Agronomy Technical Note 4:

Pest Management in the Conservation Planning Process

Introduction

This technical note is designed to help conservation planners apply the Natural Resources Conservation Service (NRCS) Integrated Pest Management (IPM) conservation practice (Code 595) and other NRCS conservation practices in the conservation planning process to prevent and/or mitigate pest management risks to natural resources.

The term “Integrated Pest Management” and its acronym “IPM” are widely used and can refer to anything from an individual pest management technique to a very complex year-round pest management system. This document references IPM techniques, elements, strategies, guidelines, systems, and programs, but the NRCS IPM practice is very specifically defined by the **NRCS Integrated Pest Management (IPM) Conservation Practice Standard (Code 595)**: ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/595.docx

NRCS Pest Management Policy

NRCS Pest Management Policy is contained in GM_190_404_A-D, Amendment 12, dated March 2009. http://directives.sc.egov.usda.gov/RollupViewer.aspx?hid=17015

NRCS Pest Management Policy states that conservation planners have four roles in pest management:

(1) Evaluate environmental risks associated with a client’s probable pest suppression strategies.

(2) Provide technical assistance to clients to mitigate identified environmental risks.

(3) Assist clients to adopt IPM techniques that protect natural resources.

(4) Assist clients to:

(i) Inventory, assess, and suppress noxious and invasive weeds on non-cropland.

(ii) Suppress weeds to ensure successful implementation and/or maintenance of permanent vegetative conservation practices (e.g., buffer type practices).

Pest Management in Conservation Planning

Conservation planners start by identifying site-specific natural resource concerns in the conservation planning process. For pest management related concerns, this can include the potential for pest management activities to impact soil, water, air, plants, animals and humans. Once site-specific natural resource concerns are identified, conservation planners perform NRCS Pest Management Policy roles 1, 2 and 3 in the conservation planning process by evaluating the potential for site-specific pest management risks to identified natural resources and applying appropriate NRCS conservation practices (including the NRCS IPM practice) to prevent and/or mitigate identified risks.

For example, if a conservation planner identified a concern about potential pesticide impacts on a nearby drinking water reservoir, they would utilize the NRCS Windows Pesticide Screening Tool (WIN-PST) to evaluate potential pesticide risks to drinking water from pesticide losses in surface runoff. Based on site-specific WIN-PST results, the NRCS IPM practice and other conservation practices could then be applied as appropriate to prevent/mitigate hazardous pesticide losses to the reservoir.

Pest management risks can also be associated with the use of mechanical, biological or cultural pest suppression techniques, but they must be evaluated with other tools such as the Revised Universal Soil Loss Equation 2 (RUSLE2) or the professional judgment of the conservation planner.

Conservation planners also perform role 4 in NRCS Pest Management Policy in the conservation planning process, but with the application of the NRCS **Brush Management** conservation practice (Code 314) and the NRCS **Herbaceous Weed Control** conservation practice (Code 315). Both of these practices are used on non-cropland to address natural resource concerns related to plant pests, including invasive, noxious and prohibited plants. Note that the NRCS IPM practice can also be used to prevent and/or mitigate pest management environmental risks associated with the application of the NRCS Brush Management and Herbaceous Weed Control conservation practices.

Applying the NRCS IPM Practice

The NRCS IPM practice is specifically designed to document the application of IPM techniques that address site-specific natural resource concerns. The NRCS IPM practice is not designed to manage pests. Technical assistance for managing pests on cropland is not an identified role for conservation planners, but they must still work closely with Extension, producers and their crop consultants to appropriately integrate all planned pest management activities into the conservation planning process. The adoption of a comprehensive IPM system is always preferred, but the NRCS IPM practice is not designed to prescribe what constitutes a comprehensive IPM system. Commodity-specific IPM elements, guidelines and Year-Round IPM Programs are often available at the state level from Land Grant Universities and Extension to identify what constitutes a comprehensive IPM system. These guidelines should be utilized to help document the application of the NRCS IPM practice. Comprehensive IPM systems utilize a site-specific combination of pest Prevention, Avoidance, Monitoring, and Suppression strategies, or IPM 'PAMS' strategies. For more information please see:

- http://www.ipmcenters.org/ipmelements/index.cfm
- http://www.ipm.ucdavis.edu/PMG/crops-agriculture.html
- http://www.ipmcenters.org/ipmsymposiumv/posters/142.pdf

While efficacy will always play an important role in what IPM techniques are appropriate for each site, the NRCS IPM practice is only used to document specific environmental risk prevention and/or mitigation benefits, not efficacy. The goal of the NRCS IPM practice is to prevent environmental risks with an efficient IPM system if possible and then to mitigate any environmental risks that cannot be prevented.

A comprehensive IPM system will prevent and avoid *pests* as much as possible to reduce the need for *pest suppression*, including the use of hazardous pesticides.

A comprehensive IPM system also includes carefully monitoring pest populations and only utilizing suppression techniques when the economic benefit is greater than the cost. These economic pest thresholds must be developed by Extension and other IPM experts for each pest in each cropping system based on the biology of the crop and pest and the pest's natural enemies. The economic threshold is then dynamically adjusted based on the current cost of the pest suppression technique and the projected value of the crop.

A comprehensive IPM system also includes carefully managing the use of different pest suppression techniques to delay the onset of pest resistance to each suppression technique. Utilizing a combination of different techniques including pesticides with different modes of action is critical to maintaining their efficacy and delaying the onset of pest resistance.

And finally, a comprehensive IPM system must also mitigate environmental risks that cannot be prevented by utilizing appropriate IPM techniques that help minimize risks to non-target species in the field and reduce off-site movement of hazardous pesticides.

In some cropping systems a comprehensive IPM system will not be feasible because appropriate IPM technology has yet to be developed. In these cases the NRCS IPM practice can be used to support the application of individual IPM techniques if they appropriately mitigate site-specific pest suppression risks to natural resources and/or humans.

NOTE: Identified risks associated with planned pest suppression can also be addressed through other conservation practices or a system of conservation practices that includes the NRCS IPM practice.

Pesticide Registration vs. Pesticide Risk Analysis in Conservation Planning

The United States Environmental Protection Agency (EPA) regulates pesticides under two major federal statutes: the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Federal Food, Drug, and Cosmetic Act (FFDCA), both amended by the Food Quality Protection Act (FQPA) of 1996.

Under FIFRA, pesticides intended for use in the United States must be registered (licensed) by EPA before they may be sold or distributed in commerce. EPA will register a pesticide if scientific data provided by the applicant show that, when used according to labeling directions, it will not cause “unreasonable adverse effects on the environment”. FIFRA defines “unreasonable adverse effects on the environment” as: “…any unreasonable risk to man or the environment, taking into account the economic, social and environmental costs and benefits of the use of any pesticide…”

Under FFDCA, EPA is responsible for setting tolerances (maximum permissible residue levels) for any pesticide used on human food or animal feed.

With the passage of the Food Quality Protection Act (FQPA) in 1996, both major pesticide statutes were amended. FQPA mandated a single, health-based standard for setting tolerances for pesticides in foods; provided special protections for infants and children; expedited approval of safer pesticides; and required periodic re-evaluation of pesticide registrations. FQPA also limited the consideration of benefits when setting tolerances. FQPA did not address the consideration of ecological risk.

The EPA pesticide registration process, including any pesticide label use restrictions, is based on a comprehensive *pesticide risk assessment* for typical conditions under which the pesticide will be used. This risk assessment is designed to address many different risks to many different species that might be impacted by a particular pesticide use, but it does not address how these risks can vary substantially across the landscape. Even when a pesticide is applied according to pesticide label instructions, site-specific conditions may cause that pesticide to pose significant risks to nearby water resources.

EPA generally only registers pesticides that will have substantially more benefits than risks and they include appropriate risk mitigation in pesticide label guidance. However, there are obvious limitations on how well a pesticide label can address site-specific concerns that often vary widely across the landscape.

One of the most carefully regulated pesticide concerns is preventing drinking water contamination, yet many public drinking water suppliers must still filter pesticide residues out of our drinking water to meet EPA guidelines. And pesticide impacts on aquatic life are much more widespread than drinking water concerns. The United States Geological Survey (USGS) National Water Quality Assessment Program (http://water.usgs.gov/nawqa/) found at least one pesticide in almost every water and fish sample collected from streams and in more than 50% of shallow wells. <u>And most importantly, more than 50% of the streams in the U.S. had a least one detection of a pesticide that exceeded a guideline for the protection of aquatic life.</u> And toxicity tests have not been done on the “pesticide soup” found in most samples: a mixture of many pesticides at low concentrations throughout the year supplemented with higher pesticide concentration pulses soon after pesticide application.

Mitigating pesticide risks to natural resources is part of NRCS’s mission, so conservation planners need to coordinate their work with the way risks are mitigated with pesticide registration label requirements. NRCS technical assistance and financial assistance programs must comply with FIFRA and all pesticide label requirements including mitigation, but conservation planners can still help producers properly interpret the mitigation requirements on pesticide labels for a particular site and also recommend supplemental mitigation to protect sensitive natural resources.

Conservation planners can utilize the NRCS Windows Pesticide Screening Tool (WIN-PST) for water quality pesticide risk analysis. The *risk analysis* done with WIN-PST for drinking water and aquatic habitat is not as comprehensive as the *risk assessment* that supports EPA’s pesticide registration process, but WIN-PST is sufficient to guide site-specific application of mitigation techniques to address natural resource concerns identified in the conservation planning process. Conservation planners use WIN-PST to identify soil/pesticide combinations that need mitigation to help protect site-specific natural resources.

Utilizing WIN-PST

WIN-PST is the NRCS supported technical tool that is used to assess relative pesticide leaching, solution runoff, and adsorbed runoff risks to water quality. WIN-PST analysis is based on:

- Soil Properties
- Pesticide Physical Properties
- Pesticide Toxicity Data
- Broadcast / Banded / Spot Treatment
- Surface Applied / Incorporated / Foliar
- Standard / Low Rate / Ultra Low Rate
- Humid / Dry (no irrigation)

The major components of the NRCS non-point source water quality pesticide risk analysis are:

1. The potential for pesticide loss in:
   - water that percolates below the rootzone;
   - water that runs off the edge of the field;
   - sediment that leaves the field in run off;
2. Chronic (long term) pesticide toxicity to humans in drinking water and fish in aquatic habitat;
3. The combination of pesticide loss potential with pesticide toxicity to humans and fish to provide site-specific ratings for off-site pesticide hazards in leaching, solution runoff, and sediment adsorbed runoff.

The final ratings are called **WIN-PST Soil/Pesticide Interaction Hazard Ratings**. The term "hazard" is used even though these ratings include both pesticide toxicity and a partial exposure analysis based on field conditions. Note that it is the responsibility of the conservation planner to put these hazard ratings into proper context by using their professional judgment to assess the potential for pesticide movement below the bottom of the rootzone and beyond the edge of the field to identified ground or surface water resources, as well as the potential for that pesticide contamination to impact identified water resources based on watershed and water body characteristics. This entire process is considered a "risk" analysis, so the term "hazard" is used in the final WIN-PST ratings to remind users that they must put these "partial" ratings into the proper context to fully analyze risk to human drinking water and aquatic habitat.

WIN-PST provides ratings for 5 different categories of resource concerns:

- **'Human Hazard Leaching**' for leaching risk to drinking water
- **'Fish Hazard Leaching**' for leaching risk to aquatic habitat (lateral flow to streams)
- **'Human Hazard Solution**' for solution runoff risk to drinking water
- **'Fish Hazard Solution**' for solution runoff risk to aquatic habitat
- '**Fish Hazard Adsorbed**' for adsorbed runoff risk to aquatic habitat including benthic organisms.

  Note: there is no WIN-PST rating for 'Human Hazard Adsorbed' since human exposure to sediment is minimal.

The final "WIN-PST Soil/Pesticide Interaction Hazard Ratings" are '**Very Low**', '**Low**', '**Intermediate**', '**High**' or '**Extra High**'.

To fully evaluate the risk of a pesticide to a human drinking water supply or aquatic habitat, the conservation planner must consider the impact of flow path characteristics between the field and the water body of concern (through the vadose zone to groundwater or overland flow to surface water); watershed characteristics; and water body characteristics.

For example, on the high end of the overall risk spectrum, the flow path from the field to the water body will be shorter and more direct with little opportunity for pesticide degradation or assimilation; the watershed will have significant pesticide loading potential from numerous fields that are managed in a similar fashion as the field being analyzed; and the water body will be sensitive to pesticide contamination due to limited flushing and dilution. At the other extreme on the low end of the overall risk spectrum, the flow path to the water body will be longer and more arduous with lots of opportunity for pesticide degradation and assimilation; the watershed will have only a few fields that are managed in a similar fashion so there will be limited loading potential for the pesticide in question; and the water body will not be very sensitive to pesticide contamination due to lots of flushing and dilution.

The NRCS IPM conservation practice standard has water quality mitigation requirements that are based on an average situation in between the high and low extremes described above. Although the NRCS IPM conservation practice mitigation requirements for water quality will serve most situations, the conservation planner may use professional judgment to determine that more mitigation is required for a specific site. In some cases a suite of conservation practices may be required to provide sufficient mitigation to meet NRCS Field Office Technical Guide (FOTG) quality criteria.

Appropriate mitigation for water quality should be chosen based on final WIN-PST hazard ratings for all applicable pesticide loss pathways to all identified water resource concerns. This will require sufficient mitigation to be applied for the highest risk(s) identified for a given planning area.

To conduct a WIN-PST analysis:

1. Choose all the major soil types for the field or planning area (generally those that cover 10% or more of the area)
2. Choose all the pesticides that the client is planning to use (Note that each pesticide can be chosen by product name, EPA registration number, or active ingredient name, but the final ratings are specific to each active ingredient)
3. Analyze the results for each soil/pesticide interaction
4. Select the highest hazard soil/pesticide combination for the identified natural resource concern(s) to plan appropriate mitigation

In the example below, there is a solution runoff concern to aquatic habitat. Pesticides X and Y are planned for a field that contains Soils A, B and C

Soil/Pesticide Combination	**WIN-PST Fish Hazard Solution Rating**
Soil A – Pesticide X (20% of the area)	Very Low
Soil B – Pesticide X (50% of the area)	Low
Soil C – Pesticide X (25% of the area)	Intermediate
Soil A – Pesticide Y (20% of the area)	Low
Soil B – Pesticide Y (50% of the area)	Intermediate
Soil C – Pesticide Y (25% of the area)	**High**

In this example, the “High” rating for the combination of Soil C with Pesticide Y would be selected to plan an appropriate level of mitigation to protect the aquatic habitat.

Mitigation Requirements in the NRCS IPM Practice

If a conservation planner identifies natural resource concerns related to pest management activities, NRCS conservation practices can be applied to address those concerns. The NRCS IPM practice (Code 595) has specific mitigation requirements for identified natural resource concerns.

For water quality concerns related to pesticide leaching, solution runoff and adsorbed runoff, WIN-PST must be used to evaluate potential hazards to humans and/or fish as appropriate for each pesticide to be used. Note that human hazard is represented by the potential for chronic impacts to drinking water and aquatic habitat hazard is represented by the potential for chronic impacts to fish. The minimum level of mitigation required for each resource concern is based on the final “WIN-PST Soil/Pesticide Interaction Hazard Ratings” Table below:

WIN-PST Identified Final Hazard Rating	Minimum Mitigation Index Score Level Needed
Low or Very Low	None Needed
Intermediate	20
High	40
Extra High	60

Mitigation requirements can be met with other conservation practices as well as IPM techniques applied with the NRCS IPM practice. See Table I at the end of this technical note for mitigation index values for IPM techniques and Table II for mitigation index values for conservation practices. The index values from Table I can be added to the index values from Table II to calculate the total index score for the planned conservation system.

For example, if "Fish Hazard Solution" is identified as a pathway of concern for an identified water resource and WIN-PST reports an 'Intermediate' rating, IPM techniques from Table I or conservation practices from Table II that address solution runoff must be applied so that the sum of the index values from either table in the 'Solution Runoff' column for the selected IPM mitigation techniques and conservation practices will be 20 or more. Similarly, a 'High' rating would require a sum of 40 or more, and an 'Extra High' rating would require a sum of 60 or more. This will be the case for all natural resource concerns and all applicable pesticide loss pathways identified by the conservation planner with the aid of WIN-PST. In some cases, mitigation requirements may be met without applying any IPM techniques, so the NRCS IPM practice is technically not required, but it can still be utilized to document that all identified natural resource concerns are adequately addressed.

As an alternative to mitigation, the conservation planner can also work with Extension personnel, published Extension recommendations, the producer or their crop consultant to see if there are lower risk alternatives that still meet the producer's objectives. A producer can choose to use a pesticide that has risk if they also apply appropriate mitigation, or they can choose a lower risk pesticide that needs less or no mitigation – pesticide choice is the producer's decision.

Pesticide drift has also been identified as a major pesticide loss pathway. Predicting spray drift is difficult because it is influenced by many rapidly changing site-specific factors including wind speed, relative humidity, temperature and the presence of temperature inversions. Spray droplet size as determined by nozzle configuration and pressure also plays an important role in spray drift.

Pesticide drift that leaves the application area may impact nearby crops that are sensitive, organically grown crops, and wildlife including pollinators and beneficial insects, as well as human bystanders.

Note that drift can also be a major pesticide loss pathway to surface water in some cases, so appropriate mitigation for drift may be required in addition to mitigation for pesticide leaching, solution runoff and adsorbed runoff in order to adequately protect a surface water resource.

If the conservation planner identifies a natural resource concern related to pesticide spray drift, the minimum level of mitigation required is an index score of 20. The index values from Table I can be added to the index values from Table II to calculate the total index score for the planned conservation system.

Pesticide Volatilization has been identified as a contributor to air quality concerns through Volatile Organic Compound (VOC) emissions that are a key precursor to ground-level ozone. The state of California has local air shed rules and regulations in place for non-attainment areas, and other states may follow.

Pesticide related VOC emissions are influenced by the vapor pressure of the active ingredients and the way pesticide products are formulated. Emulisifiable concentrates have higher VOC emissions than other formulations. If the conservation planner identifies a VOC related natural resource concern, one or more of the following VOC mitigation techniques must be applied:

1. Use lower VOC emitting pesticide formulations - specifically eliminating the use

of emulsifiable concentrates when other formulations are available;

2. Use precision pesticide application or “Smart Sprayer” technology including:

   - Near-infrared-based weed sensing systems

   - Map/GPS-based variable rate application

   - Sonar-based vegetation sensors

   - Computer controlled spray nozzles

   - Hoods and shields to direct applications

   - Wicks

   - Backpacks

   - Remote sensing, GIS, or other spatial information system

   - Fumigant delivery with precision application

   - Fumigant delivery with drip irrigation

   - Fumigant soil retention using precision water application;

3. Use impermeable tarps to cover fumigated areas;
4. Shift dates of fumigant application to outside the May - October timeframe to move VOC emissions out of the non-attainment period;
5. Use solarization (e.g. irrigate and tarp during summer fallow to kill pests without fumigation;
6. Use biofumigants or other soil treatments (e.g. thiosulfate) instead of pesticides.
7. Use steam fumigation instead of pesticides.
8. Fallow fields for several years before replanting an orchard crop or inoculate young trees (e.g. with yeast) to reduce fumigant use;

Pesticide Direct Contact can affect pollinators and other beneficial species in the application area while pesticides are being applied and later when pollinators and other beneficial species reenter the treated area. And pollinators that have been exposed in the application area at sub-lethal concentrations can return to the hive and affect others. Note that direct exposure to pesticides in the application area can occur even when spray drift is minimized.

For more information, see *How to Reduce Bee Poisoning from Pesticides* available at: http://extension.oregonstate.edu/catalog/pdf/pnw/pnw591.pdf

<u>If the conservation planner identifies a pesticide direct contact concern to pollinators and other beneficial species, two or more of the following mitigation techniques must be applied:</u>

1. Time pesticide applications when pollinators are least active (e.g. at night or when temperatures are low.) Note that dewy nights may cause an insecticide to remain wet on the foliage and still be active the following morning, so exercise caution;
2. Time pesticide applications when crops are not in bloom and keep fields weed free to discourage pollinators from venturing into the crop;
3. Use pesticides that are less toxic to pollinators and beneficial species. Note: all pesticide recommendations must come from Extension or an appropriately certified crop consultant.
4. Use selective insecticides that target a narrow range of insects (e.g. *Bacillus thuringiensis (Bt)* for moth caterpillars) to reduce harm to beneficial insects like bees;
5. Use liquid or granular formulations instead of dusts and fine powders that may become trapped in the pollen collecting hairs of bees and consequently fed to developing larvae;
6. Use alternatives to insecticides such as pheromones for mating disruption and kaolin clay barriers for fruit crops;

Cultural and Mechanical Pest Management Techniques can cause natural resource degradation. For example, burning for weed control can cause air pollution and tillage for weed control can cause soil erosion. <u>All natural resource concerns from all forms of pest management should be evaluated, and significant natural resource concerns should be addressed to FOTG quality criteria levels</u>.

<u>IPM Plans</u>

What constitutes an IPM plan can range from an efficient pesticide recommendation based on monitoring results all the way to a detailed year-round plan that address all facets of pest prevention, pest avoidance, pest monitoring and pest suppression for an entire farm or even on an area-wide basis. Conservation planners don't develop IPM plans, but they must carefully coordinate the conservation plan with the IPM plan. As long as the IPM plan or the application of individual IPM techniques appropriately mitigates site-specific pest suppression risks to natural resources and/or humans, the requirements of the NRCS IPM practice are met.

Conservation planners can work with existing IPM plans or work with Extension, producers or their crop consultants to develop new IPM plans. IPM elements and guidelines from Extension or the Land Grant University should be utilized where available. A national listing is available at: http://www.ipmcenters.org/ipmelements/index.cfm. The goal is to develop an efficient IPM system that uses prevention, avoidance, monitoring, and then finally judicious suppression when a pest population exceeds an economic threshold. IPM helps assure that unnecessary environmental risks are avoided. The best way to develop a good IPM system is to consider economics, efficacy, and environmental risk all at the same time.

IPM plans have traditionally been developed for efficient pest control including economics, efficacy and resistance management. Environmental risk reduction is an indirect benefit of an efficient IPM system, but with the advent of the National Roadmap for Integrated Pest Management in 2004, environmental risk reduction became a core principle of IPM and is now just as important as economics and efficacy. The National Roadmap for IPM can be viewed at: http://www.ipmcenters.org/Docs/IPMRoadMap.pdf.

Developing an IPM plan as part of the overall conservation planning process will allow the IPM plan to directly address identified natural resource concerns as well as provide a broader context to area-wide pest management considerations and habitat management for beneficial species.

It may take several passes through the IPM planning process to achieve all of the producer's goals. The first pass through may result in an efficient IPM system, but there may still be risks to site-specific natural resources. If a high risk suppression alternative is important to the overall IPM system, a second pass through the IPM planning process may reveal additional IPM techniques that can help to mitigate risks to site-specific natural resources.

It is important to note that other NRCS conservation practices like Conservation Crop Rotation, Cover Crop, and Field Border can be used to help develop an efficient IPM system. The IPM techniques described below in ***Table I - IPM Techniques for Reducing Pesticide Environmental Risk*** can be used together with the NRCS conservation practices described below in ***Table II - Conservation Practices for Reducing Pesticide Environmental Risk*** to develop an appropriate IPM system that provides adequate mitigation for the identified resource concerns. A collaborative effort between the IPM planner and the conservation planner to coordinate the IPM system with the conservation system will provide the best overall results for the producer.

The IPM mitigation techniques in Table I below are included in most Land Grant University IPM programs, but NRCS conservation planners have to be certain that Extension or an appropriately certified farm advisor supports and recommends the site-specific use of these techniques. NRCS Pest Management Policy does not support NRCS conservation planners changing the way a pesticide is applied or substituting a different pesticide on their own. NRCS fully supports the conservation benefits of each of these IPM risk prevention/mitigation techniques as long as they are recommended by Extension or an appropriately certified farm advisor.

Utilizing *Table I - IPM Techniques for Reducing Pesticide Environmental Risk* and *Table II - Conservation Practices for Reducing Pesticide Environmental Risk*

Table I identifies IPM techniques and Table II identifies NRCS conservation practices that have the potential to prevent or mitigate pesticide impacts on water and air quality. Pesticide impacts on water quality are divided into four separate pesticide loss pathways: leaching, solution runoff, adsorbed runoff, and drift. The pesticide drift pathway also applies to pesticide impacts on air quality.

Not all IPM techniques and NRCS conservation practices will be applicable to a given situation. Relative effectiveness ratings by pesticide loss pathway are indicated with index values of 5, 10, or 15. The tables also identify how the IPM techniques and NRCS conservation practices function and the performance criteria that the index values are based on. Effectiveness of any IPM technique or NRCS conservation practice can be highly variable based on site conditions and how the technique or practice is designed, implemented and maintained. The professional judgment of the conservation planner will ultimately determine the effectiveness of a particular IPM technique or NRCS conservation practice for a particular field or planning area.

Tables I and II are based on available research specific to that IPM technique or NRCS conservation practice, related research, and the best professional judgment of NRCS technical specialists. The ratings are relative index values as opposed to absolute values, much like the Conservation Practice Physical Effects (CPPE) matrix ratings. The index values are intended to help conservation planners choose the best combination of IPM techniques and NRCS conservation practices for identified resource concerns. The ratings are based on the relative *potential* for IPM techniques or NRCS conservation practices to provide mitigation. The IPM techniques or NRCS conservation practices need to be specifically designed, implemented and maintained for the mitigation potential to be realized. Varying site conditions can influence mitigation effectiveness, but the relative index values indicate which IPM mitigation techniques or NRCS conservation practices will generally provide more or less mitigation under a given set of conditions.

A general rule of thumb for IPM techniques or NRCS conservation practices having an index value of 5 is that they generally have the potential to reduce losses by 10 -15%. IPM techniques or NRCS conservation practices having an index value of 10 generally have the potential to reduce losses by about 25%, and IPM techniques or NRCS conservation practices having an index value 15 generally have the potential to reduce losses by 50% or more.

The original reference for many of the ratings in Tables I & II is: *Aquatic Dialogue Group: Pesticide Risk Assessment and Mitigation, Baker JL, Barefoot AC, Beasley LE, Burns LA, Caulkins PP, Clark JE, Feulner RL, Giesy JP, Graney RL, Griggs RH, Jacoby HM, Laskowski DA, Maciorowski AF, Mihaich EM, Nelson Jr HP, Parrish PR, Siefert RE, Solomon KR, van der Schalie WH, editors. 1994. Society of Environmental Toxicology and Chemistry, Pensacola, FL., pages 99-111 and Table 4-2*. This reference provides ranges of effectiveness for various mitigation techniques.

States can make adjustments to *Table I - IPM Techniques for Reducing Pesticide Environmental Risk* and *Table II - Conservation Practices for Reducing Pesticide Environmental Risk,* but any adjustments should be coordinated across state lines through the NRCS Regional Agronomists.

If you have any questions about the material in this publication, please contact your NRCS State Agronomist, your NRCS Regional Agronomist, or the NRCS National Pest Management Specialist.

Table I – IPM Techniques for Reducing Pesticide Environmental Risk

IPM Techniques[1]	Mitigation Index Value[4] (by Pesticide Loss Pathway)				Function and Performance Criteria
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	
Application Timing - Ambient Temperature				5	Reduces exposure - spraying during cooler temperatures (e.g. early morning, evening or at night) can help reduce drift losses. Avoid spraying in temperatures above 90º F.
Application Timing - Rain	15	15	15		Reduces exposure - delaying application when significant rainfall events are forecast that could produce substantial leaching or runoff can reduce pesticide transport to ground and surface water.
Application Timing - Relative Humidity				5	Reduces exposure - spraying when there is higher relative humidity reduces evaporation of water from spray droplets thus reducing drift losses.
Application Timing - Wind				10	Reduces exposure - delaying application when wind speed is not optimal can reduce pesticide drift. Optimal spray conditions for reducing drift occur when the air is slightly unstable with a very mild steady wind between 2 and 9mph.
Formulations and Adjuvants[2,3]	5	5	5	5	Reduces exposure – specific pesticide formulations and/or adjuvants can increase efficacy and allow lower application rates, drift retardant adjuvants can reduce pesticide spray drift.
Monitoring + Economic Pest Thresholds.	15	15	15	15	Reduces exposure - reduces the amount of pesticide applied with preventative treatments because applications are based on monitoring that determines when a pest population exceeds a previously determined economic threshold.
Partial Treatment	15	15	15	10	Reduces exposure - spot treatment, banding and directed spraying reduces amount of pesticide applied. Assumes less than 50% of the area is treated.

Precision Application Using "Smart Sprayers"	10	10	10	10	Reduces exposure - using "Smart Sprayer" technology (i.e. green sensors, sonar-based sensors, GPS-based variable rate application, computer controlled spray nozzles, etc.) can substantially reduce the amount of pesticide applied.
Set-backs	5	5	5	10	Reduces exposure – reduces overall amount of pesticide applied, reduces offsite pesticide drift. Assumes that the set-backs with no application are at least 30 feet wide.
Soil Incorporation[2,3]		15	15		Reduces exposure – reduces solution and adsorbed runoff losses, but potentially increases leaching losses, especially for low K_{OC} pesticides. Applicable to shallow mechanical or irrigation incorporation. Not applicable if pesticide leaching to groundwater is an identified natural resource concern. Not applicable if soil erosion is not adequately managed.
Spray Nozzle Selection, Maintenance and Operation.				10	Reduces exposure – selecting appropriate nozzle and pressure for the application, with an emphasis on higher volume spray nozzles run at lower pressures, will produce larger droplets and a narrower droplet size distribution, which reduces spray drift. Proper nozzle spacing, boom height, and boom suspension, along with frequent calibration and replacement of worn nozzles and leaking tubing, can increase efficacy and reduce drift potential.
Substitution – Cultural, Mechanical or Biological Controls	15	15	15	15	Reduces risk – partial substitution of alternative cultural, mechanical or biological pest suppression techniques reduces the application of a pesticide that poses a hazard to an identified natural resource concern. Not applicable if hazards from alternative suppression techniques are not adequately managed.
Substitution – Lower Risk Pesticides[2,3]	15	15	15	15	Reduces risk – partial substitution of an alternative lower risk pesticide reduces the application of a pesticide that poses a hazard to an identified natural resource concern. Not applicable if the alternative pesticide is not explicitly recommended by Extension or an appropriately certified crop consultant because NRCS cannot make pesticide recommendations.
Substitution - Semiochemicals	15	15	15	15	Reduces risk – using semiochemicals (e.g., mating disruption pheromones) to decrease reproductive success or control population density/location reduces the application of a pesticide that poses a hazard to an identified natural resource concern.

[1] Additional information on pest management mitigation techniques can be obtained from Extension pest management publications including IPM Guidelines and Crop Profiles, pest management consultants, and pesticide labels.

[2] The pesticide label is the law - all pesticide label specifications must be carefully followed, including required mitigation. Additional mitigation may be needed to meet NRCS pest management requirements for identified resource concerns.

[3] NRCS does not make pesticide recommendations. All pesticide application techniques must be recommended by Extension or an appropriately certified crop consultant and selected by the producer.

[4] Numbers in these columns represent index values that indicate relative effectiveness of IPM mitigation techniques to reduce hazardous pesticide losses through the identified pathways.

Table II – Conservation Practices for Reducing Pesticide Environmental Risk

Pesticide Mitigation Conservation Practices[1, 2]	Mitigation Index Value[4] (by Pesticide Loss Pathway)				Function and Performance Criteria
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	
Alley Cropping (311)	5	5	10	10	Increases infiltration and uptake of subsurface water, reduces soil erosion, can provide habitat for beneficial insects which can reduce the need for pesticides, also can reduce pesticide drift to surface water.
Anionic Polyacrylamide (PAM) Erosion Control (450)		5	15		Increases infiltration and deep percolation, reduces soil erosion.
Bedding (310)	5	5	5		Increases surface infiltration and aerobic pesticide degradation in the rootzone.
Conservation Cover (327)	10	10	10		Increases infiltration, reduces soil erosion, and builds soil organic matter In perennial cropping systems such as orchards, vineyards, berries and nursery stock.
Conservation Crop Rotation (328)	10	10	10		Reduces the need for pesticides by breaking pest lifecycles. The rotation shall consist of at least 2 crops in the rotation and no crop grown more than once before growing a different crop.
Constructed Wetland (656)	5	5	10		Captures pesticide residues and facilitates their degradation.
Contour Buffer Strips (332)		10	10		Increases infiltration, reduces soil erosion.
Contour Farming (330)		5	5		Increases infiltration and deep percolation, reduces soil erosion.
Contour Orchard and Other Fruit Area (331)		5	5		Increases infiltration and deep percolation, reduces soil erosion.
Cover Crop (340) that is incorporated into the soil.	5	5	5		Increases infiltration, reduces soil erosion, builds soil organic matter. Assumes at least 4000 lbs/ac of live biomass at the time of tillage.

Pesticide Mitigation Conservation Practices[1, 2]	Mitigation Index Value[4] (by Pesticide Loss Pathway)				Function and Performance Criteria
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	
Cover Crop (340) for weed suppression that is mulch tilled or no-tilled into for the next crop.	10	10	10	10	Increases infiltration, reduces soil erosion, builds soil organic matter. Requires at least 4000 lbs/ac of live biomass at the time of tillage and at least 30% ground cover at the time of the pesticide application.
Cross Wind Ridges (588)			5[3/]		Reduces wind erosion and adsorbed pesticide deposition in surface water. Assumes the pesticide is applied while the field is in the ridged state.
Cross Wind Trap Strips (589C)			10[3]		Reduces wind erosion and adsorbed pesticide deposition in surface water, traps adsorbed pesticides.
Deep Tillage (324)		5	5		Increases infiltration and deep percolation. Not applicable if pesticide leaching to groundwater is an identified natural resource concern.
Dike (356)		10	10		Reduces exposure potential - excludes outside water or captures pesticide residues and facilitates their degradation. Not applicable if pesticide leaching to groundwater is an identified natural resource concern.
Drainage Water Management (554)		10	10		Drainage during the growing season increases infiltration and aerobic pesticide degradation in the rootzone and reduces storm water runoff. Managed drainage mode when the field is not being cropped reduces discharge of pesticide residues from the previous growing season. Seasonal saturation may reduce the need for pesticides. Not applicable if pesticide leaching to groundwater is an identified natural resource concern.
Field Border (386)		5	10	5	Increases infiltration and traps adsorbed pesticides, often reduces application area resulting in less pesticide applied, can provide habitat for beneficial insects which reduces the need for pesticides, can provide habitat to congregate pests which can result in reduced pesticide application, also can reduce inadvertent pesticide application and drift to surface water. Assumes 20 foot minimum width.

Pesticide Mitigation Conservation Practices[1, 2]	Mitigation Index Value[4] (by Pesticide Loss Pathway)				Function and Performance Criteria
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	
Filter Strip (393)		10	15	10	Increases infiltration and traps adsorbed pesticides, often reduces application area resulting in less pesticide applied, can provide habitat for beneficial insects which reduces the need for pesticides, can provide habitat to congregate pests which can result in reduced pesticide application, also can reduce inadvertent pesticide application and drift to surface water. Assumes 30 foot minimum width.
Forage Harvest Management (511)	10	10	10	10	Reduces exposure potential - timely harvesting reduces the need for pesticides.
Hedgerow Planting (442)			10[3]	10	Reduces adsorbed pesticide deposition in surface water, also can reduce inadvertent pesticide application and drift to surface water
Herbaceous Wind Barriers (603)			5[3]	5	Reduces wind erosion, traps adsorbed pesticides, can provide habitat for beneficial insects which reduces the need for pesticides, can provide habitat to congregate pests which can result in reduced pesticide application, and can reduce pesticide drift to surface water.
Irrigation System, Microirrigation (441)	10	15	15		Reduces exposure potential - efficient and uniform irrigation reduces pesticide transport to ground and surface water.
Irrigation System, Sprinkler (442)	10	10	10		Reduces exposure potential - efficient and uniform irrigation reduces pesticide transport to ground and surface water.
Irrigation System, Surface and Subsurface (443)	5	5	5		Reduces exposure potential - efficient and uniform irrigation reduces pesticide transport to ground and surface water.
Irrigation System, Tail Water Recovery (447)		15	15		Captures pesticide residues and facilitates their degradation.
Irrigation Water Management (449)	15	15	15		Reduces exposure potential - water is applied at rates that minimize pesticide transport to ground and surface water, promotes healthy plants which can better tolerate pests.

Pesticide Mitigation Conservation Practices[1, 2]	Mitigation Index Value[4] (by Pesticide Loss Pathway)				Function and Performance Criteria
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	
Mulching (484) with natural materials	10	10	10		Increases infiltration, reduces soil erosion, reduces the need for pesticides.
Mulching (484) with plastic	10	5	5		Reduces the need for pesticides. Not applicable if erosion and pesticide runoff from non-mulched areas is not adequately managed.
Residue and Tillage Management, No-till/Strip-Till/Direct Seed (329)	5	10	15		Increases infiltration, reduces soil erosion, builds soil organic matter. Assumes at least 60% ground cover at the time of application.
Residue and Tillage Management, Mulch-Till (345)	5	5	10		Increases infiltration, reduces soil erosion, builds soil organic matter. Assumes at least 30% ground cover at the time of application.
Residue and Tillage Management, Ridge Till (346)	5	5	10		Increases infiltration, reduces soil erosion, builds soil organic matter.
Riparian Forest Buffer (391)	5	15	15	10	Increases infiltration and uptake of subsurface water, traps sediment, builds soil organic matter, and reduces pesticide drift. This assumes 30 foot minimum width.
Riparian Herbaceous Cover (390)	5	10	10	5	Increases infiltration, traps sediment, builds soil organic matter, and reduces pesticide drift. This assumes 30 foot minimum width.
Sediment Basin (350)			10		Captures pesticide residues and facilitates their degradation. Not applicable if less than 50% of the treatment area drains into the sediment basin.
Stripcropping (585)		15	15	5	Increases infiltration, reduces soil erosion and generally will only be treating half the area of concern.
Subsurface Drainage (606)	5	10	10		Increases infiltration and aerobic pesticide degradation in the root zone. *Note – avoid direct outlets to surface water
Surface Roughening (609)			5[3]		Reduces wind erosion and adsorbed pesticide deposition in surface water.

Pesticide Mitigation Conservation Practices[1, 2]	Mitigation Index Value[4] (by Pesticide Loss Pathway)				Function and Performance Criteria
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	
Terrace (600)		10	15		Increases infiltration and deep percolation, reduces soil erosion. Not applicable if pesticide leaching to groundwater is an identified natural resource concern.
Vegetative Barriers (601)			10		Reduces soil erosion, traps sediment, increases infiltration.
Water and Sediment Control Basin (638)		10	15		Captures pesticide residues and facilitates their degradation, increases infiltration and deep percolation. Not applicable if pesticide leaching to groundwater is an identified natural resource concern.
Windbreak/Shelterbelt Establishment (380)			10[3]	10	Reduces wind erosion, reduces adsorbed pesticide deposition in surface water, traps adsorbed pesticides, and reduces pesticide drift.

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[2] The pesticide label is the law - all pesticide label specifications must be carefully followed, including required mitigation. Additional mitigation may be needed to meet NRCS pest management requirements for identified resource concerns.

[3] Mitigation applies to adsorbed pesticide losses being carried to surface water by wind.

[4] Numbers in these columns represent index values that indicate relative effectiveness of pesticide mitigation techniques to reduce hazardous pesticide losses through the identified pathways.