Chapter 1
What Is Integrated Pest Management?

Integrated pest management (IPM) is an approach to pest control that utilizes regular monitoring and record keeping to determine if and when treatments are needed, and employs a combination of strategies and tactics to keep pest numbers low enough to prevent unacceptable damage or annoyance. Biological, cultural, physical, mechanical, educational, and chemical methods are used in site-specific combinations to solve the pest problem. Chemical controls are used only when needed, and in the least-toxic formulation that is effective against the pest. Educational strategies are used to enhance pest prevention, and to build support for the IPM program.

The Role of Pesticides in School IPM

Although pesticides often have a role to play in IPM programs for schools, their use should be approached with caution. The risk of harm from exposure to pesticides is relatively higher for infants and children than for adults exposed at the same levels (National Research Council 1993 [see Box 1-A]). By using the least-toxic product effective against the pest and applying it as a spot treatment in combination with non-chemical methods such as pest-proofing and improved sanitation, risks from pesticide exposure can be minimized.

The term “least-toxic” refers to pesticides that have low or no acute or chronic toxicity to humans, affect a narrow range of species, and are formulated to be applied in a manner that limits or eliminates exposure of humans and other non-target organisms. Fortunately, there are an increasing number of pesticides that fit within this “least-toxic” definition. Examples include products formulated as baits, pastes, or gels which do not volitalize in the air and which utilize very small amounts of the active ingredient pesticide, and microbial pesticides formulated from fungi, bacteria, or viruses that are only toxic to specific pest species but harmless to humans.

IPM Program Goal

The goal of a school IPM program is to protect human health by suppressing pests that vector diseases, to reduce losses from pest damage, reduce environmental pollution, reduce human exposure to pesticides,

Box 1-A.

Special Vulnerabilities of Children to Pesticides

In 1993, the National Research Council, a committee of the National Academy of Sciences, published a report entitled Pesticides in the Diets of Infants and Children. This report documented that infants and children face relatively higher risks from exposure to pesticides than do adults exposed at the same levels. This is due to a number of physiological factors including the rapid growth and development of a child’s central nervous system that makes this young nervous system particularly vulnerable to exposure to neurotoxins, and the fact that children consume more food relative to their body weight, so their actual exposure levels are often higher than those of adults. The report also points out that children can be exposed to pesticides from non-dietary sources (e.g., residues from pesticides applied in the home, school, park, etc.), and that when residues of two or more pesticides are combined, synergistic action between the compounds can significantly increase their level of toxicity.

For many years, the Environmental Protection Agency (EPA) has evaluated the safety of pesticides largely on potential risks to healthy adults (Benbrook 1996), primarily males. However, in 1996, the 104th Congress unanimously passed the Food Quality Protection Act of 1996 which amends the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Food, Drug, and Cosmetic Act to require the EPA to take into account the special risks posed to infants and children (as well as pregnant women) when determining tolerance levels for pesticide residues in food. As a result, food tolerance levels are expected to drop significantly, and not all currently registered agricultural pesticides (many of which are also used in schools), will be able to meet the new criteria. How this will affect the availability of pesticides currently used in schools is not yet clear.

particularly that of children, and to reduce costs of pest control. In IPM programs, treatments are not made according to a fixed schedule; they are made only when and where monitoring has indicated that the pest will cause unacceptable economic, aesthetic, or medical injury or damage.

"Economic injury" refers to damage to structures or plants severe enough to cause an economic loss. Examples of economic injury might be loss of food due to rodent or insect contamination, or severe structural damage due to moisture accumulation and wood-destroying fungi. "Aesthetic injury" refers to annoyance or embarrassment from visibility of a pest, or damage to the appearance of plants which may reduce aesthetic appeal but does not necessarily adversely affect plant health. The tolerance levels for aesthetic injury differ: the tolerance for weeds in lawns might be much higher in a school playground than in the front lawn or entryway to the school. "Medical injury" refers to illness in humans, pets, or wildlife caused by organisms or compounds transmitted by pests. Two examples of health-threatening pests are rodents which can carry diseases and poison oak or ivy which cause painful skin rashes.

In an IPM program, if treatments are needed, they are selected and timed to be most effective on the pest, least disruptive to its natural controls, and least hazardous to humans and the environment.

Components of an IPM Program

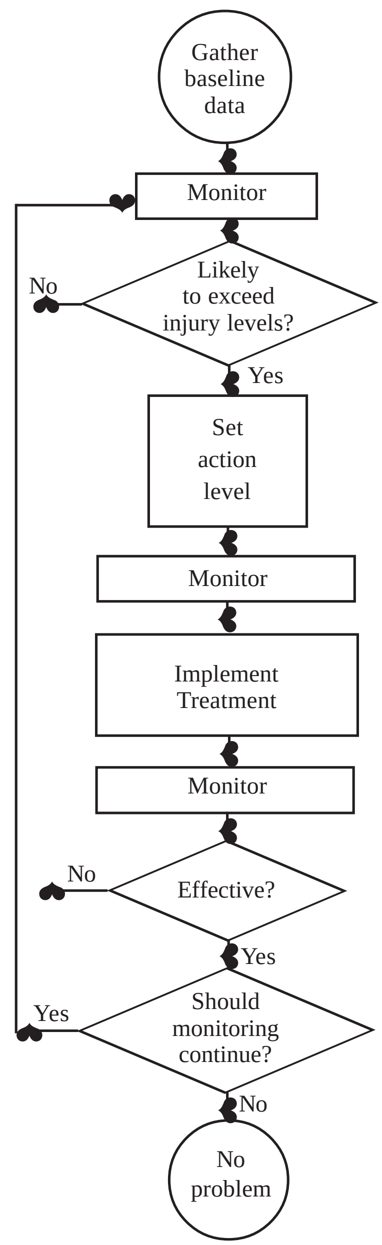
One of the characteristics of an IPM approach that makes it so effective is that the basic decision-making process is the same for any pest problem in any location. The strategies and tactics may change, but the steps taken to decide if and when treatment is needed, and which methods to use, are the same each time. Thus, the pest manager does not need to try to remember reams of pest control "recipes" for specific pests. Instead, it is an understanding of the components of an IPM program that must be mastered. The IPM decision-making process is illustrated in Figure 1-1.

An IPM program is built around the following components:

- monitoring the pest population and other relevant factors
- accurate identification of the pest
- determining injury and action levels that trigger treatments
- timing treatments to the best advantage
- spot treating the pest (to minimize human and other non-target organism exposure to pesticides and to contain costs)
- selecting the least-disruptive tactics
- evaluating the effectiveness of treatments to fine-tune future actions
- educating all people involved with the pest problem

Each of these components is discussed in detail in later chapters of this manual.

Figure 1-1.
The IPM Decision-Making Process



The Decision-Making Process

The basic IPM process helps answer four key pest management questions, easily remembered by four words: IF, WHERE, WHEN, and WHICH.

IF treatment action is necessary

Instead of taking action at the first sign of a potential pest, the IPM process begins with asking whether any actions at all are needed (see Chapter 3 for a discussion of injury and action levels). Sometimes, even a fairly large population of pests can be tolerated without causing a problem. In other cases, the presence of a single pest organism is considered intolerable. In still other cases, what is considered a pest by one group in society may be considered innocuous by another.

Example: Boxelder bugs (Leptocoris trivittatus) are brightly colored and often cluster under shrubs, on the shady side of tree trunks, or enter buildings through open doors or broken window screens. The sight of them sometimes frightens people, or raises fears that they will damage plants. In fact, these insects are harmless. They feed mainly on boxelder trees and silver maples, and rarely harm even these trees since their main food source is the tree's seeds. Thus, concern about their presence is generally unwarranted.

Example: Large rodent droppings and grease trails suggest there is a rat in a crawl space under the eaves. Even one rat can be a problem, because it can gnaw on electric wires causing fires, and leave fleas which can transmit pathogens to humans. Treatment action is usually required even if only one rat is suspected.

WHERE treatment activity should take place

If it is decided that some treatment action is necessary, the IPM process encourages pest managers to look at the whole system for the best place to solve the problem. Treatment should be applied where actions will have the greatest effect.

Example: Although mosquito problems are frequently handled by fogging buildings or school yards with insecticides, it is not possible to control mosquitoes unless treatment is directed at the immature stages of the insect. Mosquito larvae develop in water (e.g., clogged gutters and drains, stagnant ponds, low-spots in playing fields, etc.). By locating such sites and eliminating them or treating them with non-toxic microbial materials to kill the larvae, mosquito problems can be solved before mosquitoes become biting

IPM Is Federal Policy

In 1979, the Council on Environmental Quality (CEQ), an advisory body to the President, issued a report entitled Integrated Pest Management, which included recommendations that IPM be adopted as official policy in the United States. This new Federal policy was announced to the nation in the President's State of the Union address that year. It represented a significant shift in thinking about an appropriate approach to pest management for this country.

The new policy immediately influenced budget allocations and practice in Federal agencies such as the National Park Service, the Department of Agriculture, and the Environmental Protection Agency. During the following decades, state, county, and local public agencies, as well as arborists, landscapers, and nurseries began to adopt IPM as their standard.

The National Park Service (NPS) was the first federal agency to adopt an IPM policy and to implement IPM programs throughout the 70 million acres of lands and facilities then maintained by NPS. Within three years after adopting IPM system wide (1981-1983), NPS reduced pesticide use by over 70% (Johnston 1984).

In urban settings, IPM has been used to manage insect, pathogen, weed, and vertebrate pests in parks and gardens, on shade trees, in houses, apartments, office buildings, hospitals, restaurants, and at many other sites. The City of Berkeley, CA, used IPM to reduce pesticide use on municipal street trees by over 90%, saving the city $22,500 in the first year of the IPM program (Olkowski et al. 1976).

School systems have also implemented IPM programs. Maryland's Montgomery County Public Schools have reported that their IPM program cut pest control costs by $6,000 in the first three years of the program (Forbes 1991), and IPM improved overall pest control by substituting monitoring, education, sanitation, physical controls, and least-toxic pesticides in place of routine use of conventional chemical controls. This is far from an isolated example; schools and school districts in California, Oregon, Florida, Illinois, and elsewhere are adopting IPM and achieving a less-toxic environment for their teachers and students.

adults without exposing the school community to potentially hazardous pesticides.

WHEN action should take place

The timing of treatments is important. Often there is an optimal time in the life cycle of the plant or the pest to apply control measures. Conversely, there may be times when treatments actually increase pest problems. The human social system will also affect the timing of treatments. The IPM process encourages managers to discover the best timing for treatment actions (see "Timing Treatments" in Chapter 4) since long-term success of any treatment depends on timing and locating it properly.

Example of timing in the life cycle of a plant: Rose powdery mildew (Spaerotheca pannosa) *usually infects only succulent young growth on roses. Because mature leaves are rarely attacked, treatments are only necessary when growth spurts occur, and only new foliage requires treatment.*

Example of timing in the life cycle of the pest insect: BT (Bacillus thuringiensis) *is a naturally occurring bacteria developed into a commercial insecticide to control caterpillar pests. It must be applied to leaves when caterpillars are small and actively feeding in order for them to consume the bacteria and die. If BT is applied when caterpillars are large, they may have already stopped eating in preparation for spinning cocoons.*

Example of timing in the social system: When switching to IPM, it is essential to coordinate the IPM program plan with the overall budget process of the school district. For example, improving rodent and fly management may require modifications in food storage facilities or in the disposal of kitchen garbage. Substantial repair to windows or plumbing may be needed. Requesting funds for minor construction, new containers, etc. must be done at the appropriate time in the school district's budget development process.

WHICH mix of strategies and tactics are the best to use

There are three guiding principles to use when choosing treatments: conserve and enhance naturally occurring biological controls; use a multi-tactic approach; and view each pest problem in its larger context.

Conserve and enhance naturally occurring biological controls

In a landscape setting, when we kill the natural enemies of pests, we inherit their work. In many cases, the combined action of all natural enemies present may result in substantial pest control. Even when they are not able to do the complete job, natural enemies are nonetheless providing some help in protecting school landscape plants from pest insects. The IPM program should be designed to avoid damaging natural enemies (see "Biological Controls" in Chapter 4 for more information).

Example: Many spider mite populations on various trees and shrubs are kept under control by naturally occurring predatory mites. In fact, the predators keep them under such good control we many never be aware of their presence until we spray a pesticide intended to kill more obvious pests, such as aphids. For a number of reasons, most pesticides are more harmful to the predatory mites then the pest mites. The pesticide kills almost all of the predators, the spider mites are only slightly affected, and now that they are free from their natural enemies, the pest mites quickly multiply and devastate the plant. By changing the tactics for controlling the aphids, a spider mite problem can be avoided.

Use a multi-tactic approach

Every source of pest mortality, no matter how small, is a valuable addition to the program. Biological systems are so complex, rarely will a single tactic, such as the application of a pesticide, solve the problem for long. As many non-toxic tactics as possible should be combined to manage the pest problem.

Example: Controlling cockroaches requires direct tactics such as applying boric acid dust to cracks, crevices, and wall voids; placing baits in areas inaccessible to students; using an insect-growth regulator and boric acid water washes in areas not in direct contact with food or people; and releasing parasitoids for certain roach species. But, long-term cockroach control must also include habitat modification such as caulking or painting closed cracks and crevices; screening vents that may be used by cockroaches to travel between adjacent areas; eliminating water leaks and cracks around plumbing fixtures; and improving the storage of food supplies and organic wastes.

View each pest problem in its larger context

Each pest problem must be considered within the framework of the larger system in which it has arisen. Textbooks and manuals commonly treat pest problems one by one. However, in the "real world" setting of a school and the grounds around it, pest problems occur several at a time or in a sequence in which management of one influences the others. In addition, pest problems are influenced by other human activities such as waste disposal and food handling indoors, and mowing, fertilizing, and irrigating outdoors, as well as the attitudes of the many people who work and study within the district.

Using IPM means taking a "whole system" or ecosystem management approach to solving a pest problem. A successful IPM program considers all of the components of an ecosystem. As biologists and ecologists use the term, an ecosystem is usually thought of as containing non-living (abiotic) and living (biotic) components. For instance, if you consider a school building as an ecosystem, the abiotic components of the building would be the building itself and the equipment and furnishings within it. The biotic components would be the people, insects, spiders, etc. that live and work in the building.

In an IPM program, it is helpful to include another category—social/political components. In a school system this category includes teachers, students, custodians, grounds maintenance staff, food handlers, clerical staff, health personnel, carpenters, plumbers, pest control companies, refuse collectors, and other outside service providers who might be contracted for specific work in or around the school. The school district administration and school board, school neighbors or adjacent land owners, associated public agencies or institutions, professional associations and community groups, and the general public must be included. The political and legal constraints of the society at large should also be taken into consideration.

The many components of the school ecosystem can be thought of as a series of systems, each having an impact on the other, and all potentially impacted by a pest management program. To design and implement a successful IPM program, it is necessary, at least to some degree, to be aware of and obtain information from each of these components.

This raises the classic problem in systems management: where to draw the boundary of your system. If you draw the boundaries too narrowly and include only the pest, you may miss something important like the fact that people are leaving food out at night that feeds the pest. Generally speaking, it is better to read, question, and observe as much as possible about the larger system in which the pest problem exists. Otherwise, there is a risk that the solution to the pest problem will be overlooked.

Example: A nuisance fly problem inside the school may prompt use of space sprays or pesticide-impregnated plastic strips. A less toxic quick-fix might be to purchase and install electric insect traps. A broader view could lead to the observation that some window screens need repair and could be improved by the addition of weather-stripping around the frames to exclude flies. A still larger view might include the observation that the dumpster out on the school grounds is inappropriately placed or not adequately cleaned after being emptied each week, thus attracting flies.

Changing these conditions will involve cooperation from the custodial and maintenance staff. Perhaps the dumpster needs to be moved a greater distance from the door. Perhaps more frequent removal and replacement of the dumpster may also be desirable. This will undoubtedly have budgetary consequences and will involve negotiations outside immediate school personnel. Ultimately it may be discovered that the flies are part of a community-wide problem. There may be little that can be done about this directly, but complaints from the school system to the local municipal government may help in ultimately changing area-wide waste management practices.

At first it may seem that there is little that a few individuals can do to influence the process of change in the larger ecosystem; however, the individual schools and the school district can assume a leadership role in educating their community about safer and more permanent methods of pest management. This can be done indirectly by educating the student population, and directly through the participation of school personnel in community forums on pest management-related matters.

IPM Policy Statement

Schools districts will need to develop policy statements that set out how pest control will be performed. Appendix C contains a sample school pest management policy statement that can be modified to fit individual districts.

Contract Specifications for Pest Control Companies

Many schools will find it necessary to contract out all or some of their pest management. It is important to specify in the contract that IPM will be used and to list the requirements of such a program (Appendix D provides a sample contract). In some areas of the country, school districts have developed requirements for pest control firms that wish to contract with the school district (Raphael 1997). If pest control companies can fulfill these requirements, they can be included in a list of possible bidders from which individual schools can choose. This prevents schools from contracting with pest control companies that although they may be the lowest bidder, may have little expertise in running an IPM program.

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