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Managing Pesticides To Prevent Groundwater Contamination

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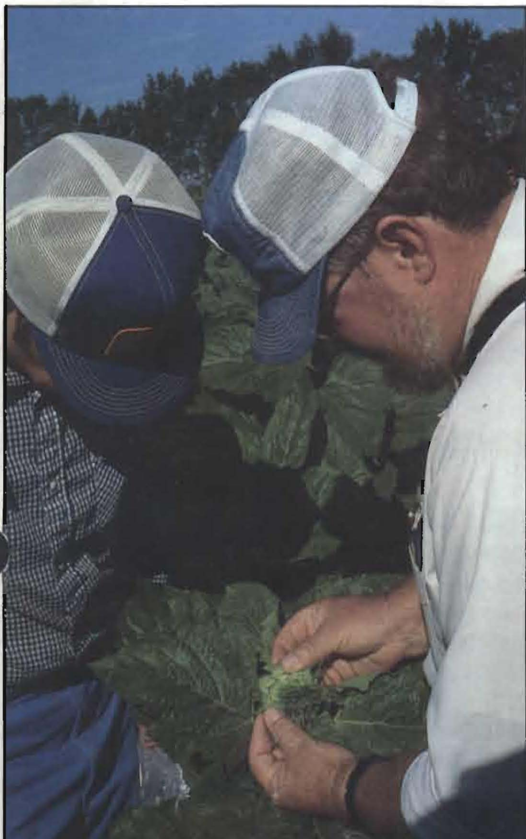

Dean K. McBride
Entomologist, NDSU Extension Service

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NDSU EXTENSION SERVICE
North Dakota State University, Fargo, ND 58105

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Groundwater is an essential natural resource. It is formed when water moves below the earth's surface and fills the void around sand, gravel, rocks and other porous materials. If enough groundwater is present to supply wells or springs, this water-bearing material is called an aquifer.

Approximately half the people in the United States depend on groundwater as their source of drinking water, and more than 90 percent of rural residents obtain their water from groundwater. In North Dakota, 60 percent of the total population utilizes groundwater for their drinking water supply and virtually all of the rural population uses groundwater.

Much is said about "pure" water, but naturally occurring groundwater is never "pure" because it contains chemical elements that are part of the environment. It is important, however, to avoid the unintentional contamination of water with chemicals such as agricultural pesticides. Since pesticides are used extensively in U.S. crop production, they are of major importance as potential sources of groundwater contamination.

Pesticides may contaminate both surface water (lakes, rivers and ponds) and groundwater. Contamination of surface water usually is less serious than groundwater contamination because most surface waters have a rapid turnover rate, which means that incoming fresh water constantly dilutes the concentration of the contaminant. In addition, most surface waters contain free oxygen, which enhances the rate at which pesticides are broken down by microorganisms, and sunlight accelerates the breakdown of many pesticides. However, pesticide contamination of surface water is of obvious concern because of the ease of entry to surface waters and because many of these chemicals can be toxic to fish and other aquatic organisms, even at low concentrations.

Approximately 800 million pounds of pesticides are used annually in the United States. The major classes of pesticides used in agriculture are herbicides, insecticides, and fungicides. Currently herbicides account for about 85 percent of the pesticides used in agriculture, insecticides 13 percent, and fungicides the remaining 2 percent. These figures are roughly equal to annual pesticide use patterns in North Dakota.

A serious problem can occur if a highly toxic and persistent pesticide reaches groundwater. The turnover rate for groundwater may be as short as a few months, but more commonly years, decades and even centuries are needed to replace the water in an underground aquifer. Oxygen is mostly absent in groundwater, and the microorganisms that live in an oxygen-free environment are much less effective in breaking down pesticides than microorganisms living with oxygen. Extremely slow dilution, cold temperatures and low microbial activity typical in groundwater means that the contaminant will be present for a long time.

The most obvious and serious hazard of contaminated groundwater is the potential toxicity to man and domestic animals who drink the water. However, another potential hazard exists if groundwater contaminated with a herbicide is used for irrigation of crops susceptible to the herbicide. Crop injury and serious monetary losses can be incurred.

Groundwater contamination by pesticides (or any other contaminants) cannot be corrected easily. Doing so requires drilling purge wells and pumping the water to the surface. The water must then be treated to remove the pesticide and disposed of. Pumping may have to be continued for a long time in order to remove all the contaminated water. Such corrective action can cost thousands of dollars.

Another alternative is to drill a new water well in an area without pesticide contamination. However, the contaminated aquifer must be monitored and may ultimately require remedial measures.

Unfortunately, both of these alternatives are expensive and time consuming. The best solution is to use the best available pesticide management practices that will prevent groundwater contamination.

Factors Influencing Groundwater Contamination

The potential for groundwater contamination is not the same for all pesticides nor for all locations. Pesticide users should have an understanding of the factors that influence the movement of a pesticide through a soil profile.

Recent monitoring of groundwater has provided data that have improved and confirmed our understanding of what factors make a pesticide likely to leach. The following are the important physical and chemical characteristics of a pesticide that may make it more or less susceptible to leaching, based on current scientific understanding.

Water Solubility: The tendency for a pesticide to dissolve in water is a major factor in leaching potential. The higher a pesticide's water solubility, the greater the amount of pesticide that can be carried in solution to surface and groundwater. Water solubility of greater than 30 parts per million has been identified as a "flag" for the possibility of a pesticide to leach.

Soil Adsorption: The tendency of a pesticide to leach also depends on how strongly it adsorbs to soil particles. Pesticides which are adsorbed onto soil particles are kept from moving to groundwater and remain in the root zone where they are available to plants and may eventually be degraded by microorganisms or other means. Adsorption refers to the attraction between a chemical and the soil particles. Compounds which are strongly adsorbed onto soil are not likely to leach, regardless of their solubility. Compounds which are weakly adsorbed, on the other hand, will leach in varying degrees depending upon their solubility. The strength of sorption is a function of the chemical properties of the pesticide, the soil type and the amount of soil organic matter present.

Pesticide dosage rate is important also. A pesticide used at 4 pounds active ingredient per acre will be more likely to contaminate water than a pesticide used at 1 ounce active ingredient per acre, even if both have the same solubility, adsorption, etc.

The adsorption partition coefficient (K_d) is determined by mixing soil, pesticide, and water, then measuring the concentration of pesticide in solution after equilibrium is reached. The adsorption coefficient then can be calculated as the ratio of pesticide concentration in the adsorbed state to that in solution:

$$K_d = \frac{\text{concentration absorbed}}{\text{concentration dissolved}}$$

A wide range exists in partition coefficients. For example:

Pesticide	K_d
Aldicarb (Temik)	10
Carbofuran (Furadan)	29
Atrazine	172
Carbaryl (Sevin)	229
Malathion (Cythion)	1,178
Parathion	7,161
DDT	243,000

In the United States, aldicarb (Temik) and atrazine have been found in groundwater in some agricultural areas while DDT has not.

Volatility: This is primarily a function of the vapor pressure of a chemical. Vapor pressure is a measure of volatility or the tendency of a compound to become a gas. The higher the vapor pressure of a pesticide, the faster it is lost to the atmosphere. The vapor pressure of a chemical is strongly influenced by environmental conditions (e.g. temperature, moisture, wind speed, etc.).

Aqueous volatility of pesticides is determined by dividing the chemical's vapor pressure by its solubility in water; this value is termed Henry's Law Constant (H).

The lower the value of the Henry's Law Constant, the higher the susceptibility of a pesticide to leaching. Examples of pesticides with a high value of H and thus low leaching potential include trifluralin (Treflan), triallate (Far-Go), and phorate (Thimet).

Degradation: The persistence of pesticides in soil is dependent on a number of environmental processes, including vaporization and several decomposition processes that cause chemical breakdown, particularly hydrolysis, photodecomposition and microbial transformation. Hydrolysis is the reaction of a chemical with water. Photodecomposition is the breakdown of a chemical from exposure to the sun's energy. Microbial transformations result from the metabolic activities of microorganisms typically using the pesticide as a food source. When a pesticide resists these decomposition processes and does not readily evaporate, it will have a long soil half-life, increasing the potential for contamination of groundwater. The risk of contamination will be even higher if the pesticide is highly soluble and has low adsorption to soil particles. Generally, pesticides with half-lives more than two or three weeks have the greatest potential to leach to groundwater.

Currently, there is insufficient data to state with certainty which pesticides will leach and which will not leach. However, data from pesticide manufacturers based primarily on the previous factors (solubility, adsorption, volatility and degradation) provide fairly substantial guidelines on leaching potential. Such data has been acquired and is available for all commonly used crop pesticides in North Dakota. The NDSU Extension Service publication containing this data is entitled, "Persistence and Mobility of Pesticides in Soil and Water," bulletin #49, available from local county extension offices and the Distribution Center in Morrill Hall at NDSU.

The U.S. Environmental Protection Agency has developed a list of threshold values for some key chemical and physical properties of pesticides (Table 1). Compounds with properties beyond any of these threshold values warrant extra attention with regard to potential for leaching to groundwater. These values, however, are only a rough guide and pesticides outside of the threshold values may leach to groundwater. Aldicarb (Temik), for example, has an estimated K_d of 10 and atrazine has a K_d of 172 but both have been found in groundwater.

Table 1. Threshold Values Indicating Potential for Groundwater Contamination by Pesticides (from U.S. EPA. 1986. Pesticides in Groundwater: Background Document).

Chemical or Physical Property	Threshold Value
Water Solubility	greater than 30 ppm
Henry's Law Constant	less than 10-2 atm-m-3 mol
K_d	less than 5, usually less than 1 or 2
K_{oc}	less than 300-500
Hydrolysis Half-Life	greater than 25 weeks
Photodecomposition Half-Life	greater than 1 week
Field Dissipation Half-Life	greater than 3 weeks

Soil Characteristics: The soil conditions at the area receiving a pesticide application can greatly affect the likelihood of any leaching. The composition and properties of the soil are the two most important factors affecting leaching potential.

Generally, the sandier the soil, the greater the possibility of groundwater contamination. Sandy soil has a low water-holding capacity, lower populations of microorganisms to break down pesticides, and less clay and organic matter to which pesticides can adsorb. At the other extreme, water may rapidly run off clay soils, which increases the possibility of surface water contamination.

Many soil characteristics affect leaching, such as soil texture, permeability, organic matter, and structure (including macropores).

Soil texture is determined by the relative proportions of sand, silt, and clay. Texture affects movement of water through soil, and therefore movement of dissolved chemicals such as pesticides. The coarser the soil texture, the faster the movement of percolating water and the less opportunity for adsorption of dissolved chemicals. Finer textured soils with more clay and organic matter tend to hold water and dissolved chemicals longer. These soils also have far more surface area on which pesticides can be adsorbed. The coarser the soil texture, therefore, the greater the chance of the pesticide reaching groundwater.

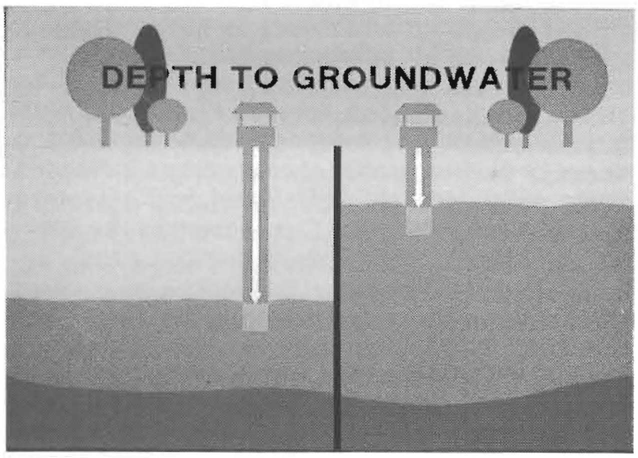
Soil permeability is a measure of how fast water can move downward through a particular soil. In general, coarser textured soils have higher permeability than finer textured soil. Water moves quickly through soils with high permeability. When heavy rainfall or excess irrigation takes place, dissolved chemicals may be lost with the percolating water. In highly permeable soils, therefore, the timing and method of application of pesticides need to be carefully designed to minimize leaching losses.

Soil organic matter influences how much water a particular soil type can hold and how well it will be able to adsorb pesticides. Increasing the soil's organic content through practices such as application of manure or plowing under of cover crops increases the soil's ability to hold both water and dissolved pesticides in the root zone. This increases the eventual degradation of pesticides in the root zone.

Soil structure, the way soil particles are aggregated, also will affect water movement. Sometimes large openings (macropores) resulting from physical processes such as animal borings or large soil cracks caused by freeze/thaw action or severe drought may be present in fine textured soils. Under certain conditions, macropores result in rapid water movement through even these fine fextured soils.

Depth to Groundwater: The shallower the depth to groundwater, the less soil there will be to act as a filter. This situation also allows rapid percolation so contaminants can reach groundwater quickly. Also because of the shallower soil profile, there will be fewer opportunities for degradation or adsorption of pesticides. Therefore, extra precautions need to be taken to protect groundwater in areas where it is close to the ground surface, such as in the sandhills regions of southeastern North Dakota. Areas of high water tables are scattered throughout the state. However, on the majority of the agricultural land groundwater lies at depths of 20 feet or more below the soil surface, so leaching of pesticides to groundwater throughout most of the state will be a slow process and usually should not occur at all.

Depth to groundwater does not remain constant over the course of the year. It varies according to the amount of precipitation and/or irrigation, whether the ground is frozen, and how much groundwater is being withdrawn by pumping. Spring and late fall generally are the times of greatest recharge and, therefore, also of highest water table levels. Groundwater levels tend to go down in summer when evaporation and plant uptake are high. Fluctuations in recharge quantities can have consequences for recharge quality as well. If spring rains come shortly after application of pesticides, higher than normal quantities of the chemicals may be transported downward to groundwater, which at that time of year is likely to be relatively close to the soil surface.



Geologic Conditions: In addition to depth to groundwater, the permeability of the geologic layers between the soil and groundwater is important. Highly permeable materials, such as sand and gravel deposits, allow water and dissolved pesticides to percolate downward to groundwater. Layers of clay, on the other hand, are relatively impermeable and inhibit the movement of water. Groundwater quality is most vulnerable in areas where soils are continuously permeable from the ground surface to the water table.

Hydrogeologic information for North Dakota can be obtained from the State Water Commission, 900 East Boulevard, Bismarck, North Dakota 58501.

Climate and Irrigation Practices: The amount and seasonal variation in the amount of recharge--rainfall and irrigation--is another important factor in leaching potential. Areas with high rates of infiltration from rainfall or irrigation water can have large amounts of water passing through the soil and therefore are more susceptible to leaching. This is particularly true if high rainfall or heavy irrigation coincides with or follows shortly after the application of agricultural chemicals, thus leaching them below the root zone.

Man-made features such as poorly constructed water supply wells, agricultural drainage wells, and faulty check valves or no check valves on chemigation systems also influence whether a pesticide will reach groundwater. These features can lead to "short circuiting" or the movement of pesticides directly to groundwater without being filtered through soil.

Pesticide Management Practices

Since site conditions, pest and crop patterns, and agricultural practices vary widely, specific recommendations for practices to reduce the risk of pesticide contamination must be specific and cannot be appropriate for all situations. However, measures to protect groundwater from pesticides generally involve the following objectives:

- Reduce the quantity of pesticide used (use the lowest effective rate).
- Use pesticides with less potential to leach.
- Use pesticides that are not persistent.
- Avoid pesticide application when conditions promote leaching.
- Prevent spills leading to a concentration of pesticide at a site which can leach to groundwater.
- Prevent back-siphoning or direct movement of pesticides down a well.

Read the Pesticide Label: The pesticide label is designed to provide useful and important information to allow efficient, safe and legal use of pesticide. There are four times when the pesticide label should be read: before the pesticide is purchased, before the pesticide is mixed and applied, before the pesticide is stored, and before disposing of the pesticide or container.

Pesticide labels contain a variety of important information on proper and safe use, and an increasing number of pesticide labels also contain information on preventing groundwater contamination.

Prevent Spills and Back-Siphoning: Pesticides spilled near wells, streams or other water sources have the potential of moving over or through the soil and reaching surface or groundwater.

Spills can occur from overfilling spray tanks or from poorly maintained application equipment. The valves and hoses on application equipment should be checked for leaks or damage and replaced as necessary.

Summary of Groundwater Contamination Potential As Influenced By Water, Pesticide and Soil Characteristics

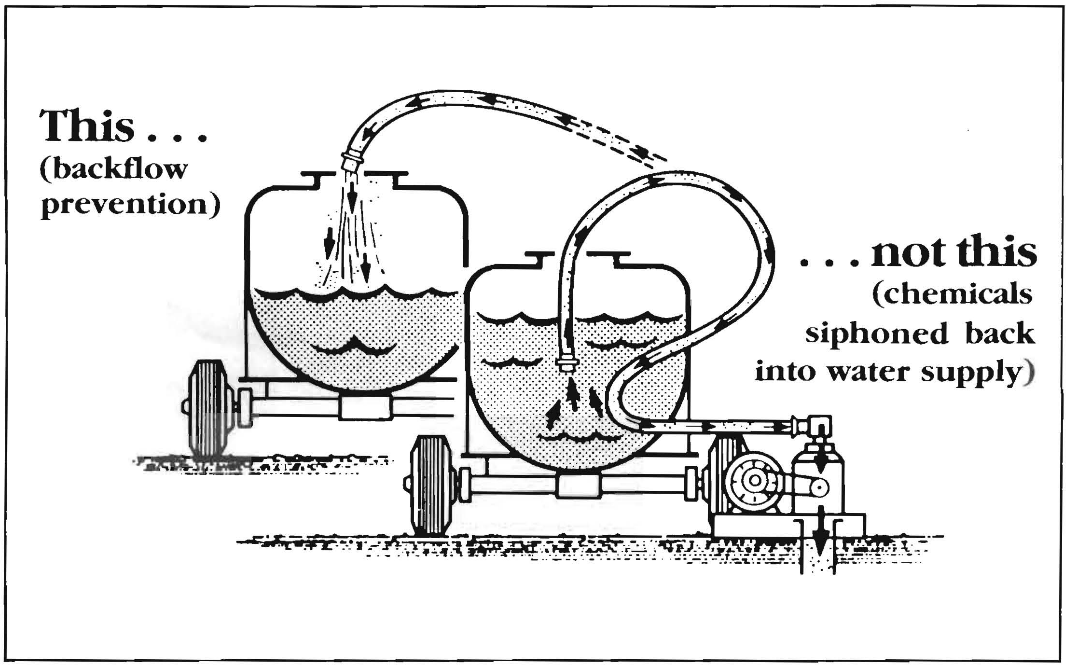
	Low Risk	High Risk
Pesticide Characteristics		
water solubility	low solubility	high solubility
soil adsorption	highly adsorbed	poorly adsorbed
persistence	short half-life (a few days)	long half-life (several weeks)
Soil Characteristics		
texture	fine clay	coarse sand
organic matter	high O.M. content	low O.M. content
macropores	few, small	many, large
depth to groundwater	deep (20 ft. or more)	shallow (10 ft. or less)
Water Volume		
rain/irrigation	small volumes at infrequent intervals	large volumes at frequent intervals

To prevent back-siphoning from spray equipment into the well, keep the end of the fill hose above the water level in the spray tank at all times (see diagram). Use an anti-backflow device when drawing mix water directly from a well, pond or stream. Inexpensive anti-backflow devices for filler hoses can be purchased from irrigation or sprayer equipment suppliers.

A well may act as a direct pipeline to groundwater. Groundwater can become contaminated if pesticides enter a well directly from the surface, through openings in the well casing, or through soil adjacent to the well.

New wells, if properly constructed, can prevent groundwater contamination. The tops of wells must be sealed to prevent entry of contaminants down the well. Wells must be grouted between the well casing and the well bore hole to prevent contaminants from moving down around the well casing.

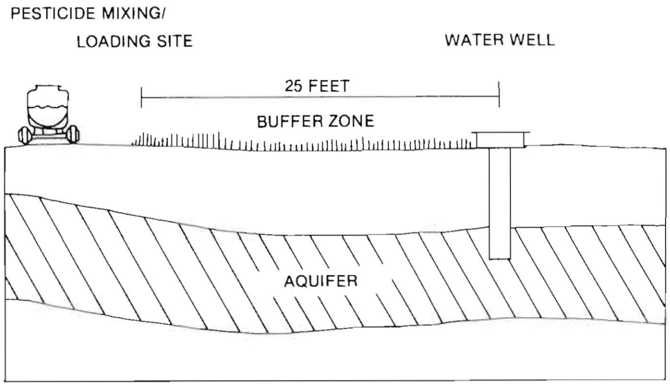
Proper maintenance of existing wells helps prevent groundwater contamination. Wells and pumps should be inspected regularly for leaks and to en-



sure that the seal is adequate to prevent pesticides from entering the groundwater. Irrigation pipes should also be checked for leaks that could lead to groundwater contamination.

As an added measure of protection, pesticides should not be handled, mixed, or placed in spray tanks directly adjacent to wells (EPA suggests a 25-foot minimum distance).

KEEP PESTICIDES AWAY FROM WATER WELLS



Leaching Potential of Soil: As previously discussed, the possibility of groundwater contamination is greater when pesticides are applied to highly permeable sandy soil than to any other soil type. However, well structured clay soils may contain a high number of macropores which can increase the potential for rapid leaching. In addition, drying out of clay soils may result in prominent shrinkage cracks. Rainfall or irrigation water flowing through macropores and cracks may promote leaching, even when other pesticide properties and site conditions are not conducive to leaching.

Producers and commercial pesticide applicators should be aware of the leaching potential of the soil at field sites where pesticides are to be applied.

Pesticides With Low Leaching Potential: The potential for movement of an agricultural chemical in soil varies according to the nature of the chemical, the properties of the soil, and the agricultural practices used.

The most significant cases of groundwater contamination have involved certain herbicides, nematicides and carbamate insecticides. Several of these compounds tend to be soluble in water and are weakly absorbed to soil. Carbamates (such as Temik and Furadan) may migrate to groundwater if they are not degraded in the upper soil levels. The organphosphate insecticides, such as malathion and parathion, generally break down rapidly in the environment and rarely have been found in groundwater. When available, alternative pesticides with lower leaching potential should be used, particularly in areas with vulnerable groundwater. Information on the relative persistence and mobility of commonly used crop pesticides in North Dakota is available in NDSU Extension Service publication #49, "Persistence and Mobility of Pesticides in Soil and Water."

IPM Helps Minimize Pesticide Needs: Integrated pest management (IPM) is the utilization of combinations of practices for pest control that can help reduce pesticide use. IPM is the integration of available pest control techniques in a manner that is economically and ecologically sound. IPM uses scientifically sound strategies, such as economic thresholds and field monitoring, to determine the need and proper timing of pesticide applications. Economic threshold is defined as the pest population level that produces damage equal to the cost of preventing that damage. Field monitoring can determine whether pest populations and damage levels are at economic threshold levels that warrant pesticides or other control methods.

Some IPM programs have successfully eliminated unnecessary pesticide applications and reduced the total number of applications in a season. This has resulted in reduced pest control costs and helped prevent adverse effects such as pest resurgence, secondary pest outbreaks, and resistance to pesticides. Also, because of reduced pesticide treatments, the risk of groundwater contamination by pesticides has been reduced.

Various estimates suggest that the adoption of currently available IPM practices would permit a 40 percent to 50 percent reduction in the use of insecticides within a five-year period. A reduction of 70 percent to 80 percent may be possible in the next 10 years. A four-county two-year study in Illinois found that 19 percent and 11 percent of corn acreage actually required insecticide usage while 67 percent and 54 percent, respectively, received it (Luckman, 1978).

Many pest management experts believe that reductions in pesticide use are possible with little or no sacrifice in crop yield or grower profit while at the same time providing an additional method of reducing groundwater contamination.

Timing of Pesticide Applications: The time of year that a pesticide is applied can be a major factor in pesticide leaching potential, depending on local environmental conditions, rainfall and temperature. Because irrigation and rain can affect the leaching of some pesticides, irrigation schedules and weather forecasts should be considered, along with optimal pest occurrence (economic thresholds), when determining the timing of pesticide application. Frequently fewer pesticide applications are necessary when they are timed in relation to pest problems, crop growth, irrigation and rainfall. Also, leaching potential in minimized when the applied pesticide is fully utilized or when soil conditions promote degradation.

Dosage Rates: Groundwater contamination can be minimized by staying within recommended label rates. Using more product than the label recommends generally will not give improved pest control and often may increase crop injury. The cost of pest control, the resistance of pests to chemical control, and the chance that the pesticide may reach groundwater will be increased. Rough approximations in dosage rates generally lead to over-application of the pesticide and increase the risk of groundwater contamination.

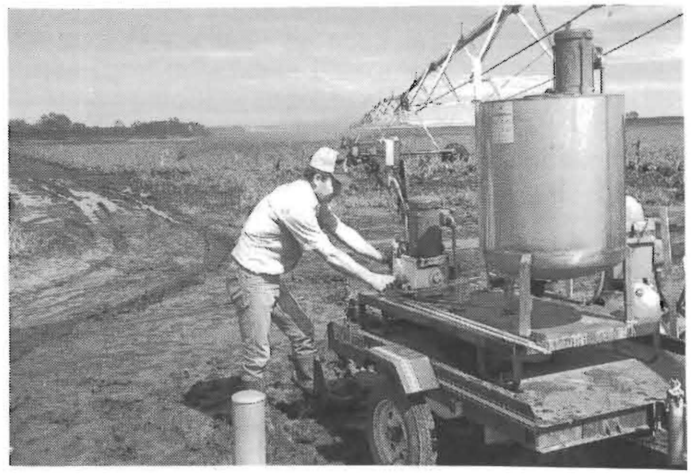
Pest density and vulnerability should be considered prior to determining pesticide dosage. For example, if the population density of grasshoppers is relatively low and the insects are in the early stages (nymphs), the lower end of the recommended rate range will often provide adequate control while resulting in lower quantities of pesticide used.

Equipment Calibration and Maintenance: Pesticide application equipment should be maintained and accurately calibrated to ensure even application of pesticides and that pesticides are applied at rates intended by the user. Poorly maintained and/or calibrated equipment can discharge incorrect quantities of an improperly diluted mixture of pesticides, which can result in inefficient use and subsequent leaching into groundwater. Ensuring the proper rate and volume of pesticide application can be made easier with the use of automatic volume regulating devices which cause spray pressure to vary accordingly with changes in speed of the application equipment.

Pesticide application equipment should be maintained and calibrated on a periodic basis to achieve the desired application rates and volume. Properly calibrated equipment reduces the chances of applying too much pesticide. If too much pesticide is applied in one spot, normal degradation processes are hindered, leaving more pesticide residue which may reach groundwater.

Information on calibration procedures can be found in NDSU Extension Service publication AE-73 "Sprayer Equipment and Calibration," available at county extension offices or the extension agricultural engineering department at NDSU.

Preventing Off-Target Pesticide Movement: Particular attention should be given to the prevention of off-target movement of pesticides as a result of drift or runoff. Be aware of adjacent sensitive sites such as sloughs or ponds where the water table may be close to the surface. Don't spray on windy days or during temperature inversions. Also, avoid excess spray pressure, which causes a fine spray mist resulting in more drift. Drift reduction additives, such as Nalco-Trol, are available to add to spray tanks when applications are necessary near groundwater sensitive areas. More information on drift prevention is available in NDSU Extension Service publication A-657, "Herbicide Spray Drift."



Chemigation: With chemigation, pesticides are applied simultaneously with irrigation water. When using chemigation, read the pesticide label and apply only the amount of water recommended to disperse and needed to activate the pesticide. Excess irrigation water may cause excessive dilution of the active ingredient, reducing pest control. Another obvious reason to minimize water amounts during chemigation would be to prevent leaching of the pesticide to groundwater. By delaying irrigation after chemigation the pesticides will be allowed to degrade or be taken up by plants. The delay time is a function of, among other factors, the rate of plant uptake of the pesticide and the pesticide degradation rate.

Studies have shown that fields are often irrigated at unnecessarily high volumes and frequencies (University of Nebraska, 1984), and irrigation amounts can sometimes be reduced with no significant impact on yield.

A method of irrigation scheduling must be used to determine the quantity and frequency of irrigation water applications. Proper scheduling may involve a predictive technique as described in NDSU Extension Service publication AE-792, "Irrigation Scheduling by the Checkbook Method," or methods which measure soil moisture levels. This practice can help determine the water requirements in a field and will identify when water contents become low enough to cause crop stress.

Pesticide Storage and Disposal: The law requires that pesticides be stored in a safe, secure, and well-identified place. Pesticides must always be stored in the original, labelled container with the label clearly visible.

Significant groundwater contamination can result if pesticide containers break from rough handling, weathering, corrosion, or age. Proper storage can help avoid these problems. The label instructions for each registered pesticide contain brief but explicit instructions regarding storage and disposal.

The storage facility should be downgrade and a safe distance from any drinking water well or other groundwater sensitive site. Spill containment measures, such as paving and diking the area, will prevent releases to the environment. Routine inspection of the condition of pesticide containers and the storage facility can minimize the potential for leaks or spills. Pesticide storage facilities should have concrete floors with pesticides stored on shelves or pallets so that leaking containers can be readily detected.

More information on pesticide storage and disposal can be found in NDSU Extension Service publication AE-897, "Storage and Disposal of Pesticides and Containers on the Farm."

Always have materials available for containing or cleaning up a spill. Know ahead of time what to do to contain and clean up spills of the various pesticides stored. Since different chemicals can require different actions, the "Emergency Response Information Sheets" or "Material Safety Data Sheets" from pesticide manufacturers should be on hand for each stored pesticide. These provide detailed information about what to do in case of a spill.

Steps should be taken to minimize pesticide-related waste and reduce disposal problems. Reduction in left-over pesticide solution, rinse water, and the number of pesticide containers requiring disposal will enhance groundwater protection efforts. In all cases the pesticide label instructions should be followed carefully. Only the required amount of pesticide solution should be mixed and equipment must be carefully calibrated. Rinse water can be sprayed on cultivated fields where feasible and consistent with label directions.

Federal law requires triple rinsing of pesticide containers or jet-spray cleaning, before disposal. Rinsed containers should be stored securely prior to disposal to minimize the chance of inadvertent exposure to humans or to environment. Metal containers may be recycled through scrap metal dealers; those not suitable for recycling or refilling by distributors may be disposed of in an approved sanitary landfill. Information on sanitary landfills suitable for disposal of triple-rinsed pesticide containers in North Dakota can be obtained from the Waste Management Division of the North Dakota Health and Consolidated Laboratories Department, 1200 Missouri Avenue, Bismarck, North Dakota, (701) 224-2366.

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Glossary of Terms and Definitions

Adsorption - Retention of organic pesticides by soil particles.

Chemigation - Application of pesticides simultaneously with irrigation water.

Decomposition - The process by which organic matter is converted (broken down) into constituent elements, i.e. decaying process.

Degradation - Changing of a chemical compound to a less complex compound.

Fumigant - A gaseous, highly volatile material which forms vapors that destroy insects, pathogens or other pests such as in grain bins or in soil.

Fungicide - A chemical that kills fungi.

Henry's Law Constant - Aqueous volatility of pesticides determined by dividing the chemical's vapor pressure by it solubility.

Herbicide - A chemical used to destroy or inhibit growth of undesirable plants.

Hydrolysis - Chemical process of (in this case) pesticide breakdown or decomposition involving a splitting of the molecule and addition of a water molecule.

Insecticide - A chemical that kills insects.

Leaching - The movement of a pesticide chemical or other substance downward through soil as a result of water movement.

Macropores - Openings in soil caused by animal borings or cracks due to freeze/thaw action or severe drought.

Microorganisms - An organism of microscopic or ultramicroscopic size, such as bacteria or protozoa.

Partition Coefficient - Ratio of pesticide concentration in the adsorbed state to that in solution.

Pesticide - An "economic poison" defined in most state and federal laws as any substance used for controlling, preventing, destroying, repelling, or mitigating any pest. Includes fungicides, herbicides, insecticides, nematicides, rodenticides, desiccants, defoliants, plant growth regulators, etc.

Photodecomposition - Break down or decomposition of organic molecules by sunlight (radiant energy).

ppb (parts per billion) - The number of parts of toxicant per billion parts of the substance in question.

ppm (parts per million) - The number of parts of toxicant per million parts of the substance in question. This may include residues in soil, water, plants or animals.

Solubility - The amount of a substance that will dissolve in a given amount of another substance.

Vapor Pressure - A measure of the tendency of a compound to become a gas.

Volatilization - The process by which volatile chemicals vaporize and are given off such as grain fumigants vaporizing in stored grain.

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