NRCS Natural Resources Conservation Service

# Alaska Pest Management Fact Sheet
# Pollution Pathways, Risk Analysis and Mitigation Techniques
# April 2008

This fact sheet provides technical information concerning pesticide pathways, risk analysis and mitigation techniques for use with the 595 Pest Management Conservation Practice.

Four major pesticide pollution pathways have been identified in pest management research. They are:

- spray drift
- runoff and leaching
- volatilization
- soil carryover

**Spray Drift**

Spray drift is the transport of pesticide droplets by wind away from the target area. Spray nozzle height above the ground, spray droplet size, air stability, and wind speed are major components controlling spray drift.

**Runoff**

Runoff can occur if rainfall occurs on a field within a few days after a pesticide application**.** Runoff is the movement of water over a sloping surface. Runoff occurs when water is applied to the soil at a faster rate than it can enter the soil. Runoff water can carry pesticides in the water itself or bound to eroding soil particles. The severity of pesticide runoff is influenced by the slope or grade of an area; the erodibility, texture, and moisture content of the soil; and the amount and timing of rainfall and irrigation. Pesticide runoff is usually greatest when a heavy or sustained rain or irrigation follows soon after an application.

**Leaching**

Leaching is the movement of pesticides through the soil as opposed to movement over the surface. Pesticide leaching depends, in part, on the chemical and physical properties of the pesticide. For example, a pesticide held strongly to soil particles by adsorption is less likely to leach. Solubility is another factor because a pesticide that dissolves in water can move with water in the soil. The persistence or longevity of a pesticide also influences the likelihood of leaching. A pesticide that is rapidly broken down by a degradation process is less likely to leach because it may remain in the soil only a short time. Soil factors that influence leaching include texture and organic matter, in part because of their effect on pesticide adsorption. Soil permeability, or how readily water moves through the soil, is also important. The more permeable a soil, the greater potential for pesticide leaching: A sandy soil is much more permeable than a clay soil.

**Volatilization**

Volatilization is the conversion of a solid or liquid into a gas. Once volatilized, a pesticide can move in air currents away from the treated surface. Vapor pressure is an important factor in determining whether a pesticide will volatilize: The higher the vapor pressure, the more volatile the pesticide. Environmental factors such as high temperature, low relative humidity and air movement tend to increase volatilization. A pesticide tightly

adsorbed to soil particles is less likely to volatilize; therefore, soil conditions such as texture, organic matter content, and moisture can influence pesticide volatilization. Formulations can also help reduce volatilization. Granular, flowable, and wettable powders are less susceptible to volatilization than emulsifiable concentrates and soluble powders.

**Soil Carryover**

Soil carryover is a soil quality issue for pesticides. The amount of pesticide remaining in the soil is primarily a function of persistence and sorption. If a pesticide persists too long in the soil, it can be toxic to the next crop. Most pesticides are broken down over time by chemical and microbiological reactions in the soil. Carryover of specific pesticides is evaluated by considering two factors, the pesticide half-life and the partition coefficient. The pesticide half-life is the amount of time it takes for one-half the original amount of a pesticide in soil to be deactivated. The partition coefficient ($K_{oc}$) value is the ratio of pesticide concentration bound to soil particles to the concentration of pesticide dissolved in the soil-water. The smaller the PC value the greater the concentration of pesticide in solution. Pesticides with small PC values are more likely to be leached when compared to those with large PC values.

U.S. laws, specifically the Federal Insecticide, Fungicide, and Rodenticide Act and the Food Quality Protection Act, define the precise conditions under which a producer or commercial pesticide applicator may legally apply a pesticide. Conditions for use are specified on the product label attached to every package of the pesticide product. These laws insure that by applying pesticides at label rates and according to application instructions an acceptable level of risk for the applicator, other humans, and natural resources and ecosystems can be obtained.

NRCS pesticide management practices are designed to go beyond the two major pesticide laws and help producers minimize their use of pesticides while being consistent with other resource protection goals and providing adequate economic returns. The goal of the pest management practice is to minimize the introduction of pesticides into the environment. Various pesticide management techniques are listed in the 595 Pesticide Management practice standard. These management techniques, such as minimum setbacks from water bodies, are often also included on product labels. In Alaska the Windows Pesticide Screening tool (WIN-PST) is used to determine the potential pesticide impacts on the environment.

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NRCS uses the following guidelines for pesticide mitigation in Alaska:

If WIN-PST "Interaction" Hazard Category is:

| | |
|---|---|
| Very Low | No Mitigation Required |
| Low | No Mitigation Required |
| Intermediate | Basic Mitigation Required<br>1 or 2 Mitigation Practices |
| High | High Mitigation Required<br>≥ 3 Mitigation Practices |
| Extra High | Mitigation may not work |

Mitigation Techniques:

1. **Application Timing** Avoid applying pesticides during periods of heavy rains or during windy conditions. By avoiding adverse weather conditions mitigation of 100 percent of losses to surface waters is possible. Ground water effects are small.

2. **Formulations and Adjuvants.** Adjuvants (additives) can enhance plant uptake of pesticides. Increasing plant uptake helps prevent runoff and leaching. Adjuvant is a broad term and includes surfactants, crop oils, antifoaming agents, stickers, and spreaders. Pesticide formulation describes the physical state of a pesticide and determines how it will be applied. Formulation differences, in some cases, can significantly reduce runoff losses.

3. **Lower Application Rates.** Reducing the rate of pesticide application is usually the most effective way to lower pesticide concentration and losses to water resources. Pesticide loss is generally decreased in direct proportion to the reduction in rate.

4. **Partial Treatment or Spot Spraying.** Partial applications that lower the overall per-area application rate result in well-documented reductions in pollution potential. In addition, placement of pesticides to avoid wheel tracks and furrows, especially under irrigation, can provide additional remediation.

5. **Setbacks.** Setbacks are specified distances that must be maintained between those areas where pesticides are applied and nearby water resources. Setbacks are a simple and practical mitigation

technique to protect water resources and biota. It is well documented that setbacks of 33 feet for ground sprays and 330 feet for aerial applications, are effective to protect nearby water resources.

6. **Soil Incorporation by tillage or irrigation**. Incorporation has well-documented, significant environmental benefits when used as a mitigation option. Volatilization, runoff potential, and even wind transport of pesticides by wind erosion can be reduced by 67 to 80 percent with incorporation to a depth of 4 inches. "Raining in" or incorporation by a small amount of irrigation, is also effective to reduce losses.

7. **Substitution: Alternative pesticides, cultural controls, and biological controls**. By using WIN-PST a lower risk pesticide can be selected when multiple pesticide choices are available. Cultural and biological controls methods are most effective when implementing Integrated Pest Management techniques.

8. **Conservation Practices that affect pest management.** Many conservation practices have direct effects on reducing risks associated with pesticide application. Highlighted below are practices used in Alaska that may help mitigate pesticide risks.

- Agrichemical Handling Facility (309)
  A properly designed facility should eliminate point discharges of chemicals from mixing and loading sites reducing the risk of pesticide leaching or runoff.
- Cover Crop (340)
  Cover crops can reduce soil erosion and increase soil organic matter and water conservation. In Alaska, this practice may have mitigation benefits by providing a mechanism for residual pesticides from prior crops to be degraded by soil microbial activity.
- Herbaceous Wind Barriers (603) and Windbreak/shelterbelt establishment/renovation (380, 650)
  Wind erosion practices clearly mitigate wind erosion and, thus,

pesticide transport in particulates.

- Filter Strip (393) and Field Border (386)
  These practices will remove pesticides that are absorbed to the sediment they catch.
- Grassed Waterway (412)
  This practice will remove sediment-associated pesticides from the drainage water it filters.
- Irrigation Water Management (449)
  IWM allows for efficient irrigation and prevents runoff of pesticides to surface waters.
- Mulching (484)
  Plant-residue mulches will behave like crop residue to intercept and facilitate dissipation of pesticides; reduce runoff loads, and improve soil quality.
- Residue Management practices (329, 344, 345)
  These practices reduce run-off water volumes, intercept and facilitate dissipation of pesticides, increase infiltration, and increase soil organic matter. These practices can drastically reduce soil erosion by wind and water and in turn reduce the amount of sediment-transported pesticides.
- Riparian Forest Buffer (391) and Riparian Herbaceous Cover (390)
  These practices will remove sediment-associated pesticides from overland flows. Zone 3, the grass filter strip at the top of the three -zone buffer system, is most effective at removing sediment-associated pesticides.

Data summarizing the various methods of mitigation and their associated affects Is found in Table 1, Documented Effects of Pesticide Management Techniques on Specific Environmental Outcomes

**References:**

Schnepf, Max and Craig Cox. Environmental Benefits of Conservation on Cropland, The Status of Our Knowledge. Soil and Water Conservation Society. 2006. pp 195-268.

Walron, Acie C. Pesticides and Goundwater Contamination, Bulletin 820. Ohio State University

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Table 1. Documented Effects of Pesticide Management Techniques on Specific Environmental Outcomes[1]

| Documented effects of pesticide management techniques on specific environmental outcomes.[a] | | | | |
|---|---|---|---|---|
| Mitigation technique | Water Quality[a] | Soil Quality | Air Quality | Documentation Adequate? |
| Application timing: Avoiding wind during and rain after | 70-100% S[b]<br><br>25% G[b] | NR[c] | No Effect | Yes |
| Formulation and adjuvant selection to minimize runoff | 0-50% S<br><br>No Effect G | NR | NR[d] | No |
| Lowering application rate | Proportional to decrease | | | Yes |
| Partial application (precision application) | Proportional to decrease[e] | Proportional to decrease[e] | Proportional to decrease[e] | Yes |
| Pesticide label requirements and hazard warnings | None[f] | None | None[f] | Documentation unnecessary |
| Set Backs:<br>33 feet-Ground<br>330 feet -Aerial | 99% S | 99% | None | Yes |
| Soil Incorporation[g] | 67% S<br><br>No effect G | None | 80% | Yes |

[a]No effects on water conservation are expected.
[b]S=adjacent surface water resources; G=shallow subsurface groundwater resources.
[c]NR=not relevant.
[d]Not relevant because farmer is seldom able to make a choice; however, formulation effect on volatilization can be large.
[e]Decrease in impact proportional to decrease in amounts applied per unit field area.
[f]Label requirements and warnings must be obeyed by law; thus, these are not remediative.
[g]Assuming incorporation is efficient and to depth of 4 inches or more.

[1]Wauchope, Don R. Pest Management Practices Pesticide Mitigation Environmental Benefits of Conservation on Cropland, The Status of Our Knowledge. Soil and Water Conservation Society. 2006 p 206