I
Pesticide Regulation: An Overview

by Tom Mather

Pesticides, like medicinal drugs, are chemicals that can provide substantial benefits while posing serious potential hazards. Pesticides have important uses in increasing crop production, curbing insect-borne diseases, and preventing pest damage to buildings, food, and stored products. But the inherent toxicity of many pesticides can cause health problems and damage the environment. The dual nature of pesticides is reflected in current laws, which direct government agencies to weigh the benefits against the hazards of pesticides when regulating their use.

Pesticide use has been one of the focal points of the environmental movement ever since the publication of *Silent Spring* in 1962. The landmark book by biologist Rachel Carson warned that unrestricted use of pesticides could result in widespread damage to the environment and human health.[1] Her warnings, backed up by extensive research, have provided the impetus for major revisions of federal and state pesticide regulations since the early 1970s.

Now, more than 30 years after the publication of *Silent Spring*, where does pesticide regulation stand in North Carolina? The N.C. Center for Public Policy Research tried to answer that question by focusing on several more specific questions: How much pesticide use occurs in North Carolina and where is its use the highest? How does North Carolina regulate pesticides, and how does its program compare with those in other states? What types of pesticide users account for the most complaints and regulatory actions? Are pesticides more effectively regulated through agricultural or environmental agencies?

The Center spent nearly two years of study trying to answer those questions. In doing so,

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This study of state regulation of pesticides and related public education activities were supported by grants from The W.K. Kellogg Foundation of Battle Creek, Michigan, and the Kathleen Price and Joseph M. Bryan Family Foundation of Greensboro, N.C. The N.C. Center for Public Policy Research extends its sincere thanks for the generous support from both foundations.

Center staff reviewed scores of previous studies on pesticides, interviewed dozens of pesticide authorities, analyzed five years of state enforcement records, and surveyed pesticide administrators in all 50 states.

This article provides an overview of the uses, benefits, environmental hazards, and health risks of pesticides. It also summarizes past and current federal regulation of pesticides. A second article, "Searching for Hens' Teeth: Information Scarce on Pesticide Usage," discusses the amounts of pesticides being used in North Carolina and the United States and examines record-keeping requirements for applicators. A third article, "Enforcement of Pesticide Regulations in North Carolina," reviews the state's pesticide enforcement programs and looks at violations of those regulations. A fourth article, "How North Carolina Stacks Up Against Other States in the Regulation of Pesticides," presents the results of the Center's 50-state survey of pesticide programs. In a concluding article, the Center makes recommendations for improving pesticide regulation in North Carolina. Interspersed among these main articles are several shorter pieces dealing with specific issues such as organic farming, integrated pest management, aerial application of pesticides, exterminator treatments, groundwater contamination, and farmworker training.

What Are Pesticides?

Generally speaking, pesticides are substances used to kill, limit, or control pests.[2] But pests can mean many things to different people. To a farmer, pests can include insects, mites, slugs, fungi, and nematodes that damage crops; weeds that compete with crops for moisture and nutrients; rodents that eat seeds or bark from fruit trees and stored grains; and birds that eat newly planted seeds and seedlings.

To a homeowner, pests can include roaches, flies, mosquitoes, and other annoying insects; moths that can destroy sweaters and other woolen clothes; termites that can eat away the wooden structure of a house; crabgrass and other weeds in lawns and vegetable gardens; mildew that tarnishes bathrooms and basements; aphids, slugs, and other pests that attack ornamental plants and vegetables; rats and mice that litter attics and storage rooms; fungi that rot timbers used to support homes and decks; and algae that turn ponds and swimming pools green. Likewise, a wide range of pests can spell trouble for businesses, hospitals, and government agencies.

Pesticides include three major classes, defined by the pests they control. **Insecticides** control insects such as aphids, beetles, mosquitoes, cockroaches, termites, fleas, and caterpillars. **Herbicides** control weeds such as crabgrass, chickweed, Bermuda grass, and nutgrass. **Fungicides** control fungi such as molds, mushrooms, mildews, and rusts. Those three classes account for 93 percent of the pesticides used in the United States, according to the U.S. Environmental Protection Agency. (See Figure 1 on p. 5.)

A variety of other pesticide types account for the remaining 7 percent, including: **rodenticides** for controlling rats and mice; **nematicides** for controlling nematodes (small worms that attack plants); **miticides** for controlling mites (small spider-like pests); and **algacides** for controlling algae (microscopic plants that can clog rivers, lakes, and swimming pools). For regulatory purposes,

Never again need there be a disaster like the famine in the 1840s in Ireland that was caused by a fungus, Fusarium, the late potato blight. That catastrophe led to the death of one third of Ireland's population from starvation, another third emigrated, and the bitterness that exists between the Irish and the English was intensified yet further. How much of the tragedy of the Emerald Isle might have been averted if a good fungicide like captan had been available?

—Dixy Lee Ray, Former Governor of Washington
from *Trashing the Planet*

Can anyone believe it is possible to lay down such a barrage of poisons on the surface of the earth without making it unfit for all life? They should not be called 'insecticides,' but 'biocides.'

—RACHEL CARSON, *SILENT SPRING*

the "other" category also includes various agricultural chemicals that the EPA classifies as pesticides but aren't used to kill pests. These include chemicals such as **plant growth regulators** that keep crops like tobacco from producing unwanted flowers; **ripening agents** that speed up or slow down the ripening of fruits and vegetables; and **defoliants** that make plants drop their leaves to ease the harvesting of crops like cotton.

Not surprisingly, the wide range of pest problems and uses has prompted the development of a dizzying array of pesticide products. Manufacturers currently produce about 20,000 pesticide products containing some 900 active ingredients.[3] In North Carolina alone, there were 12,391 pesticide products registered by the state Department of Agriculture in 1992.[4]

The Benefits of Pesticides

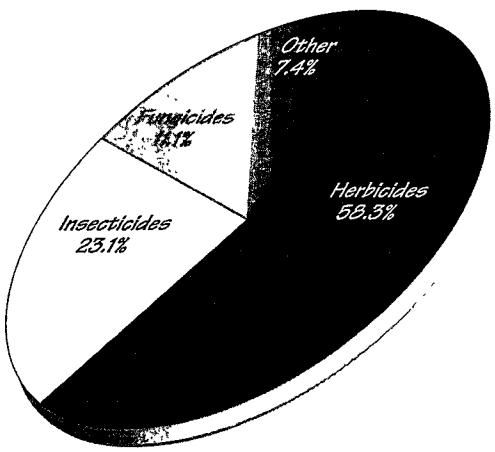
The large number of pesticide products is just one indication of their economic importance. Another indication is pesticide sales. More than $8 billion worth of pesticides were sold in the United States in 1991, representing about one-third of the world market.[5] Three-fourths of the pesticide usage in the United States is for agriculture,[6] and some studies have estimated that every dollar spent on pesticide control returns about $4 in crops saved.[7]

Pests destroy about one-third of the world's food crops during growth and storage.[8] In the United States, pests destroy at least 30 percent of the crops—totaling about $30 billion a year—despite the heavy use of pesticides and other control methods. Agricultural studies have found that pesticide use can increase crop yields up to nearly 80 percent,[9] although some studies have concluded that farmers could cut their use in half without reducing yields.[10]

"Were it not for herbicides, we would still have 10 to 12 percent of our population working on farms, instead of the present 2 percent," writes George Ware, an entomology professor at the University of Arizona. "Today's farms would quickly become perpetuating weed fields that would require tremendous levels of our human energy. Indeed, it has been estimated that more energy is expended on the weeding of crops than on any other single human task."[11]

The benefits of pesticides go far beyond their value for agriculture. They also have important health benefits in controlling diseases, improving nutrition, and preventing starvation.[12] Pesticides have been particularly important in reducing insect-borne diseases such as malaria, typhus, plague, cholera, and yellow fever. For example, the incidence of malaria in India dropped from about 100 million cases a year in the mid-1930s, before pesticides were used to control mosquitoes, to about 150,000 cases a year by the mid-1960s.[13] The role of pesticides in increasing food production has helped improve people's diets by making fruits, grains, and vegetables more available and less expensive, thus helping avoid widespread famines around the world.[14]

Figure 1.
Percentage of Pesticide Use in the United States by Class of Chemicals, 1991



Source: U.S. Environmental Protection Agency

Other societal benefits from pesticides include: increased production of timber and fiber crops; prevention of storage losses from spoilage and rodent damage; protection of buildings from termites and fungal rot; pest control for lawns, gardens, nurseries and greenhouses; control of unwanted vegetation along highways and utility rights-of-way; and quality-of-life improvements through the control of everyday pests such as cockroaches, fleas, mosquitoes, rats, and mice.

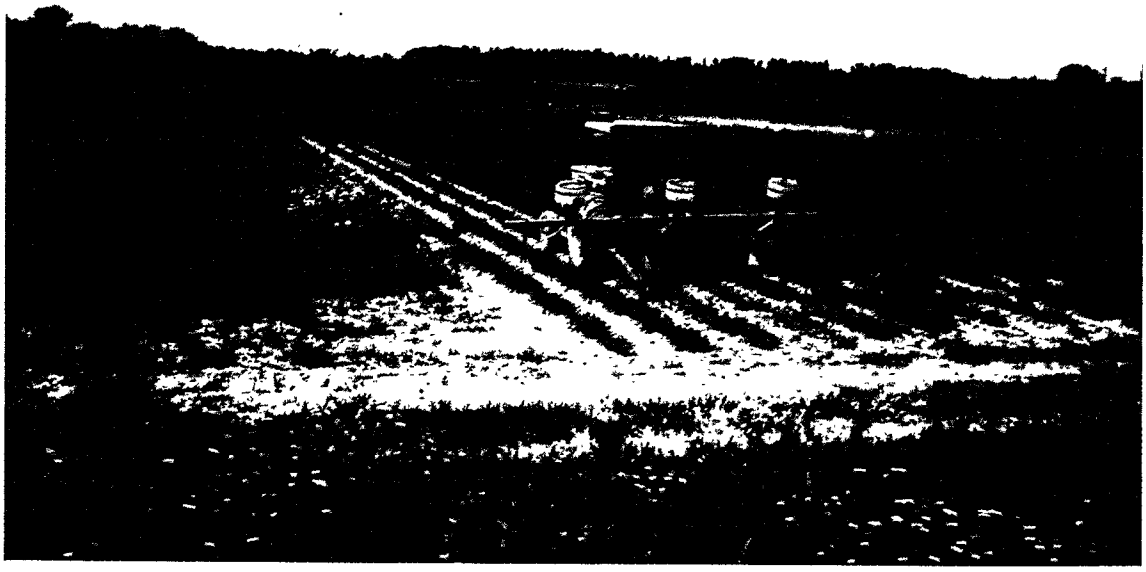
"When millions of humans are killed or disabled annually from insect-borne diseases and world losses from insects, diseases, weeds, and rats are estimated at $100 billion annually," Ware writes, "it becomes obvious that control of various harmful organisms is vital for the future of agriculture, industry, and human health. Pesticides thus become indispensable in feeding, clothing, and protecting the world's population, which will approach 6.4 billion by the year 2000."[15]

The Hazards of Pesticide Use

The wide range of benefits from pesticides has led to an explosion in their usage over the past 50 years. In the United States alone, pesticide use has grown 33-fold since 1945.[16] However, total production has declined about 10 percent since peaking at 1.2 billion pounds in 1981. That decline has been due to rising chemical costs, the production of more potent pesticides that are effective in smaller quantities, the development of more pest-resistant crops, and the use of farming techniques that lessen the need for chemicals.[17] Another factor has been increasing awareness of the hazards of pesticides.

As Rachel Carson pointed out in the early 1960s, most pesticides were developed for a single purpose—to kill living organisms—and their use can have unintended consequences. "These sprays, dusts, and aerosols are now applied almost universally to farms, gardens, forests, and homes—nonselective chemicals that have the power to kill every insect, the 'good' and the 'bad,' to still the song of birds and the leaping of fish in the streams, to coat the leaves with a deadly film, and to linger on in soil—all this though the intended target may be only a few weeds or insects. Can anyone believe it is possible to lay down such a barrage of poisons on the surface of the earth without making it unfit for all life? They should not be called 'insecticides,' but 'biocides.'"[18]

A farmer applies granular pesticides to a peanut field in Northhampton County.



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The toxicity and other dangers of pesticides have implications for the environment as well as human health. A team of scientific authorities, directed by the Environmental Protection Agency to assess the relative hazards of some 30 environmental problems, ranked pesticides as a high risk with regard to potential health and ecological effects.[19] David Pimentel, an entomology professor at Cornell University, has estimated that the environmental and social costs of agricultural pesticide use total at least $8 billion a year in the United States—about half the amount that pesticides save in crop production each year.[20] That study considered costs from human health effects; domestic animal poisonings; losses of fish, birds, bees, and other wildlife; surface and groundwater contamination; unintended crop damage; greater pest control expenses resulting from the destruction of natural enemies and the development of pesticide-resistant bugs; and increased funding for government regulation and pollution control.

These insecticides are not selective poisons; they do not single out the one species of which we desire to be rid. Each of them is used for the simple reason that it is a deadly poison. It therefore poisons all life with which it comes in contact: the cat beloved of some family, the farmer's cattle, the rabbit in the field, and the horned lark out of the sky.

—Rachel Carson,
Silent Spring

Much of the environmental damage from pesticides results from their nonselectivity. As Rachel Carson put it, pesticides often kill the good with the bad. For example, an insecticide that kills aphids also can destroy bees, ants, and other beneficial insects that are essential for pollinating many fruits and vegetables. Insecticides also can kill ladybugs and other insects that prey on pests, leading to a "rebound" effect. Although spraying initially knocks out most pests, those that survive can come back in even greater numbers because their natural predators have been eliminated. Thus, farmers are forced to repeat pesticide applications, sometimes at higher rates.

A related problem is the development of chemical-resistant pests. That is, some insects with high reproductive rates can evolve strains that are no longer susceptible to certain pesticides—similar to bacteria that develop drug-resistant strains. As a result, farmers can be forced to spray at higher application rates or use more toxic chemical alternatives.

The nonselectivity of many pesticides has other consequences as well. They can kill birds, fish, and other animals when sprays drift off-target during aerial applications, when wildlife feed in newly treated fields, and when storm runoff washes pesticide residues into streams, lakes, or coastal waters. Those effects can be particularly serious with pesticides that don't break down readily into non-toxic forms. Such persistent pesticides can build up as they are passed along the food chain, a process known as **biological magnification.**

Perhaps the best-known example of biological magnification relates to the chemical DDT, one of the most widely used insecticides of the 1950s and 1960s.[21] DDT, although relatively non-toxic to humans, had accumulated to high concentrations in many predatory animals by the late 1960s. That apparently led to the near extinction of many birds of prey—such as bald eagles, ospreys, and pelicans—because DDT caused their egg shells to thin and break, thus preventing them from reproducing. The populations of most predatory birds have rebounded sharply since the Environmental Protection Agency banned DDT in 1973,[22] although some scientists attribute the recovery to wildlife management policies rather than the DDT ban.[23]

Another hazard with pesticides is that they can contaminate drinking water supplies by seeping into groundwater and washing into streams and lakes. Groundwater contamination is particularly serious because cleaning it up can be very difficult, time-consuming, and expensive. It also could have potential health effects for large numbers of people. Wells supply drinking water to more than half of the total population and virtually all of the rural population—in North Carolina as well as the United States as a whole.[24]

Groundwater tests have found traces of pesticide residues in wells from nearly every state, including North Carolina.[25] In a 1990 study, the

U.S. Environmental Protection Agency estimated that 4.2 percent of the nation's 10.5 million rural domestic wells and 10.4 percent of the 94,600 community water system wells contained detectable amounts of one or more pesticides.[26] The EPA estimated that less than 1 percent of those wells contained pesticides at levels exceeding recommended health standards.

A more recent study found pesticide contamination in 16 percent of the wells tested at 139 farms in Eastern North Carolina from 1989–1992. "The only reasonable conclusion is that pesticides are getting into groundwater because of routine applications," says Richard P. Maas, who directed the study by researchers at the University of North Carolina at Asheville.[27] But that study's methodology has been harshly criticized by state agriculture and environmental officials, who are in the process of setting up a statewide system for monitoring groundwater contamination in North Carolina.[28]

The state monitoring program eventually will test water from more than 150 wells in 65 of North Carolina's 100 counties, focusing on areas with vulnerable groundwater supplies and large amounts of agricultural production. Preliminary tests have found detectable amounts of pesticides in six of the 97 wells (6 percent) sampled so far, with levels in two wells exceeding recommended health standards.[29] Authorities plan to complete the study by April 1995. (See the accompanying story, "Pesticide Taints Neighborhood's Drinking Water," on pp. 11–13, for an account of how contaminated groundwater can affect a community. Also see the article, "Contaminated Wells, Odor Problems Sometimes Result from Exterminator Treatments," on pp. 16–18.)

"Exaggerating the risks from manmade substances, ignoring the natural world, and converting the issue to one of blaming U.S. industry does not advance our public health efforts. If we spend all our efforts on minimal, rather than important, hazards, we hurt public health."

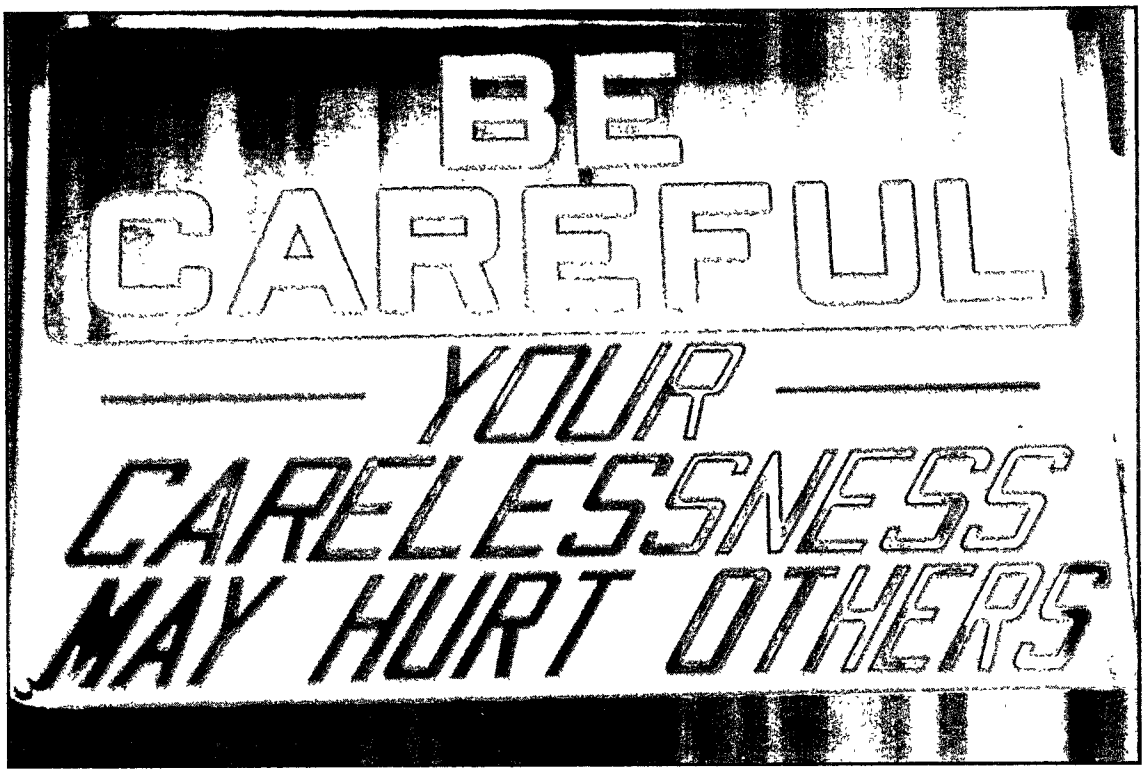
—Bruce Ames, Biochemist
University of California at Berkeley

Health Effects of Pesticides Vary Widely

With thousands of different pesticide products, it's hard to generalize about their health hazards. Some pesticides are highly poisonous, while others are less toxic than many commonly used substances such as table salt and aspirin. Generally speaking, insecticides are most toxic to humans, followed by herbicides and fungicides—but there are many exceptions. The method of exposure also is important: pesticides generally are more toxic when swallowed than when breathed or absorbed through the skin. And, as with any potential poison, the toxicity depends on the dosage and length of exposure.[30]

When discussing health hazards, it's important to distinguish between acute and chronic effects. *Acute effects* are those caused by short-term exposures to toxic chemicals, with symptoms usually appearing relatively quickly. Pesticide exposures can cause a range of acute effects, including nausea, dizziness, shortness of breath, skin rashes, and in extreme cases—blindness, poisoning, and death. In 1991, pesticides caused 84,283 poisonings, or 4.6 percent of the total human poison exposures reported to the American Association of Poison Control Centers. Pesticide poisonings caused 22 deaths in 1991, or 1.7 percent of the total for all reported fatal poisonings.[31] (Figures for North Carolina are not available because the state does not require doctors and hospitals to report pesticide-related health problems.) Most pesticide poisonings that result in death involve suicides or accidental ingestion by young children.[32]

Chronic effects are those that result from repeated or long-term exposures to chemicals such as pesticides. Laboratory studies of animals have linked various pesticides to a wide range of chronic conditions, including cancer, birth defects, nerve damage, reproductive disorders, immune-system defects, and lung, liver, and kidney damage.[33] Much of the concern about chronic effects has focused on cancer. One-third of the pesticides in use contain chemicals that are known or suspected causes of cancer, according to the Environmental



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Safety sign posted at a pesticides dealer in Greenville.

Protection Agency, which estimates that those pesticides cause 6,000 deaths a year in the United States.[34] A recent study by the National Research Council concluded that children may be more susceptible than adults to long-term pesticide exposure,[35] while other studies have suggested a link between breast cancer and certain organic pesticides.[36]

Some researchers, however, contend that the chronic health hazards of pesticides—at the levels most people are exposed—have been greatly exaggerated. For instance, Bruce Ames, a biochemist at the University of California at Berkeley, says that laboratory studies often overstate pesticides' cancer-causing potential because they are based on exposing rats and mice to levels of chemicals far higher than most people ever encounter. In addition, Ames says that many common foods and drinks that people consume every day—including apples, bananas, cabbage, coffee, mushrooms, and oranges—contain *natural* substances with far greater cancer-causing potential than the trace levels of pesticide residues typically found on food.

"We estimate that Americans eat about 1,500 mg/day of natural pesticides, 10,000 times more than manmade pesticide residues, which FDA estimates at a total of 0.15 mg/day," Ames writes. "Exaggerating the risks from manmade substances, ignoring the natural world, and converting the issue to one of blaming U.S. industry does not advance our public health efforts. If we spend all our efforts on minimal, rather than important, hazards, we hurt public health."[37]

Other researchers defend such laboratory studies, arguing that certain pesticides may pose real cancer-causing hazards to people, even in small amounts.[38] Despite such disputes, the long-term health effects are largely unknown for many pesticides.[39] But most researchers would agree that people who are exposed to large amounts of pesticides generally are the most susceptible to harm.

"[We] are more concerned about the farmers, occupationally exposed workers, pesticide applicators, weekend gardeners, and others who may be repeatedly exposed to much higher levels of pesticides and therefore are at greater risk," say researchers James Huff and Joseph Haseman of the National Institute of Environmental Health Sciences.[40]

Even studies of occupational groups that are exposed to higher levels of pesticides have raised

more questions than they have answered. For instance, a detailed review of epidemiological studies by researchers at the National Cancer Institute found that farmers were at lower risk for most major causes of death—including most types of cancer—than the general population.[41] However, the review found that farmers had moderately elevated levels for several types of cancer, including leukemia, Hodgkin's disease, multiple myeloma, and cancers of the lip, stomach, skin, prostate, brain, testes, and connective tissue.

Such concerns have led some researchers to compare pesticides to medicinal drugs. That is, both classes of chemicals have far-reaching benefits that must be weighed against their potential for causing serious harm. "The tremendous diagnostic and therapeutic value of drugs justifies their use, but in turn requires a detailed study of their side effects," writes Wayland Hayes, a physician and toxicologist at Vanderbilt University. "The same is true for pesticides. Their important contributions to our health and economy guarantee their continued use as a class and require the most complete knowledge of toxicology that we can achieve in order to avoid hazards."[42]

An Overview of Federal Pesticide Regulation

The dual nature of pesticides—that is, their potential to yield great benefits as well as cause serious damage—is the basic concept guiding modern pesticide regulation. Although the federal government has regulated pesticides since 1910, most early legislation was aimed at consumer protection and product performance.[43] Current regulation seeks to allow the beneficial uses of pesticides while minimizing their hazards to public health and the environment.[44]

The primary agency charged with implementing federal pesticide regulation is the U.S. Environmental Protection Agency (EPA). Previously, pesticides were regulated through the U.S. Department of Agriculture and the Food and Drug Administration, but Congress transferred most authority to the EPA when it created the agency in 1970. In practice, the EPA has delegated many pesticide enforcement responsibilities to the states. However, the EPA remains the final authority and can preempt states that fail to take proper enforcement actions.[45]

The primary law guiding pesticide use is the **Federal Insecticide, Fungicide, and Rodenticide Act**, or FIFRA. Originally enacted by Congress in 1947, FIFRA required pesticide manufacturers to *register* their products with the Department of Agriculture. It also required manufacturers to label their products with directions aimed at ensuring safe use.

In 1972, Congress amended FIFRA while enacting the nation's most comprehensive pesticide legislation, sometimes known as the Federal Environmental Pesticide Control Act. One of the law's central tenets is that the EPA must consider both the costs and benefits of pesticides in regulating their use.[46] "Unlike most other environmental statutes, which focus on pollution abatement, FIFRA, as amended, focuses on balancing the inherent risks and benefits of substances that are generally designed to be injurious to living organisms and deliberately introduced into the environment," according to a review of pesticide regulation by the General Accounting Office. "This balancing of risks and benefits underlies all basic regulatory decisions under the act."[47]

The FIFRA amendments of 1972 included key provisions that: made it illegal to use pesticides in ways "inconsistent" with the directions on product labels; authorized fines and penalties for dealers or applicators who violated pesticide regulations; and required that all pesticide products be registered with the EPA. Before registration, the law required that manufacturers provide scientific evidence that pesticide products—when used as directed on labels—would: (1) effectively control the targeted pests; (2) not harm humans, crops, livestock, wildlife, or the total environment; and (3) not leave illegal residues on food or feed products.

The FIFRA amendments also directed the EPA to classify all pesticides into two categories: *restricted use*, which generally includes the most hazardous products, such as the highly toxic herbicide paraquat; and *general use*, which includes less toxic chemicals, such as the herbicide Roundup (glyphosate) and other chemicals sold in garden shops.[48] The law required states to certify—that is, to train and test—anyone applying restricted-use pesticides. Most states *train* applicators through their cooperative extension services, with *certification* handled by their departments of agriculture.

Congress has amended FIFRA a number of times since 1972, with the most substantive changes dealing with product registrations. Tougher registration requirements have led the EPA to cancel more than 26,000 pesticide

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A good part of agriculture is to learn how to adapt one's work to nature. . . . To live in right relation with his natural conditions is one of the first lessons that a wise farmer or any other wise man learns.

—Liberty Hyde Bailey
Former Professor of Horticulture
at Cornell University
[As quoted by Wendell Berry
in *What Are People For?*]

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products since 1988.[49] Despite those cancellations, the EPA allows the use of a number of pesticides that have not been fully tested for health and environmental effects.[50]

Another key law dealing with pesticide regulation is the **Federal Food, Drug, and Cosmetic Act** of 1954. The law authorized the Food and Drug Administration to condemn any agricultural products that contain non-approved pesticides or pesticide residues that exceed established tolerance levels. In 1958, Congress adopted an amendment that included the so-called Delaney Clause, which has become one of the most controversial laws dealing with pesticides. In essence, the Delaney Clause states that processed foods may not contain any chemical found to cause cancer in humans or animals through laboratory tests.[51] That requirement has become increasingly troublesome for food processors because of research studies linking greater numbers of chemicals to cancer and the ability of modern analytical techniques to detect minute amounts of such chemicals.

The EPA is responsible for setting pesticide tolerance levels, but the Food and Drug Administration is charged with enforcing the limits. "Tolerances are the single most important tool by which the U.S. Government regulates pesticide residues in food," according to the National Research Council.[52] The Federal Food, Drug, and Cosmetic Act defines a tolerance as the maximum quantity of a pesticide residue allowable on a raw agricultural product or in a processed food.[53]

Increasing recognition of the special risks posed to workers handling pesticides has prompted federal agencies in recent years to issue new regulations dealing with worker safety. In 1988, the Occupational Safety and Health Administration broadened its **Hazard Communication Standard**[54] to require all employers—including farmers—to provide workers with information on the dangers and safety precautions relating to hazardous chemicals used in the workplace.

In 1992, the EPA issued its **Worker Protection Standard**[55] for ensuring the safety of the

Reginald Askew, a farmer from Eure, searches cotton plants for eggs of the boll worm, one of the most serious agricultural pests in North Carolina.

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estimated 3.9 million agricultural workers and others who are exposed to pesticides through their jobs. The regulation, which took effect in part in April 1994, applies to pesticide handlers as well as workers in treated fields, greenhouses, forests, and nurseries.[56] Under the rule, employers must: provide workers with basic pesticide safety training; notify workers when applying pesticides; restrict entry to fields for minimum time periods following pesticide applications, depending on the toxicity of the chemicals used; and post signs summarizing basic information about pesticide safety. (See the article, "Farmworkers Seek Training About Pesticide Safety," on pp. 29–31, for more discussion of worker safety issues.)

Other federal laws with important provisions dealing with pesticides include:

- **The Endangered Species Act** of 1973 requires all federal agencies to insure that their actions—including pesticide use—will not jeopardize endangered or threatened plants and animals. Unlike FIFRA, the act does not require the EPA to weigh the costs and benefits of pesticide products in prohibiting uses that could harm endangered species.
- **The Transportation Safety Act** of 1974 authorized the U.S. Department of Transportation to regulate the shipping of hazardous materials, which include many pesticides.
- **The Right-To-Know Act**[57] of 1986 applies to all facilities that manufacture, use, or store more than 300 types of hazardous chemicals, including many pesticides.[58] The law requires owners to prepare plans for dealing with fires and other emergencies. It also requires them to report the presence of hazardous chemicals to appropriate local, state, and federal authorities.
- The **Food, Conservation, and Trade Act**,[59] more commonly known as the 1990 Farm Bill, requires pesticide dealers and applicators to keep records on the sale or use of all restricted-use products. The law does not require users to report that information to the state or federal government unless requested by regulators or inspectors. The U.S. Department of Agriculture is charged with implementing the regulations, which took effect May 1993.[60] (See the article, "Searching for Hens' Teeth: Information Scarce on Pesticide Usage," on pp. 20–29, for further discussion of federal record-keeping requirements for pesticide applicators.)

FOOTNOTES

[1] Rachel Carson, *Silent Spring*, Houghton Mifflin Co.: Boston, 1962.

[2] For a thorough discussion of the uses, history, and benefits and hazards of pesticides, see George W. Ware, *The Pesticide Book*, Thomson Publications: Fresno, Calif., 1994.

[3] *Ibid.*, pp. 4–5. The number of pesticide products has declined from about 50,000 in the mid-1980s, largely due to EPA cancellations of product registrations since 1989.

[4] *North Carolina Pesticide Report*, N.C. Department of Agriculture, 1992, p. 331.

[5] Arnold Aspelin, et al., *Pesticide Industry Sales and Usage: 1990 and 1991 Market Estimates*, U.S. Environmental Protection Agency, Office of Pesticide Programs, Washington D.C., 1992, Publ. No. H-7503W, pp. 7–11.

[6] *Ibid.* According to the EPA, agriculture accounted for 75.9 percent of the total pesticide usage by weight and 73.6 per cent of the total expenditures on pesticides in the United States in 1991.

[7] See Ware, note 2 above, p. 8., and David Pimentel, *et al.*, "Environmental and Economic Costs of Pesticide Use," *BioScience*, Vol. 42, No. 10 (November 1992), p. 750.

[8] Ware, note 2 above, pp. 5–8.

[9] *Ibid.*

[10] See David Pimentel, *et al.*, "Environmental and Economic Effects of Reducing Pesticide Use," *BioScience*, Vol. 41, No. 6 (June 1991), p. 402.

[11] Ware, note 2 above, p. 8. David Pimentel, an entomology professor at Cornell University, disputes Ware's contention that 10–12 percent of the U.S. population would have to work on farms to replace the benefits of herbicides. "I seriously doubt that it would be 3 percent, which is a 50 percent increase over current labor input on U.S. farms," Pimentel says.

[12] See Ware, note 2 above, pp. 10–19; also, Wayland J. Hayes Jr. and Edward R. Laws Jr., *Handbook of Pesticide Toxicology*, Vol. 1, Academic Press: San Diego, Calif., 1991.

[13] *Ibid.*, Hayes and Laws, p. 9.

—continues on page 18

It is a myth that 'manmade' or synthetic compounds are dangerous and toxic, whereas the same compounds found in nature —for example, 'natural chemicals'—are safe. There is no chemical difference between them.

—Dixy Lee Ray, Former Governor of Washington
from *Trashing the Planet*

Contaminated

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or other pests.

"I've seen it happen in a day," Rudo says. "We saw one woman whose well water literally turned white from the Dursban. It was present in a concentration of about 25 parts per million. You could taste it. The smell was very noticeable."

Tommy and Robin Rogers were relatively lucky. They noticed their contamination soon after it occurred, and the levels of Dursban in their well were not dangerously high. The exterminator also offered to supply the family with bottled water after the contamination was detected, Rogers says. Plus, he treated their well by pumping it out and adding chlorine—which is supposed to neutralize the pesticide—at no cost. Subsequent tests have detected no more of the pesticide.

"Our well, as far as I know, is now clean," Rogers says. "But I am curious as to how it happened and why. And I wonder if it could happen again with something else." The experience also has left Rogers more wary. "I think awareness is the key to it," he says. "Anytime I have something sprayed, especially to the foundation or the soil, I would get the water tested. If it hadn't been for the smell, we'd still be drinking it."

Miller, the exterminator, says it was fortunate that he treated the Rogers' house with Dursban because it can be sensed at minute concentrations—an attribute not shared by other termiticides. "Dursban has such a strong odor that you can smell it or taste it down to 10 parts per billion," he says. "These other products do not have any odor or taste. That's what scares me."

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"This [well contamination] is an underestimated problem. I've seen this happen a couple of dozen times over the past few years. And these are just the cases we know about. There could be hundreds of other cases we never hear about."

—Dr. Ken Rudo, Toxicologist
N.C. Division of Epidemiology

—continued from page 15

[14] *Ibid.*; also see Ware, note 2 above, pp. 17–19; and National Research Council, *Pesticides in the Diets of Infants and Children*, National Academy Press: Washington, D.C., 1993, pp. 1 & 13.

[15] Ware, note 2 above, p. 19.

[16] See Pimentel, note 10 above, p. 403.

[17] *Ibid.*

[18] Carson, note 1 above, pp. 7–8.

[19] U.S. Environmental Protection Agency, "Unfinished Business: A Comparative Assessment of Environmental Problems," Office of Policy Analysis, February 1987, pp. 84–86.

[20] See Pimentel, note 7 above, p. 759.

[21] See Eugene P. Odum, *Fundamentals of Ecology*, W.B. Saunders Co.: Philadelphia, Pa., 1971, pp. 74–75.

[22] See Jim Dean, "Un-Endangered Wildlife," *Wildlife in North Carolina*, Vol. 55, No. 3 (March 1991), p. 36.

[23] For an alternative view on DDT and its effects, see Dixy Lee Ray and Lou Guzzo, *Trashing the Planet*, Regnery Gateway: Washington, D.C., 1990, pp. 68–77.

[24] According to the National Research Council, note 14 above, p. 228, wells provide drinking water to 53 percent of the total U.S. population and 97 percent of the rural population. Those percentages are essentially the same for North Carolina, according to the state Division of Environmental Health.

[25] See Elizabeth G. Nielson and Linda K. Lee, "The Magnitude and Costs of Groundwater Contamination from Agricultural Chemicals," U.S. Department of Agriculture, Economic Research Service, Report No. 576, October 1987.

[26] U.S. Environmental Protection Agency, *National Survey of Pesticides in Drinking Water Wells, Phase I Report*, Office of Pesticides and Toxic Substances, EPA 570/9-90-015, November 1990, Executive Summary, pp. vii–xv.

[27] As quoted by Stuart Leavenworth, "Study says some drinking water wells contaminated," *The News & Observer* (Raleigh, N.C.), Jan. 8, 1993, p. 1B.

[28] The Interagency Study of the Impact of Pesticide Use on Groundwater in North Carolina is being conducted jointly by the state Department of Agriculture and the Department of