Fact Sheet #13

Reducing the Risk of Groundwater Contamination by

Improving Pesticide Use and Integrated Pest Management

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Pest management is important in crop production. Even after spending approximately 34 percent of variable crop production costs on pest control, farmers lose 10 to 30 percent of potential yield because of insects, diseases and weeds. While many techniques control pests, chemical pesticides are an integral part in this process. Proper pesticide use is important in maintaining groundwater quality and the effectiveness of the chemicals.

Alternative pest management techniques along with careful use of pesticides will provide farmers with a long-term management plan that is beneficial to groundwater quality and their profit margin.

This fact sheet and companion worksheet deal with pesticide application and handling *in the field*. To learn about storage, handling and disposal of pesticides *at the farmstead*, refer to Farm•A•Syst Fact Sheet/Worksheet #2: Pesticide Storage and Handling, available through your county Extension office.

Integrated Pest Management

IPM has many definitions, but most of them are based on these underlying principles:

- using cultural and other non-chemical methods to suppress pest populations and prevent severe outbreaks
- avoiding the disruption of beneficials -- the naturally occurring enemies of pests
- tolerating some level of pest damage and treating at the economic threshold, when damage becomes significant based on the value of the crop and the cost of treatment

Economic thresholds are constantly changing. If the expected value of the crop is high, the economic threshold will be low (little damage tolerated). When fuel or pesticide prices rise, the threshold will be higher (more damage tolerated) because the higher cost of treatment offsets small gains in crop yields.

For glossary, see Worksheet # 13.

Every cropping situation is a unique ecosystem. Because IPM attempts to manage the entire system, knowledge of components specific to each system is required. This publication addresses the general principles of IPM and how they can impact groundwater. Information for individual crops or pests is available from many other sources.

1. Site Condition

Soil condition affects crop vigor and the fate of pesticides applied. Soil texture, structure, organic matter content and depth to groundwater partially determine how vulnerable the groundwater is to contamination.

Contaminants are more likely to break down the longer they remain in the cultivated surface layers where it is warm, moist but well-aerated, and microorganisms are active. Contaminant movement is affected by soil texture, structure and organic matter.

Sandy (or light) soils have large pore spaces between particles and few adsorption sites, so water and contaminants leach (move down) rapidly. Clay (or heavy) soils have small pore spaces which slow the movement of water, and many adsorption sites which can hold some types of contaminants.

Soil structure influences aeration, drainage and crop vigor. A compacted soil will have a slow infiltration rate, but is not ideal for a crop. Soil with good structure breaks fairly easily into aggregates of similar size and shape (See figure 1). This allows moderate infiltration, yet does not restrict root growth.

Organic matter functions much like clay particles, because it holds water and contaminants. It also contributes to good structure by acting as a "glue" to hold soil particles together. Most cultivated soils in New Mexico are very low in organic matter.

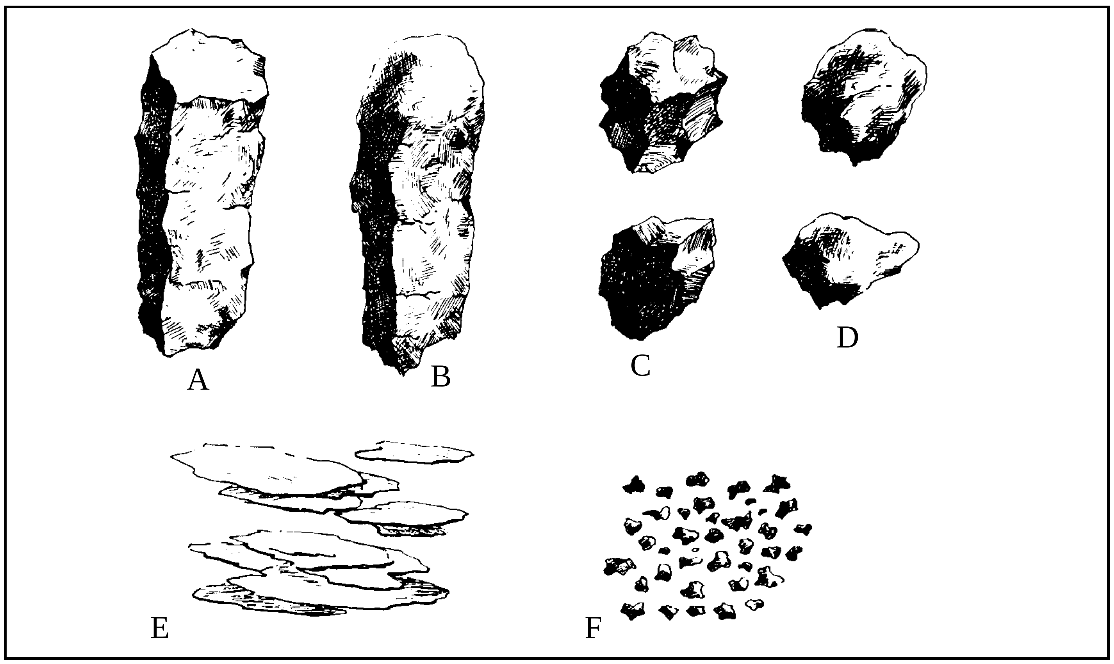


Figure 1: Some common types of soil structure. A - prismatic; B - columnar; C - angular blocky; D - subangular blocky; E - platy; F - granular. *Source: Soil Survey Manual, USDA Handbook No. 18*

Certain crop pests are more troublesome on compacted or poorly drained soils. Learn what soil conditions aggravate pest problems, then modify cultural practices such as tillage and irrigation to make these pests less competitive.

Soil type and condition vary within fields and from one field to the next. Information on soil variations in a field can be gleaned from past yields and experience, soil test results and soil survey maps (at Natural Resources Conservation Service or Extension offices).

Before applying pesticides, consider soil conditions in the field. A very soluble pesticide applied to a sandy soil over a shallow water table is likely to leach into groundwater after irrigation or rainfall.

> For soils with thin layers of different textures, consider both surface and subsurface textures, giving slightly more importance to the layer just below the cultivation depth. For a more complete site assessment, see Fact Sheet/Worksheet #11, Site Evaluation.

Adequate fertilizer helps make a crop more competitive. Over-fertilization (especially with nitrogen) is a direct threat to water quality, and can cause excessive vegetative growth (as in cotton) making the crop more susceptible to pests. Timely applications of the right amount of fertilizer protect the health of the crop *and* groundwater.

2. Management Activities

Field scouting and pest identification

Monitoring, or field scouting, provides the basis for a pest control strategy. It reveals which pests and beneficials are present and their stage of development, and how much crop damage may occur if no action is taken. Cutting corners on monitoring may lead to ill-timed and ineffective control efforts.

> Many pesticide dealers offer free or low-cost scouting services to their customers. If you take advantage of this service, be aware of the scouts qualifications and understand that their recommendations may be biased toward pesticide use. Hiring an independent crop consultant who provides services, but not products, offers some assurance that recommendations are objective.

Like other components of an IPM program, a monitoring system should be tailored to the crop and the pests likely to be present. Monitor the crop more closely at stages when it is most vulnerable to pest damage, such as at germination, flowering or fruit set. If you anticipate problems with a particular pest, know its life cycle, when and how it will damage the crop, and at what stage it is most effectively controlled.

Whether you are using chemical, biological or cultural control methods, it is absolutely essential to properly identify the pests and beneficials. Extension agents and consultants can assist those inexperienced in identification.

Recordkeeping

Keeping field records is essential to farm management planning. Complete records enable a manager to look back over several growing seasons and assess the benefits of certain practices. In addition to meeting federal (and state) requirements, detailed records of pest management practices are valuable in long-term pest management planning.

Scouting reports, non-chemical control practices, weather conditions and pest/crop response to treatment are examples of records necessary for effective planning. You may require additional information specific to your cropping system.

Certified private applicators using **restricted use** pesticides must keep records of those applications for two years, according to USDA requirements. The information required includes:

- product or brand name and EPA registration number
- total amount of product applied
- size of the area treated
- type of crop, commodity, stored product or site treated
- location of the application
- date of application
- applicator's name and certification number

Some of the same information is required if you are using a pesticide product with labeling that refers to the Worker Protection Standard (WPS). Additional information required by WPS includes restricted entry and reentry times. Pesticide use records and WPS records can be kept separately or together, whichever is most convenient for the operator.

3. Cultural Practices

Crop rotation

Crop rotation is most effective for pests that cannot survive long without a suitable host. Even with more persistent pests, rotation can make control easier.

With a few exceptions, important insects and pathogens cause damage to a few closely related crops. A field should rotate to a crop from a different plant family which has different growth habits than the previous crop.

> Sometimes a crop is not damaged by a pest, but allows the pest to multiply and persist. For example, the fungus that causes Fusarium wilt in cotton grows on barley roots. Some experimentation may be necessary to find the best rotation.

Obviously, crops in a rotation must also be profitable. When rotation reduces pest problems, the savings on pest control could make a crop or rotation more profitable.

Resistant varieties

Plant resistance refers to the plant ability to withstand or eliminate the impact of disease or insects with little or no economic loss.

Varieties exhibiting some kind of resistance are available in many crops including fibers, forages, fruits, grains, nuts and vegetables. Though resistance is only one factor to consider when choosing a crop variety, it can provide economical protection against pests.

> NOTE: Do not confuse resistance in crops with resistance in pests. Crop resistance is usually an aid to pest control. Pest resistance (to pesticides, for instance), makes pest control more difficult. *Resistance management* is taking steps to prevent pests from developing resistance to control measures.

Cultivation

Cultivation or tillage is often thought of as a way to kill weeds, but it may also contribute to the suppression of other pests. Cultivation is not compatible with a no-till farming system. In that case, choose other low-impact methods to suppress pests which otherwise could be controlled with cultivation.

Pest habitat management

Pest habitat management includes managing crop residues, eliminating breeding or overwintering sites, and cleaning equipment to reduce the spread of pests.

Crop residues often harbor insects and pathogens which affect the following crop. The best way to handle residue depends on how the pest survives and attacks the crop. Methods include plowing, removal, burning, shredding and grazing.

> In some situations, removing plant residue may be counterproductive to erosion control. With IPM, other methods such as resistant varieties and crop rotation may compensate for the lack of sanitation.

Pests may breed and overwinter in volunteer crop plants, weeds or range plants in the vicinity. These alternate hosts should be recognized and removed if possible. Ditch banks, fence rows, right-of-ways and turn rows may provide habitat for pests.

Equipment cleaning

Machinery, equipment and tools often carry plant parts or soil between fields which may spread insects, pathogens and weeds. Cleaning seeds, plant debris and soil from equipment, if done consistently and diligently, can prevent the spread of certain pests.

Irrigation water management

Managing irrigation water means making sure both the amount and timing of irrigation are correct for the crop. Obviously, too little water will not produce good yields. Too much water in the soil profile may slow crop growth and aggravate disease problems. Surplus water may run off the field as tailwater, possibly carrying pesticides off-target.

> Field preparation and irrigation techniques should allow even distribution of water and good drainage. Laser levelling and surge irrigation are examples of methods that help achieve uniform water distribution. Irrigation systems should be designed to allow recycling of soluble chemicals in tailwater.

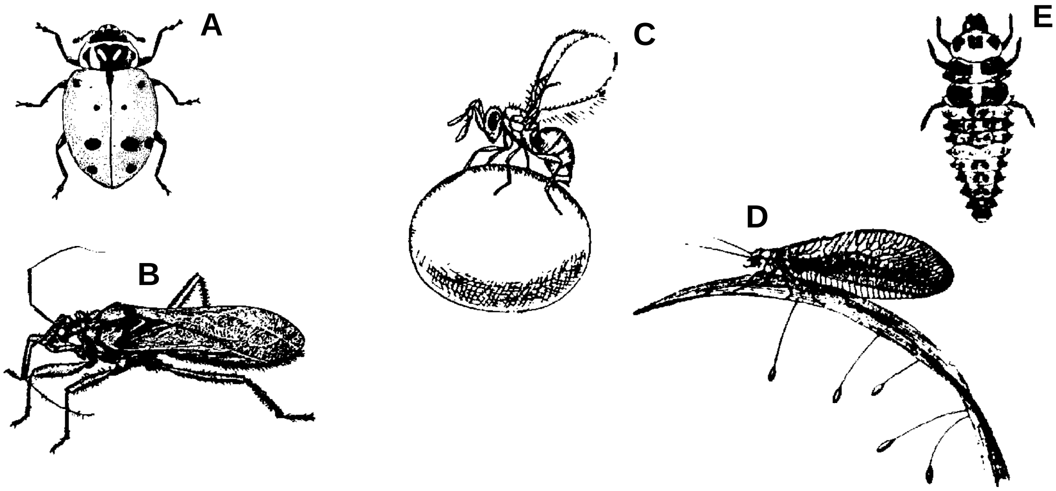
Monitoring soil moisture in each field is the best way to determine when a crop needs water. Computer models are used to predict the need for irrigation, which allows better planning. Local weather and evapotranspiration data provide a good estimate of crop water use. Visual appraisal is not accurate because plants are under stress long before they show signs of wilting.

Methods and equipment for determining soil moisture include tensiometers, gypsum blocks and electronic moisture probes. Several different methods may be used to measure the amount of water applied during an irrigation. They vary widely in cost, accuracy and convenience. Consult your county Extension agent or NRCS to find the methods that work best within your cropping and irrigation systems.

In some cases, irrigation may reduce pest numbers directly, even in the absence of a crop. For instance, a late irrigation after cotton stubble is plowed under may help reduce the number of overwintering pink bollworm larvae.

Do You Know Who Your Friends Are?

Identify each insect and whether it is a pest or beneficial. Answers are shown below.



A-ladybeetle, B-assassinbug, C -parasiticwasp, D -lacewing&eggs, E -ladybeetlelarva.Allarebeneficial.

4. Biological Controls

Biological control uses natural enemies of pests. These include pathogens (bacteria, fungi or viruses), parasites and predators. Biological controls usually fall into one of the following categories:

- Maintaining existing, naturally occurring beneficials. This method requires only that you don't destroy beneficials with pesticides or by removing their habitat.
- Augmenting beneficial populations. Accomplished by releasing beneficials or providing more favorable habitat (leaving ground cover on orchard floors, for example).
- Introducing natural enemies from the pest's native habitat. This method is usually implemented by federal agencies or university personnel after extensive research.

Biological sprays deliver a microbial agent, such as *Bacillus thuringiensis* (Bt), with convenience comparable to a chemical pesticide, but with little or no effect on beneficials. Use of pyrethrums, pheromones and selective pesticides also may help retain beneficial populations.

5. Field Application of Chemicals

Safe and effective use of pesticides requires knowledge of chemical behavior and interaction with the ecosystem. Properties of the chemical being used, such as leachability, solubility, soil bonding, and toxicity to nontarget species, partially determine the risk level. Irrigation or rainfall, crop residues, tillage and other cultural practices also affect movement of pesticides.

Using of the same pesticide (or active ingredient) repeatedly or exclusively may allow pests to develop resistance, making the chemical less effective or even useless over time. Strategies to avoid resistance include, limiting pesticide use, choosing products from different chemical classes or with different modes of action, applying mixtures (prepackaged or tank mixes). The chemical class or mode of action may occasionally be found on the label or MSDS. County Extension agents or pesticide dealers can help locate this information, as can some pesticide dealers.

Pesticide labels are the first source for information on safe and effective use. **Signal words** (figure 2) indicate the acute (immediate) toxicity to humans. Information about protecting the environment is found under the heading "Environmental Hazards,".

Additional considerations are necessary to protect surface water. Avoid applying pesticides near open water if possible. Slope of the land, vegetative cover and structural control devices may slow or prevent runoff from fields.

Signal Words

DANGER-POISON PELIGRO	WARNING	CAUTION
Indicates a highly toxic pesticide, likely to cause acute illness upon exposure. The word "DANGER" alone indicates the potential for severe eye and skin irritation.	Indicates product is moderately likely to cause acute illness, or that skin or eye irritation would be moderate.	Indicates product is slightly toxic or that skin or eye irritation would be slight.

Figure 2: Signal words found on pesticide labels give clues as to the toxicity of a formulation.

6. Machinery, Equipment and Supplies

Application rates, timing and method

Specific directions and recommendations for use of any pesticide are provided on the product label. Recommended rates are based on several factors as discussed above. The rate of chemical used should always be within the recommended range shown on the label. The label also includes practical information on when and how the product should be used.

Selection and setup

Proper selection and setup of application equipment is critical to effective and efficient pesticide use. The wide variety of options allows matching the equipment precisely to the task.

Boom sprayers are probably the most common chemical application equipment. They are frequently used for broadcast spraying, however the boom can be adapted or modified for several different operations including banding, directed spray and other specialty spraying operations.

Sprayer Calibration

Throughout the calibration procedure, keep tractor speed, spray pressure, nozzle type and number of nozzles constant. Use only clean water during calibration procedures.

Step 1 - Determine Effective Spray Width (ESW)

For BROADCAST sprayers ESW = nozzle spacing × no. of nozzles

Example: ESW = 20 in. × 8 nozzles = 120" or 10 ft.

For BAND sprayers ESW = band width × no. of nozzles

Example: ESW = 6 in.× 8 nozzles = 48" = 4 ft.

Step 2 - Measure a Test Area (TA) in square feet

TA = ESW × any convenient length

Example: TA = 10 ft. × 50 ft. = 500 sq.ft.

Step 3 - Determine number of Test Areas per acre

43,560 sq.ft./ac ÷ Square Feet Per TA = Test Areas Per Acre

Example: 43,560 sq.ft./Ac ÷ 500 sq.ft./TA = 87.1 TA/ac

Step 4 - Determine the time required to cover the Test Area

Operate sprayer with speed and pressure at field operating conditions.
Take an average of three timed trials and record the time in seconds.

Step 5 - Determine sprayer output for Test Area

Measure the fluid ounces each nozzle delivers during the time determined in Step 4. Determine the average output per nozzle, then calculate total sprayer output per Test Area. Note: Individual nozzle output should not vary more than ± 5%.

Average nozzle output in fl.oz. × no. of nozzles = fluid oz. per TA

Example: 6 fl.oz. per nozzle × 8 nozzles = 48 fl.oz. per TA

Step 6 - Determine sprayer output per acre

Fluid oz. per TA × no. of TAs per ac = fluid oz. per ac

Example: 48 fl.oz. per TA × 87.1 TA per ac = 4180.8 fl.oz. per ac

Convert fluid ounces to gallons.
Fluid oz. per ac ÷ 128 fl.oz. per gallon = gallons per acre (GPA)

Example: 4180.8 fl.oz. per ac ÷ 128 fl.oz. per gallon = 32.6 GPA

Application equipment and components provide many alternatives to reduce pesticide use. These techniques help confine the pesticides to more localized areas of a field or orchard. For example, spot treatment, rope wick applications or shielded spray will put pesticide precisely where it will do the most good. As application extends beyond the precise target location more pesticide is used, increasing costs and the potential for contamination.

Regardless of the type of equipment used, it is important to direct the pesticide to reach the targeted pest. Precise application of pesticide allows for less chemical to be used to treat a field. It will also help to ensure that re-treatment is not needed.

Calibration and Maintenance

Most applicators recognize the importance of equipment calibration. However, re-calibration is often overlooked following any change from the conditions of the previous calibration. Equipment should be checked frequently. Manually calibrated machinery should ALWAYS be checked when one or a combination of the following elements changes: operating speed, spray pressure, nozzle tip size or number of nozzles being used. Electronically monitored sprayers automatically adjust the output rate based on operating conditions.

Machinery maintenance will help keep equipment well calibrated and operating efficiently. Frequent checks of hoses, clamps, fittings, pumps, etc. are necessary to detect leaks or other problems that need correcting. Schedule equipment maintenance according to the amount of use. Many small problems can go unnoticed if maintenance is limited to only once or twice a year. Properly fitted and maintained equipment will reduce repair costs as well as pesticide use.

Chemigation

Chemigation, the application of pesticides through irrigation water, requires special precautions to protect the water supply, whether groundwater or surface water, from contamination.

The pesticide label will specify if a chemical cannot be applied through irrigation systems. If a pesticide can be applied by chemigation, the label will specify the type(s) of irrigation system, backflow prevention equipment, pesticide injection equipment, and safety precautions appropriate for that particular chemical.

Chemigation valves incorporate three backflow prevention devices into one unit. These are usually less expensive and more reliable than individual components.

All chemigation systems are required to have functional interlocking controls, or "interlocks." This simply means that the pesticide injection pump will stop if the water flow stops

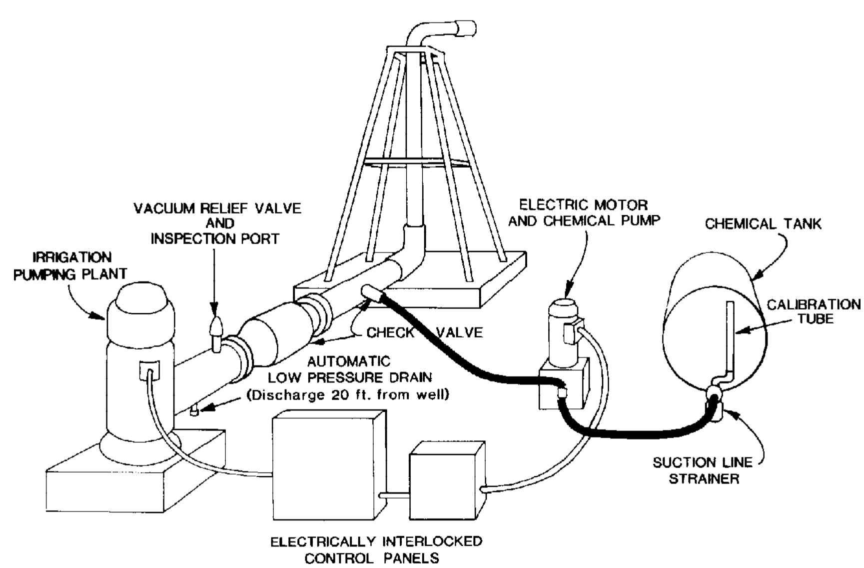


Figure 3 : Chemigation system with backflow prevention for a center pivot sprinkler.

or decreases to a critical point. For instance, an injection pump connected to an accessory pulley on an irrigation engine will stop when the engine stops (See Figure 3).

Spill readiness

No one wants to think they would be careless enough to cause a pesticide spill. Unavoidable accidents do occur, however, and applicators must be prepared to deal with spills. Having a plan and equipment to deal with spills can prevent a small spill from becoming a big problem.

Part of a spill response plan is knowing who to call for help or to report the spill. New Mexico Water Quality Act (NMSA 1978), Section 74-6-4, Paragraph C and subsequent Water Quality Standards for Interstate and Intrastate Streams in New Mexico, Section 1.100, Paragraphs B and D, require that spills of any amount to streams or lakes be reported.

New Mexico Environment Department (NMED) recommends that a spill be reported if it occurs on soil or a mixing pad, is a concentrate more than one quart, or a dilute solution greater than five gallons. It is also advisable to report a smaller spill if it threatens water resources or is an especially toxic compound.

Report spills to the Groundwater Bureau of NMED at (505) 827-2918. A 24-hour emergency hotline is also available at NMED's Hazardous and Radioactive Materials Bureau. The telephone number is (505) 827-9329. Collect calls are accepted.

Keep a Spill Kit Handy

Having a spill kit already assembled can save precious time when an accident happens. Take a few minutes and assemble these items.

- emergency telephone numbers
- personal protection equipment
- containment borders or "snakes"
- shovel and broom, foldable for easier storage
- kitty litter, garage oil dry or other absorbent material
- tarp or polyethylene sheet to cover dry spills
- plastic tub larger than the pesticide containers
- fire extinguisher rated for all types of fires

Spill cleanup tips

- Confine the spill to as small an area as possible using dirt dikes or containment borders.
- Stop the flow by placing smaller containers inside garbage bags, plastic tubs or similar containers.
- Prevent blowing of dry spills with a light mist of water or by covering with a tarp or plastic sheet.
- Always try to prevent the spill from reaching a well, ditch or any body of water.

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