Michigan Technical Note
USDA-Natural Resources Conservation Service

AGRONOMY #61
Subject: Pest Management in the Conservation Planning Process
Date: November 2011

Introduction

This technical note is designed to help conservation planners apply the Natural Resources Conservation Service (NRCS) **Integrated Pest Management (IPM) (595)** conservation practice standard 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 complex year-round pest management system. This document references IPM techniques, elements, strategies, guidelines, systems, and programs, but the NRCS IPM conservation practice is very specifically defined by the NRCS Integrated Pest Management (IPM) (595) conservation practice standard available at: ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/595.docx.

NRCS Pest Management Policy

The 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.

The 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 conservation 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 conservation 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, he or she would use 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 conservation 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 the NRCS pest management policy in the conservation planning process, but with the application of the NRCS **Brush Management (314)** conservation practice standard and the NRCS **Herbaceous Weed Control (315)**, conservation practice standard. Both of these conservation practices are used on non-cropland to address natural resource concerns related to plant pests, including invasive, noxious, and prohibited plants. The NRCS IPM conservation 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 conservation practice

The NRCS IPM conservation practice is specifically designed to document the application of IPM techniques that address site-specific natural resource concerns. The NRCS IPM conservation 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 the Cooperative Extension Service, 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 conservation 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 the Cooperative Extension Service to identify what constitutes a comprehensive IPM system. These guidelines should be used to help document the application of the NRCS IPM conservation practice. Comprehensive IPM systems use a site-specific combination of pest prevention, avoidance, monitoring, and suppression (PAMS) strategies. For more information, see:

- http://www.ipmcenters.org/ipmelements/index.cfm
- http://www.ipm.ucdavis.edu/PMG/cropsagriculture.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 conservation practice is only used to document specific environmental risk prevention and/or mitigation benefits, not efficacy. The goal of the NRCS IPM conservation practice is to prevent environmental risks with an efficient IPM system, if possible, and 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 using suppression techniques when the economic benefit is greater than the cost. These economic pest thresholds must be developed by the Cooperative Extension Service 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 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. Using 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.

Finally, a comprehensive IPM system must also mitigate environmental risks that cannot be prevented by using appropriate IPM techniques that help minimize risks to non-target species in the field and reduce offsite 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 conservation 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 conservation practice.

Pesticide registration versus pesticide risk analysis in conservation planning

The U.S. Environmental Protection Agency (EPA) regulates pesticides under two major Federal statutes: the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and 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 the EPA before they may be sold or distributed in commerce. The 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 FQPA, 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 reevaluation 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.

The 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 U.S. 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 percent of shallow wells. Most importantly, more than 50 percent of the streams in the United States had a least one detection of a pesticide that exceeded a guideline for the protection of aquatic life. Also, toxicity tests have not been conducted 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 the 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 use 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 the 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.

Using 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 are 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 nonpoint source water quality pesticide risk analysis are:

- the potential for pesticide loss in:
    - water that percolates below the root zone
    - water that runs off the edge of the field
    - sediment that leaves the field in runoff
- chronic (long-term) pesticide toxicity to humans in drinking water and fish in aquatic habitat
- the combination of pesticide loss potential with pesticide toxicity to humans and fish to provide site-specific ratings for offsite 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 root zone 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 five 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 has water quality mitigation requirements that are based on an average situation in between the high and low extremes described. 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.

Conducting a WIN–PST analysis

Step 1 Choose all the major soil types for the field or planning area (generally those that cover 10 percent or more of the area).

Step 2 Choose all the pesticides that the client is planning to use.
(Note: 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.)

Step 3 Analyze the results for each soil/pesticide interaction.

Step 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. 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.

Soil/Pesticide Combinations	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 area0	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

Mitigation requirements in the NRCS IPM conservation practice

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

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. 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:

WIN-PST Identified Final Hazard Rating	Minimum Mitigation Index Score Level Needed
Low or Very Low	None
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 conservation practice. See Table 1 at the end of this technical note for mitigation index values for IPM techniques and Table 2 for mitigation index values for conservation practices. The index values from Table 1 can be added to the index values from Table 2 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 1 or conservation practices from Table 2 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 conservation practice is technically not required, but it can still be used to document that all identified natural resource concerns are adequately addressed.

As an alternative to mitigation, the conservation planner can also work with Cooperative Extension Service personnel, published Cooperative Extension Service 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.

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 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 1 can be added to the index values from Table 2 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 nonattainment 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. Emulsifiable 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:

- Use lower VOC-emitting pesticide formulations—specifically eliminating the use of emulsifiable concentrates when other formulations are available.
- 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
- Use impermeable tarps to cover fumigated areas.
- Shift dates of fumigant application to outside the May to October time frame to move VOC emissions out of the nonattainment period.
- Use solarization (e.g., irrigate and tarp during summer fallow) to kill pests without fumigation.
- Use biofumigants or other soil treatments (e.g., thiosulfate) instead of pesticides.
- Use steam fumigation instead of pesticides.
- 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. Pollinators that have been exposed in the application area at sublethal concentrations can return to the hive and affect others. 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.

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:

- 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.
- Time pesticide applications when crops are not in bloom and keep fields weed free to discourage pollinators from venturing into the crop.
- Use pesticides that are less toxic to pollinators and beneficial species. **Note:** all pesticide recommendations must come from the Cooperative Extension Service or an appropriately certified crop consultant.
- 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.
- 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.
- 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. 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.

IPM plans

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 do not 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 conservation practice are met.

Conservation planners can work with existing IPM plans or work with Cooperative Extension Service producers or their crop consultants to develop new IPM plans. IPM elements and guidelines from the Cooperative Extension Service or the land-grant university should be used 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 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 Road Map 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 Road Map for Integrated Pest Management 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 areawide 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 in Table 1 can be used together with the NRCS conservation practices described in Table 2 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 1 are included in most land-grant university IPM programs, but NRCS conservation planners have to be certain that the MSU Extension Service or an appropriately certified farm advisor supports and recommends the site-specific use of these techniques. The 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. The NRCS fully supports the conservation benefits of each of these IPM risk prevention/mitigation techniques as long as they are recommended by MSU Extension or an appropriately certified farm advisor.

Using Tables 1 and 2

Table 1 identifies IPM techniques, and Table 2 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 conservation 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 1 and 2 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 to 5 percent. IPM techniques or NRCS conservation practices having an index value of 10 generally have the potential to reduce losses by about 25 percent, and IPM techniques or NRCS conservation practices having an index value 15 generally have the potential to reduce losses by 50 percent or more.

States can make adjustments to tables 1 and 2, but any adjustments should be coordinated across State lines through NRCS regional agronomists.

For questions about the information in this publication, contact the NRCS State agronomist, NRCS State Water Quality Specialist, NRCS regional agronomist, or NRCS national pest management specialist.

References

Aquatic Dialogue Group. 1994. Pesticide Risk Assessment and Mitigation, J.L. Baker, A.C. Barefoot,L.E. Beasley, L.A. Burns, P.P Caulkins, J.E. Clark, R.L. Feulner, J.P Giesy, R.L. Graney, R.H. Griggs,H.M. Jacoby, D.A. Laskowski, A.F. Maciorowski,E.M. Mihaich, H.P Nelson Jr., P.R. Parrish, R.E.Siefert, K.R. Solomon, W.H. van der Schalie, editors.Society of Environmental Toxicology andChemistry. pp. 99–111 and table 4–2. Pensacola,FL.

USDA-NRCS. 2011. Pest Management in the Conservation Planning Process. National Agronomy Technical Note No. 5.

Table 1. IPM Techniques for Reducing Pesticide Environmental Risk

IPM Techniques [1]	Mitigation Index Value [4]					Performance Criteria
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	Pollinator	
Application Timing – Ambient Temperature				5		Spraying during cooler temperatures (e.g., early morning, evening or at night) to reduce drift losses. Avoid spraying in temperatures above 90F.
Application Timing - Rain	15	15	15			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		Spraying when there is a high relative humidity reduces evaporation of water from spray droplets thus reducing drift losses.
Application Timing - Wind				10		Apply pesticides only when wind speed is optimal to 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		Specific pesticide formulations and/or adjuvants are used to increase efficacy and allow lower application rates, or drift retardant adjuvants are used to reduce pesticide spray drift
Monitoring + Economic Pest Thresholds	15	15	15	15		Reduces the total amount of pesticide applied because applications are based on monitoring that determines when a pest population exceeds a previously determined economic threshold.
Partial Substitution	15	15	15	15	5	One or more application of pesticide replaced by an alternate cultural, mechanical, biological or chemical pest suppression technique, reducing the typical application amount of the pesticide that poses a hazard to a natural resource. Use of seriochemicals such as mating disruption pheromones is included in this technique. Note: Alternative pesticides must be approved by MSU Extension and MUST be client-selected as NRCS does NOT make pesticide recommendations.
Rotation of Pesticides with Different Modes of Action	5	5	5			Pesticides with different modes of action are rotated within a season or from one season to the next or used in tank mix where permitted, to reduce the risk of pesticide-resistant pests. Pesticides with the highest risk of resistance are not used when alternatives are available. Refuge requirements for transgenic seed are followed.
Setback	5	10	10	10		A setback from the edge of the field will be used when required by the pesticide label. No application of chemicals within the downslope or downwind edge(s) of the field.
Spray Nozzle Selection, Maintenance and Operation				10		Select appropriate nozzles and operating pressure for the application, with an emphasis on higher volume spray nozzles run at lower pressures, that will produce larger droplets and a narrower droplet size distribution, Maintain proper nozzle spacing, boom height, and boom suspension. Calibrate frequently and replace worn nozzles and leaking tubing.

Table 1. IPM Techniques for Reducing Pesticide Environmental Risk – continued

IPM Techniques [1]	**Mitigation Index Value [4]**					**Performance Criteria**
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	Pollinator	
Application Timing – Pollinator Activity					5	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.
Applicator Timing – Pollinator Food Source Availability – Crop Bloom					5	Time pesticide applications when crops are not in bloom, to discourage pollinators from venturing into the crop.
Applicator Timing – Pollinator Food Source Availability – Weed Bloom					5	Keep weeds from flowering to discourage pollinators from venturing into the crop around the time of pesticide applications.
Pesticide Formulation – Reduced Risk to Pollinators					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.

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 the identified resource concerns.
3/ The NRCS does not make pesticide recommendations. All pesticide application techniques must by 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 2. Conservation Practices for Reducing Pesticide Environmental Risk

Conservation Practices[1,2]	**Mitigation Index Value** [4]					**Performance Criteria**
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	Pollinator	
Alley Cropping (311)	5	5	10	10		Trees or shrubs are planted in sets of single or multiple rows with agronomic, horticultural crops or forages produced in the alleys between the sets of woody plants that produce additional products. Increases infiltration and uptake of subsurface water, reduces soil erosion, and can also reduce pesticide drift.
Conservation Cover (327)	10	10	10			Establishing and maintaining permanent vegetative cover. 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			Growing crops in a planned sequence to manage plant pests, break pest lifecycles and/or allow for the use of a variety of control methods. Implementation results in reduced application of pesticides. Meets the additional criteria to manage plant pests..
Constructed Wetland (656)	5	5	10			A constructed wetland is used to control runoff from a field. All runoff leaving the field flows through the wetland in a controlled manner.
Contour Buffer Strips (332)		10	10			Narrow strips of permanent, herbaceous vegetative cover established around the hill slope, and alternated down the slope with wider cropped strips used to control runoff and sediment movement from the field.
Contour Farming (330)		5	5			The crops are planted on or near the contour to control runoff and sediment
Contour Orchard and Other Fruit Areas (331)		5	5			The orchard or vineyard is established on or near the contour to control runoff and sediment.
Cover Crop (340) (green manure)	5	5	5			Typically a green manure cover crop used to provide organic material for improving soil quality. Must have at least 4000 lbs/Ac of biomass at the time of kill. Increases infiltration, reduces erosion and builds soil organic matter..
Cover Crop (340) for weed suppression that is mulch tilled or no-tilled in for the next crop	5	5	5			Typically a fast-growing, densely-planted deep-rooted grass cover crop (e.g., ryegrass) used to capture residual nutrients after a crop and improve soil quality. Must have at least 4000 lbs/Ac of biomass at the time of kill. Increases infiltration, reduces erosion and builds soil organic matter.
Cross Wind Trap Strips (589)			10 [3/]			Trap strips are used to control sediment movement (and associated adsorbed pesticide) by wind.
Deep Tillage (324)		5	5			Performing tillage operations below the normal tillage depth to modify adverse physical or chemical properties of a soil. Increases infiltration and deep percolation. Not applicable if pesticide leaching to groundwater is an identified natural resource concern..

Table 2. Conservation Practices for Reducing Pesticide Environmental Risk - continued

Conservation Practices[1,2]	Mitigation Index Value [4]					Performance Criteria
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	Pollinator	
Dike (356)		10	10			A barrier constructed of earth or manufactured materials to exclude outside water from entering the field and thus reducing pesticide losses associated with runoff events..
Drainage Water Management (554)		10	10			Managed discharge when the field is not being cropped reduces discharge of pesticide residues from the previous growing season..
Field Border (386)		5	10	5		The field border is acting as a buffer for runoff and sediment. The field border is installed in accordance with the proper additional criteria that address runoff and sediment. Assumes 20 ft minimum width.
Filter Strip, < 30ft (393)		5	10	10		A filter strip is used to control runoff and sediment movement from the field. The filter strip is installed in accordance with the proper additional criteria to address runoff and sediment.
Filter Strip, ≥ 30ft (393)		10	15	10		A filter strip is used to control runoff and sediment movement from the field. The filter strip is installed in accordance with the proper additional criteria to address runoff and sediment.
Forage Harvest Management (511)	10	10	10	10		Harvest periods are scheduled to control pest and there is a documented reduction in pesticide use because of the implementation of the practice.
Hedgerow Planting (442)			10 [3/]	10		Dense vegetation in a linear design when installed on the downslope edge of a field reduces adsorbed pesticide deposition in surface water. Also can reduce inadvertent pesticide application and drift to adjacent surface waters.
Herbaceous Wind Barriers (603)			5 [3/]	5		Herbaceous vegetation established in rows or narrow strips in the field across prevailing wind direction reduces wind erosion, traps adsorbed pesticides and can reduce pesticide drift to surface waters..
Irrigation System, Microirrigation (441)	10	15	15			When well-maintained and competently operated, these systems apply irrigation water more efficiently and uniformly when compared to 442 and 443 systems. The more uniform and efficient application of irrigation water reduces pesticide transport to ground and surface water. The field system must meet the 441 Criteria Applicable to Preventing Contamination of Ground and Surface Water.
Irrigation System, Sprinkler (442)	10	10	10			When well-maintained and competently operated, these systems apply irrigation water more efficiently and uniformly when compared to the 443 system. The more uniform and efficient application of irrigation water reduces pesticide transport to ground and surface water. The field system must meet the 442 General Criteria.

Table 2. Conservation Practices for Reducing Pesticide Environmental Risk - continued

Conservation Practices[1,2]	Mitigation Index Value [4]					Performance Criteria
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	Pollinator	
Irrigation System, Surface and Subsurface (443)	5	5	5			A system in which all necessary earthwork, multi-outlet pipelines, and water-control structures have been installed for distribution of water by surface means, such as furrows, borders, and contour levees, or by subsurface means through water table control. When installed according to the 443 General Criteria these systems have the potential to reduce offsite water quality impacts over systems that do not meet 443 General Criteria.
Irrigation Water Management (449)	15	15	15			Water application shall be at rates that minimize transport of sediment and pesticides to surface waters and that minimize transport of pesticides to groundwater.
Mulching (484) with natural materials	10	10	10			Applying plant residues or other suitable materials produced off site to the land surface.
Mulching (484) with plastic	10	5	5			Applying plastic mulch, typically around seedlings or more mature plants. 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			.Managing the amount, orientation and distribution of crop and other plant residue on the soil surface year round while limiting soil-disturbing activities to only those necessary to place nutrients, condition residue and plant crops. These systems typically reduce runoff loss more effectively than 346 or “conventional tillage” systems. Assumes at least 60% ground cover at the time of application.
Residue and Tillage Management, Mulch-Till (345)	5	5	10			.Managing the amount, orientation and distribution of crop and other plant residue on the soil surface year round while limiting soil-disturbing activities to only those necessary to place nutrients, condition residue and plant crops. These systems typically reduce runoff loss more effectively than “conventional tillage” systems. Assumes at least 30% ground cover at the time of application.
Residue and Tillage Management, Ridge Till (346)	5	5	10			.Managing the amount, orientation and distribution of crop and other plant residue on the soil surface year round while growing crops on pre-formed ridges alternated with furrows protected by crop residue. These systems have the potential to reduce runoff loss more effectively than “conventional tillage” systems..

Table 2. Conservation Practices for Reducing Pesticide Environmental Risk - continued

Conservation Practices[1,2]	Mitigation Index Value [4]					Performance Criteria
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	Pollinator	
Riparian Forest Buffer (391)	5	15	15	10		An area of predominantly trees and/or shrubs located adjacent to an up-gradient from watercourses or water bodies. Typically increases infiltration and uptake of subsurface water, traps sediment and reduces pesticide drift. This assumes 30ft minimum width.
Riparian Herbaceous Cover (390)	5	10	10	5		Grasses, sedges, rushes, ferns, legumes and forbs tolerant of intermittent flooding or saturated soils, established or managed as the dominant vegetation in the transitional zone between upland crop field and aquatic habitats. Typically increases infiltration, traps sediment and reduces pesticide drift. This assumes 30ft minimum width.
Sediment Basin (350)			10			A basin constructed with an engineered outlet, formed to capture and detain sediment laden runoff for a sufficient length of time to allow it to settle out in the basin. Thus also capturing pesticides adsorbed to sediment and potentially facilitating their degradation. Not applicable if less than 50% of the treatment are drains into the sediment basin.
Stripcropping (585)		15	15	5		Growing planned rotations of row crops, forages, small grains, or fallow in a systematic arrangement of equal width strips across a field. Reduces the total area available on any given year that would typically be highly susceptible to increased runoff losses.
Subsurface Drain (606)	5	10	10			A conduit, such as corrugated plastic tubing, tile or pipe, installed beneath the ground surface to collect and/or convey drainage water. Has the potential to reduce surface runoff and increase aerobic pesticide degradation in the root zone. Note – Avoid direct outlets to surface water.
Terrace (600)		10	15			An earth embankment or a combination ridge and channel, constructed across the field slope to reduce erosion by reducing slope length. Not applicable if pesticide leaching to groundwater is an identified resource concern.
Vegetative Barriers (601)			10			Permanent strips of stiff, dense vegetation established along the general contour of slopes or across concentrated flow areas to reduce sheet and rill erosion, reduce ephemeral gully erosion, manage water flow and/or stabilize steep slopes.

Table 2. Conservation Practices for Reducing Pesticide Environmental Risk - continued

Conservation Practices[1,2]	**Mitigation Index Value** [4]					**Performance Criteria**
	Leaching	Solution Runoff	Adsorbed Runoff	Drift	Pollinator	
Water and Sediment Control Basins (638)		10	15			An earth embankment or a combination ridge and channel constructed across the slope of minor watercourses to form a sediment trap and water detention basin with a stable outlet. Thus also capturing pesticides adsorbed to sediment and potentially facilitating their degradation. Not applicable if pesticide leaching to groundwater is an identified natural resource concern or if less than 50% of the treatment area drains into the sediment basin.
Windbreak/ Shelterbelt Establishment (380)			10 [3/]	10		Windbreaks or shelterbelts are single or multiple rows of trees or shrubs in linear configurations. Reduces wind erosion, reduces adsorbed pesticide deposition in surface water, traps adsorbed pesticides, and reduces pesticide drift.

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/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.