest Control

Pests

Interactions between pests and humans, plants, or animals can cause a variety of problems including competition for food and water; injury to plants, property, or animals; spread of diseases; or nuisance or annoyance.

> An organism should not be considered to be a pest until it is proven to be one. Most organisms are not pests. A species may be a pest in some situations and not in others.

Insects and their relatives (arthropods) - roaches, termites, mosquitoes, aphids, beetles, fleas, and caterpillars, AND mites, ticks, and spiders, etc.

Microbial organisms - bacteria, fungi, nematodes, viruses, etc.

Weeds - any plants growing where they are not wanted.

Mollusks - snails and slugs.

Vertebrates - rats, mice, other rodents, birds, fish, and snakes.

Kinds of Pests

Key pests are nearly always present and require regular control.

Occasional pests reaching damaging levels only in some years or under special conditions.

Pest Identification

Accurate identification is the first step in an effective pest management program. It is the key to all kinds of information about the pest, including its life cycle, behavior, and effective management recommendations. Incorrect pest identification is a leading cause of pest control failures and improper use of pesticides.

Your county Cooperative Extension Service office can help with pest identification and control recommendations. Diagnostic labs in plant disease, insect, and weed identification are available along with help in determining how to take useful samples. Most of these services are free.

WEEDS

Any plant can be considered a weed when it is growing where it is not wanted. Weeds become a problem when they reduce crop yields, increase costs of production, and reduce the quality of crop and livestock products. In addition, some weeds cause allergic effects, such as skin irritation and hay fever, and some are poisonous to people and livestock. Weeds also spoil the beauty of turf and landscape plantings.

Weeds harm desirable plants by: competing for water, nutrients, light, and space, contaminating the product at harvest, harboring pest insects, mites, vertebrates, or plant disease agents, and releasing toxins into the soil that inhibit growth of desirable plants.

Weeds may become pests in water by: hindering fish growth and reproduction, promoting mosquito production, hindering boating, fishing, and swimming, and clogging irrigation ditches, drainage ditches, and channels.

Weeds can interfere in the production of grazing animals by: poisoning the animals, and causing an "off-flavor" in milk and meat.

In cultivated crops, the weeds usually found are those that are favored by the crop production practices. The size and kind of weed problem often depends more on the crop

production method, especially the use or nonuse of cultivation, than on the crop species involved.

In noncrop areas, weed populations may be affected by factors such as: weed control programs used in the past, frequency of mowing or other traffic in the area, and susceptibility to herbicides.

Development Stages

All crop plants have four stages of development: 1) **Seedling** – small, delicate plantlets. 2) **Vegetative** – fast growth; production of stems, roots, and leaves. Uptake and movement of water and nutrients is fast and thorough. 3. **Seed production** – energy directed to producing flowers and seed. Uptake of water and nutrients is slow and is directed mainly to flower, fruit, and seed structures. 4. **Maturity** – little or no energy production or movement of water and nutrients.

Life Cycles Of Plants

Plants with a 1-year life cycle are **annuals**. They grow from seed, mature, and produce seed for the next generation in 1 year or less. They are grasslike (crabgrass and foxtail) or have broad leaves (henbit and common cocklebur).

There are two types: **Summer annuals** are plants that grow from seeds that germinate in the spring. They grow, mature, produce seed, and die before winter. Examples: crabgrass, foxtail, common cocklebur, pigweed, and common lambsquarters. **Winter annuals** are plants that grow from seeds that germinate in the fall. They grow, mature, produce seed, and die before summer. Examples: cheat, henbit, and annual bluegrass.

Plants with a 2-year life cycle are **biennials**. They grow from seed and develop a heavy root and compact cluster of leaves (called a rosette) the first year. In the second year, they mature, produce seed, and die. Examples: mullein, burdock, and bullthistle.

Plants that live more than 2 years are **perennials**. Some perennial plants mature and reproduce in the first year and then repeat the vegetative, seed production, and maturity stages for several following years. In other perennials, the seed production and maturity stages may be delayed for several years. Some perennial plants die back each winter; others, such as deciduous trees, may lose their leaves, but do not die back to the ground.

Most perennials grow from seed; many species also produce tubers, bulbs, rhizomes (below-ground rootlike stems), or stolons (above-ground stems that produce roots). Examples of perennials are Johnsongrass, field bindweed, dandelion, and plantain.

Simple perennials normally reproduce by seeds. However, root pieces that may be left by cultivation can produce new plants. Examples: dandelions, plantain, trees, and shrubs.

Bulbous perennials may reproduce by seed, bulblets, or bulbs. Wild garlic, for example, produces seed and bulblets above ground and bulbs below ground.

Creeping perennials produce seeds but also produce rhizomes (below-ground stems) or stolons (above-ground stems that produce roots). Examples: Johnson grass, field bindweed, and Bermuda grass.

Weed Classification

Most weeds are grasses, sedges, or broadleaf plants.

Grass seedlings have only one leaf as they emerge from the seed. Their leaves are generally narrow and upright with parallel veins. Grass stems are round and may be either hollow or solid. Most grasses have fibrous root systems. The growing point on seedling grasses is sheathed and located below the soil surface. Some grass species are annuals; others are perennials.

Sedges are similar to grasses except that they have triangular stems and three rows of leaves. They are often listed under grasses on the pesticide label. Most sedges are found in wet places but principal pest species are found in fertile, well-drained soils. Yellow and purple nutsedge are perennial weed species that produce rhizomes and tubers.

The seedlings of **broadleaf weeds** have two leaves as they emerge from the seed. Their leaves are generally broad with netlike veins. Broadleaf weeds usually have a taproot and a relatively coarse root system. All actively growing broadleaf plants have exposed growing points at the end of each stem and in each leaf axil. Perennial broadleaf plants may also have growing points on roots and stems above and below the surface of the soil. Broadleaves contain species with annual, biennial, and perennial life cycles.

Parasitic seed plants, Dodders, broomrape, witchweed, and some mosses are important weeds on some agricultural plants. They live on and get their food from the host plants. They can severely stunt and even kill the host plants by using the host plant's water, food, and minerals. These plants reproduce by seeds. Some can also spread from plant to plant in close stands by vining and twining.

Weed Control Strategy

Weed control is nearly always designed to **prevent** or **suppress** a weed infestation. Eradication usually is attempted only in regulatory weed programs and in relatively small, confined areas, such as greenhouses or plant beds.

To control weeds that are growing among or close to desirable plants, you must take advantage of the differences between the weeds and the desired species. Be sure that the plants you are trying to protect are not susceptible to the weed control method you choose. Generally, the more similar the desirable plant and the weed species are to one another, the more difficult weed control becomes. For example, broadleaf weeds are usually more difficult to control in broadleaf crops, and grass weeds are often difficult to control in grass crops.

A plan to control weeds may include: biological control, cultural control, sanitation, and chemical control.

Chemical Control

Some weed problems can best be controlled with the use of herbicides.

Several factors affect a plant's susceptibility to herbicides: Growing points that are sheathed or located below the soil surface are not reached by contact herbicide sprays. Leaf shape - herbicides tend to bounce or run off narrow, upright leaves. Broad, flat leaves tend to hold the herbicide longer. Sprays applied to leaves may be prevented from entering by a thick, waxy cuticle. The waxy surface also may cause a spray solution to form droplets and run off the leaves.

A dense layer of leaf hairs holds the herbicide droplets away from the leaf surface, allowing less chemical to be absorbed into the plant. A thin layer of leaf hairs causes the chemical to stay on the leaf surface longer than normal, allowing more chemical to be absorbed into the plant.

Young, rapidly growing plants are more susceptible to herbicides than are larger, more mature plants.

Deactivation certain plants can stop the action of herbicides and so are less susceptible to injury from these chemicals. Such plants may become dominant over a period of time if similar herbicides are used repeatedly.

Stage in life cycle -Seedlings are very susceptible to herbicides and to most other weed control practices. Plants in the vegetative and early bud stages are generally very susceptible to translocated herbicides. Plants with seeds or in the maturity stage are the least

susceptible to most chemical weed control practices.

Herbicides

Just as there are many types of weeds, there also are many kinds of herbicides. They work in several different ways to control weeds. Some herbicides are applied to the leaves and other above-ground parts of the plant (foliar applications) and some are applied to the soil.

Contact/Translocated

Some herbicides kill plants on contact; others work by translocation (moving throughout the plant's system).

Contact herbicides kill only the parts of the plant the chemical touches. They usually are used to control annuals and biennials and are characterized by the quick dieback they cause.

Translocated herbicides are absorbed by roots or leaves and carried throughout the plant. Translocated herbicides are particularly effective against perennial weeds, because the chemical reaches all parts of the plant – even deep roots and woody stems. Translocated herbicides may take longer than contact herbicides to provide the desired results. Control may take as much as 2 or 3 weeks – even longer for woody perennials.

Selective/Nonselective

Selective herbicides are used to kill weeds without causing significant damage to desirable plants nearby. They are used to reduce weed competition in crops, lawns, and ornamental plantings.

Nonselective herbicides, if applied at an adequate rate, will kill all plants in the area. They are used where no plant growth is wanted, such as fence rows, irrigation and drainage ditch banks, and greenhouse floors and benches.

Factors affecting selectivity

Herbicide selectivity may vary according to the application rate. High rates of selective herbicides usually will injure all plants at the application site. Some nonselective herbicides can be used selectively by applying them at a lower rate.

Other factors that affect selectivity include the time and method of application, environmental conditions, and the stage of plant growth.

Persistent/Nonpersistent

Pesticides that quickly break down after application are called **nonpersistent**. These pesticides are often broken down easily by microorganisms or sunlight. A nonpersistent herbicide performs its control function soon after application and then is no longer active against weeds.

The chemical structure of **persistent herbicides** does not change for a long time after application. Persistent herbicides may stay on or in the soil and give long-term weed control without repeated applications. If sensitive plants are later planted in the treated area, these herbicides may injure them. Persistent herbicides are sometimes called "residual" herbicides.

Chemicals That Change Plant Processes

Plant growth regulators, defoliants, and desiccants are classified as pesticides in Federal laws. These chemicals are used on plants to alter normal plant processes in some way. Overdosing will kill or seriously damage the plants.

A plant growth regulator will speed up, stop, retard, prolong, promote, start, or in some other way influence vegetative or reproductive growth of a plant. These chemicals are sometimes called growth regulators or plant regulators. They are used, for example, to thin apples, control suckers on tobacco, control the height of some floral potted plants, promote

dense growth of ornamentals, and stimulate rooting.

A defoliant causes the leaves to drop from plants without killing the plants. A desiccant speeds up the drying of plant leaves, stems, or vines. Desiccants and defoliants are often called "harvest aid" chemicals. They usually are used to make harvesting of a crop easier or to advance the time of harvest. They are often used on cotton, soybeans, tomatoes, and potatoes.

ARTHROPODS

This group of invertebrate animals is characterized by having a hard external skeleton and segmented legs and bodies. They include insects, spiders, scorpions, millipedes, centipedes, ticks, and mites.

There are more kinds of **insects** on earth than all other living animals combined. They can be divided into three categories according to their importance to people:

Ecologically important– About 99 % of all species are in this category. They don't directly help or harm people, but they are crucial in the food web. They are food for birds, fish, mammals, reptiles, amphibians, aquatic life, and other insects. Some remove animal wastes and dead plants and animals, returning nutrients to the environment.

Beneficial insects – A small but important group are the predators and parasites that feed on harmful insects, mites, and weeds. Examples are ladybird beetles, some bugs, ground beetles, tachinid flies, praying mantids, and many tiny parasitic wasps. Also in this category are the pollinating insects, such as bumblebees and honeybees, some moths, butterflies, and beetles.

Destructive insects – feed on, cause injury to, or transmit disease to people, animals, plants, food, fiber, and structures. This category includes, for example, aphids, beetles, fleas, mosquitoes, caterpillars, and termites.

Physical Characteristics

All adult insects have two physical characteristics in common. They have three pairs of jointed legs, and they have three body regions – the head, thorax, and abdomen.

The **head** has antennae, eyes, and mouthparts. Antennae vary in size and shape and can be a help in identifying some pest insects. Insects have compound eyes made up of many individual eyes. These compound eyes enable insects to detect motion, but they probably cannot see clear images.

The four general types of mouthparts are: chewing, piercing-sucking, sponging, and siphoning.

Chewing mouthparts contain toothed jaws that bite and tear. Cockroaches, ants, beetles, caterpillars, and grasshoppers are in this group.

Piercing-sucking mouthparts consist of a long slender tube that is forced into plant or animal tissue to suck out fluids or blood. Insects with these mouthparts include stable flies, sucking lice, bed bugs, mosquitoes, true bugs, and aphids.

Sponging mouthparts are tubular tongue-like structures with a spongy tip to suck up liquids or soluble food. This type of mouthpart is found in flesh flies, blow flies, and house flies.

Siphoning mouthparts are formed into a long tube for sucking nectar. Butterflies and moths have this type.

The **thorax** contains the three pairs of legs and (if present) the wings. The various sizes, shapes, and textures of wings and the pattern of the veins can be used to identify insect species. The forewings take many forms. In the beetles, they are hard and shell-like; in the grasshoppers, they are leathery. The forewings of flies are membranous; those of true bugs are

part membranous and part hardened. Most insects have membranous hindwings. The wings of moths and butterflies are membranous but are covered with scales.

The abdomen is usually composed of 11 segments, but 8 or fewer segments may be visible. Along each side of most of the segments are openings (called spiracles) through which the insect breathes. In some insects, the tip end of the abdomen has tail-like appendages.

Life Cycles of Insects

Most insect reproduction results from the males fertilizing the females. A few insects give birth to living young; however, life for most insects begins as an egg.

Temperature, humidity, and light are some of the major factors influencing the time of hatching. Eggs come in various sizes and shapes: elongate, round, oval, and flat. Eggs of cockroaches, grasshoppers, and praying mantids are laid in capsules. Eggs may be deposited singly or in masses on or near the host – in soil or water or on plants, animals, or structures.

The series of changes through which an insect passes in its growth from egg to adult is called **metamorphosis**.

When the young first hatches from an egg, it is called either a larva (complete metamorphosis) or a nymph (incomplete metamorphosis). After feeding for a time, the young grows to a point where the skin cannot stretch further; the young sheds its skin (molts) and new skin is formed.

The number of these developmental stages (called instars) varies with different insect species and, in some cases, may vary with the temperature, humidity, and food supply. The heaviest feeding generally occurs during the final two instars.

The mature (adult) stage is when the insect is capable of reproduction. Winged species develop their wings at maturity. In some species, mature insects do not feed, and in some species the adults do not feed on the same material as the immature forms.

No metamorphosis

Between hatching and reaching the adult stage, some insects do not change except in size. Examples are silverfish, firebrats, and springtails. The food and habitats of the young (called nymphs) are similar to those of the adult.

Gradual metamorphosis

Insects in this group pass through three different stages of development before reaching maturity: egg, nymph, and adult. The nymphs resemble the adult in form, eat the same food, and live in the same environment. The change of the body is gradual, and the wings become fully developed only in the adult stage. Examples are cockroaches, boxelder bugs, lice, termites, aphids, and scales.

Complete metamorphosis

The insects with complete metamorphosis pass through four stages of development: egg, larva, pupa, and adult. The young, which may be called larvae, caterpillars, maggots, or grubs, are entirely different from the adults. They usually live in different situations and in many cases feed on different foods than adults. Examples are the beetles, butterflies, flies, mosquitoes, fleas, bees, and ants.

Larvae hatch from the egg. They grow larger by molting and passing through one to several instar stages. Moth and butterfly larvae are called caterpillars; some beetle larvae are called grubs; most fly larvae are called maggots. Caterpillars often have legs; maggots are legless. Weevil grubs are legless; other kinds of beetle larvae usually have three pairs of legs.

The pupa is a resting stage during which the larva changes into an adult with legs, wings, antennae, and functional reproductive organs. Some insects form a cocoon during this stage.

Insect Relatives

Some other kinds of pest organisms – such as mites, ticks, spiders, sowbugs, pillbugs, centipedes, millipedes, nematodes, and mollusks – are similar to insects in many ways. Most of these pests resemble insects and have similar life cycles; all of them cause similar damage and usually can be managed with the same techniques and materials used to manage insects.

Arachnids

Mites, ticks, spiders, and scorpions have eight legs and only two body regions. They are wingless and lack antennae. The metamorphosis is gradual and includes both larval and nymphal stages. Eggs hatch into larvae (six legs) that become nymphs (eight legs) and then adults. Ticks and mites have modified piercing-sucking mouthparts; spiders and scorpions have chewing mouthparts.

Crustaceans

Sowbugs and pillbugs, water fleas, and wood lice have 10 or more legs. They are wingless and contain only one segmented body region. They have two pairs of antennae and chewing mouthparts. Sowbugs and pillbugs have a hard, protective shell-like covering and are related to the aquatic lobsters, crabs, and crayfish. The metamorphosis is gradual, and there may be up to 20 instars before adulthood is reached.

Centipedes and Millipedes

Centipedes have one pair of legs per segment. They have chewing mouthparts. Some species can inflict painful bites.

Millipedes have two pairs of legs per segment and are cylindrical like an earthworm. The body is wingless. The antennae are short and mouthparts are comb-like. Millipedes feed on decaying organic matter, seeds, bulbs, and roots.

There is no metamorphosis; centipedes and millipedes do not change except in size between hatching and reaching the adult stage.

Mollusks

Mollusks are a large group of land and water animals including slugs, oysters, clams, barnacles, and snails. They have soft, unsegmented bodies and often are protected by a hard shell. ***Snails and slugs*** – Land snails and slugs are soft-bodied and have two pairs of antennae-like structures. Their bodies are smooth and elongated. Snails have a spiral-shaped shell into which they can completely withdraw for protection when disturbed or when weather conditions are unfavorable. Slugs do not have a shell and must seek protection in damp places. Snails and slugs deposit eggs in moist, dark places. The young mature in a year or more, depending on the species. Adults may live for several years. They overwinter in sheltered areas. They are active all year in warm regions and in greenhouses.

Damage Caused By Insects and Insect-Like Pests

Insects, ticks, mites, and mollusks, damage plants, animals, and structures in many ways. The damage may provide clues to the identity of the pest.

Even though pests are present, the level of damage they are causing may not be of enough economic importance to warrant control measures. The potential for harm may be greater at some times than others. For example, insects that damage leaves in the spring are usually more harmful to a plant than insects that damage leaves in the late summer when the plant is already about to lose its leaves.

Pests of Plants

Some insects and insect-like pests feed on plant leaves. For many plants, the loss of a few leaves will not cause reduced yield. But when pests remove most or all of the leaves from a plant, the plant is killed or is left stunted and unproductive. The larval stage (caterpillars) of some butterflies and moths can cause costly damage. Examples include gypsy moths that feed on trees and imported cabbageworms that feed on cabbage leaves. Some beetles are also leaf- eating pests, including the Colorado potato beetle and the Mexican bean beetle.

Snails and slugs feed on plants at night. They tear holes in foliage, fruits, and soft stems, using a rasp-like tongue. They may eat entire seedlings. As they move, snails and slugs leave a slime-like mucous trail that dries into silvery streaks. These streaks are undesirable on floral and ornamental crops and on the parts of crops that are to be sold for human food.

Some insects bore into develop inside fruit, grain, or other plant parts. Usually the larval stage causes the damage during feeding. Because they are inside the plant, these pests often cause significant damage before they are detected. They are also more difficult to control when they are inside the plant. Internal feeders include boll weevils, rice weevils, birch leaf miners, and codling moths.

The larval stage of some insects and insect-like pests bore into stalks or stems. This harms the plant by weakening the stalk or stem and by preventing water and food from flowing freely within the plant. Weakened plants may blow over or wilt as a result of the damage. Examples of these borers include European corn borers, squash vine borers, and dogwood borers.

Some insects and insect-like pests have sucking mouthparts that allow them to suck juices from plants. The activity of these pests can lead to curling and stunting of leaves and stems; wilting caused by blockage of water-conducting tissues; and dead areas caused by toxins the pest injects during feeding.

As they feed, plant-sucking pests may also spread plant disease organisms. Some plant diseases can be controlled by controlling the insect pests that cause their spread.

While they suck on the plants, aphids and similar insects excrete honeydew that drips onto the lower parts of the plant. A fungus that causes a black sooty mold often grows on this sticky material.

Other examples of plant-sucking pests are stink bugs and squash bugs.

Underground feeders

Many insects and insect-like pests cause damage by feeding on plant roots. Root-feeding pests interfere with the plant's water and nutrient uptake. They can cause dead spots in turf grass, "goose-necking" in corn, and poor color, stunting, and loss of vigor in a wide range of crops. Some underground feeders are the larval stage of insects. They include white grubs, corn rootworm, and many kinds of fly maggots. Underground pests are often difficult to identify, because they cannot be seen without uprooting the plants.

Pests of Humans and Animals

The insects, ticks, mites, and similar pests that attack people and other animals have mouthparts similar to those of the plant feeders, but they suck blood and animal fluids rather than plant fluids.

Mosquitoes, lice, and ticks are bloodsucking pests. Cattle grubs, the ox warble of cows, and the bot fly of horses are internal feeding insects. Face flies, house flies, and gnats annoy and cause discomfort.

Some insects and insect-like pests inject disease-causing organisms, such as bacteria, viruses, and other parasites, into the animals they are feeding on. In the United States,

mosquitoes carry encephalitis and ticks carry Rocky Mountain spotted fever and Lyme disease.

Pest Control Strategy

Control of insects and similar pests may involve any of the three basic pest control objectives. Control is usually aimed at **suppression** of pests to a point where the presence or damage level is acceptable. **Prevention** and **eradication** are useful only in relatively small, confined areas or in programs designed to keep foreign pests out of a new area.

To successfully control insects and insect-like pests, you need a thorough knowledge of their habitats, feeding habits, and life cycle stages.

Environmental conditions, such as humidity, temperature, and availability of food, can affect the length of the life cycle by altering the growth rate of the insects. A favorable environment (usually warm and humid) can shorten the time of development from egg to adult.

You must carefully monitor pest populations and take management action at a time when you are most likely to succeed. Timing may be essential, for example, when you need to control an internal feeder before it enters the plant. It is particularly useful to know the life cycle stages in which the pests are most vulnerable:

In the **egg and pupal stages**, insects generally are difficult to control, because these stages are inactive. The pests are not feeding, are immobile, and often are in hard-to-reach areas such as under the ground, in cocoons or cases, and in cracks or crevices.

In the **late instar and adult stages**, insects may be controlled with moderate success. Because of their size, the insects are easiest to see in these stages and usually are causing the most destruction. However, larger insects are often more resistant to pesticides, and adults already may have laid eggs for another generation.

The **early larval or nymphal stages**, when the insects are small, active, and vulnerable, is when you usually can achieve the best control.

Control methods used for insects and similar pests include: host resistance, natural enemies, cultural control, mechanical control, sanitation, and chemical control.

Host Resistance

Some crops, animals, and structures resist insects and similar pests better than others. Some varieties of crops and wood are immune to certain pests. Use of resistant types helps keep pest populations below harmful levels by making the environment less favorable for the pests.

Natural enemies

Most insect and insect-like pests have a variety of natural predators and parasites that help keep their numbers in check. If these natural enemies of the insect you need to control are already present in the area, you may be able to make use of them. If you use pesticides, try to use ones that are not toxic to the predators and parasites you want to encourage – or apply the pesticides at a time when the beneficial organisms are not vulnerable.

used to control fleas, cockroaches, and fire ants. The pest populations slowly decline over several weeks, since they are unable to reproduce. Juvenile hormones are seldom used in agriculture because a quick kill is usually desired.

Cultural Control

In general, plants that are grown under conditions that allow them to be healthy and free of stress are usually more able to resist insect attacks than are less hardy plants. Depending on the situation, there are several

specific cultural techniques that may help control insects and similar pests.

Mechanical Control

Mechanical controls used on insects and similar pests include: screens and other barriers, traps, light, and heat and cold.

Sanitation

Tilling fields and burning crop residues soon after harvest greatly aid in the control of some insect. Removing litter from around buildings helps control pests that use it for breeding or shelter. Ants, termites, and some other indoor pests may be suppressed by using this technique.

Sanitation is important in the control of animal parasites and filth flies. Fly control in and around barns, poultry houses, and livestock pens, for example, is greatly aided by proper manure management.

Indoors, sanitation is a major method of preventing insect pest problems. Keeping surfaces clean and dry is an important factor in suppressing ant, fly, and cockroach infestations.

Chemical Control

Some problems with insects, mites, spiders, and nematodes can best be managed with the use of chemicals. Chemicals such as insecticides, acaricides, and molluscicides, are used to control these pests.

Mode of Action

Most of these pesticides either repel the pests or poison them:

Repellents keep pests away from an area or from a specific host. Products designed to keep mosquitoes, chiggers, and ticks off people are an example.

Poisons act on one or more life systems in the pest. **Stomach poisons** must be eaten by the pest; **contact poisons** act when the pest touches them.

A few insecticides kill insects by interfering mechanically with their body functions. For example, mineral oils suffocate insects; silica dusts destroy their body water balance by damaging their protective wax covering.

Persistence

Insecticides and related chemicals vary in the length of time they remain active after they are applied. Some kill the pests they contact at the time of application and then break down almost immediately. These are **nonpersistent** pesticides.

Others, known as **persistent** – or residual – pesticides, remain active for varying periods of time after they are applied. The active pesticide residue that these products leave behind gives continued protection against pests that may enter the area after the application is completed.

Applying insecticides

Thorough knowledge of the target pest helps determine what chemicals to use and how often to apply them. One well-timed application of an effective pesticide may provide the desired control. Sometimes repeated applications will be necessary as the infestation continues and pesticide residues break down. The pesticide label, Extension Service recommendations, and other sources, such as pesticide dealers, usually indicate a range of treatment intervals and dosages. By carefully observing the pest problem and applying chemicals when the pests are most vulnerable, you often will be able to use lower doses of pesticides and apply them less often. Over a long growing period, this can mean considerable savings in time, money, and total pesticides applied.

The best control strategies take advantage of the natural controls provided by the pest's natural enemies. When you choose a pesticide, consider what effect it will have on these beneficial organisms.

Also think about how a pesticide treatment will affect other pests in the area. If your treatment kills the predators and parasites of an insect that does not currently require control, that insect could quickly multiply to become a problem.

Ask your pesticide dealer, your Extension agent, or other experts for advice about the need for monitoring pest populations, delaying insecticide use, and choosing pest-specific products.

VERTEBRATE PESTS

All vertebrate animals have a jointed backbone. They include mammals, birds, reptiles, amphibians, and fish. Most vertebrate animals are not pests, but a few can be pests in some situations.

Birds, rodents, raccoons, or deer, may eat or injure agricultural and ornamental crops. Birds and mammals may eat newly planted seed. Birds and rodents consume stored food and often contaminate and ruin more than they eat. Birds and mammals that prey on livestock and poultry cause costly losses to ranchers each year.

Rodents, other mammals, and some birds may carry serious diseases of humans and domestic animals such as rabies, plague, and tularemia. Rodents are an annoyance and a health hazard when they get into buildings.

Burrowing and gnawing mammals may damage dams, drainage and irrigation tunnels, turf, and outdoor wood products such as building foundations. Beavers may harm desirable plants, and they may cause flooding by building dams.

Undesirable fish species may crowd out desirable food and sport species. The few poisonous species of snakes and lizards become a problem when people, livestock, or pets are threatened. Water snakes and turtles may cause disruption or harm in fish hatcheries or waterfowl nesting reserves. Amphibians occasionally clog water outlets, filters, pipes, hoses, and other equipment associated with irrigation systems and drains.

Controlling Vertebrates

Techniques for control of vertebrate pests depend on whether the pest problem is indoors or outdoors.

Indoor vertebrate pest control usually is aimed at eradicating existing pest infestations and preventing new pests from getting in. Nearly all indoor vertebrate pests are rodents, but others, such as bats, birds, and raccoons, also may require control.

Outdoors, the strategy usually is to suppress the vertebrate pest population to a level where the damage or injury is economically acceptable.

Local and State laws may prohibit the killing or trapping of some animals such as birds, coyotes, muskrats, and beavers without special permits. Before you begin a control program, check with local authorities, such as fish and wildlife officials or the State agency responsible for pesticide regulation.

Methods of vertebrate pest control include: mechanical control, biological control, sanitation, and chemical control.

Mechanical Control

Mechanical control methods for vertebrate pests include traps, barriers, and pesticides.

Traps are sometimes a good choice for vertebrate pest control. Leg-hold traps have been used traditionally, but these traps cause the trapped animal to suffer and may injure

nontarget animals. Traps that quickly kill only target pests are better.

Pesticides for rodent pest control usually are formulated in baits. Because the chemicals may be highly toxic to people, livestock, and other animals, correct bait placement is important. To use baits effectively, you need a thorough knowledge of the pest's habits.

Few pesticides are available for control of vertebrate **pests other than rodents**, and most of them require special local permits for use. The chemicals that are registered are usually bait applications. A few chemicals designed for aquatic pests or massive populations of pest birds are used as broadcast applications. The chemicals used to control vertebrate pests include rodenticides, piscicides (fish), avicides (birds), and predacides (predators).

PLANT DISEASE AGENTS

A plant disease is any harmful condition that makes a plant different from a normal plant in its appearance or function. Pathogens include: fungi, bacteria, and viruses, viroids, and mycoplasmas. Nematodes are sometimes considered plant disease agents because of the type of injury they cause to the host plant.

Pathogenic Plant Diseases

Pathogens that cause plant disease are parasites that live and feed on plant debris and on or in host plants. Many can be passed from one plant to another.

Disease Triangle

Three factors are required before a pathogenic disease can develop – a susceptible host plant, a pathogenic agent, and an environment favorable for development of the pathogen.

The disease process starts when the pathogen arrives at a part of a plant where infection can occur. If environmental conditions are favorable, the pathogen will begin to develop. Infection begins when the pathogen enters the plant. The plant is diseased when it responds.

The three main ways a plant responds are: **overdevelopment of tissue**, such as galls, swellings, and leaf curls, **underdevelopment of tissue**, such as stunting, lack of chlorophyll, and incomplete development of organs, and **death of tissue**, such as blights, leaf spots, wilting, and cankers.

The pathogens that cause plant diseases may be spread by wind; rain; insects, birds, snails, slugs, and earthworms; transplant soil; nursery grafts; vegetative propagation (especially in strawberries, potatoes, and many flowers and ornamentals); contaminated equipment and tools; infected seed stock; pollen; dust storms; irrigation water; and people.

Fungi

Fungi are plants that lack chlorophyll and cannot make their own food. They get food by living on other organisms. Some fungi live on dead or decaying organic matter. Most are beneficial because they help release nutrients from dead plants and animals and thus contribute to soil fertility. These fungi can be a pest problem when they rot or discolor wood. They can do considerable damage to buildings and lumber that are improperly ventilated or in contact with water or high humidity.

Most fungi that cause plant diseases are parasites on living plants. They may attack plants and plant products both above and below the soil surface. Some fungus pathogens attack many plant species, but others are restricted to only one host species.

Most fungi reproduce by spores, which function about the same way seeds do. Fungus spores are often microscopic and are produced in tremendous numbers. Some spores can survive for weeks, months, or even years without a host plant. Excessive water or high humidity are nearly always essential for spore germination and active fungal growth. Spores

can spread from plant to plant and crop to crop through wind, rain, irrigation water, insects, and insect-like pests, and by people through infected clothing and equipment.

Fungal infections frequently are identified by the vegetative body of the fungus (mycelium) and the fruiting bodies that produce the spores. These can usually be seen with the naked eye. Symptoms of fungal infections include soft rot of fruits, plant stunting, smuts, rusts, leaf spots, wilting, and thickening or curling of leaves. Powdery and downy mildew, smut, root and stem rots, and sooty and slime molds are examples of fungus diseases.

Bacteria

Bacteria are microscopic, one-celled organisms. They usually reproduce by single cell division. Each new cell is exactly like the parent. Bacteria can build up quickly under warm, humid weather conditions. Some can divide every 30 minutes. Bacteria may attack any part of a plant, either above or below the soil surface. Many leaf spots and rots are caused by bacteria.

Viruses, Viroids, and Mycoplasmas

Viruses and mycoplasmas are so small that they cannot be seen with an ordinary microscope. They are generally recognized by their effects on plants. It may be difficult to distinguish between diseases caused by viruses or mycoplasmas and those caused by other plant disease agents such as fungi and bacteria.

A positive diagnosis requires sophisticated testing, such as inoculating indicator plants and observing the results or using specifically identified antibodies to test for the presence of the organism.

Viruses depend on other living organisms for food and to reproduce. They cannot exist separately from the host for very long. Viruses are commonly spread from plant to plant by mites and by aphids, leafhoppers, whiteflies, and other plant- feeding insects. They may be carried along with nematodes, fungus spores, and pollen, and may be spread by people through cultivation practices, such as pruning and grafting. A few are spread in the seeds of the infected plant.

Viruses can induce a wide variety of responses in host plants. Most often, they stunt plant growth and/or alter the plant's natural color. Viruses can cause abnormal formation of many parts of an infected plant, including the roots, stems, leaves, and fruit. Mosaic diseases, with their characteristic light and dark blotchy patterning, usually are caused by viruses.

Viroids are similar to viruses in many ways, but they are even smaller and lack the outer layer of protein that viruses have. Only a few plant diseases are known to be viroid-caused, but viroids are the suspected cause of many other plant and animal disorders. Viroids are spread mostly through infected plant stock. People can spread infected plant sap during plant propagation and other cultural practices. A few viroids are known to be transmitted with pollen and seeds.

Mycoplasmas are the smallest known independently living organisms. They can reproduce and exist apart from other living organisms. They obtain their food from plants. Yellows diseases and some stunts are caused by mycoplasmas. Most mycoplasmas are spread by insects, most commonly by leafhoppers. Mites may also spread them. Mycoplasmas are also readily spread among woody plants by grafting.

Nematodes

Nematodes are small, usually microscopic, roundworms. The mouthparts of those that feed on plants are like a hollow needle. They use it to puncture plant cells and feed on the contents. Nematodes may develop and feed either inside or outside of a plant. They move with an eel-like motion in water, even water as thin as the film of moisture around plant cells or soil particles.

Because nematodes are not visible to the naked eye, it is easy for people to unknowingly spread them when they get on footwear, tools, and equipment.

The life cycle of a nematode includes an egg, several larval stages, and an adult. Most larvae look like adults, but are smaller. In adverse conditions, the females of some species, such as root knot and cyst nematodes, form an inactive, resistant form called a cyst. The cyst is the hard, leathery, egg-filled body of the dead female. It is difficult to penetrate with pesticides. A cyst may provide protection for several hundred eggs for as long as 10 years.

Diagnosis of Plant Disease

If you try to control a plant disease without having enough information about it, you usually will fail. The first step in disease management is to diagnose the disease correctly.

You can recognize diseased plants by comparing them with healthy plants. To recognize a disease condition, you must know the plant's normal growth habits. When you are trying to identify the cause of a plant disease, you need to observe: **symptoms** – the host plant's **reaction** to the disease agent, and **signs** – **visible presence** of the disease agent.

Many plant diseases cause similar **symptoms** in the host plants. Such things as leaf spots, wilts, galls on roots, or stunted growth may be caused by many different agents, including many that are not pathogens. For example, the symptoms may be a result of mechanical injury, improperly applied fertilizers and pesticides, or frost.

Often the only way to pinpoint the cause is by finding the observable **signs** that the particular disease agent is present – such as fungal spores and mycelium or bacterial ooze.

Some pathogenic diseases occur regularly on specific agricultural, ornamental, and forestry plantings. For these diseases, noticing specific symptoms may be enough to allow you to correctly identify the cause. But many less common pathogenic disease agents, including some fungi and bacteria, may have to be positively identified by an expert with access to sophisticated laboratory procedures.

Controlling Plant Disease

At present, plant disease control measures are mainly preventive. Once a plant or plant product is infected and symptoms appear, few control methods – including pesticides – are effective.

The main methods for control of plant diseases include: host resistance, cultural control, sanitation, and chemical control.

Host Resistance

The use of disease-resistant varieties is usually one of the most effective, long-lasting, and economical ways to control plant disease.

In some crop and greenhouse situations, resistant varieties are the only way to ensure continued production. For many diseases in low-value forage and field crops, for example, chemical controls are too costly. For other diseases, such as many soil-borne pathogens, no economical or effective chemical control method is available.

Cultural Control

For a plant disease to develop, a pathogen and its host must come together under the right environmental conditions. Cultural practices can prevent an infection by altering the environment, the condition of the host, or the behavior of the pathogen.

Sanitation

Basic sanitation practices help to prevent and suppress some plant diseases by removing the pathogens themselves or their sources of food and shelter. Examples include: using pathogen-free seed stock, pathogen-free propagation,

clean planting sites, removal of infected plants, crop residue management, and disinfection of equipment and tools.

Chemical Control

Chemicals used to control plant disease pathogens include fungicides and bactericides (disinfectants). The general term "fungicide" is often used to describe pesticides that combat both fungi and bacteria.

Persistence

Fungicides vary in the length of time they remain active after they are applied. A **nonpersistent** fungicide controls the pathogen on contact or shortly after and then is no longer chemically active against the plant disease. A **persistent** fungicide can retain its chemical effectiveness for a period of time after application.

The pesticide label will tell you how frequently you need to apply the product. The interval may depend not only on the persistence of the pesticide, but also on:

1) environmental conditions (high humidity and warm temperatures may make more frequent applications necessary), and

2) whether rainfall, irrigation, or watering washes the fungicide off plant surfaces.

Mode of action

Fungicides may be classified as protectants, eradicants, and systemics.

Protectants must be applied before or during infection of the plant by the pathogen. In order to be effective, a protectant fungicide must either be persistent or be applied repeatedly. Most chemicals now available to combat plant diseases are protectants.

Eradicants are less common and are applied after infection has occurred. They act on contact by killing the organism or by preventing its further growth and reproduction.

Systemics are used to kill disease organisms on living plants. Systemic chemicals are transported in the sap stream from the application site to other plant parts. This type of chemical may act as both a protectant and an eradicant.

Successful chemical control of plant diseases requires **proper timing**. You usually must begin plant disease control **before** infection occurs. Apply the protectant chemical when environmental conditions are expected to be ideal for the development of plant disease organisms. If you do not apply the protectant in time, major crop damage may result or you may need to use the more expensive eradicant sprays.

Most fungicides prevent or inhibit disease growth for a period of time. Once the fungicide is no longer effective, the controlled disease may start to grow again or to produce spores and spread. For this reason, you may need to apply the fungicide at regular intervals.

Frequent applications are common during production of some fruit and vegetable crops and some turf. Different disease threats occur throughout the growing season, and many of the disease-causing organisms are capable of causing repeated infections. Some crops, however, are vulnerable to disease only during a short time period and a single application of fungicide may provide adequate protection.

Coverage

Almost all plant disease control chemicals are applied as cover sprays. The purpose is to reach and protect all potential sites of infection. Unlike insects and other pests, disease organisms do not move once they contact the plant. For good disease control, you need to apply fungicides and bactericides evenly over the entire plant surface.

Secondary infections

A few fungicides prevent the plant- disease organisms from reproducing in an infected plant. The fungicides prevent spore production in existing leaf infections and reduce the likelihood of spread. These fungicides are used, for example, against new apple scab infections, and they prevent spore production in existing leaf infections.

Seed treatment

Seeds are often treated with a fungicide to control disease-causing organisms in or on the seeds. Chemical seed treatment is also used to protect seeds from disease organisms that cause seed or seedling rots and to protect seedlings from infection by damping-off fungi in the soil.

Soil applications

In-row and spot applications of soil fungicides at the time of planting protect young seedlings from many disease organisms in the soil. Soil fungicides may also be used to protect the roots of established plants from infection by pathogens. These fungicides are applied as drenches and must move down through the soil into the root zone at a concentration adequate for control.

Other pesticides

Some pesticides that are not fungicides are used for indirect control of plant diseases. Insecticides and miticides may be used to control the insects and mites that spread plant disease organisms or that damage the plant in a way that makes it more vulnerable to plant disease. Sometimes herbicides are used to eliminate weeds that may harbor disease-causing organisms.

Pest Control Programs

Pest control should be initiated only when a pest is causing or is expected to cause more harm than is reasonable to accept. Then, each dollar spent for pest control should return several dollars in reduced losses or quality. Often, low or moderate pest numbers will not cause damage or economic loss. In these cases, the cost of control is greater than the amount of damage that the pest would cause.

When control is justified, select an effective strategy that is safe for the applicator and poses minimum potential harm to the environment.

Pest Control Goals

The three general goals of pest control goals are prevention, suppression, or eradication. It is important to select the most appropriate one for the situation.

Prevention may be a goal when the pest's presence or abundance can be predicted in advance or prevention is the most effective way to deal with it. Application of a pre-emergence herbicide to control crabgrass is an example. Also, some plant diseases occur only under very specific environmental conditions. If the proper conditions are predicted, you may make a preventive fungicide application to protect valuable plants or turf , especially, if there are no other effective alternatives.

Suppression is the goal in many pest situations. Here, the idea is to keep or reduce the number of pests to an acceptable level. Insecticides or post-emergence herbicides can be used in suppression programs.

Eradication or complete elimination of a pest is hard to do and advisable only in certain situations. It has the greatest chance of being successful in enclosed environments, such as greenhouses or interior plantscapes. It also is the approach taken in homes, office buildings,

health care facilities, food processing plants and places where pests cannot or will not be tolerated.

Eradication is occasionally attempted through a government program when a foreign pest has been accidentally introduced and potential economic losses are very high. This has happened when the Mediterranean fruit fly has been found in California or Florida and threatens entire industries.

Threshold Levels

Thresholds are the levels of pest infestation or activity at which a control measure is applied. At or above the threshold, the pest can cause unacceptable injury or harm if nothing is done.

Thresholds may be based on plant appearance, health, or economics. These levels, which are known as "action thresholds," have been determined for many pests. They may be based on a percentage of plants infested or when a certain level of feeding damage is seen.

Economic thresholds, seen for some field crop pests, include pest levels, control costs, and crop value.

In some pest control situations, the threshold level is 1 because the presence of a single pest is not acceptable. For example, the presence of any rodents in food processing facilities forces action. In homes, people generally take action to control some pests, such as rodents or roaches, even if only one or a few have been seen.

Pest Monitoring

In most pest control situations, the area to be protected should be checked often. Regular monitoring can answer several important questions:

What kinds of pests are present and are there enough to justify control?

When is the right time to begin control?

How well did the control measure work?

Monitoring of arthropod, vertebrate, mollusk, and weed pests can be done by visual inspection or trapping. In some cases, it is most important to watch environmental conditions. Temperature and moisture levels, especially humidity, are often important clues in predicting disease outbreaks.

Avoiding Harmful Effects

Pest control involves more than simply identifying a pest and using a control tactic. The treatment site usually contains other living organisms (people, animals, and plants) and nonliving surroundings (such as air, water, structures, objects, and surfaces). All of these could be affected by pest control measures. Unless you consider the possible effects on the entire system, your pest control effort might cause harm or lead to continued or new pest problems. Rely on pesticide labeling and good judgment to be safe.

Integrated Pest Management (IPM)

IPM is the combination of several appropriate pest control tactics into a single plan to reduce pests and their damage to an acceptable level. Using many different tactics to control a pest problem tends to cause the least disruption to the environment in which you work.

Pesticides are important tools to reduce outbreaks but continued reliance on them can be very expensive and may lead to resistance to pesticides, outbreaks of other pests, or harm to non-target or beneficial organisms. With some pests, using pesticides alone will not achieve adequate control.

Steps to Solving Pest Problems

Identify the pest or pests and determine whether or not control is needed.

Determine your pest control goal – suppression, eradication.

Evaluate the alternatives and select one that will be most effective and will cause the least harm to people and the environment.

Evaluate the results and adjust your strategy as needed.

Natural Controls

Natural control factors that affect pest populations include climate, predators and parasites, and the availability of food, water and shelter. Some natural forces act on all organisms, causing their numbers to rise and fall from year to year. They act independently of humans and may either help or hinder pest control. You may not be able to alter the action of natural forces on a pest population but you should be aware of their influence and take advantage of them when possible.

Climate – Weather conditions, especially temperature and humidity, affect pest activity, development, and rate of reproduction. Pests also may be suppressed or killed by freezing temperatures, drought, or other adverse conditions. Climate also affects pests indirectly by influencing the growth and development of their hosts. Unusual weather conditions can change normal patterns so that increased or decreased damage results or different pests are more active.

Natural enemies – Birds, mammals and other animals feed on some pests and help control their numbers. Many predatory and parasitic insects and their relatives can regulate pest populations. In addition, diseases, such as a fungus that kills aphids, can help with natural control.

Food and water supply – Pest populations can thrive only as long as they have adequate food and water. Once the food source – plant or animal - is exhausted, the pests die or become inactive. The life cycle of many pests depends on the availability of water.

Shelter – The availability of shelter can affect some pest populations. Overwintering sites and places to hide from predators are important to the survival of some pests. Removing shelters can mean lower pest survival.

Applied Controls

Natural controls often do not affect pests quickly or completely enough to prevent unacceptable injury or damage so other tactics or methods are needed. Examples include resistant varieties, sanitation, cultural practices, mechanical control, and pesticides.

Resistant varieties - Some plants, animals, and structures resist or tolerate pests better than others. Use of resistant varieties, when available, helps keep pest populations below harmful levels by making conditions less favorable for the pests.

Host resistance varieties can work in different ways. 1) Chemicals in the host repel the pest or prevent the pest from completing its life cycle. 2) The host is more vigorous or tolerant than other varieties and thus less likely to be seriously damaged by pest attacks. 3) The host has physical characteristics – waxy leaves, for example, that make it more difficult to attack.

Sanitation helps to suppress or prevent some pests by removing their sources of food and shelter. Urban and industrial pests can be reduced by improving cleanliness, eliminating pest hiding places and increasing the frequency of garbage pickup. Management of pests attacking domestic animals is enhanced by good manure management. Carryover of agricultural pests from one planting to the next can be reduced by removing crop residues.

Other forms of sanitation that help prevent pest spread include using pest-free seeds or transplants and decontaminating equipment, animals, and other possible carriers before allowing them to enter a pest-free area or leave an infested area. The proper design of food-handling areas can reduce access and shelter for many pests.

Cultural control is the use of standard practices to reduce pest numbers of impact of their effects. They disrupt the normal relationship between the pest and the host plant and make the pest less likely to survive, grow, or reproduce. Common cultural practices include planting date, crop rotation, cultivation, harvest, and fertilization.

Mechanical (physical) control uses traps, screens, barriers, fences, or nets to catch pests or to prevent them from getting into an area. Lights, heat, and refrigeration can alter the environment enough to suppress or eradicate some pest populations. Altering the amount of water, including humidity, can control some pests, especially insects and disease agents.

Pesticides are chemicals that used to destroy pests, control their activity, or prevent them from causing damage. Some pesticides either attract or repel pests. Chemicals that regulate plant growth or remove foliage also are classified as pesticides. Pesticides are generally the fastest way to control pests. In many instances, they are the only tactic available.

Pest Control Failures

Pest control can fail for any of a variety of reasons. Failures should be reviewed in order to try to determine what went wrong.

Common Reasons for Failure

1) Was the pest identified correctly? Sometimes a pesticide application fails because the pest was not identified correctly and the wrong pesticide was chosen or was applied at the wrong time.

2) Was the pesticide rate used? Lack of calibration or faulty spray equipment can cause control failures.

3) Was the application timed correctly? Sometimes the pests are too large to be controlled by a pesticide or in a less susceptible stage. In other cases, the damage is already done and killing the pest has no impact on the problem.

4) What were weather conditions before and after application? Weather can impact pest control. Rain may wash off pesticide residues before the product can work. Poor growing conditions may keep herbicides from being effective.

Resistance to Pesticides

In some cases, control measures fail because the pests are resistant to pesticides. Consider this when planning pest control programs that rely heavily on pesticides. Rarely does any pesticide kill all the target pests. Each time a pesticide is used, it selectively kills the most susceptible individuals. Some pests avoid the pesticide. Others withstand its effects. Pests that are not killed may pass along to their offspring the trait that allowed them to survive.

Pesticides can be divided into groups based on how they attack a target pest. When pesticides that attack in the same way are used repeatedly, against the same pest, the survivors may be more resistant to the pesticide. The opportunity for resistance is greater when a pesticide is used over a wide geographic area or when a pesticide is applied repeatedly to a rather small area where pest populations are isolated. A pesticide that leaves a residue that gradually loses its effectiveness over time will help select out resistance. Rotating pesticides that attack pests in different ways may help reduce the development of pest resistance.

Test Your Knowledge

Q.-1 What is the first thing you should do when you find a pest that you think you may need to control?

A. Identify it so the most effective control measures can be used.

Q.-2 What is a key pest?
A. Key pests are nearly always present and can be very damaging or destructive.

Q.-3 Explain what is meant by suppression of pests.

A. Suppression is reducing pest numbers or damage to an acceptable level.

Q-4. What are thresholds? Why should you consider thresholds when you develop a pest control strategy?

A. Thresholds are the levels of pest numbers or infestations at which a pest control action should be taken to prevent unacceptable damage or injury.

Q-5. Describe pest monitoring and explain how it can be important to pest control strategy.

A. Monitoring is a means of checking or scouting to determine what pests are present, how many of each kind are in the area, and how much damage they are causing. Monitoring is important to many pest control strategies because it helps determine if the threshold has been reached and whether control measures have been effective.

Q-6. Define "integrated pest management" (IPM) and list several possible control tactics that may be used in an IPM strategy.

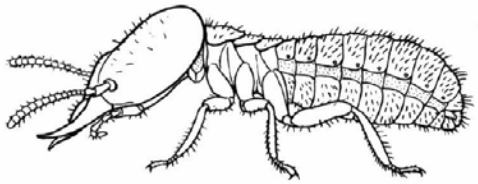
A. Integrated pest management is an approach to pest control that combines several tactics into a single plan to reduce pests and to keep their damage to an acceptable level. Pest control tactics may include: resistance varieties, cultural, mechanical or chemical (pesticide) controls, and sanitation.

Q-7. You applied a pesticide, but it did not control the pest. Name three reasons why your control effort might have failed.

A. The failure of the pesticide might have been caused by misidentifying the pest, pest resistance, choosing the wrong pesticide, applying the wrong amount, or applying the pesticide incorrectly.

Q-8. What can you do to keep the pests you are trying to control from becoming resistant to the pesticides you use?

A. Pest resistance can be reduced by using integrated pest management and rotating the types of pesticides used.



2 - Pesticide Labeling

The pesticide product label and labeling is the main way a pesticide manufacturer communicates with pesticide users.

The information printed on or attached to the pesticide container is the label. Labeling includes the label plus all other information you receive from the dealer when you buy a product. This can include brochures, leaflet

ts, and other information that accompanies the pesticide product. Pesticide labeling gives you instructions on how to use the product safely and correctly. **Pesticide users are required by law to follow all the instructions and directions for use in pesticide labeling.**

EPA Approval of Pesticide Labeling

No pesticide may be sold in the US until the Environmental Protection Agency (EPA) has reviewed the manufacturer's application for registration and has determined that the use of the product will not present an unreasonable risk to humans or the environment. As part of this process, the EPA has certain labeling information requirements and must approve all language that the manufacturer proposes to include in the product labeling.

EPA reviews the labeling to make sure that it contains all the information needed for safe and effective use of the pesticide product. The information must be backed up by data submitted (or cited) by the manufacturer. EPA may require the manufacturer to change the labeling if it does not contain enough information or if the information is wrong. EPA also may require that the labeling include other information about laws or regulations that have been adopted to protect humans or the environment.

Only after EPA has reviewed the labeling and registered the product can a pesticide product be sold. If the manufacturer wants to change the information in the labeling after the product and labeling are registered, EPA must approve the change. EPA also may require changes in labeling.

Pesticides also must be registered with the Kentucky Department of Agriculture (KDA) before it is legal to sell and use them in the state. These registrations must be renewed annually by the manufacturer.

Types of Pesticide Registration

There are three major types of registration:

1) All pesticides must have a Federal EPA registration (authorized by Section 3 of the Federal Insecticide Fungicide, and Rodenticide Act (FIFRA).

2) State or Special Local Needs registration (authorized by Section 24-C of the Federal Insecticide Fungicide, and Rodenticide Act (FIFRA). These labels allow the KDA to further control how the pesticide is used, including registering additional uses or adding limitations for a federally registered pesticide.

These registrations often involve adding application sites, pests, or alternate control techniques to those listed on the federally registered labeling.

Supplemental labeling must be provided for each SLN registration. Applicators must have a copy of the SLN labeling in their possession in order to apply the pesticide for that purpose.

The registration number of SLN labeling will include the initials "SLN" and the standard two-letter abbreviation code for the state that issued the registration. These registrations are legal only in Kentucky or local area specified in the labeling and are valid for 3 years. Any application in another state or region is subject to civil and criminal penalties. The KDA, extension personnel, pesticide dealers, and other professionals will help inform you of SLN registrations that pertain to your area.

3) Emergency exemptions from registration (authorized by Section 18 of the Federal Insecticide Fungicide, and Rodenticide Act (FIFRA). Emergency exemptions are used when a very serious pest situation arises for which no pesticide is registered. If both federal and SLN registrations would take too long to enact, an emergency registration can be used.

These Section 18 exemptions are handled by the Commissioner of Agriculture (KDA). They allow pesticides to be sold and used for non-registered purposes for a specified period of time. Additional labeling with instructions for use is given to you by the dealer. The label is valid only in Kentucky or local area specified in the labeling. Strict controls and recordkeeping are required for all these emergency uses.

You must understand all of the special requirements and responsibilities involved whenever you use pesticides with emergency exemptions. The agency that has granted the emergency exemption will provide application rates, safety precautions, and other vital information.

Classification of Pesticide Uses

EPA categorizes every use of every pesticide as either unclassified (general use) or Restricted Use. Often all uses of a particular formulation are classified as restricted or all are unclassified. Sometimes, however, certain uses of a formulation are restricted and other uses of the same product are not. In these cases, the directions for use for the two classifications must be clearly separate. Entirely different packaging and labeling are used.

Restricted-Use Pesticides

A pesticide, or some of its uses, is classified as Restricted if it could cause harm to humans (pesticide handlers or other persons) or to the environment unless it is applied by certified applicators who have the knowledge to use these pesticides safely and effectively.

The word "use" in this phrase is a general term, it refers to such activities as: application, mixing and loading, transporting, storing, or handling pesticides after the manufacturer's seal is broken; care and maintenance of application and handling equipment; and disposal of pesticides and their containers

Parts of a Pesticide Label

The information on a pesticide label usually is grouped under headings to make information easier to find. Some information is required by law to appear on a certain part of the label or under certain headings. Other information may be placed wherever the manufacturer chooses.

Identifying Information

Pesticide labeling contains basic information that helps users clearly identify the product. Some of these items will be on the front panel of every label according to EPA requirements. Other items, while generally on the front panel, may be located elsewhere on the label or in the labeling if the manufacturer chooses.

Each manufacturer has a **brand name** for every product. Different manufacturers may use different brand names for the same pesticide active ingredient. Most companies register each brand name as a trademark and do not allow any other company to use that name. The brand or trade name is the one used in advertisements and by company salespeople. The brand name shows up plainly on the front panel of the label.

Beware of choosing a pesticide product by brand name alone. Many companies use the same basic name with only minor variations to designate entirely different pesticide chemicals. For example:

DePesto = Carbary BUT
DePesto Super = carbaryl + Malathion
AND DePesto Supreme = carbaryl + malathion + pyrethrins

Sometimes several companies will sell the same pesticide product under different brand names. For example:

De Weed 2E = diquat 2 lbs per gallon EC formulated by Company X

No Weeds = diquat 2 lbs per gallon EC formulated by Company Z.

Always read the ingredient statement to determine the active ingredients in a product.

Ingredient statement – Each pesticide label must list what is in the product. It must be written so you can readily see what the active ingredients are and the percentage of each one. The ingredient statement must list the official chemical name and / or common name for each active ingredient. Inert ingredients need not be named but the label must show their percent of the total contents.

The **chemical name** is a complex name that identifies the chemical components and structure of the pesticide. This name is almost always listed in the ingredient statement on the label. The chemical name for the common insecticide Sevin is *1-naphthyl N-methyl carbamate*.

Because pesticides have complex chemical names, many are given a shorter **common name**. Only common names that are officially accepted by the EPA may be used in the ingredient statement on the pesticide label. The official common name for Sevin is carbaryl. For example, a label with the brand name Sevin® 50% WP would read:

Active ingredient:
Carbaryl (1-naphthyl N-methyl carbamate) 50%

Inert ingredients 50%

By purchasing pesticides according to the common or chemical names, you will always be sure to get the right active ingredient.

Registration and establishment numbers – The pesticide handler needs these numbers in case of poisoning, claims of misuse, or liability claims.

An EPA **registration number** (for example, EPA Reg. No. 3120-280-AA) indicates that the pesticide label has been approved by EPA. Most products will contain only two sets of numbers; for example, EPA Reg. No. 3120-280. The first set of numbers, 3120, identifies the manufacturer or company. The second set, 280, identifies the product.

Additional letters and numbers are sometimes part of the EPA registration number; for example, EPA Reg. No. 3120-280-AA-0850. The letters AA might be required by a particular state to appear on that label. The 0850 is the distributor's identification number and appears on labels of distributor products.

When a pesticide is registered by a state because of a special local need, the registration is designated, for example, as EPA SLN No. KY-XX0009. In this case, SLN indicates "special local need" and KY means that the product is registered for use in Kentucky. XX are the last two digits of the year the label went into effect. If the SLN registration is for only a few of the registered uses in the pesticide labeling, the SLN number may not be on the front panel of the pesticide label. Instead, it may be located in the supplementary labeling for the use to which it applies.

The **establishment number** (for example, EPA Est. No. 5840-AZ-I) appears on either the pesticide label or container. It identifies the facility where the product was made in case there are questions or concerns about the pesticide product, the facility that made the product can be determined.

Name and address of manufacturer– The law requires this so you will know who made or sold the product.

Net contents – The front panel of the pesticide label tells you how much is in the container.

This can be expressed as pounds or ounces for dry formulations and as gallons, quarts, pints, or fluid ounces for liquids. Liquid formulations also may list the pounds of active ingredient per gallon of product.

Type of pesticide – The type of pesticide usually is listed on the front panel of the label. This short statement indicates in general terms what the product will control. For example:

Insecticide for control of certain insects on fruits, nuts, and ornamentals.

Herbicide for the control of trees, brush, and weeds

Type of formulation – The front panel of some pesticide labels will tell you what kind of formulation the product is. The formulation may be named or the label may show only an abbreviation, such as WP for wettable powder, D for dust, or EC for emulsifiable concentrate.

Restricted-Use Designation

When a pesticide is classified as restricted, the label will state "Restricted Use Pesticide" in a box at the top of the front panel.

Below this heading may be a statement describing the reason for the restricted-use classification. Usually another statement will describe the category of certified applicator who can buy and use the product. Unclassified pesticides have no designation on the product label. Examples of restricted-use statements on pesticide labels include:

"*RESTRICTED USE PESTICIDE due to ground water concern. 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 applicators' certification. Users must read and follow all precautionary statements and instructions for use in order to minimize potential of [active ingredient] to reach ground water.*"

Front-Panel Precautionary Statements

Signal words and symbols – The signal words – DANGER, WARNING, or CAUTION – must appear in large letters on the front panel of the pesticide label. It indicates how acutely toxic the product is to humans. The signal word is immediately below the statement, "Keep out of reach of children," which also must appear on every label.

> The signal word is based not on the active ingredient alone but on the contents of the formulated product. It reflects the hazard of any active ingredients, carriers, solvents, or inert ingredients.

The signal word indicates the risk of acute effects from the four routes of exposure to a pesticide product (oral, dermal, inhalation, and eye) and is based on the one that is greatest. The signal word does not indicate the risk of delayed effects or allergic effects.

Use the signal word to help you decide what precautionary measures are needed for you, your workers, and other persons (or animals) who may be exposed.

DANGER – This word signals you that the pesticide is highly toxic. The product is very likely to cause acute illness from oral, dermal, or inhalation exposure, or to cause severe eye or skin irritation.

POISON/SKULL AND CROSSBONES – All highly toxic pesticides that are likely to cause acute illness through oral, dermal, or inhalation exposure also will carry the word POISON printed in red and the skull and crossbones symbol. Products that have the signal word DANGER due to skin and eye irritation potential will not carry the word POISON or the skull and crossbones symbol.

WARNING – This word signals you that the product is moderately likely to cause acute illness from oral, dermal, or inhalation

exposure or that the product is likely to cause moderate skin or eye irritation.

CAUTION – This word signals you that the product is slightly toxic or relatively nontoxic. The product has only slight potential to cause acute illness from oral, dermal, or inhalation exposure. The skin or eye irritation it would cause, if any, is likely to be slight.

Statement of practical treatment (first aid) – Most pesticide products are required to include instructions on how to respond to an emergency exposure involving that product. The instructions usually include first aid measures and may include instructions to seek medical help. If the *Statement of Practical Treatment* is not located on the front panel, a statement on the front panel must refer the user to the section of the label or labeling where the *Statement of Practical Treatment* may be found.

Hazards to Humans and Domestic Animals

Acute effects statements – The label or labeling will contain statements that indicate which route of entry (mouth, skin, eyes, lungs) you must particularly protect and what specific action you need to take to avoid acute effects from pesticide exposure. These statements may be on the front or side panel of the label, or they may be somewhere else in the labeling. The statements will warn you if you may be harmed by swallowing or inhaling the product or getting it on your skin or in your eyes.

Many pesticides can cause acute effects by more than one route, so study these statements carefully. These precautionary statements tell you what parts of your body will need the most protection.

"*DANGER: Fatal if swallowed or inhaled*" gives a far different indication than "*DANGER: Corrosive – causes eye damage and severe skin burns*."

Delayed effects statements – The labeling of pesticides that the EPA considers to have the potential to cause delayed effects must warn you of that fact. These statements will tell you whether the product has been shown to cause problems such as tumors or reproductive problems in laboratory animals.

Allergic effects statement – If tests or other data indicate that the pesticide product has the potential to cause allergic effects, such as skin irritation or asthma, the product labeling must state that fact. Sometimes the labeling refers to allergic effects as "sensitization."

Personal protective equipment statements – Immediately following the statements about acute, delayed, and allergic effects, the labeling usually lists personal protective equipment requirements. These statements tell you the **minimum** personal protective equipment that you must wear when using the pesticide. Sometimes the statements will require different personal protective equipment for different pesticide handling activities.

For example, an apron may be required only during mixing, loading or equipment cleaning. Sometimes the statements will allow reduced personal protective equipment when you use safety systems, such as closed systems or enclosed cabs.

Environmental Hazards

This section of the pesticide labeling will indicate precautions for protecting the environment when you use the pesticide. Some general statements appear on the labeling of nearly every pesticide.

Most pesticide labeling, for example, will warn you not to contaminate water when you apply the pesticide or when you clean your equipment or dispose of pesticide wastes. The labeling will contain specific precautionary statements if the pesticide poses a specific hazard to the environment. For example, it may warn you that the product is highly toxic to bees or other wildlife.

Physical or Chemical Hazards

This section of the pesticide labeling will tell you of any special fire, explosion, or chemical hazards the product may pose. For example, it will alert you if the product is so flammable that you need to be especially careful to keep it away from heat or open flame or if it is so corrosive that it must be stored in a corrosion-resistant container.

NOTE: The physical or chemical hazard statements are not located in the same place in all pesticide labeling. Some labeling groups them in a box under the heading "Physical or Chemical Hazards." Other labeling may list them on the front panel of the label beneath the signal word. Still other labeling may list the hazards in paragraph form under headings such as "Note" or "Important." If there are no unusual physical or chemical hazards, there may be no statement in the labeling.

Directions for Use

Directly under the heading "Directions for Use" on every pesticide product labeling is the following statement: "It is a violation of Federal Law to use this product in a manner inconsistent with its labeling." The *Directions for Use* section also contains sections on storage and disposal and may contain a section on entry into treated areas after a pesticide application. In addition, the *Directions for Use* section will contain specific directions for product use.

Use inconsistent with the labeling – It is illegal to use a pesticide in any way not permitted by the labeling. A pesticide may be used 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 use, including directions concerning safety, mixing, diluting, storage, and disposal.

You must wear the specified personal protective equipment even though you may be risking only your own safety by not wearing it. **The use directions and instructions are not advice, they are requirements.**

Exceptions to Label Instructions

Federal law **does** allow you to use pesticides in some ways not specifically mentioned in the labeling. Unless you would be in violation of the laws of your state, you may:

1. Apply a pesticide at any dosage, concentration, or frequency less than that listed on the labeling.

2. Apply a pesticide against any target pest not listed on the labeling if the application is to a plant, animal, or site that is listed.

3. Use any appropriate equipment or method of application that is not prohibited by the labeling.

4. Mix a pesticide or pesticides with a fertilizer if the mixture is not prohibited by the labeling.

5. Mix two or more pesticides, if all of the dosages are at or below the recommended rate.

Entry statement – Most pesticide labeling contains a precaution about entering a treated area after application. This statement tells you how much time must pass before people can enter a treated area except under special circumstances. This is called the Restricted Entry Interval (REI).

The entry statement may be printed in a box under the heading "Entry" or "Worker Protections," or it may be in a section with a title such as "Important," "Note," or "General Information." If the entry interval applies only to certain uses or locations, the heading may indicate that limitation. For example, the heading might be "Agricultural Use Restrictions."

Storage and disposal – All pesticide labeling contains some instructions for storing the pesticide. These may include both general statements, such as "Keep out of reach of children and pets," and specific directions, such as "Do not store in temperatures below 32°F."

Pesticide labeling also contains some general information about how to dispose of excess pesticide and the pesticide container in ways that are acceptable under federal regulations. State and local laws vary, however, so the labeling usually does not give exact disposal instructions.

Storage and disposal statements usually appear in a special section of the labeling titled "Storage and Disposal."

Other directions for use – The instructions on how to use the pesticide are an important part of the labeling. This is the best way you can find out the right way to handle the product.

The use instructions will tell you: the **pests** that the manufacturer claims the product will control – the plant, animal, or **site** the product is intended to protect – in what **form** the product should be applied – the **correct equipment** to use – h**ow much** pesticide to use and **mixing** directions – whether the product can be **tank-mixed** with other often-used products – whether the product is likely to cause unwanted **injuries** or stains to plants, animals, or surfaces – **where** the material should be applied, and **when** and **how often** it should be applied.

Directions for use by reference – Some directions for use that pesticide users must obey are contained in documents that are only **referred to** on the product labeling. Such instructions include EPA or other government agency regulations or requirements concerning the safe use of the pesticide product. For example, a pesticide label might state:

"*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.*"

This statement probably would be the only indication on the pesticide label or in the labeling that other use directions and restrictions apply to the product.

You are responsible for determining whether the regulation, bulletin, or other document referred to on the pesticide product labeling applies to your situation and your intended use of the pesticide product. If the document is applicable, you must comply with all the specific directions for use and other requirements that it contains.

These documents do not always accompany the pesticide product when it is sold. Instead, you may have to get the additional directions and requirements from other sources, such as pesticide dealers or company representatives, industry or commodity organizations, land-grant universities, or Cooperative Extension educators.

This reference to other documents is a new practice. It is necessary because there is no longer room on the traditional pesticide label to explain the requirements of all laws and regulations that may apply to the user. For example, EPA has adopted or is considering new requirements concerning:

Ground water protection – Endangered species protection – Pesticide transportation, storage, and disposal – Worker protection

Some of these are general use directions that apply to all pesticides, so one copy should be sufficient for each affected user. In other cases, the instructions and restrictions apply only in certain geographical areas or to certain uses of a pesticide product. Directions for use

applicable in these specific situations need to be distributed only to the affected users.

The EPA decision not to require all applicable directions for use to be distributed with each pesticide product places greater responsibility on the pesticide user. One sentence or paragraph on a pesticide label may be the only notice you will receive that additional use directions are required in order for the product to be used in compliance with its labeling.

You must determine whether you are affected, locate the applicable directions for use, determine how to comply with the instructions and requirements in the directions for use, and comply with those instructions and requirements.

Know the Law

Federal Insecticide, Fungicide, and Rodenticide Act, FIFRA, was passed by Congress in 1947 and substantially amended in 1972, 1975, 1978, and 1988. It regulates the registration, manufacture, sale, transportation, and use of pesticides.

Penalties Under FIFRA

If you violate FIFRA, or regulations issued under it, you are subject to civil penalties. They can be as much as $5,000 for each offense ($1,000 for private applicators). Before EPA can fine you, you have the right to ask for a hearing in your city or county. Some violations of the law also may subject you to criminal penalties. These can be as much as $25,000 or one year in prison, or both, for commercial applicators; $1,000 and/or 30 days in prison for private applicators. States may establish higher penalties.

Test Your Knowledge

Q. Explain the differences between the terms "label" and "labeling."

A. The label is the information printed on or attached to the pesticide container. Labeling includes the label, plus all other product information received from the manufacturer when you buy it.

Q. What do the words "Restricted Use Pesticide" tell you about the pesticide product?

A. "Restricted Use Pesticide" means that the product has been shown to be likely to harm people or the environment if it is not used correctly. It may be purchased and used only by certified applicators.

Q. Where would you look to find out whether a pesticide is classified as Restricted Use?

A. The words "Restricted Use Pesticide" will appear in a box on the front panel of the pesticide label.

Q. Explain the differences between chemical name, common name, and brand name. Which of these terms should you use to most accurately identify a pesticide product?

A. The chemical name is a complex name that identifies the chemical components and structure of the pesticide. A common name is a substitute for the chemical name. The brand name is the name – usually a trademark – used by a chemical company to identify a pesticide product. The common name is the most accurate and useful way to identify a pesticide product.

Q. Name and explain the meaning of the signal words and symbols you may see on a pesticide product.

A. "Caution" - slightly toxic or relatively nontoxic. "Warning" - moderately toxic.

"Danger" - highly toxic. "Poison" and the skull and crossbones indicates that the pesticide product is highly toxic as a poison, rather than as a skin or eye irritant.

Q. Can you use the signal word on a pesticide label to judge the likelihood of suffering acute, delayed, or allergic effects if you are overexposed to the product? Explain.

A. No.

Q. What types of hazard statements should you look for in the pesticide labeling?

A. You should look for precautions about hazards to humans (and domestic animals), environmental hazards, and physical/chemical hazards.

Q. What types of precautionary statements may be included in the labeling section titled "Hazards to Humans"?

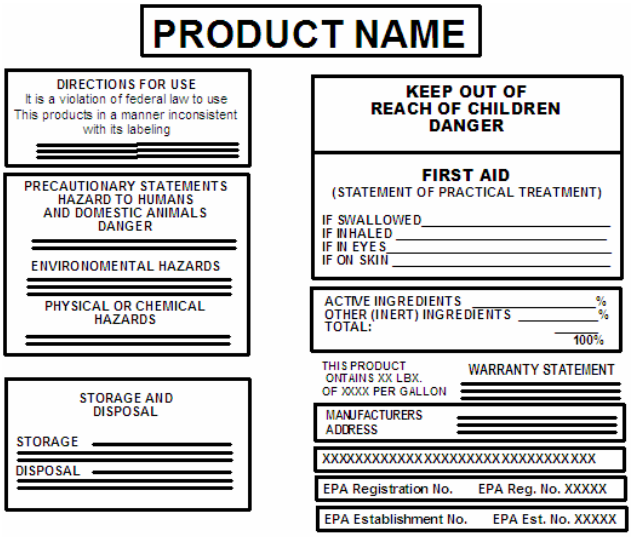
A. Acute effects precautions, delayed effects precautions, allergic effect precautions, and personal protective equipment requirements may be in the section of the labeling titled "Hazards to Humans."

Q. What is the meaning of the statement: "It is a violation of Federal law to use this product in a manner inconsistent with its labeling"?

A. It is illegal to use a pesticide in any way not permitted by the labeling. A pesticide may be used 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 use, including directions concerning safety, mixing, diluting, storage, and disposal. You must wear the specified personal protective equipment even though you may be risking only your own safety by not wearing it.

Q. Does the pesticide label contain all the instructions and directions for use that you need to use the product safely and legally?

A. Some pesticide products have all the necessary instructions and directions for use on the product label. For other products, more instructions and directions may be in other labeling that accompanies the product at the time of purchase. The label or labeling of still other products may refer to separate documents that contain specialized instructions and directions. Pesticide users are required by law to comply with all these types of instructions and directions – not just with the label itself.



3 - Formulations

Formulations

The active ingredients (ai) in a pesticide are the chemicals that control the target pest. Most pesticide products also have other ingredients, called inert (inactive) ingredients. They are used to dilute the pesticide or to make it safer, more effective, easier to measure, mix, and apply, and more convenient to handle.

Other chemicals in the product may include wetting agents, spreaders, stickers, or extenders. **This mixture of active and inert ingredients is called a pesticide formulation.**

Some formulations are ready for use (RTU). Others must be further diluted with water, a petroleum-based solvent, or air (as in airblast or ULV applications) by the user before they are applied.

A single active ingredient often is sold in several formulations. If you find that more than one formulation is available for your pest control situation, you must choose the best one for the job. Before you choose, ask yourself several questions about each formulation. For example:

● Do you have the necessary application equipment?

● Can the formulation be applied safely under the conditions in the application area?

● Will the formulation reach your target and stay in place long enough to control the pest?

● Is the formulation likely to harm the surface to which you will apply it?

To answer these kinds of questions, you need to know something about the characteristics of different types of formulations and the general advantages and disadvantages of each type.

Liquid Formulations

Emulsifiable Concentrates (EC or E)

An emulsifiable concentrate formulation usually contains a liquid active ingredient, one or more petroleum-based solvents, and an agent that allows the formulation to be mixed with water to form an emulsion. Each gallon of EC usually contains 25 to 75 percent (2 to 8 pounds) of active ingredient.

> An emulsion is a fine dispersion of one liquid in another. Emulsions often have a milky appearance.

EC's are among the most versatile formulations. They are used against agricultural, ornamental and turf, forestry, structural, food processing, livestock, and public health pests. They are adaptable to many types of application equipment, from small, portable sprayers to hydraulic sprayers, low-volume ground sprayers, mist blowers, and low-volume aircraft sprayers.

Advantages:
▲ Relatively easy to handle, transport, measure and store
▲ Little agitation required – will not settle out or separate when equipment is running
▲ Not abrasive and do not plug screens or nozzles
▲ Leaves little visible residue on treated surfaces

Disadvantages:
▼ High concentration makes it easy to over-treat or under-treat through mixing or calibration errors
▼ Solvent may burn tender plant foliage
▼ Easily absorbed through skin of humans or animals
▼ Solvents may cause rubber or plastic hoses, gaskets, and pump parts and surfaces to deteriorate

▼ May cause pitting or discoloration of painted finishes

▼ Flammable – should be used and stored away from heat or open flame
▼ May be corrosive – burn eyes or skin

Solutions (S)

Some pesticide active ingredients dissolve readily in a liquid solvent, such as water or a petroleum-based solvent. When mixed with the solvent, they form a solution that will 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 any type of sprayer indoors or outdoors.

Ready-to-use (RTU) – Some solutions are products that contain the correct amount of solvent when you buy them. No further dilution is required before application. These formulations, usually solutions in petroleum-based solvents, contain small amounts (often 1 percent or less) of active ingredient per gallon.

Concentrate Solutions (C or LC) – Other solutions are sold as concentrates that must be further diluted with a liquid solvent before you apply them. Occasionally the solvent is water, but more often the solvent is a specially refined oil or petroleum-based solvent.

Advantages:
▲ No agitation necessary

Disadvantages:
▼ Limited number of formulations available

The other advantages and disadvantages of solutions vary depending on the solvent used, the concentration of the active ingredient, and the type of application involved.

Ultra-low-volume (ULV)

These concentrates may approach 100 percent active ingredient. They are designed to be used as is or to be diluted with only small quantities of specified solvents. These special-purpose formulations are used mostly in outdoor applications, such as in agricultural, forestry, ornamental, and mosquito control programs.

Advantages:
▲ Relatively easy to handle, transport, and store
▲ Little agitation required
▲ Not abrasive to equipment and will not plug screens and nozzles
▲ Little visible residue on treated surfaces

Disadvantages:
▼ Difficult to keep pesticide in the target site – high drift hazard
▼ Specialized equipment required
▼ Easily absorbed through skin of humans or animals
▼ Solvents may cause rubber or plastic hoses, gaskets, and pump parts and surfaces to deteriorate

Flowables (F or L)

Some active ingredients are insoluble solids. These may be formulated as flowables in which the finely ground active ingredients are mixed with a liquid, along with inert ingredients, to form a suspension.

Flowables are mixed with water for application and are similar to EC or wettable powder formulations in ease of handling and use. They are used in the same types of pest control operations as EC's.

Advantages:
▲ Seldom clog nozzles and easy to handle and apply

Disadvantages:
▼ Requires moderate agitation and may leave a visible residue

Aerosols (A)

These formulations contain one or more active ingredients and a solvent. Most aerosols contain a low percentage of active ingredient. There are two types of aerosol formulations –

the ready-to-use type and those made for use in smoke or fog generators.

Ready-to-use aerosols – These aerosol formulations are usually small, self-contained units that release the pesticide when the nozzle valve is triggered. The pesticide is driven through a fine opening by an inert gas under pressure, creating fine droplets. These products are used in greenhouses, in small areas inside buildings, or in localized outdoor areas. Commercial models, which hold 5 to 10 pounds of pesticide, are usually refillable.

Advantages:

▲ Easily stored
▲ Convenient way to buy small amount of a pesticide
▲ Retain potency over fairly long time

Disadvantages:
▼ Practical for very limited uses
▼ Risk of inhalation injury
▼ Hazardous if punctured, overheated, or used near an open flame
▼ Difficult to confine to target site or pest

Formulations for smoke or fog generators – These aerosol formulations are not under pressure. They are used in machines that break the liquid formulation into a fine mist or fog (aerosol) using a rapidly whirling disk or heated surface. These formulations are used mainly for insect control in structures such as greenhouses and warehouses and for mosquito and biting fly control outdoors.

Advantages:
▲ Easy way to fill entire space with pesticide

Disadvantages:
▼ Highly specialized use and equipment
▼ Difficult to confine to target site or pest
▼ May require respiratory protection to prevent risk of inhalation injury

Invert Emulsions

This mixture contains a water-soluble pesticide dispersed in an oil carrier. Invert emulsions require a special kind of emulsifier that allows the pesticide to be mixed with a large volume of petroleum-based carrier, usually fuel oil. When applied, invert emulsions form large droplets that do not drift easily. Invert emulsions are most commonly used in vegetation control along rights-of-way where drift to susceptible non-target plants is a problem.

Dry Formulations

Dusts (D)

Most dust formulations are ready to use and contain a low percentage of active ingredient (usually 1/2 to 10 percent), plus a very fine dry inert carrier made from talc, chalk, clay, nut hulls, or volcanic ash. The size of individual dust particles varies.

Dusts are always used dry, and they easily drift into non-target sites. In structures, dust formulations are used in cracks and crevices and for spot treatments. They are widely used in seed treatment. Dusts also are used to control lice, fleas, and other parasites on pets and livestock.

Advantages:
▲ Usually ready to use, with no mixing
▲ Effective where moisture from a spray might cause damage 1
▲ Require simple equipment
▲ Effective in hard-to-reach indoor areas

Disadvantages:
▼ Easily drift off target
▼ Residue easily moved off target by air movement or water
▼ May irritate eyes, nose, throat, and skin
▼ Do not stick to surfaces
▼ Difficult to get an even distribution of particles on surfaces

Baits (B)

A bait formulation is an active ingredient mixed with food or another attractive substance. The bait either attracts the pests or is placed where the pests will find it. Pests are killed by eating the pesticide in the bait. The amount of active ingredient in most bait formulations is quite low, usually less than 5 percent.

Baits are used inside buildings to control ants, roaches, flies, other insects, and rodents. Outdoors they sometimes are used to control snails, slugs, and some insects, but their main use is to control vertebrate pests such as rodents, other mammals, and birds.

Advantages:
▲ Entire area need not be covered because pest goes to bait
▲ Control pests that move in and out of an area

Disadvantages:
▼ Can be attractive to children and pets ▼ May kill domestic animals and non-target wildlife outdoors
▼ Pest may prefer other food to the bait
▼ Dead pests may cause odor problem

Granules (G)

Granular formulations are similar to dust formulations except that granular particles are larger and heavier. The coarse particles are made from an absorptive material such as clay, corn cobs, or walnut shells. The active ingredient either coats the outside of the granules or is absorbed into them. The amount of active ingredient is relatively low, usually ranging from 1 to 15 percent.

Granular pesticides are most often used to apply chemicals to the soil to control weeds, nematodes, and insects living in the soil. Sometimes granular formulations are used in airplane or helicopter applications to minimize drift or to penetrate dense vegetation.

Granular formulations also are used to control larval mosquitoes and other aquatic pests. Granules are used in agricultural, structural, ornamental, turf, aquatic, right-of-way, and public health (biting insect) pest control operations.

Advantages:
▲ Ready to use – no mixing
▲ Drift hazard is low
▲ Less hazard to applicator – no spray, little dust
▲ Granule carries the formulation through foliage to soil or water target
▲ Simple application equipment, such as seeders or fertilizer spreaders
▲ May break down more slowly due to slow-release coating

Disadvantages:
▼ Does not stick to surfaces
▼ May need to be incorporated into soil or planting medium
▼ May need moisture to be activated
▼ May be hazardous to non-target species, especially waterfowl and other birds that mistakenly feed on the grain- or seed-like granules

Pellets (P or PS)

Most pellet formulations are very similar to granular formulations; the terms often are used interchangeably. In a pellet formulation, however, all particles are the same weight and shape. The uniformity of the particles allows them to be applied by precision applicators such as those being used for precision planting of pelleted seed. A few fumigants are formulated as pellets; however, these will be clearly labeled as fumigants and should not be confused with nonfumigant, granule-like pellets.

Wettable Powders (WP or W)

Wettable powders are dry, finely ground formulations that look like dusts. They usually must be mixed with water for application as a spray. A few products, however, may be

applied either as a dust or as a wettable powder – the choice is left to the applicator.

Wettable powders contain 5 to 95 percent active ingredient, usually 50 percent or more. Wettable powder particles do not dissolve in water. They settle out quickly unless constant agitation is used to keep them suspended.

Wettable powders are one of the most widely used pesticide formulations. They can be used for most pest problems and in most types of spray equipment where agitation is possible.

Advantages:
▲ Easy to store, transport, and handle
▲ Less likely than EC and other petroleum-based pesticides to cause unwanted harm to treated plants, animals, and surfaces
▲ Less skin absorption than EC and other liquid formulations

Disadvantages:
▼ Inhalation hazard to applicator while pouring and mixing the concentrated powder
▼ Requires good and constant agitation (usually mechanical) in the spray tank; quickly settles out if agitation stops
▼ Abrasive to many pumps and nozzles, causing them to wear out quickly
▼ Difficult to mix in very hard or very alkaline water
▼ Can clog nozzles and screens
▼ Can leave visible residues

Soluble powders (SP or WSP)

Soluble powder formulations look like wettable powders. However, when mixed with water, soluble powders dissolve readily and form a true solution. After they are mixed thoroughly, no additional agitation is necessary. The amount of active ingredient in soluble powders ranges from 15 to 95 percent; it usually is over 50 percent.

Soluble powders have all the advantages of wettable powders and none of the disadvantages except the inhalation hazard during mixing. Few pesticides are available in this formulation because few active ingredients are soluble in water.

Microencapsulated (M)

Microencapsulated formulations are particles of pesticides (liquid or dry) surrounded by a plastic coating. The formulated product is mixed with water and applied as a spray. Once applied, the capsule slowly releases the pesticide. The encapsulation process can prolong the active life of the pesticide by providing a timed release of the active ingredient.

Advantages:
▲ Increased safety to applicator
▲ Easy to mix, handle, and apply
▲ Releases pesticide over a period of time

Disadvantages:
▼ Constant agitation necessary in tank
▼ Some bees may pick up the capsules and carry them back to their hive where the released pesticide may poison the entire hive

Water-Dispersible Granules (dry flowables) (WDG or DF)

Water-dispersible granular formulations are like wettable powder formulations, except the active ingredient is prepared as granule-sized particles. Water-dispersible granules must be mixed with water to be applied. Once in water, the granules break apart into fine powder. The formulation requires constant agitation to keep it suspended in water. Water-dispersible granules share the advantages and disadvantages of wettable powders except:

▲ They are more easily measured and mixed
▲ They cause less inhalation hazard to the applicator during pouring and mixing.

Fumigants

Fumigants are pesticides that form poisonous gases when applied. Some active ingredients are liquids when packaged under high pressure but change to gases when they are released.

Other active ingredients are volatile liquids when enclosed in an ordinary container and so are not formulated under pressure. Others are solids that release gases when applied under conditions of high humidity or in the presence of water vapor. Fumigants are used for structural pest control, in food and grain storage facilities, and in regulatory pest control at ports of entry and at State and national borders. In agricultural pest control, fumigants are used in soil and in greenhouses, granaries, and grain bins.

Advantages:
▲ Toxic to a wide range of pests
▲ Can penetrate cracks, crevices, wood, and tightly packed areas such as soil or grains
▲ Single treatment usually will kill most pests in treated area

Disadvantages:
▼ The target site must be enclosed or covered to prevent the gas from escaping
▼ Highly toxic to humans and all other living organisms
▼ Requires specialized protective equipment, including respirators
▼ Requires specialized application equipment

Adjuvants

An adjuvant is a chemical added to a pesticide formulation or tank mix to increase its effectiveness or safety. Most pesticide formulations contain at least a small percentage of adjuvants. Some of the most common adjuvants are **surfactants** – "**surf**ace **act**ive ingredients" that alter the dispersing, spreading, and wetting properties of spray droplets.

Common adjuvants are:

Wetting agents – allow wettable powders to mix with water.

Emulsifiers – allow petroleum-based pesticides (EC's) to mix with water.

Invert emulsifiers – allow water-based pesticides to mix with petroleum carrier.

Spreaders – allow pesticide to form a uniform coating layer over the treated surface.

Stickers – allow pesticide to stay on the treated surface.

Penetrants – allow the pesticide to get through the outer surface to the inside of the treated area.

Foaming agents – reduce drift.

Thickeners – reduce drift by increasing droplet size.

Safeners – reduce the toxicity of a pesticide formulation to the pesticide handler or to the treated surface.

Compatibility agents – aid in combining pesticides effectively.

Buffers – allow pesticides to be mixed with diluents or other pesticides of different acidity or alkalinity.

Anti-foaming agents – reduce foaming of spray mixtures that require vigorous agitation.

Test Your Knowledge

Q-1. What is a pesticide formulation?

- **A.** A pesticide formulation is the mixture of active and inert (inactive) ingredients that forms a product.

Q-2. What is the difference between active ingredients and inert ingredients?

- **A.** Active ingredients are the chemicals in a pesticide product that control pests. Inert ingredients are the chemicals in a pesticide

product that are added to make the product safer, more effective, easier to measure, mix, and apply, and more convenient to handle.

Q-3. What types of factors should you consider when you have a choice of formulations for a pest control task?

- **A.** You should think about the characteristics of each formulation, and you should consider which of the formulation's advantages and disadvantages are important in your application situation.

Q-4. If you had a choice of either a WP or an EC for a particular pest control task, which would be better if you were concerned about harming the treated surface? Which would be best if you were diluting with very hard or alkaline water?

- **A.** The WP would be the best choice in the first situation, because EC are corrosive and may cause pitting, discoloration, or other damage to treated surfaces. WP are difficult to mix in very hard or very alkaline water, so the EC formulation would be the best choice in the second situation.

Q-5. Why are adjuvants sometimes added to pesticide formulations?

- **A.** Adjuvants are added to a pesticide formulation or tank mix to increase its effectiveness or safety.

Q-6. What type(s) of adjuvants should you consider for reducing drift? for coating a surface evenly? when you wish to combine two or more pesticides for one application?

- **A.** Foaming agents and thickeners help reduce drift. Spreaders help coat the treated surface with an even layer of pesticide. Compatibility agents aid in combining pesticides effectively.

4 - Pesticides in the Environment

The **environment** is everything around us. It includes not only the natural elements that the word "environment" most often brings to mind, but also people and the manmade components of our world.

The environment is not limited to the outdoors – it also includes the indoor areas where we live and work. It is air, soil, water, plants, animals, houses, restaurants, office buildings, and factories and all that they contain.

Anyone who uses a pesticide – indoors or outdoors, in a city or in the country – must ask two questions:

1) How will this pesticide affect the immediate environment where it is being used? 2) What are the dangers that the pesticide will move out of the use site and cause harm to other parts of the environment?

Pesticides can harm all types of environments if they are not used correctly. **Responsible pesticide users know and follow good practices that achieve effective pest control with very little risk of environmental damage.**

Pesticide product labeling statements are intended to alert you to particular environmental concerns that a pesticide product poses. Use good judgment, too. The lack of a particular precautionary statement does not necessarily mean that the product does not pose a hazard to the environment.

Both the public and the EPA are becoming increasingly concerned about harmful effects on the environment from pesticide use. As a result, the EPA is looking closely at environmental effects when it considers new registration applications. It also is reexamining existing pesticide registrations.

Previously, the primary reason for the EPA classifying a pesticide as a Restricted Use product was its potential as a hazard to humans. Now, more and more pesticide labels list environmental effects, such as contamination of ground water or toxicity to birds or aquatic invertebrate animals, as a reason for restriction.

Sources of Contamination

Environmental contamination is caused by either **point-source** or **non-point-source** pollution.

Point-source pollution comes from a specific, identifiable place (point). A pesticide spill that moves into a storm sewer is an example of point-source pollution.

Non-point-source pollution comes from a wide area. The movement of pesticides into streams after broadcast applications is an example of non-point-source pollution. Non-point-source pollution from pesticide applications has commonly been blamed for pesticide contamination outdoors.

However, studies are revealing that much of the environmental contamination does not result from non-point-source pollution. Contamination also results from point sources, such as:

– wash water and spills produced at equipment cleanup sites, –improper disposal of containers, water from rinsing containers, and excess pesticides, –pesticide storage sites where leaks and spills are not correctly cleaned up, and –spills that occur while mixing concentrates or loading pesticides into application equipment.

These kinds of tasks are involved with nearly every pesticide use, whether the pesticide is applied outdoors or in or around an enclosed structure.

If you use Restricted Use pesticides, you must become aware of the potential for environmental contamination during every phase of your pesticide operation. Many pesticide uses are restricted because of environmental concerns. Whenever you release a pesticide into the environment – whether intentionally or accidentally – consider:

Are there sensitive areas at the pesticide use site that might be harmed by contact with the pesticide?

Are sensitive offsite areas near the use site that might be harmed by contact with the pesticide?

Are there are environmental conditions at the use site that might cause the pesticide to move offsite?

Do you need to change any factors in your application or in the pesticide use site to reduce the risk of environmental contamination?

Sensitive Areas

Sensitive areas are sites or living things that are easily injured by a pesticide.

Sensitive areas outdoors include:

where ground water is near the surface or easily accessed (wells, sinkholes, porous soil, etc.); in or near surface water; schools, playgrounds, hospitals, and other institutions; habitats of endangered species; apiaries (honeybee sites), wildlife refuges, or parks; and ornamental gardens, food or feed crops, or other sensitive plantings.

Sensitive areas indoors include: where people – especially children, pregnant women, the elderly, or the sick – live, work, or are cared for;

where food or feed is processed, prepared, stored, or served;

where domestic or confined animals live, eat, or are otherwise cared for; and

where ornamental or other sensitive plantings are grown or maintained.

Sometimes pesticides must be deliberately applied to a sensitive area to control a pest. These applications should be performed by persons well-trained about how to avoid causing injury in such areas.

At other times, the sensitive area is part of a larger target site. Whenever possible, take special precautions to avoid direct application to the sensitive area. For example, leaving an untreated buffer zone around sensitive areas is often a practical way to avoid contamination.

In other instances, the sensitive area may be near a site that is used for application, mixing/loading, storage, disposal, or equipment washing. Pesticide users must take precautions to avoid accidental contamination of the sensitive area. For example, a permanent site for mixing/loading or equipment washing could be equipped with a collection pad or tray to catch and contain leaks, spills, or waste water.

Pesticide Movement

Pesticides that move away from the release site may cause environmental contamination. This can occur indoors or outdoors and may cause harm in both environments. Pesticides move in several ways, including:

AIR - through wind or through air currents generated by ventilation systems,

WATER through runoff or leaching,

on or in OBJECTS, plants, or animals (including humans) that move or are moved offsite.

Air

Pesticide movement away from the release site in the air is usually called drift. Pesticide particles, dusts, spray droplets, and vapors all may be carried offsite in the air. People who mix, load, and apply pesticides outdoors usually are aware of the ease with which pesticides drift offsite. People who handle pesticides indoors may not realize how easily some pesticides move offsite in the air currents created by ventilation systems and by forced-air heating and cooling systems.

Particles and droplets – Lightweight particles, such as dusts and wettable powders, are easily carried by moving air. Granules and pellets are much heavier and tend to settle out of air quickly. Small spray droplets also are easily carried in air currents. High-pressure and fine nozzles produce very small spray droplets that are very likely to drift. Lower pressure and coarse nozzles produce larger droplets with less drift potential.

The likelihood that pesticide particles and spray droplets will drift offsite depends partly on the way they are released. Pesticides released close to the ground or floor are not as likely to be caught up in air currents as those released from a greater height. Pesticides applied in an upward direction or from an aircraft are the most likely to be carried on air currents.

Vapors – Pesticide vapors move about easily in air. Fumigant pesticides are intended to form a vapor when they are released. Persons using fumigants must take precautions to make sure the fumigant remains in a sealed container until it is released into the application site, which also must be sealed to prevent the vapor from escaping.

Some non-fumigant pesticides also can vaporize and escape into the air. The labeling of volatile pesticides often includes warning statements that the pesticide handler should heed. Any time you release a volatile pesticide in an enclosed area, consider the hazards not only to yourself and to fellow workers, but also to people, animals, and plants in or near the release site or which may be in the area soon after the release.

Typical pesticide labeling statements that alert you to avoid drift include:

"*Do not apply when weather conditions favor drift from areas treated.*"

Water

Pesticide particles and liquids may be carried offsite in water. Pesticides can enter water through:

■ Drift, leaching, and runoff from nearby applications,

■ Spills, leaks, and back-siphoning from nearby mixing, loading, storage, and equipment cleanup sites, and

■ Improper disposal of pesticides, rinsates, and containers.

Most pesticide movement in water is across the treated surface (runoff) or downward from the surface (leaching).

Runoff and **leaching** may occur when:

Too much liquid pesticide is applied, leaked, or spilled onto a surface, or

Too much rainwater, irrigation water, or other water gets onto a surface containing pesticide residue.

Runoff water in the outdoor environment may travel into drainage ditches, streams, ponds, or other surface water where the pesticides can be carried great distances offsite. Pesticides that leach downward through the soil in the outdoor environment sometimes reach the ground water.

Runoff water in the indoor environment may get into domestic water systems and from there into surface water and ground water. Runoff can flow into floor drains or other drains and into the water system. Sometimes a careless pesticide handler washes pesticide down a sink drain and into the water system.

Some pesticides can leach downwards in indoor environments. In a greenhouse, for example, pesticides may leach through the soil or other planting medium to floors or benches below. Some pesticides used indoors may be absorbed into carpets, wood, and other porous surfaces and remain trapped for a long time.

Typical pesticide labeling statements that alert you to these concerns include:

"*Do not contaminate water through runoff, spills, or improper disposal of excess pesticide, spray mixtures, or rinsates*."

"*Maintain a buffer zone (lay-off distance) of 100 feet from bodies of water*."

On or in Objects, Plants, or Animals

Pesticides can move away from the release site when they are on or in objects or organisms that move (or are moved) offsite. Pesticides may stick to shoes or clothing, to animal fur, or to blowing dust and be transferred to other surfaces.

When pesticide handlers bring home or wear home contaminated personal protective equipment, work clothing, or other items, residues can rub off on carpeting, furniture, and laundry items and onto pets and people.

Pesticides may stick to treated surfaces, such as food or feed products that are to be sold. To protect consumers, there are legal limits (tolerances) for how much pesticide residue may safely remain on crops or animal products sold for food or feed. Products exceeding these tolerances are illegal and cannot be sold.

Crops and animal products will not be over tolerance if the pesticides are applied according to product labeling. Illegal pesticide residues usually result when:

— Too much pesticide is applied to the crop or animal,

— The days-to-harvest, days-to-grazing, or days-to-slaughter directions on the pesticide labeling are not obeyed, or

— Pesticides move out of the release site and contaminate plants or animals nearby.

Typical pesticide labeling statements -

"*Do not apply within five days of harvest*."

"*Do not pasture or feed treated hay to lactating dairy cattle within 21 days after application*."

Harmful Effects on Non-target Plants and Animals

Non-target organisms may be harmed by pesticides in two ways:

1) by direct contact 2) leaving pesticide residues that causes later injuries.

Harmful Effects from Direct Contact

Pesticides may harm non-target organisms present during application. Poorly timed applications can kill bees and other pollinators in or near the target site. Pesticides may harm other wildlife, too. Even tiny amounts of some pesticides may harm them or destroy their food source.

Pesticides applied over large areas, such as in mosquito, biting fly, and forest pest control, must be chosen with great care to avoid poisoning non-target plants and animals in or near the target site.

Read the warnings and directions on the pesticide labeling carefully to avoid harming non-target organisms during a pesticide application.

Drift from the target site may injure wildlife, livestock, pets, sensitive plants, and people. For example, herbicide drift can damage sensitive nearby plants, including crops, forests, or ornamental plantings. Drift also can kill beneficial parasites and predators near the target site.

Pesticide runoff may harm fish and other aquatic animals and plants in ponds, streams, and lakes. Aquatic life also can be harmed by careless tank filling or draining and by rinsing or discarding used containers along or in waterways.

Typical pesticide labeling statements that alert you to these concerns include:

"*Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area*."

"*Extremely toxic to aquatic organisms. Do not contaminate water by cleaning of equipment or disposal of wastes*."

Harmful Effects from Residues

A **residue** is the part of a pesticide remaining in the environment after an application or spill.

Pesticides usually break down into harmless components after they are released into an environment. The breakdown time ranges from less than a day to several years. The rate of pesticide breakdown depends mostly on the chemical structure of the active ingredient in the pesticide.

The rate of breakdown also may be affected by environmental conditions at the release site, such as:

▪ surface type, chemical composition, and pH, ▪ surface moisture, ▪ presence of microorganisms, ▪ temperature, and ▪ exposure to direct sunlight.

Persistent pesticides leave residues that stay in the environment without breaking down for a long time. Sometimes these pesticides are desirable because they provide long-term pest control and may reduce the need for repeated applications.

However, some persistent pesticides that are applied to or spilled on soil, plants, lumber, and other surfaces or into water can later cause harm to sensitive plants, animals, or humans that contact them.

Here is an example labeling statement for a persistent pesticide product:

"*Can remain in the soil for 12 months or more and cause injury to certain crops other than those listed as acceptable on the label*."

When using persistent pesticides, consider whether their continued presence in the environment is likely to harm people, plants or animals.

When pesticides build up in the bodies of animals or in the soil, they are said to **accumulate**. When the same mixing/loading site or equipment cleaning site is used frequently without taking steps to limit and clean up spills, pesticides are likely to accumulate in the soil. When this occurs, plants, animals, and objects that come into contact with the soil may be harmed.

When pesticides accumulate in the soil, there is also a higher likelihood that the pesticides will move offsite and contaminate the surrounding environment or move into surface or ground water.

Sometimes animals can be harmed when they feed on plants or animals that have pesticide residues on or in them. A special concern is for predator birds or mammals that feed on

animals that have been killed by pesticides. The predators may be harmed by the pesticide residues remaining on or in the bodies of the dead animals.

Harmful Effects on Surfaces

Sometimes surfaces are harmed by pesticides or pesticide residues. Some surfaces may become discolored, while others may become pitted or marked. Some pesticides can corrode or obstruct electronic systems or metal. Others will leave a visible deposit on the treated surface.

Typical pesticide labeling statements that alert you to these concerns include:

"Do not apply to carpeting, linoleum, or other porous floor coverings, as discoloration may result."

"Do not spray on plastic, painted, or varnished surfaces."

Test Your Knowledge

Q-1. What is the "environment"?

- **A.** The environment is everything that surrounds us – indoors and outdoors – including natural elements, manmade objects, people, and other living organisms.

Q-2. Explain what is meant by point-source and non-point-source contamination of the environment by pesticides, and give an example of each.

- **A.** Point-source pollution comes from a specific, identifiable place (point). A pesticide spill that moves into a storm sewer is an example of point-source pollution. Non-point-source pollution comes from a wide area. The movement of pesticides into streams after broadcast applications is an example of non-point-source pollution.

Q-3. Name some ways that careless pesticide handling could lead to point-source pollution.

- **A.** 1. Mismanagement of wash water and spills produced at equipment cleanup sites. 2. Improper disposal of containers, water from rinsing containers, and excess pesticides. 3. Failure to correctly clean up leaks and spills at pesticide storage sites. 4. Spilling pesticides while mixing concentrates or loading pesticides into application equipment.

Q-4. What environmental factors should you consider any time you accidentally or intentionally release a pesticide into an environment?

- **A.** 1. Whether there are sensitive areas in the environment at the pesticide use site that might be harmed by contact with the pesticide, 2. Whether there are sensitive offsite areas near the use site that might be harmed by contact with the pesticide, 3. Whether there are conditions in the immediate environment that might cause the pesticide to move offsite, and 4. Whether you can change any factors in your application or in the pesticide use site to reduce the risk of environmental contamination.

Q-5. What is a "sensitive area"? Give four examples of sensitive areas that you must be especially careful to protect when you are handling pesticides.

- **A.** Sensitive areas are sites or living things in environments that are easily injured by a pesticide. Some examples of sensitive areas include: places where pesticides might get into ground water or surface water; homes, schools, playgrounds, hospitals, and other places where people are present; places where there are animals – endangered species, bees, other wildlife, livestock, pets; places where crops, ornamental plants, or other sensitive plants are growing; and areas where food or feed is processed, stored, or served.

Q-6. List three routes by which pesticides can move offsite.

- **A.** 1. In air, through wind or through air currents generated by ventilation systems

2. In water, through runoff or leaching

3. On or in objects, plants, or animals (including humans) that move or are moved offsite.

Q-7. What factors influence whether a pesticide will move offsite in the air?

- **A.** 1. Droplet or particle size 2. Height and direction of release 3. Whether the pesticide tends to form vapors

Q-8. Name two circumstances that might cause a pesticide to move offsite in water.

- **A.** 1. Too much liquid pesticide is applied, leaked, or spilled onto a surface

2. Too much rainwater, irrigation water, or wash water gets onto a surface that contains pesticide residue

Q-9. Give some examples of ways that pesticides can move offsite on or in objects, plants, or animals.

- **A.** 1. Pesticides may be carried offsite if they stick to such things as shoes or clothing, animal fur, or blowing dust – anything that moves from the use site to another location.

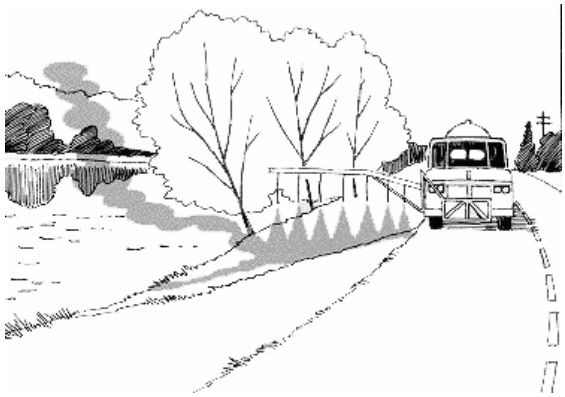
2. Pesticide residues may remain on treated surfaces, such as food or feed products, when they are taken from the use site to be sold.

Q-10. In addition to direct contact with the pesticide during application or through drift or runoff, how else may non-target plants and animals be harmed by a pesticide?

- **A.** Non-target plants and animals may be harmed by pesticide residues that stay in the environment after the release. These can be residues in soil or on surfaces, or they may be residues that build up in the bodies of animals, harming those animals themselves and sometimes other animals that feed on them.

Q-11. What kinds of damage can some pesticides cause to surfaces?

- **A.** Surfaces may become discolored, be pitted or marked, be corroded or obstructed, or be left with a visible deposit.



5 - Special Environmental Concerns – Protecting Ground Water and Endangered Species

Concerns about wildlife and the environment are becoming more important in decisions about which pesticides will be registered and what they may be used for. Two environmental concerns are receiving particular attention in Kentucky are:

protection of ground water, and

protection of endangered species

Federal and state efforts to protect ground water and endangered species are resulting in new instructions and limitations for pesticide handlers. Whether you apply pesticides indoors or outdoors, in an urban area or in a rural area, you must become aware of the importance of protecting these two vital national resources.

Pesticides that are incorrectly or accidentally released into the environment – either during application or during other handling activities, such as mixing, loading, equipment cleaning, storage, transportation, or disposal – pose a threat to ground water and endangered species.

> Whether or not you must take special action to protect ground water and endangered species depends mainly on the location of your use site.

Ground water contamination is of greatest concern in release sites where ground water is close to the surface or where the soil type or the geology allows contaminants to reach ground water easily.

Protection of endangered species usually is required only in locations where they currently live or are being reintroduced. Read the pesticide labeling carefully to determine whether or not your pesticide use is subject to any special ground water or endangered species limitations.

The EPA may establish specific limitations or instructions for pesticide users in locations where ground water or endangered species are most at risk. These limitations and instructions are often too long to be included in pesticide labeling. The labeling may tell you to consult another source for details about the instructions and limitations for your situation. Your legal responsibility for following instructions that are distributed separately is the same as it is for instructions that appear in full on the pesticide labeling.

Protecting Ground Water

Ground water is water located beneath the earth's surface. Many people think that ground water occurs in vast underground lakes, rivers, or streams. Usually, however, it is located in rock and soil. It moves slowly through irregular spaces within otherwise solid rock or seeps between particles of sand, clay, and gravel. An exception is in limestone areas of Kentucky, where ground water may flow through large underground channels or caverns.

Surface water may move several feet in a second or a minute. Ground water may move only a few feet in a month or a year. If the ground water is capable of providing significant quantities of water to a well or spring, it is called an aquifer. Pesticide contamination of aquifers is very troubling because these are sources of drinking, washing, and irrigation water.

Sources of Ground Water

Ground water is recharged (replaced) mostly from rain or snow that enters the soil. However, some water from lakes and streams and from irrigation also becomes ground water.

Water that is above the ground can move in three ways: 1) it can evaporate into the air; 2) it can move across the surface, as in a stream or river; or, 3) it can move down from the surface. Some water that moves downward is absorbed by plants and other organisms. Another portion of this water is held in the upper soil layers. The rest moves down through the root zone and the relatively dry soil zone until it reaches a zone saturated with water. This saturated zone is the uppermost layer of ground water and is called the water table. The water table is the "dividing line" between the ground water and the unsaturated rock or soil above it.

Groundwater Use in Kentucky

According to Division of Water estimates, approximately 500,000 Kentuckians depend on 200,000 wells and springs for household water. More than 250 public water systems use groundwater to supply more than 1,200,000 people. Another 226 million gallons are used daily in commercial and industrial operations. Groundwater sustains important ecosystems by providing base flow to rivers, streams and lakes. Groundwater will continue to be very important in Kentucky because it is neither practical nor economical to replace it with surface water.

Pesticide Contamination of Ground Water

When water that is moving downward from the surface contains pesticides – or comes into contact with them as it moves – the pesticides may be carried along with the water until they eventually reach the ground water.

Five major factors determine whether a pesticide will reach ground water: 1) pesticide user practices, 2) the presence or absence of surface water where the pesticides are released, 3) the chemical characteristics of the pesticides, 4) the type of soil in the site where the pesticides are released, 5) the location of the ground water – its distance from the surface and the type of geological formations above it.

By being aware of these considerations, you can handle pesticides in ways that will make the potential for ground water contamination less likely.

Practices for Pesticide Users

The best way to keep from contaminating ground water is to follow labeling directions exactly. Be sure to note whether the labeling requires you to take any special steps to protect ground water. In addition, remember the following:

1. Avoid the temptation to use more pesticide than the labeling directs.
2. Overdosing will increase both the cost of pest control and the odds that the pesticide will reach ground water. Overdosing is also illegal. Keeping the use of pesticides to a minimum greatly reduces the risk of ground water contamination.
3. Consider whether your application method presents any special risks. For example, soil injection of some pesticides may not be wise when ground water is close to the surface.
4. Take precautions to keep pesticides from back-siphoning into your water source.
5. Locate pesticide storage facilities at least 100 feet from wells, springs, sinkholes, and other sites that directly link to ground water to prevent their contamination from runoff or firefighting water.
6. Whenever possible, locate mix-load sites and equipment-cleaning sites at least 100 feet from surface water or from direct links to ground water. This will help prevent back-siphoning, runoff, and spills from contaminating the water sources. If you must locate one of these work sites near a water source, use methods such as dikes, sump pits,

and containment pads to keep pesticides from reaching the water.
7. Do not contaminate ground water through improper disposal of unused pesticides, pesticide containers, or equipment and container rinse water. Dispose of all pesticide wastes in accordance with local, state, tribal, and federal laws.

Water on the Treated Surface

If there is more water on the soil than the soil can hold, the water (along with any pesticides it contains) is likely to move downward to the ground water. Prolonged heavy rain or excessive irrigation will produce excess water on the soil surface.

Rain – If weather forecasts or your knowledge of local weather signs cause you to expect heavy rain, delay outdoor handling operations – including mixing and loading, application, and disposal – to prevent wash-off, surface runoff, or leaching.

Irrigation – Pesticide movement into ground water is affected by both the amount of water used in irrigation and how soon before or after a pesticide application the irrigation is done. If irrigation water contains pesticides, be careful to prevent it from flowing into water sources.

Pesticide Factors

Some pesticides are more likely than others to move to ground water. Such movement depends mainly on:

Solubility – Some pesticides dissolve easily in water and are more likely to move into water systems.

Adsorption – Some pesticides become tightly attached (strongly adsorbed) to soil particles and are not likely to move out of the soil and into water systems.

Persistence – Some pesticides break down slowly and remain in the environment for a long time.

These factors are all related to one another. Pesticides most likely to move into ground water are highly soluble, moderately to highly persistent, and are not strongly adsorbed to soil.

A non-persistent pesticide would be less likely to move to ground water, even if it is highly soluble or not strongly adsorbed to soil. A pesticide that is strongly adsorbed to soil would be less likely to move to ground water even if it is persistent.

Pesticide labeling usually does not tell you about these properties of the pesticide product. The Natural Resources Conservation Service, Cooperative Extension Service, your trade association, or your pesticide dealer may have specific information about the characteristics of the pesticides you are using.

Soil Factors

Soil is also an important factor in the breakdown and movement of pesticides. Your local Soil Conservation Service can help you determine the types of soil in your area and how they affect breakdown and movement.

The three major soil characteristics that affect pesticides are texture, permeability, and organic matter.

Soil texture is an indication of the relative proportions of sand, silt, and clay in the soil. Coarse, sandy soils generally allow water to carry the pesticides rapidly downward. Finer textured soils generally allow water to move at much slower rates. They contain more clay, and sometimes organic matter, to which pesticides may cling.

Soil permeability is a general measure of how fast water can move downward in a particular soil. The more permeable soils must be managed carefully to keep pesticides from reaching ground water.

Soil organic matter influences how much water the soil can hold before it begins to

move downward. Soil containing organic matter has greater ability to stop the movement of pesticides. Soils in which plants are growing are more likely to prevent pesticide movement than bare soils.

Geology

The **distance from the soil surface to the water table** is the measure of how deep the ground water is in a given location. If the ground water is within a few feet of the soil surface, pesticides are more likely to reach it than if it is farther down. In humid areas, the water table may be only a few feet below the soil surface. In arid areas, the water table may lie several hundred feet below the soil surface. The depth to the water table does not stay the same over the course of the year.

It varies according to: – the amount of rain, snow, and irrigation water being added to the soil surface, – the amount of evaporation and plant uptake, – whether the ground is frozen, and – how much ground water is being withdrawn by pumping.

The Natural Resources Conservation Service can provide you with valuable information on the geology of an area and on the potential for ground water contamination on your property.

The water table generally is closest to the soil surface in spring and fall. The water table often moves downward during the summer when evaporation and plant uptake are high and irrigation is used. The water table also moves downward in winter if surface water cannot move down through the frozen soil to recharge the ground water.

The **permeability of geological layers** between the soil and ground water is also important. If surface water can move down quickly, pesticides are more likely to reach ground water. Gravel deposits are highly permeable. They allow water and any pesticides in it to move rapidly downward to ground water.

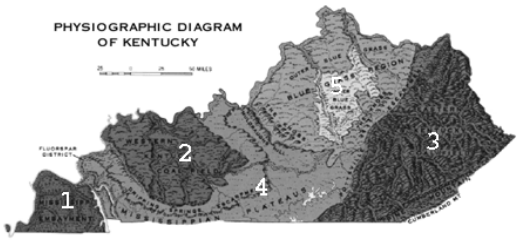
Regions of Kentucky with limestone deposits are particularly susceptible to ground water contamination, because water may move rapidly to the ground water through caverns or "rivers" with little filtration or chemical breakdown. On the other hand, layers of clay may be totally impermeable and may prevent most water and any pesticides in it from reaching the ground water.

Sinkholes are especially troublesome. Surface water often flows into sinkholes and disappears quickly into the ground water. If a pesticide is released into an area that drains to a sinkhole, even a moderate rain or irrigation may carry some of the pesticide directly to the ground water.

Kentucky Geology

Geology controls the occurrence and movement of groundwater and therefore has an important effect on groundwater quality. Different types of rocks have different magnitudes of permeability. (Permeability is a measure of how fast water can move through a rock.)

Five physiographic regions occur in Kentucky. They are based primarily on the type of rock units that underlie each area.



The **(1) Mississippi Embayment** (Jackson Purchase) is made up of loose to semi-consolidated sediments ranging in size from gravel to sand, silt and clay. Because groundwater flows between the grains, these units are said to have intergranular permeability. Recharge from rainfall or irrigation can be rapid, allowing easy

downward movement of pollutants to the groundwater table.

The **(2) Western and (3) Eastern Coal Fields** are composed primarily of granular rocks such as sandstones, siltstones and shales. Because these units have been compacted into hard bedrock, permeability (and related groundwater movement) is less than in the semi-consolidated sediments of the Ohio River Valley and the Mississippi Embayment. In general, the potential for groundwater pollution is lower.

The **(4) Mississippian Plateaus** and the **(5) Bluegrass regions** are composed of limestone and dolomite. These rocks are very dense but they tend to dissolve along fractures and other zones of weakness and form solution channels. Surface sinkholes are connected by open solution channels in what is called a karst system. In some cases these solution channels have widened during vast amounts of geologic time to form cave and cavern systems such as Mammoth Cave. Because surface water is free to move directly into sinkholes and then rapidly through the underground solution openings, pollutants can easily contaminate the groundwater in karst systems.

Kentucky is fortunate because hydrologic atlases, topographic maps and geological maps are available at the Kentucky Geological Survey for every part of the state. These maps point out many of the geologic features that affect our groundwater quality and provide useful information for protecting this valuable resource.

The Certified Applicator's Role

Some pesticides or certain uses of some pesticides may be classified as restricted use because of ground water concerns. As a certified applicator, you have a special responsibility to handle all pesticides safely in and near use sites where ground water contamination is particularly likely. Take extra precautions when using techniques that are known to be likely to cause contamination of ground water, such as chemigation and soil injection.

When a pesticide product has been found in ground water or has characteristics that may pose a threat of contamination of ground water, the pesticide product labeling may contain statements to alert you to the concern.

A typical pesticide labeling statement:

"*This chemical has been identified in limited ground water sampling and there is the possibility that it can leach through the soil to ground water, especially where soils are coarse and ground water is near the surface*."

Protection of Endangered Species

An endangered species is a plant or animal in danger of becoming extinct. There are two classifications of these plants and animals – "endangered species" and "threatened species." The term "endangered species" is used here to refer to the two classifications collectively. Scientists believe that some pesticides may threaten the survival of some of America's endangered species if they are used where these plants and animals still exist.

A federal law, the Endangered Species Act, requires the EPA to ensure that endangered species are protected from pesticides. An EPA goal is to remove or reduce the threat that pesticide use poses to endangered species. Reaching this goal will require some limitations on pesticide use. These limitations usually will apply only in the currently occupied habitat or range of each endangered species at risk. Occasionally, the limitations will apply where endangered species are being reintroduced into a habitat they previously occupied.

Habitats, sometimes called "critical habitats," are the areas of land, water, and air space that an endangered species needs for survival. Such areas include breeding sites; sources of food,

cover, and shelter; and surrounding territory that gives room for normal population growth and behavior.

Limitations on Pesticide Use

Read all pesticide labeling carefully to find out whether the use of that product requires you to take any special steps to protect endangered species. The label may direct you to another source for the details about what you must do. When limitations do apply, they usually will be in effect only in some specific geographic locations.

Use of a particular pesticide is usually limited in a particular location when: the site is designated as the current habitat of an endangered species, **and** the endangered species that uses the site might be harmed by the use of the pesticide within (or close to) its habitat.

Habitats of Endangered Species

The U.S. Fish and Wildlife Service is responsible for identifying the current habitat or range of each endangered species. For aquatic species, the restricted habitat often will include an additional zone around the body of water to keep any drift, runoff, or leachate in the watershed from reaching the water.

The U.S. Fish and Wildlife Service is attempting to identify the habitats as accurately as possible so that pesticide use will need to be limited only in locations where it is absolutely necessary. For this reason, limitations on pesticide use may apply on one property, while a similar adjoining property may not have these limitations.

Importance of Protecting Endangered Species

Hundreds of animals (including fish, birds, mammals, reptiles, amphibians, insects, and aquatic invertebrates) and thousands of plants have been named as endangered or threatened species under the provisions of the Endangered Species Act. Regardless of the size or apparent significance of these endangered species, it is important that each is allowed to survive – mankind's well-being depends on maintaining **biological diversity**.

Biological diversity is the variety and differences among living things, and the complex ways they interact. Diversity is necessary for several reasons:

Agriculture – Nearly all of today's crops started as wild species. Genes from wild species often are used to create new hybrids that have resistance to plant diseases and insects, better climatic tolerance, and higher yields. Having different varieties available is necessary insurance against devastating crop failures caused by climate extremes or major pest outbreaks.

Medicine – Many of today's most important medicines come from obscure plant and animal species. A mold is the source of penicillin, the miracle drug; an herb is the source of quinine, a cure for malaria. Scientists are testing countless plant and animal species around the world for sources of cures for major diseases.

Preserving choices – No one can predict which species may be essential to the future of mankind. A species that is allowed to become extinct might have been the key to stopping a global epidemic or to surviving a major climate change.

Interdependence – The extinction of a single species can set off a chain reaction of harm to other species. The disappearance of a single kind of plant from an area, for example, may lead to the disappearance of certain insects, higher animals, and other plants.

Natural balance – Extinction has always been a natural part of an ever-changing process. During most of history, species have formed at a rate greater than the rate of extinctions. Now, however, it appears that human activity is greatly speeding up the rate of extinctions. People, plants, and animals live together in a

delicate balance; the disappearance of species could easily upset that balance.

Stability – The more diversity that exists in an ecosystem, the more stable it is likely to be. There is less likelihood of huge swings in populations of particular organisms. There is also less likelihood of devastation from the introduction of a new species from outside the system.

Kentucky's Threatened and Endangered Species

Forty-two species are listed as threatened or endangered including 33 animals and 9 plants. Three species of bats and several species of fresh water mussels are on the list along with minnows and birds.

In addition to the mussels, the Kentucky cave shrimp is a good example of a species that could be severely impacted by groundwater contamination. Its distribution is limited to the Mammoth Cave National Park region and is threatened because it has specific habitat requirements. In addition to being adapted to a highly specialized and restricted environment it also is shrimp is threatened by potential pesticide contamination of the groundwater flowing into its habitat.

The Certified Applicator's Role

Pesticides have the potential to harm living organisms, including endangered species:

Pesticides can kill endangered plants and animals directly.

Pesticides in the habitat of the endangered organisms can disrupt or destroy their sources of food and shelter.

Pesticide application, drift, runoff, and leachate can contaminate water ingested by or inhabited by endangered organisms.

Some pesticides can build up to dangerous levels in endangered predators that feed on plants or animals exposed to pesticides.

As a certified applicator, you have a clearly defined legal responsibility to protect endangered species against the hazards posed by pesticides. Using pesticides carefully in and around the key habitat areas will help these fragile plants and animals survive, and it also may prevent some important pesticides from being removed from the market.

Know the Law

The Endangered Species Act (ESA) is a federal law administered by the Fish and Wildlife Service (FWS) of the Department of the Interior. The ESA makes it illegal to kill, harm, or collect endangered or threatened wildlife or fish or to remove endangered or threatened plants from areas under federal jurisdiction. It also requires other federal agencies to ensure that any action they carry out or authorize is not likely to jeopardize the continued existence of any endangered or threatened species, or to destroy or adversely modify its critical habitat. As a result, EPA must ensure that no registered pesticide use is likely to jeopardize the survival of any endangered or threatened species.

The FWS has the authority to designate land and freshwater species as endangered or threatened and to identify their current habitat or range. The National Marine Fisheries Service has the same authority for marine species.

The FWS has the authority to prosecute persons, including pesticide users, who harm endangered or threatened species. In addition, EPA enforcement personnel have the authority to ensure that pesticide users observe labeling restrictions.

Test Your Knowledge

Q-1. Which pesticide handling activities pose a threat to ground water or endangered species?

- **A.** All handling activities may pose a threat.

Q-2. Why is the location of your pesticide use site the main factor that determines whether you must take special action to protect endangered species or ground water?

- **A.** These special limitations on pesticide use are usually in effect only in locations where endangered species live or are being introduced and in areas where ground water is especially likely to be contaminated. Unless your pesticide use site is in one of these places, the special restrictions do not apply to you.

Q-3. How will you know if you must take special action to protect endangered species or ground water?

- **A.** The pesticide labeling will tell you if special measures are necessary, but it may not contain the detailed instructions that you must follow. The labeling may instruct you to get these from another source.

Q-4. What are some factors that determine whether pesticides will reach ground water?

- **A.** The factors include: practices followed by pesticide users; presence or absence of water on the surface of the site where the pesticides are released; chemical characteristics of the pesticides; type of soil in the site where the pesticides are released; location of the ground water – its distance from the surface and the type of geological formations above it.

Q-5. How can you help to prevent pesticides from reaching ground water?

- **A.** Avoid using more pesticide than the labeling directs; avoid application methods that present special risks; keep pesticides from back-siphoning into your water source; locate pesticide storage facilities at least 100 feet from wells, springs, sinkholes, and other sites that directly link to ground water; locate mix-load sites and equipment-cleaning sites at least 100 feet from surface water or from direct links to ground water or take precautions to protect those sites; dispose of unused pesticides, pesticide containers, and equipment and container rinse water correctly.

Q-6. Explain why the amount of water on the surface of the soil at the pesticide use site is an important factor in ground water contamination.

- **A.** If there is more water on the soil than the soil can hold, the water (along with any pesticides it contains) is likely to move downward to the ground water.

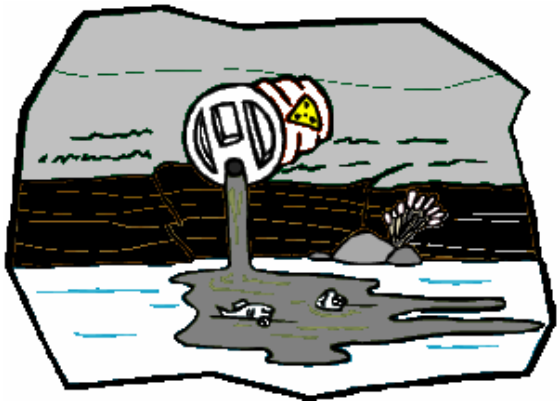
Q-7. Explain how the solubility, adsorption, and persistence of a pesticide affect its ability to move into ground water.

- **A.** Solubility – Some pesticides dissolve easily in water and are more likely to move into water systems.

Adsorption – Some pesticides become tightly attached (strongly adsorbed) to soil particles and are not likely to move out of the soil and into water systems.

Persistence – Some pesticides do not break down quickly and remain in the environment for a long time, so are more likely to move into ground water.

Q-8. What types of soil slow the movement of pesticides into ground water? What types permit rapid movement?



- **A.** Soils that are fine-textured and contain organic matter slow the downward movement of water containing pesticides. Coarse, sandy soils generally allow water to carry pesticides rapidly downward.

Q-9. What geologic factors affect the movement of pesticides into ground water?

- **A.** Distance to ground water, permeability of geologic layers, and the presence or absence of sinkholes.

Q-10. What is an endangered species?

- **A.** An endangered species is a plant or animal that is in danger of becoming extinct.

Q-11. What is a habitat?

- **A.** A habitat is the area of land, water, and air space that an endangered species needs for survival. Such areas include breeding sites; sources of food, cover, and shelter; and enough surrounding territory to give room for normal population growth and behavior.

Q-12. What is biological diversity?

- **A.** Biological diversity is the variety and differences among living things, and the complex ways they interact.

Q-13. How can pesticides harm endangered species?

- **A.** Pesticides may harm endangered species by direct contact; by disrupting or destroying sources of food and shelter; by contaminating water ingested by or inhabited by endangered organisms; by building up to dangerous levels in endangered predators that feed on plants or animals exposed to pesticides.

6 - Harmful Effects and Emergency Response

Most pesticides are designed to harm or kill pests. Because some pests have systems similar to the human system, some pesticides also can harm or kill humans. Fortunately, humans usually can avoid harmful effects by avoiding being exposed to pesticides.

Humans may be harmed by pesticides in two ways: they may be **poisoned** or **injured.** Pesticide **poisoning** is caused by pesticides that harm internal organs or other systems inside the body. Pesticide-related **injuries** usually are caused by pesticides that are external irritants.

Pesticides that are chemically similar to one another cause the same type of harmful effects to humans. These effects may be mild or severe, depending on the pesticide involved and the amount of overexposure. But the **pattern** of illness or injury caused by each chemical group is usually the same. Some pesticide chemical families can cause both external irritation injuries and internal poisoning illnesses.

Some pesticides are highly toxic to humans; only a few drops in the mouth or on the skin can cause extremely harmful effects. Other pesticides are less toxic, but too much exposure to them also will cause harmful effects. A good equation to remember is:

Hazard = Toxicity x Exposure

Hazard is the risk of harmful effects from pesticides. Hazard depends on both the **toxicity** of the pesticide and your **exposure.**

Exposure

When a pesticide contacts a surface or organism, that contact is called a pesticide exposure. For humans, a pesticide exposure means getting pesticides in or on the body. The toxic effect of a pesticide exposure depends on how much pesticide is involved and how long it remains there.

Types of Exposures

Pesticides contact your body in four main ways:

Oral exposure (when you swallow a pesticide),
Inhalation exposure (when you breathe in a pesticide),
Ocular – (through the eyes), or
Dermal (through the skin)

Avoiding Exposure

Avoiding and reducing exposures to pesticides will reduce the harmful effects from pesticides. You can avoid exposures by using safety systems, such as closed systems and enclosed cabs, and you can reduce exposures by wearing appropriate personal protective equipment (PPE), washing exposed areas often, and keeping your personal protective equipment clean and in good operating condition.

In most pesticide handling situations, the skin is the part of the body that is most likely to receive exposure.

> About 97 percent of all body exposure that happens during pesticide spraying is through skin contact.

The only time inhalation is a greater hazard than skin contact is when you are working in a poorly ventilated enclosed space and are using a fumigant or other pesticide that is highly toxic by inhalation.

The amount of pesticide absorbed through your skin (and eyes) and into your body depends on – the pesticide and the material used to dilute it.

ECs, oil-based liquid pesticides, and oil-based diluents (such as xylene) are, in general, absorbed most readily. Water-based pesticides and dilutions (such as WPs, SPs and DFs) usually are absorbed less readily than the oil-based liquid formulations but more readily than dry formulations. Dusts, granules, and other dry formulations are not absorbed as readily as liquids.

The area of the body exposed. The genital area tends to be the most absorptive. The scalp, ear canal, and forehead are also highly absorptive.

Cuts, abrasions, and skin rashes allow absorption more readily than intact skin. Hot, sweaty skin will absorb more pesticide than dry, cool skin.

Causes of Exposure

One of the best ways to avoid pesticide exposures is to avoid situations and practices where exposures commonly occur.

Oral exposures often are caused by:not washing hands before eating, drinking, smoking, or chewing, mistaking the pesticide for food or drink, accidentally applying pesticides to food, or splashing pesticide into the mouth through carelessness or accident.

Inhalation exposures often are caused by: prolonged contact with pesticides in closed or poorly ventilated spaces, breathing vapors from fumigants and other toxic pesticides, breathing vapors, dust, or mist while handling pesticides without appropriate protective equipment, inhaling vapors immediately after a pesticide is applied; for example, from drift or from reentering the area too soon, and using a respirator that fits poorly or using an old or inadequate filter, cartridge, or canister.

Dermal exposures often are caused by: not washing hands after handling pesticides or their containers, splashing or spraying pesticides on unprotected skin, wearing pesticide-contaminated clothing (including boots and gloves), applying pesticides in windy weather, wearing inadequate personal protective equipment while handling pesticides, and touching pesticide-treated surfaces.

Eye exposures often are caused by splashing or spraying pesticides in eyes, applying pesticides in windy weather without eye protection, rubbing eyes or forehead with contaminated gloves or hands, and pouring dust, granule, or powder formulations without eye protection.

Toxicity

Toxicity is a measure of the ability of a chemical to cause harmful effects. It depends on the types and amounts of active ingredient(s), solvent(s), – inert ingredient(s), and formulation.

The toxicity of a particular pesticide is measured by subjecting laboratory animals (usually rats, mice, rabbits, and dogs) or tissue cultures to different dosages of the active ingredient and of the formulated product over various times. These toxicity studies help to estimate the risk that the pesticide may cause harmful effects in humans.

However, some people react more severely or more mildly than estimated. Be alert to your body's reaction to the pesticides you are handling. Some people seem to be especially sensitive to individual pesticides or to groups of similar pesticides.

You may have a choice of pesticides for a particular pest problem. Consider how toxic each pesticide is to persons who will use it or be exposed to it.

Harmful Effects

Pesticides can cause three types of harmful effects: **acute**, **delayed**, and **allergic**.

Acute Effects

Acute effects are illnesses or injuries that may appear immediately after exposure to a pesticide (usually within 24 hours).

Studying a pesticide's relative ability to cause acute effects has been the main way to assess and compare how toxic pesticides are. Acute effects can be measured more accurately than delayed effects, and they are more easily diagnosed than effects that do not appear until long after the exposure. Acute effects usually are obvious and often are reversible if appropriate medical care is given promptly.

Pesticides cause four types of acute effects: ORAL, INHALATION, SKIN, and EYE.

Acute oral effects – Your mouth, throat, and stomach can be burned severely by some pesticides. Other pesticides that you swallow will not burn your digestive system but will be absorbed and carried in your blood throughout your body and may cause harm in various ways.

For some pesticides, swallowing even a few drops from a splash or wiping your mouth with a contaminated glove can make you very ill or make it difficult to eat and drink.

Acute inhalation effects – Your entire respiratory system can be burned by some pesticides, making it difficult to breathe. Other pesticides that you may inhale may not harm your respiratory system but are carried quickly in your blood throughout your whole body where they can harm you.

Acute dermal effects – Contact with some pesticides will harm your skin. These pesticides may cause your skin to itch, blister, crack, or change color. Other pesticides can pass through your skin and eyes and get into your body. Once inside your body, these pesticides are carried throughout your system where they can harm you.

Acute eye effects – Some pesticides that get into your eyes can cause temporary or permanent blindness or severe irritation. Other pesticides may not irritate your eyes but pass through your eyes and into your body. These pesticides can travel throughout your body, harming you.

Delayed Effects

Delayed effects are illnesses or injuries that do not appear immediately (within 24 hours) after exposure to a pesticide or combination of pesticides. Often the term "chronic effects" is used to describe delayed effects, but this term is applicable only to certain types of delayed effects.

Delayed effects may be caused by: r**epeated exposures** to a pesticide, a pesticide group, or a combination of pesticides over a long period of time, OR

a **single exposure** to a pesticide (or combination of pesticides) that causes a harmful reaction that does not become apparent until much later.

Sometimes repeated exposures to a pesticide or family of pesticides will result in a delayed effect but a larger exposure will cause an acute effect. A person who is repeatedly exposed to two or more specific chemicals may become ill even though any one of the chemicals alone would have had no harmful health impact.

In some cases, a **single exposure** to a pesticide (or combination of pesticides) could adversely affect the exposed person's health later. For example, large exposures to herbicide paraquat may cause severe or fatal lung injury that does

not appear for 3 to 14 days after the initial exposure. After an exposure, paraquat slowly builds up in the lungs and destroys lung cells.

Some kinds of harmful effects may not occur unless a certain set of circumstances is present. These effects can occur after the first exposure, but the likelihood is small. Continuous or frequent exposures over a long period of time make it more likely that all the necessary factors will be present. Some genetic changes that result in the development of cancer or other delayed effects are in this category.

Types of delayed effects include: 1) chronic effects, 2) developmental and reproductive effects, and 3) systemic effects.

Chronic effects – Chronic effects are illnesses or injuries that appear a long time, usually several years, after exposure to a pesticide. Some delayed effects that are suspected to result from pesticides' chronic toxicity include:
▪ production of tumors (oncogenic effect),
▪ production of malignancy or cancer (carcinogenic effect), or ▪ changes in the genes or chromosomes (mutagenic effect).

Determining delayed effects – Because of the time delay between the exposure and the observable effect, and because many other types of exposures may have occurred during the delay, it is sometimes hard to identify the cause of a delayed effect. Although some pesticides may cause delayed effects in laboratory animals, further studies are needed to determine whether these pesticides will affect humans the same way.

When there is clear evidence that a pesticide may cause chronic, developmental, reproductive, or systemic effects in humans, the EPA will determine what steps are appropriate to reduce or eliminate the risk. Such actions include:

removing the pesticide from use,

requiring label warning statements about the possible effects,

requiring specific personal protective equipment or safety systems during handling of the pesticide,

requiring changes in dosages, method or frequency of application, and waiting times before entry or harvest/slaughter/grazing,

restricting the use to certified applicators.

Avoiding delayed effects – Scientists, pesticide manufacturers, and the EPA cannot yet be sure what the delayed effects of too much exposure to individual pesticides or combinations of pesticides may be. It may be years before there are clear answers on the effects of all the pesticides and combinations of pesticides used today. Meanwhile, it makes good sense to reduce your exposure to all pesticides as much as possible.

Allergic Effects

Allergic effects are harmful effects that some people develop in reaction to substances that do not cause the same reaction in most other people. Allergic reactions are not thought to occur during a person's first exposure to a substance. The first exposure causes the body to develop repelling response chemicals to that substance. Later exposures result in the allergic response. This process is called **sensitization**, and substances that cause people to become allergic to them are known as **sensitizers**.

Certain substances cause many people to develop an allergic reaction. Poison ivy, for example, causes a severe skin rash in many people. Other substances cause allergic reactions in only a few people. Turfgrass, for example, causes a severe skin rash in relatively few people.

Types of allergic effects – Some people are sensitized to certain pesticides. After being exposed once or a few times without effect, they develop a severe allergy-like response upon later exposures. These allergic effects include:

systemic effects, such as asthma or even life-threatening shock,

skin irritation, such as rash, blisters, or open sores, and

eye and nose irritation, such as itchy, watery eyes and sneezing.

Unfortunately, there is no way to tell which people may develop allergies to which pesticides. However, certain people seem to be more chemically sensitive than others. They develop an allergic response to many types of chemicals in their environment. These persons may be more likely to develop allergies to pesticides.

Typical precautionary statements on pesticide labeling include:

"*This product may produce temporary allergic side effects characterized by redness of the eyes, mild bronchial irritation, and redness or rash on exposed skin areas. Persons having allergic reactions should contact a physician*."

Avoiding allergic effects – Depending on how severe the allergic reaction is, persons with allergies to certain pesticides may have to stop handling or working around those pesticides. They may be unable to tolerate even slight exposures. Sometimes persons with allergies to certain pesticides can continue to work in situations where those pesticides are present by reducing their exposure to them.

Know the Law

The **Hazard Communication Standard (HCS)**, a regulation under the Occupational Safety and Health Act (OSHA), requires employers to provide protections to workers who may be exposed to hazardous chemicals under normal operating conditions or in foreseeable emergencies. The HCS, which is administered by the U.S. Department of Labor, requires employers to:

1) Make a list of the hazardous chemicals in the workplace,

2) Obtain material safety data sheets (MSDS) for all hazardous substances on their list and keep them in a file that is available to all workers,

3) ensure that all containers of hazardous materials are labeled at all times,

4) train all workers about the hazardous materials in their workplace.

Signs and Symptoms of Harmful Effects

Watch for two kinds of clues to pesticide-related illness or injury. Some clues are feelings that only the person who has been poisoned can notice, such as nausea or headache. These are **symptoms**. Other clues, like vomiting or fainting, can be noticed by someone else. These are **signs**.

You should know:

what your own symptoms might mean, and

what signs of poisoning to look for in your coworkers and others who may have been exposed.

Many of the signs and symptoms of pesticide poisoning are similar to signs and symptoms of other illnesses you might experience, such as the flu or even a hangover. If you have been working with pesticides and then develop suspicious signs and symptoms, call your physician or poison control center. Only a physician can diagnose pesticide poisoning injuries.

External irritants cause redness, blisters, rash, and/or burns on skin, and swelling, a stinging sensation, and/or burns in eyes, nose, mouth, and throat.

Pesticide poisoning may cause nausea, vomiting, diarrhea, and/or stomach cramps, headache, dizziness, weakness, and/or confusion, excessive sweating, chills, and/or thirst, chest pains, difficult breathing, cramps in your muscles or aches all over your body.

Telltale signs or symptoms – Ask your physician or poison control center to obtain the latest edition of "Recognition and Management of Pesticide Poisonings" by Donald P. Morgan, M.D., Ph.D. It is available through the U.S. Environmental Protection Agency or from the U.S. Government Printing Office. Many physicians have not been trained to recognize and treat pesticide poisonings or injury and may rarely see such cases.

Be informed – You should know the kinds of harmful effects most likely to be caused by the pesticides you use. The appendix, *Effects of Pesticides on the Human Body*, contains a guide to help you judge how the products you use might affect you. The chart lists the major groups of pesticides. For each group, it tells:

▪ the action of the poison on the human system, ▪ acute poisoning (systemic) effects, ▪ acute irritation effects, ▪ delayed or allergic effects, and ▪ type of pesticide.

Responding to a Poisoning Emergency

Get medical advice quickly if you or any of your fellow workers have unusual or unexplained symptoms starting at work or later the same day. Do not let yourself or anyone else get dangerously sick before calling your physician or going to a hospital. It is better to be too cautious than too late. Take the pesticide container (or the labeling) to the physician. Do not carry the pesticide container in the passenger space of a car or truck.

First Aid for Pesticide Poisoning

First aid is the initial effort to help a victim while medical help is on the way. If you are alone with the victim, make sure the victim is breathing and is not being further exposed to the pesticide before you call for emergency 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. It gives specific first aid instructions. Follow those instructions carefully.

> The best first aid in pesticide emergencies is to stop the source of pesticide exposure as quickly as possible.

Pesticide on skin:

Drench skin and clothing with plenty of water. Any source of relatively clean water will work. If possible, 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 may have pesticides in them.

Remove personal protective equipment and contaminated clothing.

Wash skin and hair thoroughly with a mild liquid detergent and water. If one is available, a shower is the best way to completely and thoroughly wash and rinse the entire body surface.

Dry victim and wrap in blanket or any clean clothing at hand. Do not allow to become chilled or overheated.

If skin is burned or otherwise injured, cover immediately with loose, clean, dry, soft cloth or bandage.

Do not apply ointments, greases, powders, or other drugs in first aid treatment of burns or injured skin.

Pesticide in eye:

Wash eye quickly but gently. Use an eyewash dispenser, if available. Otherwise, hold eyelid open and wash with a gentle drip of clean running water positioned so that it flows across the eye rather than directly into the eye.

Rinse eye for 15 minutes or more.

Do not use chemicals or drugs in the rinse water. They may increase the injury.

Inhaled pesticide:

Get victim to fresh air immediately.

If other people are in or near the area, warn them of the danger.

Loosen tight clothing on victim that would constrict breathing.

Apply artificial respiration if breathing has stopped or if the victim's skin is blue. If pesticide or vomit is on the victim's mouth or face, avoid direct contact and use a shaped airway tube, if available, for mouth-to-mouth resuscitation.

Pesticide in mouth or swallowed:

Rinse mouth with plenty of water.

Give victim large amounts (up to 1 quart) of milk or water to drink.

Induce vomiting only if instructions to do so are on the labeling.

Procedure for inducing vomiting:

Position victim face down or kneeling forward. Do not allow victim to lie on his back, because the vomit could enter the lungs and do additional damage.

Put finger or the blunt end of a spoon at the back of victim's throat or give syrup of ipecac. Do not use salt solutions to induce vomiting.

Do not induce vomiting:

If the victim is unconscious or is having convulsions.

If the victim has swallowed a corrosive poison. A corrosive poison is a strong acid or alkali. It will burn the throat and mouth as severely coming up as it did going down. It may get into the lungs and burn there also.

If the victim has swallowed an EC or oil solution. EC and oil solutions may cause death if inhaled during vomiting.

Know the Law

The **Occupational Safety and Health Act (OSHA)**, administered by the U.S. Department of Labor, contains some requirements that could affect you if you or one of your employees is involved in a pesticide-related injury or illness.

Employers must keep records of all work-related deaths, injuries, and illnesses and make periodic reports. Minor injuries needing only first aid treatment need not be reported. You must keep records if the injury involved medical treatment, loss of consciousness, restriction of work or motion, or transfer to another job.

OSHA will investigate employee complaints related to exposure to hazardous materials, such as pesticides.

Heat Stress

Heat stress is the illness that occurs when your body is subjected to more heat than it can cope

with. Heat stress is not caused by exposure to pesticides, but may affect pesticide handlers who are working in hot conditions. Personal protective equipment worn during pesticide handling activities can increase the risk of heat stress by limiting your body's ability to cool down. If you are under a physician's care, you should consult your physician before working in hot conditions.

Signs and Symptoms of Heat Stress

Mild forms of heat stress will make you feel ill and impair your ability to do a good job. You may get tired sooner, feel weak, be less alert, and be less able to use good judgment. Severe heat stress is a serious illness. Unless victims are cooled down quickly, they can die. Severe heat stress is fatal to more than 10 percent of its victims, even young, healthy adults. Many who survive suffer permanent damage. Sometimes the victims remain highly sensitive to heat for months and are unable to return to the same work.

Learn the signs and symptoms of heat stress and take immediate action to cool down if you suspect you may be suffering from even mild heat stress. Signs and symptoms may include:

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 complete lack of sweating,

altered behavior (confusion, slurred speech, quarrelsome or irrational attitude).

First Aid for Heat Stress

It is not always easy to tell the difference between heat stress illness and pesticide poisoning. The signs and symptoms are similar. Don't waste time trying to decide what is causing the illness. Get medical help.

First aid measures for heat stress victims are similar to those for persons who are overexposed to pesticides:

Get the victim into a shaded or cool area.

Cool victim as rapidly as possible by sponging or splashing skin, especially face, neck, hands, and forearms, with cool water or, when possible, immersing in cool water.

Carefully remove all personal protective equipment and any other clothing that may be making the victim too warm.

If the victim is conscious, have them drink as much cool water as possible.

Keep the victim quiet until help arrives.

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

Heat Cramps

Heat cramps can be quite painful. These muscle spasms in the legs, arms, or stomach are caused by loss of body salt through heavy sweating. To relieve cramps, have the victim drink lightly salted water or "sports drinks." Stretching or kneading the muscles may temporarily relieve the cramps. However, if you suspect that stomach cramps are being caused by pesticides rather than heavy sweating, get medical help right away.

Test Your Knowledge

Q-1. Explain the terms hazard, toxicity, and exposure, and tell how they relate to one another.

- **A.** *Hazard* is the risk of harmful effects from pesticides. *Toxicity* is a measure of the ability of a pesticide to cause harmful effects. *Exposure* is the total amount of pesticide that gets on or in the body.

Hazard = Toxicity x Exposure

Q-2. What are the four routes through which pesticides can contact your body and cause you to be exposed?

- **A.** 1. Oral exposure (when you swallow a pesticide) 2. Inhalation exposure (when you inhale a pesticide) 3. Ocular exposure (when you get a pesticide in your eyes) and 4. Dermal exposure (when you get a pesticide on your skin).

Q-3. Which route of exposure should you, as a pesticide handler, be most concerned about?

- **A.** Exposure to the skin is the most common route of exposure for pesticide handlers.

Q-4. What three factors determine how much pesticide will be absorbed through your skin and into your body?

- **A.** The amount of pesticide that is absorbed through your skin (and eyes) and into your body depends on: 1. The pesticide itself and the material used to dilute the pesticide. 2. Which area of the body is exposed. 3. The condition of the skin that is exposed.

Q-5. Explain delayed effects.

- **A.** Delayed effects are illnesses or injuries that do not appear immediately (within 24 hours) after exposure to a pesticide or combination of pesticides.

Q-6. How can you avoid harmful effects from pesticides?

- **A.** Avoiding and reducing exposures to pesticides will reduce the harmful effects from pesticides. You can reduce exposures by wearing appropriate personal protective equipment, washing exposed areas often, and keeping your personal protective equipment clean and in good operating condition.

Q-7. Name four signs or symptoms of pesticide poisoning and two signs or symptoms of irritation effects from pesticides.

- **A.** Pesticide poisoning may cause nausea, vomiting, diarrhea, and/or stomach cramps; headache, dizziness, weakness, and/or confusion; excessive sweating, chills, and/or thirst; chest pains; difficult breathing; cramps in your muscles or aches all over your body.

External irritants may cause redness, blisters, rash, and/or burns on skin, and swelling, a stinging sensation, and/or burns in eyes, nose, mouth, and throat.

Q-8. What is the first thing you should do when you or someone else is overexposed to pesticides?

- **A.** The best first aid in pesticide emergencies is to stop the source of pesticide exposure as quickly as possible. If pesticide is on the skin or in the eyes, flood with water; if the pesticide has been swallowed, drink large amounts of water; if the pesticide has been inhaled, get to fresh air.

Q-9. What is heat stress?

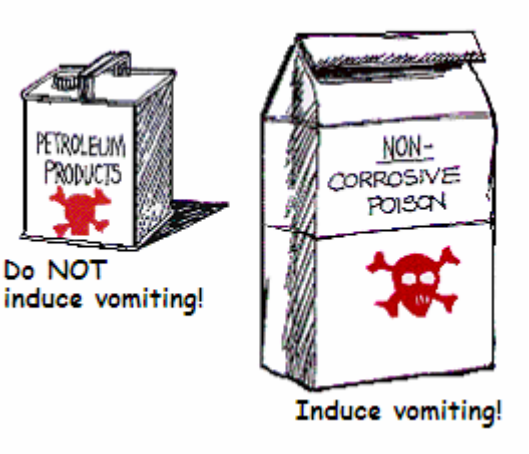
- **A.** Heat stress is the illness that occurs when your body is subjected to more heat than it can cope with.

Q-10. What are some common signs and symptoms of heat stress?

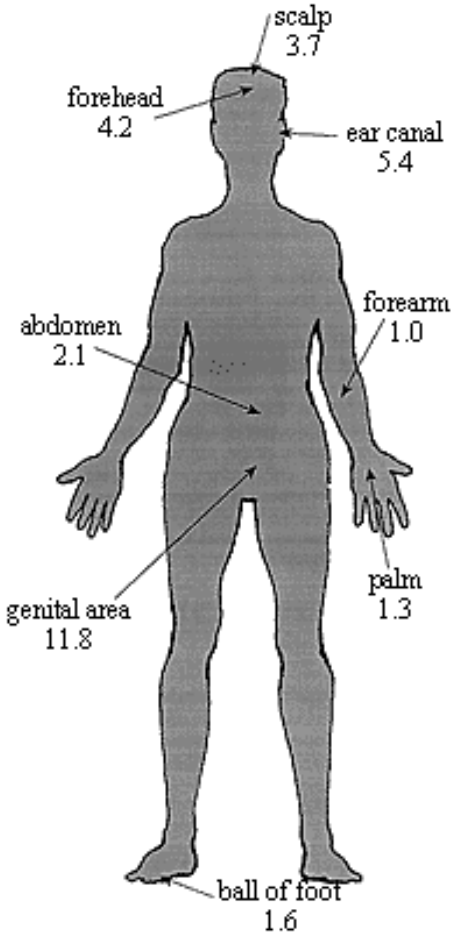
- **A.** Heat stress may cause fatigue (exhaustion, muscle weakness); headache, nausea, and chills; dizziness and fainting; severe thirst and dry mouth; clammy skin or hot, dry skin; heavy sweating or complete lack of sweating; altered behavior (confusion, slurred speech, and quarrelsome or irrational behavior).

Q-11. If you are not sure whether a person is suffering from heat stress or pesticide poisoning, what should you do?

- **A.** Because so many signs and symptoms could be from either heat stress or pesticide poisoning, do not waste time trying to diagnose the problem – get medical help. In the meantime, get the person to a cooler place away from pesticides. Remove personal protective equipment or other clothing that could be contaminating the skin or making the person too warm, use water to clean and cool the skin, and give the person plenty of water to drink. Office (Endangered Specialist) or personnel of the State Fish and Game Office.



ABSORPTION RATE



7 - Personal Protective Equipment

Personal protective equipment (PPE) is clothing and devices worn to protect the human body from contact with pesticides or pesticide residues. Personal protective equipment includes coveralls or protective suits, footwear, gloves, aprons, respirators, eyewear, and headgear.

Ordinary shirts, pants, shoes and other regular work clothing usually are not considered personal protective equipment, although the pesticide labeling may require you to wear specific items of work clothing during some activities.

Exposure to pesticides can cause harmful effects. To prevent or reduce exposure to pesticides, you need to wear personal protective equipment.

> You are legally required to follow all personal protective equipment instructions on the label or with the labeling.

Remember, the lack of any requirement for personal protective equipment or the mention of only one piece of equipment does not rule out the need for more protection. No pesticide labeling instructions can cover all situations. Your common sense, the information on the labeling about precautions for humans, and the task you will be performing will help you to assess your potential hazard and to select the amount and kind of personal protective equipment you need for each handling job.

Pesticide labeling lists the **minimum** personal protective equipment you must wear while handling the pesticide. Sometimes the labeling lists different requirements for different activities. For example, more personal protective equipment may be required for mixing and loading than for application.

Chemical-Resistant Personal Protective Equipment

Some pesticide labeling requires you to wear chemical-resistant personal protective equipment. You must select a material that will be resistant for the period of time that you will be exposed to the pesticide. Most chemical-resistant personal protective equipment items are made of plastic or rubber, but these materials are not equally resistant to all pesticides and in all circumstances.

Factors Affecting Chemical Resistance

How chemical-resistant a material will be in your pesticide handling situation depends on the length of exposure, the exposure situation, and the chemical to which the material is exposed.

Length of exposure – Not all types of materials that are resistant to a particular pesticide will protect you for the same amount of time. Some materials will keep the pesticide out for a fairly long time. Others will allow the pesticide to go through the material to your skin fairly quickly. Thin materials, such as disposable plastic gloves, shoe covers, or aprons, may be as much protection as you need for tasks that can be done in a few minutes. Longer jobs usually require items made of a heavier material.

Chemical resistance is often stated in terms of exposure time. For example, neoprene is resistant to acetone for 30 minutes or less and to diesel fuel for more than 4 hours. If you wear neoprene gloves while handling pesticides with an acetone solvent, you must change the gloves at least every 30 minutes; otherwise, the pesticide and the acetone will get through the gloves and onto your hands.

Exposure situation – Even a chemical-resistant material will not continue to protect you if it becomes damaged during pesticide

handling. For tasks involving sharp or pointed objects or walking through rough terrain, for example, a heavy-duty or sturdy material probably would be necessary to ensure chemical resistance.

Type of chemical – Few materials will protect you from all pesticide products. The level of chemical resistance may depend not only on what the active ingredient is, but also on whether the pesticide is liquid or dry and what diluents or solvents are used.

Choosing Chemical Resistant Materials

Always read the pesticide labeling to see if it tells you what materials are resistant to the pesticide product. If it does not, look for another source of information. The EPA, the United States Department of Agriculture Cooperative Extension Service, pesticide producers, or personal protective equipment manufacturers may offer guidance about which materials are resistant to particular pesticides. When no outside advice is available, use your best judgment to select a material.

When selecting a chemical-resistant material, there are some general guidelines to follow.

□ Cotton, leather, canvas, and other absorbent materials are not chemical resistant, even to dry formulations. Powders and dusts sometimes move through cotton and other woven materials as quickly as wet formulations and may remain in the fibers even after three launderings.

□ Do not use hats that have a cloth or leather sweatband, and do not use cloth or cloth-lined gloves, footwear, and aprons. These materials are difficult or impossible to clean after pesticide gets on them, and they are too expensive to be disposed of after each use.

Chemical-resistant suits and hoods –The best choice of materials for chemical-resistant suits and hoods is generally:

rubber or plastic, such as butyl, neoprene, or polyvinyl chloride (PVC), or

non-woven fabric coated with plastic or another barrier material. Read the packaging for the suits carefully to be sure that they are "chemical resistant," "chemical protective," or "liquid proof."

Other chemical-resistant items – For other chemical-resistant items, such as gloves, footwear, aprons, and hats, you can choose from many types of materials. Barrier-laminate materials such as 4H® or Silver Shield® are resistant to most pesticides, but many pesticide handlers consider them uncomfortable to wear and difficult to use while performing many tasks.

Any plastic or rubber material is resistant to dry pesticides and to water-based pesticides. Dry pesticides include dusts, granules, pellets, and some baits. Water-based pesticides include wettable powders, soluble powders, some solutions, dry flowables (water-dispersible granules), and microencapsulated pesticides.

The type of material that is resistant to non-water-based liquid pesticides depends on the type of solvent used. Pesticides that do not dissolve in water are often mixed with other solvents to form liquid formulations. Liquid pesticides that are not water based include EC, ULV and low-volume concentrates, low-concentrate solutions, flowables, aerosols, and invert emulsions.

Common solvents are xylene, fuel oil, other petroleum distillates, and alcohol. When xylene is in a formulation, it must be listed in the ingredient statement on the front panel of the pesticide label.

Some solvents do not have to be listed in the ingredient statement, so you may not be able to choose a chemical-resistant material on the basis of what is in the formulation. For these pesticides, select sturdy barrier-laminate, butyl,

or nitrile materials. Then watch for signs that the material is not chemical resistant.

Sometimes it is easy to see when a plastic or rubber is not resistant to a pesticide. The material may:

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, discard the item and choose another material.

Protecting Your Skin

The skin is the part of your body that usually gets the most exposure when you handle pesticides. Cover as much of your skin as possible. Remember that personal protective equipment protects you only if the pesticide remains on the outside of the material. Once the pesticide gets on the inside and next to your skin, the material works against you. It holds the pesticide tightly next to your skin for as long as it is worn. When this happens, more pesticide will get on your skin and cause irritation or will go through your skin and into your body.

Body Protection

Any time you handle pesticides, wear at least a long-sleeved shirt and long-legged pants. In many instances the pesticide labeling will require you to wear a coverall, a chemical-resistant suit, or a chemical-resistant apron.

Long-sleeved shirt and long-legged pants – Long-sleeved shirt and long-legged pants should be made of sturdy material. Fasten the shirt collar completely to protect the lower part of your neck.

Coveralls – Coveralls should be made of sturdy material such as cotton, polyester, a cotton-synthetic blend, denim, or a non-woven fabric. When wearing a coverall, close the opening securely so the entire body except the feet, hands, neck, and head are covered.

When handling pesticides that are highly or moderately toxic dermally or are skin irritants, consider wearing a coverall over another set of clothing. An entire set of clothing such as a long-sleeved shirt and long-legged pants worn under the coverall is ideal.

Always read the pesticide label before making decisions about the use of coveralls or any other protective equipment. If the pesticide label states specific protective clothing requirements, you must follow them.

Chemical-resistant suit – Some pesticide labeling requires handlers to wear a chemical-resistant suit. This usually indicates that the pesticide is very hazardous, either for acute effects or for delayed effects, and that extra precaution is necessary to prevent the pesticide from getting on you.

If you expect to be in a situation where a large amount of pesticide could be deposited on your clothing, and if you will be in that situation for a long time, consider wearing a chemical-resistant suit even if the pesticide labeling does not require it. Under those circumstances, even pesticides that are applied dry, such as dusts or granules, can get through ordinary fabric and harm you.

Chemical-resistant suits made of rubber or plastic often are referred to as "rainsuits." They may be sold as one-piece coveralls or as two-piece outfits consisting of a jacket worn over overalls. Chemical-resistant suits made of coated non-woven fabric usually are sold as one-piece coveralls.

The biggest drawback to chemical-resistant suits is that they may make you uncomfortably warm. Unless you are handling pesticides in cool or climate-controlled environments, heat stress becomes a major concern. Wearing a chemical-resistant suit in even moderate temperature and humidity conditions can cause you to become overheated very quickly. Take extra precautions to avoid heat stress by drinking plenty of water and taking frequent rest breaks to cool down.

Chemical-resistant apron – The pesticide labeling may require you to wear a chemical-resistant apron while you are mixing and loading the pesticide and while you are cleaning pesticide equipment. Consider wearing an apron whenever you are handling pesticide concentrates. It will protect you from splashes, spills, and billowing dusts and will protect your coverall or other clothing. Wear an apron over the coverall or long-sleeved shirt and long-legged pants required for application or other handling activities.

Choose an apron that extends from your neck to at least your knees. Some aprons have attached sleeves and gloves. This style is especially protective because it protects your arms, hands, and front and eliminates the potential gap where the sleeve and glove or sleeve and apron meet.

Sometimes an apron can be a safety hazard. It can get caught in machinery or get in your way. At those times, consider wearing a chemical-resistant suit.

Hand and Foot Protection

Pesticide handlers get by far the most pesticide exposure on their hands and forearms. As a result, most pesticide labeling will require you to wear chemical-resistant gloves at all times while handling the pesticide. Wear chemical-resistant gloves any time you may get pesticides on your hands.

Interpreting Labeling PPE Statement

The table below lists PPE choices that are appropriate for different labeling statements.

Labeling Statement	Acceptable PPE
Waterproof gloves	Any rubber or plastic gloves sturdy enough to remain intact throughout the task being performed.
Chemical-resistant gloves	Barrier-laminate gloves; or other gloves that glove selection charts or guidance documents indicate are chemical-resistant to the pesticide for the period of time required to perform the task.
Chemical-resistant gloves such as butyl or nitrile	Butyl-gloves; nitrile gloves; or other gloves that glove selection charts or guidance documents indicate are chemical-resistant to the pesticide for the period of time required to perform the task.
Shoes	Leather, canvas or fabric shoes; chemical-resistant shoes; chemical-resistant boots; or chemical-resistant shoe coverings.
Chemical-resistant footwear	Chemical-resistant shoes; chemical-resistant boots; or chemical-resistant shoe coverings.

Pesticide handlers also often get pesticides on their feet. Sturdy shoes and socks are sufficient to protect your feet during a few pesticide handling activities. Canvas, cloth, and leather are difficult or impossible to clean adequately, however. Consider using chemical-resistant materials when pesticides or pesticide residues, especially concentrates, may get on your footwear. Some pesticide labeling requires you to wear chemical-resistant footwear. Such footwear can be shoes, shoe covers, or boots. If a pesticide is likely to get on your lower legs or feet, consider wearing chemical-resistant boots. The boots should extend past the ankle and at least halfway up the knee.

One situation where you should not wear chemical-resistant gloves and footwear is when handling some fumigants, such as methyl bromide, because the gloves and footwear can trap the gas near the skin and cause burns. The labeling on these fumigants will instruct you not to wear chemical-resistant gloves and footwear or other chemical-resistant clothing.

Wear gloves and footwear correctly – Always start out with gloves and footwear that you know are new or freshly cleaned. Don't choose a pair just because they are close by. They may already have pesticides on the inside and will not protect your hands or feet.

If pesticides get inside your gloves or footwear, take them off immediately, wash your hands or feet, and put on a clean pair. Keep several pairs of gloves and footwear available and change to a clean set whenever you suspect the inside has become contaminated.

Avoid contaminating the inside of gloves and footwear – Even when you are wearing gloves and footwear, you can get pesticides on your hands and feet unless the gloves and footwear are: chemical-resistant to the pesticide being handled, worn correctly, in good condition, cleaned and cared for, and replaced often.

Contamination often happens when handlers remove their gloves briefly to adjust their equipment, open a pesticide container, wipe their face, etc., and then put the gloves on again over their contaminated hands. If you must remove your gloves during a handling activity, **wash your gloves thoroughly before taking them off, and wash your hands thoroughly and dry them before you put the gloves on again.**

Handlers also sometimes make the mistake of putting on footwear with contaminated hands. This may transfer the pesticide from your hands to your socks and feet.

Keep pesticides from running down your sleeves or pant legs and into your gloves and footwear. For many jobs, you must be working with your arms raised and some of the time with them lowered. Close the glove cuff tightly outside the sleeve and put heavy-duty tape or an elastic band around the end of the glove where it meets the sleeve. Some gloves have a method of tightening the cuff to your sleeve so the pesticide cannot run down into the glove.

For jobs where your arms are mostly lowered, place sleeves outside the gloves to keep pesticides from running down the sleeves and into the gloves. Use gloves that go up over your wrist and at least half way to your elbow. If you will be raising your arms most of the time, you may leave your gloves outside your sleeves. Fold the cuff of your gloves up toward your fingers an inch or two to catch the pesticide before it runs down your arm.

For jobs when you will be exposed to pesticides on your legs, put your pant legs outside the boots so the pesticide will not travel down your leg and collect in the hoots or shoe covers.

Head and Neck Protection

If you will be exposed to pesticides from above, protect your head and neck. A chemical-resistant hood or wide-brimmed hat will help keep pesticides off your head, neck, eyes, mouth, and face. Plastic "safari" hats with plastic sweatbands are a good choice. They are relatively cool in hot weather. Other more flexible hats and hoods are also available in chemical-resistant materials. Many chemical-resistant jackets or coveralls can be purchased with attached protective hoods.

Protecting Your Eyes

When the pesticide labeling requires you to wear protective eyewear, wear goggles, a face shield, or safety glasses with shields at

both the brow and sides. Eyes are very sensitive to the chemicals in some pesticide formulations, especially concentrates, and temporary blindness caused by an accident may delay or prevent self-treatment. Eyes also readily absorb some pesticides.

Shielded safety glasses or full-face shields are a good choice in many handling situations because they are comfortable, do not cause fogging or sweating, and give good eye protection for many exposure situations. Face shields that are cupped inward toward your throat give better protection from splashes than straight face shields. Either goggles or shielded safety glasses can be worn with a half-face respirator. Full-face respirators are supplied with their own face shield, so additional eye protection is not required.

Protecting Your Respiratory Tract

The respiratory tract – the lungs and other parts of the breathing system – is much more absorbent than the skin. You must wear a respirator when the pesticide labeling directs you to do so.

Even if the labeling does not require it, you should consider wearing a respiratory protective device if you are in an enclosed area and the pesticide you are handling has a labeling precautionary statement such as

"*Do not breathe vapors or spray mist*" or "*Harmful or fatal if inhaled*".

Labeling Statement	Acceptable PPE
Chemical-resistant hood or wide-brimmed hat	Rubber- or plastic-coated safari-style hat; rubber- or plastic-coated fire-fighter-style hat; plastic- or other barrier-coated hood; rubber or plastic hood; or full hood or helmet that is part of some respirators.
Protective eyewear	Shielded safety glasses; face shield; goggles; or full-face style respirator.
Goggles	Goggles; or full-face style respirator
Dust/mist filtering respirator	Dust/mist respirator; respirator with dust/mist filtering cartridges; respirator with organic vapor-removing cartridge and pesticide prefilter; or respirator with canister approved for pesticides; or air-supplying respirator
Cartridge respirator	Respirator with organic vapor-removing cartridge and pesticide prefilter; or respirator with canister approved for pesticides; or air-supplying respirator
Canister respirator (gas mask)	Respirator with canister approved for pesticides, or air-supplying respirator
Air-supplying respirator or Self-contained breathing apparatus (SCBA)	Air-supplying respirator or self-contained breathing apparatus (SCBA)

Some fumigants and a few other pesticide formulations contain an additive that will warn you if you begin to inhale the pesticide. Such warning agents often are used when the active ingredients in the pesticide are highly toxic ones that you would otherwise not be able to detect. The additive may have a characteristic odor or be a mild irritant to alert you that you should put on a respirator or that your respirator is no longer protecting you. The warning agent can help you determine when you should

use a respirator for products whose labeling does not require respiratory protection in all situations.

Some pesticide labels list the type of respirator you should wear when handling the product. Other labeling requires the use of a respirator, but does not specify the type or model to be used. NIOSH and MSHA approve respirators as adequate for certain types of uses. When the pesticide labeling requires you to use a respirator, you must wear one that is approved by NIOSH and MSHA. If the respirator has more than one part, all parts must be approved.

Studies have shown that many pesticide handlers do not use respirators correctly and are not well protected. Before you use a respirator, learn the correct procedures for selecting, fitting, cleaning and sanitizing, inspecting, and maintaining respiratory protective equipment.

Disposable and Reusable PPE

Personal protective equipment items either should be disposable or should be easy to clean and sturdy enough for repeated use.

Disposables

Disposable personal protective equipment items are not designed to be cleaned and reused. Discard them when they become contaminated with pesticides.

Inexpensive disposables may be a good choice for brief pesticide handling activities that require flexibility and will not tear the thin plastic. For example, you might use disposable gloves, shoe covers, and an apron while pouring pesticides into a hopper or tank, cleaning or adjusting a nozzle, or making minor equipment adjustments.

Dust/mist masks, prefilters, canisters, filtering and vapor-removing cartridges, and a few cartridge respirators are disposable. They cannot be cleaned and should be replaced often.

Reusables

Some personal protective equipment may be cleaned and reused several times; however, do not make the mistake of reusing these items when they are no longer protecting you.

Rubber and plastic suits, gloves, boots, aprons, capes, and headgear often are designed to be cleaned and reused, but even these reusables should be replaced often. Wash them thoroughly between uses. Before you put them on, inspect reused items carefully for signs of wear or abrasion. If they show any sign of wear, throw them out. Even tiny holes or thin places can allow large quantities of pesticides to move to the inside surface and transfer onto your skin. Check for rips and leaks during cleaning by using the rinse water to form a "balloon" or by holding the items up to the light.

Even if you can't see signs of wear, replace reusable chemical-resistant items regularly. The ability of a chemical-resistant material to resist the pesticide decreases each time it is worn, and after repeated exposure to pesticides. Even though the material may not visibly change, the pesticide may be moving through the material and getting on your skin. The pesticide moves through the material in the same way air leaks through the surface of a balloon – slowly, but steadily.

A good rule of thumb is to throw out gloves that have been worn for about five to seven work days. Extra-heavy-duty gloves, such as those made of butyl or nitrile rubber, may last 10 to 14 days. Because hand protection is the most important concern for pesticide handlers, make glove replacement a high priority. The cost of frequently replacing your gloves is a prudent investment.

Footwear, aprons, headgear, and protective suits may last longer than gloves, because they generally receive less exposure to the pesticides and less abrasion from rough surfaces. However, they should be replaced regularly and at any sign of wear.

Fabric coveralls are designed to be cleaned after each day's use and reused. However, absorbent materials such as cotton, polyester, cotton blends, denim, and canvas cannot be cleaned adequately after they are drenched or thoroughly contaminated with concentrated pesticides labeled with the signal word "DANGER" or "WARNING". **Always** discard any such clothing or footwear. They cannot be safely reused.

Most protective eyewear and respirator bodies, facepieces and helmets are designed to be cleaned and reused. These items may last many years if they are good quality and are maintained correctly.

Maintaining Personal Protective Equipment

When you finish an activity where you are handling pesticides or are exposed to them, remove your personal protective equipment right away. Wash the outside of your gloves with detergent and water **before** you remove them. Consider washing the outside of other chemical-resistant items before you remove them also. This helps you avoid contacting the contaminated part of the items while you are removing them and helps keep the inside surface uncontaminated. If any other clothes have pesticides on them, change them also. Determine whether the items should be disposed of or cleaned for reuse.

Place reusable items in a plastic bag or hamper away from your other personal clothes and away from the family laundry. Place disposables in a separate plastic bag or container. The pesticides remaining on your personal protective equipment, work clothing, and other work items could injure persons who touch them. Do not allow children or pets near them. Do not allow contaminated gloves, boots, respirators, or other equipment to be washed in streams, ponds, or other bodies of water.

Clean all reusable personal protective equipment items between uses. Even if they were worn for only a brief period of exposure to pesticides during that day, wash them before you wear them again. Pesticide residues that remain on the personal protective equipment are likely to continue to move slowly through the personal protective equipment material, even chemical-resistant material. If you wear that personal protective equipment again, pesticide may already be on the inside next to your skin. Also, personal protective equipment that is worn several times between launderings may build up pesticide residues. The residues can reach a level that can harm you, even if you are handling pesticides that are not highly toxic.

Washing Personal Protective Equipment

Wash pesticide-contaminated items separately from uncontaminated clothing and laundry. Otherwise, the pesticide residues can be transferred onto the other clothing or laundry and can harm you or your family.

Alert the persons who do the washing – Be sure that the people who clean and maintain your personal protective equipment and other work clothes know that they can be harmed by touching the pesticide that remains on the contaminated items. Tell them that they should: wear gloves and an apron, especially if handling contaminated items regularly or handling items contaminated with highly toxic pesticides.

Work in a well-ventilated area, if possible, 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 detailed instructions, or offers no cleaning instructions at all, follow the procedure below. Some chemical-resistant items that are not flat, such as gloves, footwear, and coveralls, must be washed twice – once to thoroughly clean the outside of the item and a second time after turning the item inside out. Some chemical-resistant items, such as heavy-duty boots and rigid hats or helmets, can be washed by hand using hot water and a heavy-duty liquid detergent. They should be dried and aired as directed below.

The best procedure for washing non-chemical-resistant items, such as cotton, cotton/polyester, denim, canvas, and other absorbent materials, and most chemical-resistant items is:

1. **Rinse** in a washing machine or by hand.

2. **Wash only a few items at a time** so there will be plenty of agitation and water for dilution.

3. **Wash in a washing machine,** using a heavy-duty liquid detergent and hot water for the wash cycle.

4. **Rinse twice** using two entire rinse cycles and warm water.

5. **Use two entire machine cycles** to wash items that are moderately to heavily contaminated.

6. **Run the washer through at least one additional entire cycle** without clothing, using detergent and hot water, to clean the machine after each batch of pesticide-contaminated items, and before any other laundry is washed.

Drying procedure – Hang the items to dry, if possible. It is best to let them hang for at least 24 hours in an area with plenty of fresh air. Even after thorough washing, some items still may contain pesticides. When the items are exposed to clean air, remaining pesticide residues move to the surface and evaporate. You may wish to buy two or more sets of equipment at a time so you can leave one set airing in a clean place while you are using the other set. Do not hang items in enclosed living areas, because pesticides that remain in the items may evaporate and expose people or animals in the area.

Using a clothes dryer is acceptable for fabric items, if it is not possible to hang them to dry. However, over a period of time, the dryer may become contaminated with pesticide residues.

Maintaining Eyewear and Respirators

Wash goggles, face shields, shielded safety glasses, and respirator bodies and facepieces after each day of use. Use a detergent and hot water to wash them thoroughly. Sanitize them by soaking for at least two minutes in a mixture of 2 tablespoons of chlorine bleach in a gallon of hot water. Rinse thoroughly to remove the detergent and bleach. Dry thoroughly or hang them in a clean area to dry.

Pay particular attention to the headbands. Replace headbands made of absorbent materials with chemical-resistant headbands. After each day of use, inspect all headbands for signs of wear or deterioration and replace as needed.

Store respirators and eyewear in an area where they are protected from dust, sunlight, extreme temperatures, excessive moisture, and pesticides or other chemicals. A zip-closable sturdy plastic bag works well for storage.

Respirator maintenance is especially important. Inspect your respirator before each use. Repair or replace it whenever any part shows sign of wear or deterioration. Maintain an inventory of replacement parts for the respirators you own, and do not try to

use makeshift substitutes or in-compatible brands. If you keep a respirator for standby or emergency use, inspect it at least monthly and before use.

If you remove your respirator between handling activities:

Wipe the respirator body and facepiece with a clean cloth.

Replace caps, if available, over cartridges, canisters, and prefilters.

Seal the entire respirator in a sturdy, airtight container, such as a zip-closable plastic bag. If you do not seal the respirator immediately after each use, the disposable parts will have to be replaced more often. Cartridges, canisters, prefilters, and filters will continue to collect impurities as long as they are exposed to the air.

At the end of any work day when you wore a reusable respirator:

Remove the filter or prefilter. Most filters should be discarded. A few are designed to be washed and reused.

Take off the cartridges or canisters. Discard them or, if still usable, replace their caps and seal them in an airtight container, such as a zip-closable plastic bag.

Clean and store respirator as directed above.

Discard disposable respirators according to manufacturer's instructions. Do not try to clean them.

Test Your Knowledge

Q-1. What legal responsibility do you have for wearing the personal protective equipment that the pesticide labeling lists for your handling situation?

- **A.** By law, you must wear at least the personal protective equipment listed on the labeling for the handling task you will be performing. You are allowed to wear additional or more protective personal protective equipment.

Q-2. Define the term "chemical resistant".

- **A.** Chemical resistant: Able to prevent movement of the pesticide through the material during the period of use.

Q-3. How can you tell when a material is not chemical-resistant to the pesticide you are handling?

- **A.** 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.

Q-4. What factors determine how well your coverall will protect your body?

- **A.** 1. A coverall is most protective if it fits loosely so there is a layer of air between it and the skin or inner clothing.

2. A coverall is most protective if it is worn over another layer of clothing because each layer of clothing adds a protective layer of air as well as a layer of fabric.

3. Coveralls are most protective if they have tightly constructed seams and snug, overlapping closures that do not gap or come unfastened readily.

Q-5. When should you wear chemical-resistant gloves? Why are gloves so important to a pesticide handler?

- **A.** Wear chemical-resistant gloves any time you may get pesticides on your hands, except for some fumigants whose labeling may direct you to not wear gloves. The hands are by far the most likely route of exposure for a pesticide handler.

Q-6. If you need to remove your gloves during pesticide handling, what steps should you take to remove them and put them back on?

- **A.** 1. Wash gloves thoroughly before taking them off.

2. Wash hands thoroughly and dry them before putting the gloves on again.

Q-7. Why do pesticides sometimes get on your skin even when you are wearing gloves and protective footwear?

- **A.** The items may not be chemical-resistant to the pesticide being handled; they may not be worn correctly; they may not be in good condition; or they may not have been cleaned correctly or replaced soon enough.

Q-8. What are the differences among dust/mist-filtering respirators, vapor-removing respirators, and air-supplying respirators?

- **A.** Dust/mist-filtering respirators are masks or cartridges that filter dust, mists, and particles out of the air around you. Vapor-removing respirators use a cartridge or canister to remove pesticide gases and vapors from the air around you. 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.

Q-9. What special hazards do fumigants pose for pesticide handlers?

- **A.** Fumigants pose a serious inhalation hazard to pesticide handlers. Some fumigants also can cause severe skin burns if they are trapped next to the skin by tight clothing or chemical-resistant personal protective equipment.

Q-10. If the chemical-resistant gloves you have selected are reusable, how often should you routinely replace them? Under what conditions should you replace chemical-resistant items immediately?

- **A.** Throw out most reusable gloves that have been worn for about five to seven work days. Extra-heavy-duty gloves, such as those made of butyl or nitrile rubber, may last 10 to 14 days. Replace chemical-resistant items immediately if they show any sign of wear or have holes, tears, or leaks.

Q-11. What should you do with a coverall that has highly toxic pesticide concentrate spilled on it?

- **A.** Dispose of the coverall. It cannot be adequately cleaned.

Q-12. What should you tell the people who will be laundering your clothing about how to protect themselves from pesticides?

- **A.** Tell them to:

1. Wear chemical-resistant gloves and apron, especially if handling contaminated items regularly or handling items contaminated with highly toxic pesticides.

2. Work in a well-ventilated area and do not inhale steam from the washer and dryer.

Q-13. What should you do with your respirator between handling tasks?

- **A.** Seal the respirator in a clean, airtight container, such as a sturdy zip-closable plastic bag. If possible, put caps over the opening on the cartridges or canisters.

8 - Pesticide Handling Decisions

Before performing a pesticide handling task, you need to make some important decisions. For any pesticide handling activity, decide how to ensure the safety of yourself, others, and the environment. Before applying a pesticide, decide how to fit the application to your pest control situation.

Personal Safety Considerations

Make safety one of your first concerns every time you handle pesticides. By making a few simple safety decisions, you can prevent many pesticide accidents and reduce the severity of others. Ask yourself the following basic safety questions.

Have I Read the Labeling?

Always read the applicable sections of the pesticide labeling before you open a pesticide container or begin any pesticide handling activity. Pesticide labeling contains precautions and instructions that you must follow to use the product safely and appropriately. It may contain very specific information that concerns the task you plan to do. Be sure you understand everything you need to know about the pesticide product before you are exposed to it.

How Can I Avoid Exposure to Pesticides?

The key to personal safety when handling pesticides is to avoid exposure to them. Always keep personal clothing, food, drinks, chewing gum, tobacco products, and other belongings away from where pesticides are stored or handled. They could become contaminated and poison or injure you when you use them.

When you take a break, wash your gloves on the outside, remove your gloves, and wash your hands and face thoroughly. Then you can safely chew gum, eat, drink, or smoke.

Avoid getting pesticide on yourself when you use the toilet. The skin in the genital area has been shown to absorb more pesticides than any other skin area. Wash your hands thoroughly before using the toilet, and be careful not to contaminate yourself from pesticides that may be on the outside of your clothing.

Be aware of other situations where you might be exposed to pesticides on the job. Protect yourself not only during mixing, loading, and application, but also during spill cleanup, repairing or maintaining equipment, and when transporting, storing, or disposing of pesticide containers that are open or have pesticides on their outer surface. Use personal protective equipment when necessary to keep pesticides from getting on your skin and in your mouth, eyes, or lungs.

What Personal Protective Equipment Is Needed?

Decide what personal protective equipment you and the people you supervise will need. You must use what the labeling requires, and you may decide that you need additional equipment. Make sure that the personal protective equipment is clean and in good operating condition.

Is the Equipment Ready and Safe?

Decide what equipment is necessary for your task. Check to make sure that you have all the equipment you need and that it is clean and in good operating condition. Make sure that anyone who will use the equipment knows how to operate it safely and correctly. Do not allow children, livestock or pets, or unauthorized people to touch the equipment. If they are injured or poisoned, you are responsible.

Am I Avoiding the Accidental Spread of Pesticides?

Make it a habit to consider how you may accidentally spread pesticides. You may transfer pesticides to objects, people, and animals when you touch them with gloves that you wore while handling pesticides. When you sit in your car or on a chair while wearing your pesticide-handling outfit, you may leave pesticides behind. If you step into your office or home to answer a telephone call or use the toilet, you may leave pesticides on surfaces there.

Any time you take home or wear home your work clothing, personal protective equipment, or other items that are contaminated with pesticides, the pesticides can rub off on carpeting, furniture, and laundry items, and onto pets and people who come into contact with the contaminated materials. When you do not clean up a spill, no matter how small, other people or animals may get pesticide on themselves without knowing they are being exposed. Pesticides that you spread may harm whoever or whatever touches them.

Am I Prepared for Emergencies?

Before you begin any pesticide handling activity, be sure you are prepared to deal with emergencies such as spills, injuries, and poisonings. Your emergency supplies should include at least:

Personal decontamination equipment – Keep plenty of clean water, detergent, and paper towels nearby in a protected container to allow for fast decontamination in an emergency. Have an extra coverall-type garment nearby in case clothing becomes soaked or saturated with pesticide and must be removed.

First aid equipment – Have a well-stocked first aid kit on hand. It should include a plastic eyewash dispenser that has a gentle flushing action.

Spill cleanup equipment – Always keep a spill cleanup kit on hand. The kit should contain not only all the items needed for prompt and complete spill cleanup, but also personal protective equipment to protect you while you are dealing with the spill.

Know who to call in a medical emergency, and be familiar with the signs and symptoms of poisoning caused by the pesticides you handle. In a poisoning emergency, get the person out of the exposure at once, quickly summon medical assistance, and provide first aid.

Are People and Animals Out of the Area?

Do not allow anyone but trained and equipped pesticide handlers to be present during any pesticide handling task. You have the legal responsibility to make sure that no one is overexposed to pesticides that you are handling. Always warn workers, supervisors, and any other people who may be near the application site about which sites you plan to treat and how long they must stay out of those sites.

Pre-Application Decisions

Take the time to think carefully about every pesticide application before you begin. The decisions you make will determine whether you will be using the pesticide safely and correctly. Making the wrong decisions can cause problems.

Incorrect use can result in wasted material, failure to control the pest, and damage to the target site (the animal, plant, or place to which you were applying the pesticide).

Misused pesticides can cause immediate as well as long-term harmful effects to humans, other living things, property, and other parts of the environment.

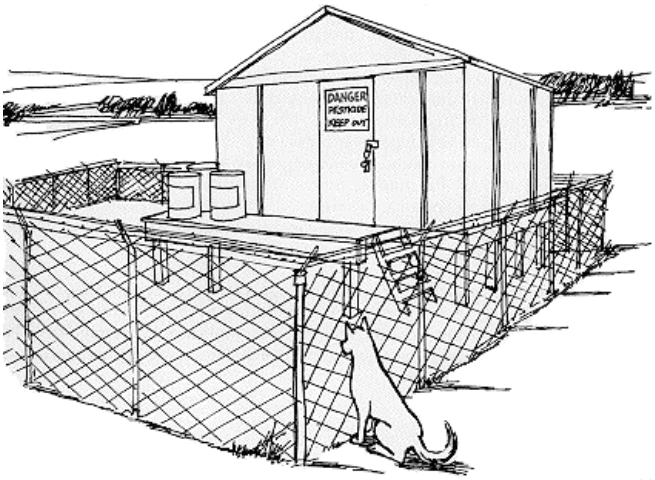
Misused pesticides can result in fines as well as legal actions charging you with liability for damages.

Pesticides are expensive. Using them incorrectly can be costly.

Test Your Knowledge

Q-1. What eight basic safety questions should you ask yourself whenever you or those you supervise will be using pesticides?

- **A.** 1. Have I read the labeling? 2. How can I avoid exposure to pesticides? 3. What personal protective equipment is needed? 4. Is the equipment ready and safe? 5. Am I avoiding the accidental spread of pesticides? 6. Have I instructed the handlers I supervise? 7. Am I prepared for emergencies? 8. Are people and animals out of the area?



Q-2. List some consequences of the incorrect use of pesticides.

- **A.** 1. Incorrect use can result in wasted material, failure to control the pest, and damage to the target site.

2. Misused pesticides can cause immediate as well as long-term harmful effects to humans, to other living things, to property, and to other parts of the environment.

3. Misused pesticides can result in fines as well as legal actions charging you with liability for damages.

4. Pesticides are expensive. Using them incorrectly can be costly.

9 - Mixing, Loading and Application

Mixing, loading, and application are the primary pesticide handling tasks. They are also among the most hazardous aspects of a handler's job. Never try to cut corners where safety is concerned, and do not assume that every job will be like every other. For example, even though you are familiar with a pesticide, take time to read the labeling every time you buy the product – new information may have been added.

Safe Mixing and Loading Practices

Pesticide handlers are most often exposed to harmful amounts of pesticides when mixing or loading concentrated pesticides. Handlers who mix and load concentrated pesticides with high acute toxicity have an especially high risk of accidental poisoning. By observing some simple precautions, you can reduce the risks involved in this part of your job.

Select an Appropriate Area

Choose the pesticide mixing and loading area carefully. It should be outdoors or in a well-ventilated area away from unprotected people, animals, food, other pesticides, and other items that might be contaminated. Choose a place with good light, especially if you are working at night. Be particularly careful not to mix or load pesticides indoors unless lighting and ventilation are adequate.

Protect Your Water Source

Protect your water source by keeping the water pipe or hose well above the level of the pesticide mixture. This prevents contamination of the hose and keeps pesticides from back-siphoning into the water source. If you are pumping water directly from the source into a mix tank, use a check valve, anti-siphoning device, or backflow preventer to prevent back-siphoning if the pump fails. Backflow prevention devices are required by law in some areas.

Avoid mixing or loading pesticides in areas where a spill, leak, or overflow could allow pesticides to get into water systems. When mixing situations require you to use water from a faucet, well, stream, pond, or other water system, take special precautions.

Place your mixing equipment where spills, leaks, and overflows will not flow toward a drain or into the water supply. If necessary, install dikes or other barriers, or grade the soil to divert the flow. If you will be mixing or loading at the site often, consider installing a collection pad or tray.

Opening Containers

Do not tear paper or cardboard containers to open them. Use a sharp knife. Clean the knife afterward and do not use it for other purposes. Open pesticide containers only when they are sitting on a flat, stable surface. If they are tipped on an angle or are in an unstable position, they can easily spill over or leak out when the seal is broken.

Transferring Pesticides

When pouring any pesticide from its container, keep the container and pesticide below face level. This will avoid a splash, spill, or dust from getting on your face or into your eyes and mouth. If there is a wind outdoors or a strong air current indoors, stand so the pesticide cannot blow back on you.

If you are siphoning the pesticide from the container to the tank, never use your mouth to get the siphon started. You could easily get a mouthful of pesticide.

Spills

To prevent spills, close containers after each use. Even if you plan to mix more pesticide soon, close the container tightly each time. Never leave a tank unattended while it is being filled. It may overflow and contaminate the area.

If you splash or spill a pesticide on yourself while mixing or loading, stop right away and remove your contaminated clothing. Wash thoroughly with a mild liquid detergent (or soap) and water as quickly as possible. Put on clean personal protective equipment. Then clean up the spill.

Empty Pesticide Containers

Even after it appears that all of the pesticide product has been removed from a container, it usually is not truly empty. The pesticide that clings to the inside of the container can be dangerous to you, other people, and the environment. Take care of empty containers at once.

Rinse plastic containers as soon as they are empty. Rinsing often saves money because it removes pesticide from the sides and bottom of the container and allows you to add it to the spray tank.

If you rinse empty pesticide containers thoroughly, you usually can dispose of them as non-hazardous waste. Rinsed containers that are to be stored for later disposal should be clearly marked to indicate that they have been rinsed.

Return rinsed pesticide containers to the pesticide storage area or the container holding area. Do not leave them unattended at the mixing, loading, or application site. Never give pesticide containers to children to play with or to adults to use.

If you have empty pesticide containers that cannot be refilled, reconditioned, recycled, or returned to the manufacturer, crush, break, or puncture them. This will make the containers unusable and may also save storage space. Dispose of containers in accordance with label directions and with federal, state, tribal, and local laws and regulations. For more specific information on how to dispose of containers, see the chapter on "Transportation, Storage, Disposal, and Spill Cleanup."

Pressure rinsing is an alternative to triple rinsing. Some pesticide equipment, including some closed system mixing and loading equipment, is equipped with a mechanism to pressure rinse pesticide containers when they are emptied.

The system usually operates by inserting a high-pressure nozzle and hose into the container, rotating the nozzle and rinsing for at least 30 seconds, and draining the container thoroughly into the mix tank.

Non-rinsable containers

You may not be able to rinse bags, boxes, and other containers of dry pesticides because the container will not hold up to the rinsing. 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. Containers that cannot or should not be rinsed must be emptied as completely as possible. Shake or tap the container to remove as much of the pesticide product as you can. Drain containers of liquid pesticides for at least an additional 30 seconds.

Combining Pesticides

Pesticide handlers often like to combine two or more pesticides and apply them at the same time. Such mixtures can save time, labor, and fuel. Manufacturers sometimes

combine pesticides for sale as a pre-mix. Sometimes pesticide handlers combine pesticides at application.

Under federal law, combining pesticides is legal unless the pesticide labeling of any of the pesticides involved instructs you not to combine them. However, not all pesticides work well when mixed together. They must be compatible – that is, mixing them together must not reduce their safety or effectiveness. The more pesticides you mix together, the greater the chance of undesirable effects.

Some pesticide mixtures that are physically incompatible make the mixture difficult or impossible to apply and may clog equipment, pumps, and tanks. These reactions sometimes cause the pesticide to form lumps or gels, to become solids that fall to the bottom of the mix tank, or to separate into layers that cannot be remixed.

Sometimes the combined pesticides create a chemical reaction that cannot be seen by looking at the mixture. However, the chemical change can result in loss of effectiveness against the target pests, increased toxicity to the pesticide handler, and injury to the treated surface.

Some pesticide labeling lists pesticides (and other chemicals) known to be compatible with that formulation. Compatibility charts are available in some pest management recommendations, pesticide trade publications, and Cooperative Extension or industry recommendations. If you cannot find a chart that lists the compatibility of the two pesticides (or the pesticide and other chemical) that you wish to mix, test a small amount of the mixture before you mix large quantities.

Compatibility testing – First, put on personal protective equipment. Wear at least the equipment required by the labeling of any of the pesticides to be combined; protective eyewear; and chemical-resistant gloves and apron, both preferably made of foil laminate. Get a large, clean, clear glass container, such as a quart jar. Use the same water (or other diluent) that you will use when making up the larger mixture. Add the water and each of the products in the same proportions as you will mix them. Unless the pesticide labeling states otherwise, add pesticides to the diluent (usually water) using the **"W-A-L-E"** plan:

1. Add some of the diluent first.

2. Add **W**ettable and other powders and **W**ater-dispersible granules.

3. **A**gitate thoroughly and add the remaining diluent.

4. Add the **L**iquid products, such as solutions, surfactants, and flowables.

5. Add **E**mulsifiable concentrates last.

Shake the jar vigorously. Feel the sides of the jar to determine if the mixture is giving off heat. If so, the mixture may be undergoing a chemical reaction and the pesticides should not be combined. Let the mixture stand for about 15 minutes and feel again for unusual heat.

If scum forms on the surface, if the mixture clumps, or if any solids settle to the bottom (except for wettable powders), the mixture probably is not compatible. Finally, if no signs of incompatibility appear, test the mixture on a small area of the surface where it is to be applied.

Applying Pesticides Safely

Sprayer Parts

Tanks should have large openings for easy filling and cleaning. Tanks should be designed to allow the use of strainers during filling, and also should allow mechanical or hydraulic agitation devices to be installed. The tank should be made of corrosion-

resistant material such as stainless steel or fiberglass. If made of mild steel, it should have a protective lining or coating.

The tank should have a large drain, and other outlets should be sized to the pump capacity. If you use dual tanks, make sure the plumbing allows both tanks to have agitation and adequate withdrawal rates. All tanks should have a gauge to show the liquid level. External gauges should be protected to prevent breakage. All tanks should have a shutoff valve for storing liquid pesticide temporarily while other sprayer parts are being serviced.

The **pump** must have enough capacity to supply the needed volume to the nozzles and to the hydraulic agitator (if necessary) and to maintain the desired pressure. The pump parts should resist corrosion, and they should be abrasion-resistant if abrasive materials such as wettable powders will be used. Select gaskets, plunger caps, and impellers that resist the swelling and chemical breakdown caused by many liquid pesticides. Consult your dealer for available options.

Never operate a sprayer pump at speeds or pressures above those recommended by the manufacturer. Pumps will be damaged if operated when dry or with restricted flow at the inlet or outlet. Pumps depend on the spray liquid for lubrication and for cooling the heat caused by friction.

Pesticide mixtures should go travel through **strainers** to remove dirt, rust flakes, and other foreign materials from the tank mixture. Proper filtering protects the working parts of the sprayer from undue wear and avoids time loss and uneven application caused by clogged nozzle tips.

Strainers are your best defense against nozzle plugging and pump wear. Nozzle screens should be as large as nozzle size permits; however, the screen opening should be less than the nozzle opening. Check nozzle catalogs for the proper screen size for each nozzle.

Select neoprene, rubber, or plastic **hoses** that: have burst strength greater than the peak operating pressures, have a working pressure at least equal to the maximum operating pressure, resist oil and solvents present in pesticides, are weather resistant.

Suction hoses should be reinforced to resist collapse. They should be larger than pressure hoses, with an inside diameter equal to or larger than the inlet part of the pump. All fittings on suction lines should be as large as or larger than the inlet part of the pump.

Keep hoses from kinking or being rubbed. Flush hoses after use and wash them often to prolong life. During the off-season, store the sprayer out of the sun. Replace hoses at the first sign of surface deterioration (cracking or checking).

Pressure gauges monitor the line pressure of your spraying system. They must be accurate and have the range needed for your work.

Check frequently for accuracy against an accurate gauge. Excess pressure will destroy a gauge. If yours does not zero, replace it. Use gauge protectors to guard against corrosive pesticides and pressure surges.

The **pressure regulator** controls the pressure and, indirectly, the quantity of spray material delivered by the nozzles. It protects pump seals, hoses, and other sprayer parts from damage caused by excessive pressure.

Keep the bypass line from the pressure regulator to the tank fully open and unrestricted. The bypass line should be large enough to carry the total pump output without excess pressure buildup. The pressure range and flow capacity of the regulator must match the pressure range you

plan to use and the capacity of the pump. Never attach mechanical agitation devices to the bypass line discharge.

Sprayers must have **agitation** to keep the spray material uniformly mixed. If there is too little agitation, the pesticide will be applied unevenly. If there is too much agitation, some pesticides may foam and interfere with pump and nozzle operation. The type of agitation needed depends on the pesticide formulation.

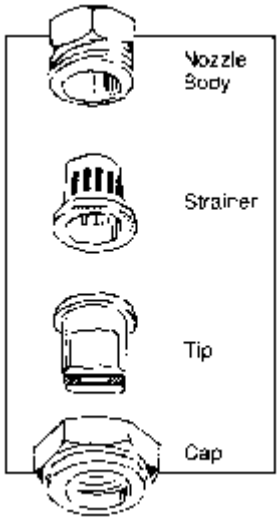
Most **nozzles** have four major parts: the nozzle body, the cap, the strainer (screen), and the tip or orifice plate. They also may include a separate spinner plate. Successful spraying depends on the correct selection, assembly, and maintenance of the nozzles.

The nozzle **body** holds the strainer and tip in proper position. Several types of tips that produce a variety of spray patterns may be interchanged on a single nozzle body..

The **cap** is used to secure the strainer and the tip to the body. The cap should not be overtightened.

The nozzle **strainer** is placed in the nozzle body to screen out debris that may clog the nozzle opening. The type of nozzle strainer needed depends on the size of the nozzle opening and the chemical being sprayed.

Special nozzle screens equipped with a check valve help prevent nozzle dripping. Check valves should be used in situations where a sprayer must be stopped and started frequently, such as in small target areas, near sensitive crops or areas, indoors, or for right-of-way treatments. The operator must check these spring-loaded ball valves frequently to be sure they are working properly.



Nozzle tips break the liquid pesticide into droplets. They also distribute the spray in a predetermined pattern and are the principal element that controls the rate of application. Nozzle performance depends on: nozzle design or type, operating pressure, size of the opening, discharge angle, distance of nozzle from the target.

Nozzle Patterns

Nozzle patterns are of three basic types: solid stream, fan, and cone. Some special-purpose nozzle tips or devices produce special patterns. These include "raindrops," "flooding," and others that produce wide-angle fan or cone-shaped patterns.

Solid stream nozzles are used in handgun sprayers to spray a distant or specific target such as livestock or tree pests. They also are used for crack and crevice treatment in and around buildings. Solid stream nozzles may be attached to booms to apply pesticides in a narrow band or inject them into the soil.

At least three types of nozzle tips have **fan patterns**. They are used mostly for uniform spray coverage of surfaces; for example, broadcast soil applications of herbicides or insecticides.

1) The **regular flat fan** nozzle tip makes a narrow oval pattern with tapered ends. It is used for broadcast herbicide and insecticide spraying at 15 to 60 psi. The pattern is designed to be used on a boom and to be overlapped 30 to 50 percent for even distribution. Spacing on the boom, spray angle, and boom height determine proper overlap and should be carefully controlled.

2) The **even flat fan** nozzle makes a narrow oval pattern. Spray delivery is uniform across its width. It is used for band spraying and for treating walls and other surfaces. It is not useful for broadcast applications

3) The **flooding** (flat fan) nozzle delivers a wide-angle flat spray pattern. It operates at very low pressure and produces large spray droplets. Its pattern is fairly uniform across its width but not as even as the regular flat fan nozzle pattern. If used for broadcast spraying, it should be overlapped to provide double coverage. It is often used for applying liquid fertilizers or fertilizer-pesticide mixtures or for directing herbicide sprays up under plant canopies.

Cone pattern nozzles

Hollow and solid cone patterns are produced by several types of nozzles. These patterns are used where penetration and coverage of plant foliage or other irregular targets are desired. They are most often used to apply fungicides and insecticides to foliage, although some types are used for broadcast soil applications of herbicides or fertilizers or combinations of the two.

Nozzle Materials

Most nozzle parts are available in several materials. Here are the main features of each kind:

Brass: resists corrosion from most pesticides, wears quickly from abrasion, probably the best material for general use, may be corroded by liquid fertilizers.

Plastic: will not corrode, resists abrasion better than brass, may swell when exposed to some solvents, useful life about equal to that of brass nozzles.

Stainless steel: resists abrasion, especially if hardened, good corrosion resistance, suited for high pressures, especially with wettable powders, lasts longer than brass.

Aluminum: resists some corrosive materials, easily corroded by some fertilizers, useful life much shorter than brass.

Tungsten carbide and ceramic: highly resistant to abrasion and corrosion, best material for high pressures and wettable powders, lasts much longer than brass.

Sprayer Selection, Use, and Care

Choosing the correct sprayer for each job is important. Your sprayer should be:

designed to do the job you want to do, durable, convenient to fill, operate, and clean.

Always read and follow the operator's manuals. They will tell you how to use and care for your spray equipment. After each use, rinse the entire system. Check for leaks in lines, valves, seals, and tank. Remove and clean nozzles, nozzle screens, and strainers.

Be alert for nozzle clogging and changes in nozzle patterns. If nozzles clog or other trouble occurs in the field, be careful not to contaminate yourself while correcting the problem. Shut off the sprayer and move it to the edge of the field before dismounting. Wear personal protective equipment while making repairs. Clean clogged nozzles only with a non-metal nozzle-cleaning tool. Sharp metal can ruin the nozzle. Never use your mouth to blow out a nozzle.

To prepare spray equipment for storage, follow manufacturer's instructions. If there

are no instructions, rinse and clean the system. Then fill the tank almost full with clean water. Add a small amount of new lightweight oil to the tank. Coat the system by pumping this mixture out through the nozzles or handgun. Drain the pump and plug its openings or fill the pump with lightweight oil or antifreeze. Remove nozzles and nozzle screens and store in lightweight oil or diesel fuel.

Hand-carried application equipment – When you carry the application equipment, such as hand-held sprayers or shake cans, you risk being directly exposed to the pesticide. A dripping or partially clogged nozzle, an unfastened cap, a leaky hose, or a loose connection are extremely likely to cause exposure. Consider wearing extra personal protective equipment to protect the area of your body that is in contact with the equipment.

If the application equipment is carried in front, consider wearing a sleeved apron, an apron with built-in gloves and sleeves, or an apron plus arm-covering gloves to protect your front from leaks, drift, and splashes.

If the application equipment is a type that is carried on your back, such as backpack, consider wearing a cape to protect your back and shoulders from leaking equipment.

If you carry only the nozzle, consider wearing arm-covering gloves or elbow-length gloves with the cuffs taped or otherwise sealed to the coverall sleeve.

Entering the path of the released pesticide – Many applications performed while on foot cause you to walk into the path of the pesticide you are releasing. Whenever possible, apply pesticides so that you are backing into the untreated area, away from where the pesticide is being released. However, under many conditions, it is unsafe to walk backward in an application site.

If you must walk into the path of the released pesticide, consider wearing shin-high or knee-high boots, or protective footwear with chemical-resistant pants. Spraying a thick coating of fabric starch or fabric stain protectant on the lower legs of your coveralls can provide a temporary barrier for low-toxicity pesticides and also makes the coveralls easier to clean.

When applying pesticides from a vehicle, use equipment that releases the pesticide to the rear so that you are located in front of and above the area of release and are moving away from it.

Whether you are walking or riding, if the pesticide is not directed downward or if it remains suspended in the air long enough to cause exposure to the front of your body, wear an apron or chemical-resistant suit. If the pesticide mist or dust reaches as high as your face, consider a dust/mist respirator and eye protection.

Walking into a just-treated area – Even when you apply a pesticide from a vehicle, you may need to walk into an area that was just treated. For example, you may need to repair or adjust the equipment or check the pesticide dispersal. You probably will be climbing over a contaminated rig and walking through an area that was treated only moments before. Consider putting on additional personal protective equipment while you are out of the vehicle.

If the vegetation in the treated area is covered with pesticide spray or dust and is fairly short, consider shin-high or knee-high boots, or protective footwear with chemical-resistant pants. In this situation, as with walking into the path of the released pesticide, consider applying spray starch or fabric stain protector to pant legs.

If the plants in the treated area are tall, consider wearing a chemical-resistant suit in addition to the footwear. If you cannot wear

a chemical-resistant suit because of the heat, try a cape or an apron.

If spray is dripping or dust is falling from overhead, consider a hood or wide-brimmed hat in addition to the body protection and footwear. A dust/mist respirator and protective eyewear may be necessary, too.

High-exposure applications – Certain types of pesticide applications pose a special exposure risk, because they engulf you in pesticide fallout. They include: ● mist blower or airblast 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.

Whenever you work in these situations, large amounts of pesticide fallout are likely to be deposited on your skin and clothing, often to the point of completely drenching or covering you. Unless you are in an enclosed cab, you cannot avoid this exposure, even if you perform the application during times of little or no air currents.

In these situations, you should wear more personal protective equipment than the pesticide labeling requires for other types of applications. Only a chemical-resistant suit with a hood, gloves and footwear with sealed cuffs, and a full-face respirator or half-face respirator with sealed goggles can provide enough protection for these high-exposure applications.

Applications in enclosed spaces – Pesticides sometimes are applied in enclosed spaces such as warehouses, factories, homes, and other buildings; railcar, ship, and truck cargo areas; silos, elevators, and other grain storage areas; and greenhouses. When you use pesticides in enclosed spaces, you increase the risk of inhaling the pesticide. You may need to use a respirator even if you would not need one for the same application outdoors.

Adjusting pesticide-coated equipment – You may need to wear a protective apron while doing some types of equipment adjustments and repairs. Consider wearing a vapor-removing respirator, even outdoors, if you must adjust fumigation equipment.

Immersing hands and forearms – Some application techniques, such as animal, plant, or seed dipping vats and spray-dip machines, require you to place your hands and forearms into the pesticide liquid or dust. With this exposure, consider a sleeved apron for full front and arm protection, and protective footwear. A face shield will protect against splashes or drifting dusts.

Applying in air currents – If you will be applying pesticides into or across wind or air currents, consider wearing extra personal protective equipment because pesticide may be blown onto you. More body protection, protective eyewear, and a dust/mist filtering respirator may be appropriate.

Applying concentrates – You may be exposed to highly concentrated pesticides during some applications. Ultra-low-volume concentrates and fumigant formulations may be close to 100-percent active ingredient and often are highly toxic. Consider using extra personal protective equipment when applying concentrates, such as that required for mixing and loading of those formulations.

Application Procedures

Every time you apply a pesticide, follow these basic procedures to make sure that you are using the pesticide safely and effectively:

Deliver the pesticide to the target – Be sure that the pesticide is reaching the surface or space to which you are directing it. Pesticide deposited elsewhere is a waste of time and money and may harm non-target areas.

Check the delivery rate – Be sure that you are applying the pesticide evenly and in approximately the right amounts. Be especially careful in areas where you turn or pause. Many types of application equipment continue to release pesticide even when not in motion.

When you have applied the pesticide to the first part of the area or space that is to be treated, check to be sure that approximately the correct proportion of pesticide has been used. If too little is being released, check the equipment openings for clogging or obstructions. If too much is being released, check for worn or stuck openings.

Check for appearance – As you apply, notice whether the pesticide you are releasing looks the way it should. Applications of wettable powders usually have a whitish color. If the liquid is clear, check to be sure that you are agitating the mixture enough to keep the wettable powder mixed with the water. Granules and dusts should appear dry and should not form clumps. Emulsifiable concentrates usually look milky. If the pesticide does not look right, be sure you have the right mixture and that it is blended evenly.

Check the appearance of the target area where you have just released the pesticide. If the surface is changing colors or is stained unexpectedly, stop and check whether you are harming the surface.

Avoid non-target organisms – Before you apply a pesticide, clear all unprotected people from the area. It is illegal to allow them to be exposed to a pesticide application – either directly or through drift. Also, remove any pets or livestock not being treated with the pesticide. Even when the pesticide application is narrowly directed such as a crack and crevice treatment, keep people and animals out of the immediate area during application.

Check the pesticide labeling to find out when people and non-target animals can re-enter the treated area. The labeling of some pesticides may restrict entry into treated areas for periods ranging from several hours to several days.

In general, if the pesticide labeling has no such instructions, it may be best to restrict the entry of unauthorized people into the treated areas at least until any dusts or mists have settled or sprays have dried. If necessary, provide ventilation to disperse vapors.

Avoid non-target surfaces – When possible, clean the application site of any items that should not be contaminated. Cover or protect any items that cannot be removed from the area and that are not involved in the handling activity, including such things as food and food utensils; bedding; toys; seed; pet or livestock feed, water, or supplies; and other items that could transfer pesticides to people, pets, or livestock.

Operate equipment safely – Turn off equipment whenever you pause or need to make any adjustments or repairs. When you stop application to take a break, to move to another site, or for repairs, depressurize any pressurized tanks. Turn off the main pressure valve on the tank and release any pressure remaining at the nozzles.

When applying pesticides at a distance from your equipment – at the end of a long hose, for example – be sure that unprotected people and pets stay away from the equipment. You may need to post a helper near it.

Check hoses, valves, nozzles, hoppers, and other equipment parts occasionally while you are applying. If you notice a problem, stop immediately 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

used for this kind of job is never used for any other purpose.

After Mixing, Loading, and Application

As soon as you finish mixing, loading, or applying a pesticide, you should do a few important follow-up tasks. Take the time to clean up properly. Wash your pesticide equipment and then wash yourself. Return equipment to its designated place and safely store or dispose of all pesticide materials and other chemicals.

Be sure that your work site presents no hazards to people or the environment. Never leave the site unattended until everything has been cleaned up and put away. While you can still remember the facts, make a record of what you have applied and the conditions at the application site.

Equipment Cleaning

Always clean mixing, loading, and application equipment as soon as you finish using it – do not leave equipment with pesticides on it or in it at the mixing and loading site or at the application site. When the job is completed and the tank or hopper is empty, return the equipment to the designated equipment cleanup area.

Avoid washing equipment repeatedly in the same location unless you use a containment pad or tray. Over time, the flooring or soil in a frequently used area can become contaminated with large amounts of pesticides. This contamination increases the likelihood of harmful effects to people and animals and increases the likelihood of runoff or leaching into water systems. Also avoid keeping pesticide-contaminated equipment in one location all the time. Pesticides may move off the outside of the equipment and onto the floor or soil.

Do not assign a worker to clean pesticide-contaminated equipment unless that person has been instructed in the basic rules of pesticide safety. Remember that equipment cleaning presents as great a risk of exposure to pesticides as do many other pesticide handling tasks and that all parts of the equipment are likely to have pesticides or pesticide residues on them. When you clean pesticide-contaminated equipment, wear the personal protective equipment that the labeling requires for handling jobs, plus a chemical-resistant apron.

Benefits of correct cleaning – Sloppy cleanup practices are one of the main causes of equipment failure or malfunction. Never keep excess pesticides in your equipment for more than a short time. Even small amounts can damage equipment.

Liquid pesticides left in the equipment may quickly corrode the equipment and clog or corrode the nozzle openings. They may cause the equipment to leak or cause the nozzles to release too little or too much pesticide when the equipment is operated. Some liquid pesticides change if they are stored after being diluted and will not be suitable for application later. Some will settle out and form a solid clump at the bottom of the tank that even mechanical agitation cannot remix. Others will separate into two or more liquids that cannot be remixed easily. Liquid pesticides that are allowed to stay in the equipment until they are totally dry may be impossible to remove completely.

Dry pesticides that become wet through humidity, rain, dew, or other moisture tend to clump and stick to the sides and hopper openings. They cannot be applied later, and cannot be easily removed from the equipment.

Cleaning procedures – After the equipment is empty, clean both the inside and outside thoroughly, including nozzles or hopper openings. Sometimes you may need to use the diluent used in the pesticide mixture (kerosene or high-grade oil), special

cleaning agents, or water under pressure. In other cases, ordinary water may be enough.

Collect the rinsate – the liquid that results from the washing process. If you do not have a way to reuse or dispose of the rinsate, limit the amount of material you use, so you will create less waste.

Carefully wash any vehicles, such as vans and trucks, that may be used for transporting unprotected workers or for family use. People have been poisoned by riding in vehicles that had been used to apply pesticides or to perform flagging for aerial applications.

Rinsates – Remember that the rinsates you create when you clean your equipment contain pesticides and can harm people and the environment. Do not allow rinsates to flow into water systems, including sink or floor drains, rainwater culverts, wells, streams, lakes, and rivers. Do not create puddles that children, other unprotected persons, or animals could get into.

You may use equipment rinsate as a diluent for future pesticide mixtures, if ● the pesticide in the rinsate is labeled for use on the target site where the new mixture is to be applied, ● the amount of pesticide in the rinsate plus the amount of pesticide product in the mixture does not exceed the labeling rate for the target site, ● the rinsate is used to dilute a mixture containing the same pesticide or a compatible pesticide, ● you comply with other application instructions specified on the labeling, including any specific labeling instructions for application as an excess pesticide.

<u>The rinsate cannot be added to a pesticide mixture if:</u> ● the pesticide labeling does not list the rinsate as an acceptable diluent; for example, if 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 the pesticide will be applied, ● the rinsate would alter the pesticide mixture and make it unusable; for example, if the pesticides are physically or chemically incompatible.

If you have any rinsates that you **cannot** use, dispose of them as you would excess pesticides.

Personal Cleanup

When you finish working with pesticides or pesticide-contaminated equipment, take time for personal cleanup. Wash the outside of your gloves first, before taking them off. Then carefully peel back your personal protective equipment to avoid getting pesticides on your skin. Remove any other clothing that has pesticide on it.

If you cannot take a shower right away, use a mild liquid detergent and warm water to wash your face, hands, forearms, and any other area that may have pesticides on it. As soon as you can – no later than the end of the work day – wash your whole body and hair thoroughly with a mild liquid detergent and plenty of warm water.

When you remove your personal protective equipment and work clothing, put it in a plastic box or bag until it can be laundered. Do not allow children or pets to play with these items. Do not wash work clothing and personal protective equipment in the same wash water with the family laundry.

Recordkeeping

KRS 217b requires that private and commercial applicators keep records of pesticide use and applications for a period of three (3) years following application. A sample form is available at the end of this manual

Dealers must keep records of pesticide sales for two (2) years.

Records can establish proof of proper use. If an error has been made, records are helpful in finding the cause. They also can provide you with information to use in response to claims of excess residues or damages.

Good records can save you money. They allow you to compare the results obtained from using different pesticides, different formulations, and different equipment, and from applying under various site conditions. You can improve your pest-control practices and your efficiency.

Records can help you reduce pesticide mistakes or misuse. If a pest is not controlled, if damage has occurred in the target area, or if a pesticide has moved off the target area and caused problems, you may be able to determine what went wrong.

Records may help you to determine that a particular pesticide, a particular formulation, a type of application equipment, or some condition in the treatment area caused the problem. Then you can take steps to avoid such a situation in future pesticide applications.

Good records can help you better determine the exact amount of pesticide you'll need. Some pesticides do not store well for long periods of time, and disposal of excess pesticide can be expensive.

Pesticide Containment Systems

If you often mix and load pesticides in one place, or if you often clean equipment at one location, you may find a pesticide collection pad or tray a good investment. These pads and trays are designed to catch spills, leaks, overflows, and wash water and allow them to be recovered for reuse or disposal. Larger pads may be permanently installed, but smaller pads and trays can be portable.

These systems can save you time and money. They make spill cleanup easier, and they reduce pesticide waste by allowing you to 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 – A collection tray can be used at mixing, loading, and equipment cleaning sites where only small amounts of pesticide are handled at a time and portable equipment is used. Such tasks often occur on a counter or bench. The tray can be made of sturdy chemical-resistant rubber or plastic, such as a boot or shoe mat. The tray must have a rim around it to collect spills and leaks and should have a spout where the contents can be poured off.

Collection pads – A collection pad is suitable for mixing, loading, and equipment cleaning sites where large quantities of pesticides are handled and large equipment is cleaned. Such operations often take place outdoors or in a large, open space in a building such as a warehouse or barn.

The collection pad should be made of a waterproof material, such as sealed, smooth concrete; glazed ceramic tile; or no-wax sheet flooring. Porous surfaces, such as wood, asphalt, soil, or carpeting, are not acceptable. The pad must be concave or must have curbs or walls high enough to hold the largest amount of spill, leak, or equipment wash water likely to be created at the site. It also must be equipped with a

system for removing and recovering spilled, leaked, or released material – either an automatic sump system or a manually operated pump.

Locate 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 the environment and to animals and unprotected people.

Test Your Knowledge

Q-1. What two precautions should you take to avoid getting pesticides into your water source at a mix-load site?

- **A.** 1. Keep the water pipe or hose well above the level of the pesticide mixture, and use a device to prevent back-siphoning, if necessary. 2. Avoid mixing or loading pesticides in areas where a spill, leak, or overflow could allow pesticides to get into water systems.

Q-2. What four types of personal protection, beyond what you need during application, should you consider wearing while mixing or loading pesticides?

- **A.** Front protection, face protection, protection from dusts, and protection from vapors.

Q-3. What should you do with an empty pesticide container?

- **A.** If containers are rinsable, rinse them as soon as they are empty. Dispose of containers in accordance with labeling directions and with any laws or regulations that apply.

Q-4. What two methods of rinsing can you use?

- **A.** Triple rinsing and pressure rinsing.

Q-5. What are two ways to help you decide whether you can safely mix two pesticides together for application?

- **A.** 1. Check the pesticide labeling. It may list the pesticides (and other chemicals) known to be compatible with the formulation. 2. Test a small amount of the mixture before mixing large quantities of the pesticides together.

Q-6. What should you do with rinsate that you create when you clean your pesticide equipment?

- **A.** Collect the rinsate. Reuse it, if possible, or dispose of it as excess pesticide.

Q-7. When you are finished with pesticide handling tasks, what steps should you take for personal cleanup?

- **A.** Wash the outside of your gloves before taking them off. Then carefully peel back your personal protective equipment to avoid getting pesticides on your skin. As soon as you can – no later than the end of the work day – wash your whole body and hair thoroughly with a mild liquid detergent and plenty of warm water.

Q-8. Why should you keep records of pesticide applications?

- **A.** It is required by law.

Q-9. When should you consider installing a pesticide containment systems?

- **A.** If you often mix and load pesticides in one place, or if you often clean equipment at one location.

10 - Applying the Correct Amount

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.

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

> 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.

Under-dosing 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 that will achieve good control. Sometimes consultants, industry organizations, pest or pesticide specialists, Cooperative Extension agents, university specialists, or pesticide dealers will recommend appropriate amounts.

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 fluid ounces 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. 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** – for example, 0.5% by volume or 1% by weight. 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 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.

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 application equipment, the speed at which the equipment moves (or is carried)

through the target site is one of the main factors determining application rate. For other equipment, speed is not a factor.

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 equipment speed 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.

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.

Uniform Release

If your application equipment has more than one nozzle (or more than one cluster of nozzles) or hopper, part of the calibration process is to measure the output from each to be sure that they are releasing a uniform amount of pesticide.

First, check for clogging or obstructions, leaks, or worn nozzles. Then, measure the pesticide output for each nozzle (or cluster of nozzles) or hopper for a specific period of time. The output must be within 10% of the average of the nozzles (or cluster of nozzles) or hoppers. Finally, replace worn or damaged nozzles or hoppers if the output is beyond 10 % of the average.

You can check for uniform output in two ways. Either method requires that you attach containers to collect the output from each nozzle, nozzle cluster, or hopper.

1 Operate the equipment for a set period of time and compare the amount of output in each container to the amount desired.

2) 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 container 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 containers 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); and

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, add 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 amount required.

However, you may not have 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, test smaller sites and then calculate the application rate.

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. Take time to check the calibration regularly.

Be alert for possible calibration problems each time you use 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, stop the 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

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 marked or graduated utensils. If you are measuring a dry formulation, use a scale to weigh out the exact number of pounds or ounces you need. For 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 how much 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.

Measuring utensils that you use with pesticides should never be used for other purposes. Clean them thoroughly after each use and store them with other pesticide equipment.

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.

Test Your Knowledge

Q-1. 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 be liable for damages.

Q-2. Where can you find out how much pesticide to apply?

- **A.** From the Directions for Use section of the pesticide labeling.

Q-3. What are some 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-4. 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-5. 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-6. 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.

Some Standard measures

1 mph = 88 ft per minute
1 acre = 43,560 square feet
1 teaspoon = 0.17 fluid ounces
1 tablespoon = 3 teaspoons
1 fluid ounce = 2 tablespoons
1 pint = 16 fluid ounces
1 quart = 32 fluid ounces
1 gallon = 128 fluid ounces
1 gallon = 3.785 liters

Calculating the area of:

Circle = 3.14 * $(\text{radius})^2$
Rectangle = length * width
Triangle = ½ (base + height)

11- Transportation, Storage, Disposal, and Spill Cleanup

When you transport, store, or dispose of pesticides and their containers, you must take safety precautions. You can prevent many pesticide accidents and reduce the severity of others, if you are well prepared. Before beginning any pesticide handling task, know what do to in case of spills and have the proper cleanup equipment on hand.

Transportation of Pesticides

You are responsible for the safe transport of pesticides in your possession. Carelessness in transporting pesticides can result in broken containers, spills, environmental contamination, and harm to yourself and others. Accidents can occur even when transporting materials a short distance.

Do all you can to prevent a mishap, but be prepared in case of an emergency. Before transporting pesticides, know what to do if a spill occurs. If any pesticide is spilled in or from the vehicle, take action right away to make sure the spill is cleaned up correctly.

Vehicle Safety

The safest way to transport pesticides is in the back of a truck. Flatbed trucks should have side and tail racks. Steel or plastic-lined beds are best because they can be more easily cleaned if a spill occurs.

Never carry pesticides in the passenger section of your car, van, or truck. Hazardous vapors may be released and make the driver and other passengers ill. Pesticides may cause illness or injury if they spill on you or your passengers. It is nearly impossible to completely remove spills from the fabric of seats and floor mats. They can cause future contamination if they are not cleaned up correctly. If you must transport pesticides in the back of a station wagon, open the side windows and do not allow anyone to ride in the back.

Never allow children, other passengers, and pets to be exposed to pesticides during transportation.

Never transport pesticides with food, clothing, or other things meant to be eaten by or come into contact with people or animals.

Never leave your vehicle unattended when transporting pesticides in an unlocked trunk compartment or open-bed truck. You are responsible and liable if curious children or careless adults are accidentally poisoned by the pesticides. Whenever possible, transport pesticides in a locked compartment.

Consider transporting highly volatile pesticides in separate trips from other chemicals. Spills, or even fumes from opened containers, can make the other chemicals worthless.

Transporting Pesticide Containers

Transport pesticides only in containers with intact, undamaged, and readable labels. Inspect containers before loading to be sure that all caps, plugs, and other openings are tightly closed and that there are no pesticides on the outside of the containers. Handle containers carefully to avoid rips or punctures.

Anchor all containers securely to keep them from rolling or sliding. Packing or shipping containers provide extra cushioning. Protect paper and cardboard containers from moisture, because they become soggy and split easily when wet.

Protect pesticides from extreme temperatures during transport. Extremely

hot or cold temperatures can damage pesticide containers by causing them to melt or become brittle. Such temperatures also may reduce the usefulness of the pesticides.

Pesticide Storage

Many pesticide handlers use existing buildings or areas within existing buildings for pesticide storage. However, if large amounts of pesticides will be stored, build a special storage building for pesticides.

Establish a Storage Site

A correctly designed and maintained pesticide storage site is essential. A suitable storage site:

Protects people and animals from accidental exposure,

Protects the environment from accidental contamination,

Prevents damage to pesticides from temperature extremes and excess moisture,

Protects the pesticides from theft, vandalism, and unauthorized use, and

Reduces the likelihood of liability.

Secure the site – Keeping out unauthorized people is an important function of the storage site. Whether the storage site is as small as a cabinet or closet or as large as an entire room or building, keep it securely locked. Post signs on doors and windows to alert people that pesticides are stored there. Post "No smoking" warnings.

Prevent water damage – Choose a storage site where water damage is unlikely to occur. Water from burst pipes, spills, overflows, excess rain or irrigation, or flooding streams can damage pesticide containers and pesticides. Water or excess moisture can cause metal containers to rust, paper and cardboard containers to split or crumble, pesticide labeling to peel, smear, run, or otherwise become unreadable. Dry pesticides will clump, degrade, or dissolve, and slow-release products may begin to breakdown.

Control the temperature – The storage site should be indoors, whenever possible. Choose a cool, well-ventilated room or building that is insulated or temperature-controlled to prevent freezing or overheating. The pesticide labeling may tell you at what temperature the product should be stored.

Freezing temperatures can cause containers to break. Excessive heat can cause plastic containers to melt, some glass containers to explode, and some pesticides to volatilize and drift away from the storage site. Temperature extremes can destroy the potency of some pesticides.

Provide adequate lighting – The storage site should be well lighted. Pesticide handlers using the facility must be able to see well enough to read pesticide container labeling, to notice whether containers are leaking, corroding, or otherwise disintegrating.

Use nonporous materials – The floor of the storage site should be made of sealed cement, glazed ceramic tile, no-wax sheet flooring, or another easily cleaned material. Carpeting, wood, soil, and other absorbent floors are difficult or impossible to decontaminate in case of a leak or spill. For ease of cleanup, shelving and pallets should be made of nonabsorbent materials such as plastic or metal. If wood or fiberboard materials are used, they should be coated or covered with plastic, polyurethane or epoxy paint.

Prevent runoff – Inspect the storage site to determine the likely path of pesticides in case of spills, leaks, drainage of equipment wash water, and heavy pesticide runoff from firefighting or floods. Pesticide movement

away from the storage site could contaminate sensitive areas, including surface water or ground water. If your storage site contains large amounts of pesticides, you may need to use a collection pad11 to contain pesticide runoff.

Provide clean water – Each storage site must have an immediate supply of clean water. Potable running water is ideal. If running water is not practical, use a large, sealable container with clean water. Change the water at least weekly to ensure that it remains safe for use on skin and eyes. Keep an eyewash dispenser immediately available for emergencies.

Maintain the Storage Site

Prevent contamination – Store only pesticides, application equipment, and a spill cleanup kit at the storage site. Do not keep food, drinks, tobacco, feed, medical or veterinary supplies or medication, seeds, clothing, or personal protective equipment (other than personal protective equipment necessary for emergency response) at the site. These could be contaminated by vapors, dusts, or spills and cause accidental exposure to people or animals.

Keep labels legible – Store pesticide containers with the label in plain sight. Costly errors can result if the wrong pesticide is chosen by mistake. Labels should always be legible. They may be damaged or destroyed by exposure to moisture, dripping pesticide, diluents, or dirt. You can use transparent tape or a coating of lacquer or polyurethane to protect the label. If the label is destroyed or damaged, request a replacement from the pesticide dealer or the pesticide formulator immediately.

Keep containers closed – Keep pesticide containers securely closed whenever they are being stored. Tightly closed containers help protect against a spill, cross-contamination with other stored products, evaporation of liquid pesticides or the solvent, clumping or caking of dry pesticides in humid conditions, and dust, dirt, and other contaminants getting into the pesticide, causing it to be unusable.

Use original containers – Store pesticides in their original containers. Never put pesticides in containers that might cause children and other people to mistake them for food or drink. You are legally responsible if someone or something is injured by pesticides you have placed in unlabeled or unsuitable containers.

Watch for damage – Inspect containers regularly for tears, splits, breaks, leaks, rust, or corrosion. When a container is damaged, put on appropriate personal protective equipment and take immediate action. If the damaged container is an aerosol can or fumigant tank that contains pesticides under pressure, use special care to avoid accidentally releasing the pesticide into the air. When a container is damaged:

Use the pesticide immediately at a site and rate allowed by the label, or

Transfer the pesticide into another pesticide container that originally held the same pesticide and has the same label still intact, or

Transfer the contents to a sturdy container that can be tightly closed. If possible, remove the label from the damaged container and use it on the new container. Otherwise, temporarily mark the new container with the name and EPA registration number of the pesticide, and get a copy of the label from the pesticide dealer or formulator (whose telephone number is usually on the label) as soon as possible, or

Place the entire damaged container and its contents into a suitable larger container. Consider this option carefully, however. Many times the label on the leaking container becomes illegible. The pesticide is

useless and becomes a disposal problem unless you know the name and registration number and can get a copy of the label.

Store volatile products separately – Volatile pesticides, such as some types of 2,4-D, should be stored apart from other types of pesticides and other chemicals. A separate room is ideal. Vapors from opened containers of these pesticides can move into other nearby pesticides and chemicals and make them useless. The labeling of volatile herbicides usually will direct you to store them separately from seeds, fertilizers, and other types of pesticides.

Isolate waste products – If you have pesticides and pesticide containers that are being held for disposal, store them in a special section of the storage site. Accidental use of pesticides meant for disposal can be costly. Clearly mark containers that have been triple rinsed or cleaned by an equivalent method because they are more easily disposed of than unrinsed containers.

Know your inventory – Keep an up-to-date inventory of stored pesticides. Each time a pesticide is added to or removed from the storage site, update the inventory. The list will help you track your stock and will be essential in a fire or flood emergency. The inventory list also will aid in insurance settlements and in estimating future pesticide needs.

Do not store unnecessarily large quantities of pesticides for a long time. Buy only as much as you will need for a year. Pests, pesticides, or pesticide registrations may change by the next year and make the pesticides useless. Some pesticides have a relatively short shelf life and cannot be carried over from year to year.

Consider shelf life – Mark each pesticide container with the date of purchase before it is stored. Use older materials first. If the product has a shelf life listed in the labeling, the purchase date will indicate whether it is still usable. Excessive clumping, poor suspension, layering, or abnormal coloration may indicate that the pesticide has broken down. However, sometimes pesticide deterioration from age or poor storage conditions becomes obvious only after application. Poor pest control or damage to the treated surface can occur. If you have doubts about the shelf life of a pesticide, call the dealer or manufacturer for advice.

Prevent Pesticide Fires

Some pesticides are highly flammable; others do not catch fire easily. The labeling of pesticides that require extra precautions often will contain a warning statement in either the *Physical/ Chemical Hazards* section or the *Storage and Disposal* section. Pesticides that contain oils or petroleum-based solvents are most likely to contain these warning statements. Some dry products also present fire and explosion hazards.

Store combustible pesticides away from open flames and other heat sources, such as steam lines, heating systems, kerosene heaters or other space heaters, gas-powered equipment, or incinerators. Do not store glass containers in sunlight where they can focus the heat rays and possibly explode or ignite. Install fire detection systems in large storage sites, and equip each storage site with a working fire extinguisher approved for all types of fires, including chemical fires.

If you store highly toxic pesticides or large amounts of any pesticide, inform your local fire department, hospital, public health officials, and police of the location of your pesticide storage building before a fire emergency occurs. Tell fire department officials what types of pesticides are regularly stored at the site, give them a floor plan, and work with them to develop an emergency response plan.

Disposal

Pesticide users are responsible for correctly dealing with empty pesticide containers, excess usable pesticides, and waste materials that contain pesticides or their residues. There is growing concern about the serious harm to humans and the environment that incorrect disposal of pesticide wastes can cause. For information on disposal options in your area, contact your state or tribal pesticide authority.

Excess Pesticides

The best solution to the problem of what to do with excess pesticides is to avoid having them:

Buy only the amount needed for a year or a season.

Calculate carefully how much diluted pesticide is needed for a job and mix only that amount.

Use all the mixed pesticide in accordance with labeling instructions.

If you have excess usable pesticides, try to find a way to use them as directed on the label. The best option is to apply the pesticide on a site listed in the use directions on the pesticide labeling, under the following conditions:

The total amount of pesticide active ingredient applied to the site, including all previous applications, must not exceed the rate and frequency allowed on the labeling.

You must comply with other application instructions specified on the labeling.

If you have pesticide products in their original containers that you cannot use, you may be able to find another pesticide handler who can. Or you may be able to return them to a dealer, formulator, or manufacturer.

Most container rinsates should not become excess pesticides because they can be added into the tank during mixing. You also may be able to add some rinsates from equipment cleaning, spill cleanup, and other activities to a tank mixture that contains the same pesticide, as long as doing so will not violate labeling instructions. However, some rinsates will contain dirt, cleaning agents, or other substances that will make them unusable.

Pesticide Wastes

Excess pesticides and rinsates that cannot be used must be disposed of as wastes. Other pesticide wastes include such things as contaminated spill cleanup material and personal protective equipment items that cannot be cleaned and reused. Whenever possible, avoid creating pesticide wastes that require disposal.

Sometimes pesticide wastes can be disposed of in a landfill operating under EPA, state, or local permit for hazardous wastes. Most sanitary landfills are not suitable. Some regions have pesticide incinerators for disposing of pesticide wastes. Never burn, bury, or dump excess pesticides, and never dispose of them in a way that will contaminate public or private ground water or surface water or sewage treatment facilities.

Pesticide wastes that cannot be disposed of right away should be marked to indicate the contents and then stored safely and correctly until disposal is possible.

Containers

Try to avoid the need to dispose of pesticide containers as wastes. If possible, use containers that are designed to be refilled by the pesticide dealer or the chemical company or arrange to have the empty containers recycled.

Refillable containers – Some types of containers are designed to be refilled with pesticide repeatedly during their lifetime, which may be many years. They usually are not designed to be triple rinsed or pressure rinsed by the pesticide user. When necessary, they are cleaned by the pesticide dealer or chemical company before refilling. Common types of refillable containers include mini-bulks and small-volume returnables.

Triple-rinsed or pressure-rinsed containers – Containers that have been correctly triple rinsed or pressure rinsed usually may be disposed of as regular trash in a sanitary landfill, unless prohibited by the pesticide labeling or by State, or local authorities. Mark the containers to show that they have been rinsed.

Unrinsed containers – To dispose of unrinsed containers, take them to an incinerator or landfill operating under EPA or state permit for hazardous waste disposal. If this is not possible, check with your state or local authorities to find out what to do. Otherwise, you may need to store the containers until you have a way to dispose of them.

Spill Management

A spill is any accidental release of a pesticide. As careful as people try to be, pesticide spills can and do occur. The spill may be minor, involving only a dribble from a container, or it may be major, involving large amounts of pesticide or pesticide-containing materials such as wash water, soil, and absorbents.

You must know how to respond correctly when a spill occurs. Stopping large leaks or spills is often not simple. If you cannot manage a spill by yourself, get help. Even a spill that appears to be minor can endanger you, other people, and the environment if not handled correctly. Never leave a spill unattended. When in doubt, get assistance.

You can get help from Chemtrec (Chemical Transportation Emergency Center) by calling 1-800-424-9300. This number is for emergencies only.

The faster you can contain, absorb, and dispose of a spill, the less chance there is that it will cause harm. Clean up most spills immediately. Even minor dribbles or spills should be cleaned up before the end of the work day to keep unprotected persons or animals from being exposed.

> When a spill emergency occurs, remember the "three C's: Control, Contain, and Clean up.

Control the Spill Situation

Protect yourself – Put on appropriate personal protective equipment before contacting the spill or breathing its fumes. If you do not know how toxic the pesticide is or what type of personal protective equipment to wear, don't take a chance! Wear barrier-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 has tipped over and is too heavy to be righted, you will not be able to stop the source.

Protect others – Isolate the spill site by keeping children, other unprotected people, and animals well back. Rope off the site if necessary. If you suspect the spill contains a highly volatile or explosive pesticide, you may need to keep people back even farther. Warn people to keep out of reach of any drift or fumes. Do not use road flares or allow anyone to smoke if you suspect the leaking material is flammable.

Stay at the site – Do not leave the spill site until another knowledgeable and correctly protected person arrives. Someone should be at the spill site at all times until the spill is cleaned up.

Contain the Spill

Confine the spill – As soon as the source of the leak is under control, move quickly to keep the spill in as small an area as possible. Do everything you can to keep it from spreading or getting worse. For small spills, use containment snakes to surround the 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 – Keep the spill out of any body of water or any pathway that will lead to water, such as a ditch, floor drain, well, or sinkhole. If the spilled pesticide is flowing toward such an area, block it or redirect it.

Absorb liquids – Liquid pesticide spills can be further contained by covering the entire spill site with absorbent materials, such as spill pillows, fine sand, vermiculite, sawdust, clay, kitty litter, shredded newspaper, or absorbent pads.

Cover dry materials – Prevent dry, dusty pesticide spills, such as dusts, powders, or granules, from becoming airborne by covering them with a sweeping compound or a plastic covering or by very lightly misting the material with water. Do not mist too much, because water may release the pesticidal action or may cause the pesticide to form clumps and be unusable.

Warning: Pesticides that are oxidizers, such as calcium hypochlorite (a common sanitizer) and some herbicides and desiccants that contain chlorites, should not be contained with sawdust, shredded paper, or sweeping compounds. These absorbent compounds combine with the oxidizer to create a fire hazard and could burst into flame.

Clean Up

After you have contained the spill, pick up the spilled material and decontaminate the spill site and any contaminated items or equipment.

Clean up the spill – For spilled liquid pesticides, sweep up the absorbent material containing the pesticide and place it into a heavy-duty plastic drum or bag. Keep adding the absorbent material until the spilled liquid is soaked up and removed.

Spills of dry pesticides should be swept up for reuse if possible. Avoid contaminating the spilled materials with soil or other debris, so it can be used in the usual application equipment and will not clog the nozzles or hopper openings. However, if the dry spill has become wet or full of debris, it must be swept up and placed in a heavy-duty plastic drum or bag for disposal.

Decontaminate the spill site – Once you have collected as much of the spilled material as possible, 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 surface on which the pesticide has spilled is nonporous, such as sealed concrete, glazed ceramic tile, or no-wax sheet flooring, use water (or the chemical listed on the label to dilute the pesticide) and a strong detergent to remove the residues of the spill from the surface. Do not allow any of the wash solution to run off the site being cleaned. Place fresh absorbent material over the wash solution until it is all soaked up. Then sweep up the absorbent material and place it in a plastic drum or bag for disposal as an excess pesticide.

If the surface upon which the pesticide has spilled is porous, such as soil, unsealed

wood, or carpet, you may have to remove the contaminated surface and dispose of it as an excess pesticide. Depending on the size of the spill and the toxicity of the pesticide, however, sometimes the site can be successfully neutralized.

Neutralize the spill site – The labeling of a few pesticides will instruct you to neutralize a spill of that pesticide. Sometimes an authority, such as the pesticide manufacturer or Chemtrec, also will instruct you to neutralize the spill site. Follow instructions carefully.

Neutralizing a spill often consists of mixing full-strength bleach with hydrated lime and working this mixture into the spill site with a coarse broom. Fresh absorbent material is then spread over the spill site to soak up the neutralizing liquid. This material is swept up and placed in a plastic drum or bag for disposal. You may be instructed to repeat the process several times to make sure that the site is thoroughly neutralized.

Soil is sometimes neutralized by removing and disposing of the top 2 to 3 inches and then neutralizing the remaining soil. You may be instructed to mix activated charcoal into the soil or to cover the spill site with 2 or more inches of lime and cover the lime with fresh topsoil.

Sometimes you may be instructed to cover minor spills with activated charcoal. The activated charcoal can adsorb or tie up enough pesticide to avoid adverse effects to plants and animals that contact the soil in the future. However, activated charcoal is not effective for large spills.

Decontaminate equipment – Clean any vehicles, equipment, and personal protective equipment that were contaminated by the spill or during the containment and cleanup process. Use a strong mixture of chlorine bleach, dishwasher detergent, and water to clean the vehicles and equipment.

Wash personal protective equipment thoroughly, following manufacturers' instructions and the guidelines in the personal protective equipment unit of this manual. Remember particularly that porous materials, such as brooms, leather shoes, and clothing, cannot be cleaned effectively if they are thoroughly saturated with pesticide. They should be discarded.

Decontaminate yourself – When you are finished with the spill and equipment cleanup, wash yourself thoroughly with detergent and water. Wash any part of your skin that might have been exposed, and always wash your face, neck, hands, and forearms.

Spill Followup

For all large spills, and any spills that take place off your property, consider keeping records of your containment and cleanup activities and your conversations with authorities and the public about the spill. Photographs help to document any damage as well as the cleanup process. Report the spill to the appropriate agency, when necessary.

Spill Assistance

Chemtrec, the Chemical Transportation Emergency Center, is a public service of the Chemical Manufacturing Association. Located in Washington, DC, Chemtrec is staffed 24 hours a day by trained personnel who can advise you how to manage chemical emergencies.

When you request help from Chemtrec or any other source, have the product label on hand. Many pesticide labels list an emergency telephone number that gives you direct access to the manufacturer and people who know how to manage emergencies for that product.

If the spill occurs on a highway, call the highway patrol or highway department right

away. If the spill occurs on a county road or city street, call the county sheriff, city police, or fire department. These authorities are trained for such emergencies and will be able to assist you in your cleanup. Many local and state authorities require that you notify them of a pesticide spill.

If you suspect that a large spill is flammable, call the fire department for assistance. However, do not let them hose down the spill unless an authority directs them to do so.

If the spill may expose the public to pesticides or pesticide residues, contact public health officials. If anyone is poisoned by contacting the spill or if you suspect that an exposure may lead to poisoning call the hospital emergency room and provide them with the brand name, active ingredients, and any other labeling information about human health hazards, signs and symptoms of poisoning, and antidotes.

Spill Kit

Keep a spill cleanup kit immediately available whenever you handle pesticides or their containers. If a spill occurs, you will not have the time or the opportunity to find all of the items.

The kit should consist of:

telephone numbers for emergency assistance,

sturdy gloves, footwear, and apron that are chemical-resistant to most pesticides, such as barrier-laminate gear,

protective eyewear,

an appropriate respirator, if any of the pesticides require the use of 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, sawdust, pet litter, activated charcoal, vermiculite, or paper to soak up liquid spills,

sweeping compound to keep dry spills from drifting or wafting during cleanup,

a shovel, broom, and dustpan (foldable brooms and shovels are handy, because they can be carried easily),

heavy-duty detergent,

a fire extinguisher rated for all types of fires,

any other spill cleanup items specified on the labeling of any products you use regularly, and

a sturdy plastic container that will hold the quantity of pesticide from the largest pesticide container being handled and that can be tightly closed.

All of these items can be stored in the plastic container and kept clean and in working order until a spill occurs.

Test Your Knowledge

Q-1. What are two precautions that you should take when you transport pesticides in a vehicle?

- **A.** Never carry pesticides in the passenger section. Never allow children, other passengers, and pets to ride with pesticides.

Q-2. What steps should you take to protect pesticide containers during transport?

- **A.** 1. Transport containers with intact, undamaged, and readable labels.
2. Inspect containers to be sure that all openings are tightly closed and that there are

no pesticides on the outside of the containers. 3. Handle containers carefully. 4. Anchor all containers securely. 5. Protect paper and cardboard containers from moisture. 6. Protect pesticides from extreme temperatures.

Q-3. List four actions that you should take to establish a safe storage site.

- **A.** Keep unauthorized people out; prevent water damage; control the temperature; provide adequate lighting; use nonporous materials; prevent runoff; provide clean water.

Q-4. List four actions to maintain a safe storage site.

- **A.** Prevent contamination; keep labels legible; keep containers closed; use original containers; watch for damage; store volatile products separately; isolate waste products; know your inventory; consider shelf life.

Q-5. When a pesticide container is damaged, what can you do?

- **A.** 1. Use the pesticide immediately at a site and rate allowed by the labeling. 2. Transfer the pesticide into another pesticide container that originally held the same pesticide and has the same label still intact 3. Transfer the contents to a sturdy container that can be tightly closed and fasten the label to the outside of the new container. 4. Place the entire damaged container and its contents into a suitable larger container.

Q-6. If you have excess pesticide materials that are still usable, what can you do with them?

- **A.** Apply them to a site listed on the labeling; find someone else who can legally use them; return them to the dealer, formulator, or manufacturer.

Q-7. If you have pesticide wastes (other than empty containers) what can you do with them?

- **A.** Dispose in a hazardous waste landfill or pesticide incinerator, or store until disposal is possible.

Q-8. List three ways to avoid the need for disposing of empty pesticide containers as wastes.

- **A.** Use refillable containers; recycle or recondition the containers; use soluble packaging.

Q-9. What do the three C's of spill management stand for?

- **A.** Control, Contain, Clean up.

Q-10. What should you do to control a spill situation?

- **A.** Protect yourself; stop the source of the spill; protect others; stay at the site.

Q-11. How should you contain a spill?

- **A.** Confine the spill; protect water sources; absorb liquids; cover dry materials.

Q-12. What should cleanup include?

- **A.** Clean up the spill; decontaminate the spill site; neutralize the spill site, if necessary; decontaminate equipment; decontaminate yourself.

Q-13. Who can you call when you need help to manage a spill?

- **A.** Chemtrec; emergency numbers on pesticide labeling; police department or highway patrol; fire department; public health department.

RECORD OF CROP PROTECTION PRODUCTS APPLIED

Farm Location

Kentucky Department of Agriculture
Richie Farmer, Commissioner
visit: *www.kyagr.com*

FOR MORE INFORMATION CONTACT:
Division of Environmental Services
Pesticide Regulation
107 Corporate Drive • Frankfort, KY 40601 • 502-573-0282 • TTY 502-573-0302

Field Number	Date of Application mo/day/yr	Applicator Name & Certification Number	Crop/ Product Treated	Size of Area / Acres	Materials Applied			Rate Per		Volume of Water or Carrier/Acre	Purpose of Application	Chemical Type (General/ Restricted)	Add for WPS Compliance		
					Product Name	EPA Reg. No.	Total Amount Applied	Acre	____				REI	Time of Application	Active Ingredient(s)
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Definitions

The date of the pesticide application, including month, day, and year.

The Brand or Product Name; trademark name of the pesticide being used. The EPA Registration Number (on the label). The registration number is not the same as the EPA Establishment Number which is also located on the label.

The total quantity of the pesticide applied in common units of measure. Such as pints, quarts, gallons, etc. of concentrated pesticide. This does not refer to the % of active ingredient (a.i.).

The location of the pesticide application. Not the address of the farm or business. Options are by: a) County, range, township, or section, b) Identification system established by USDA, such as plat IDs used by the FSA or the NRCS, c) Legal property description, or d) Your field naming system that accurately identifies the location of the application.

Crop Commodity, Stored Product, or Site being treated.

Size of area treated. Record this information in the unit of measure (such as acres, linear feet, bushel, cubic feet, number of animals, etc.) which is normally expressed on the label in reference to the application being made.

The certification number of the private applicator. If the name of the private applicator and the certification number are kept together, this information only has to be listed once (Note: the name and certification number may be noted at the front of a record book if the same applicator is making the application).

Spot treatments are especially useful in the control of noxious weeds if you apply restricted use pesticides on the same day in a total area of less than 1/10 of an acre, you are required to record the following: Date of application including month, day, and year. Brand or product number. EPA registration number. Total amount of pesticide applied. Location of the pesticide application, designated as "Spot application" and short description. The spot treatment provision *excludes greenhouse and nursery applicators*, which are required to keep all data elements as listed.

Attending licensed health care professionals or those acting under their direction, USDA representatives, and State regulatory representatives with credentials have legal access to the records.

No standard federal form is required, so that pesticide recordkeeping can be integrated into the applicator's current recordkeeping schemes.

All certified commercial pesticide applicators will continue to maintain the records they currently keep under State or Federal regulations. The federal pesticide recordkeeping regulations require all commercial applicators, both agricultural and non-agricultural, to furnish a copy of the data elements required by this regulation or their state, to the customer within 30 days of the restricted use pesticide application.

PESTICIDE EMERGENCY TELEPHONE NUMBERS

First Call- 911

SPILLS

Be prepared to provide specific information on location, injuries, amount and type of any materials spilled.

Second Call- (800) 928-2380 KY Environmental Response

Be prepared to provide specific information on location, amount and type of any materials spilled. You may be instructed to call other agencies.

CHEMTREC (24 hour) Pesticide Emergency Hotline (800) 424-9300

EXPOSURE

If you have a person who has been exposed to a particular pesticide, provide your physician or emergency room personnel with the following information.

KENTUCKY REGIONAL POISON CONTROL CENTER

State (800) 222-1222 (KY Only)