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WATER QUALITY TECHNICAL NOTE NO. NM 8

SUBJECT: WQP – "SUMMARY OF MITIGATION OPTIONS FOR NUTRIENT AND PEST MANAGEMENT."

Purpose: To distribute information to the field.

The enclosed publication (excerpted from the NEDC Nutrient and Pest Management course) provides a summary of some of the most common mitigation or conservation treatment options/alternatives for reducing nutrient and pesticide losses to surface or ground water.

File the attached publication in the Water Quality Tech Note section of your field office reference library.

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Summary of Mitigation Options

The following Tables provides a summary of all of the mitigation options discussed and provides a general (High, Moderate and Low) range of reductions expected and specific comments associated with each option. An important point to be remembered is that within these categories, the reductions are not necessarily additive. Implementing one option can possibly increase or decrease the percent reduction that may be obtained by implementing other options.

Table 6.1. Practice Summary Guide for Nutrient Runoff Losses to Surface Water

Practice	Potential reduction of Runoff transport		Comments
	Nitrogen	Phosphorus	
FIELD LOSS REDUCTIONS			
lower application rate	H	H	loss reduction should correspond directly to rate reduction; soil testing and crediting all sources of nutrients reduces the necessity for amended fertilizer
partial substitution	L	L	no substitution for either nutrient in plant metabolism; some and water components can supply these nutrients to plants (soil organic matter, irrigation water, atmospheric nitrogen)
partial treatment	M	M	concentrating nutrients in bands lessens applied surface area exposed to runoff and erosion; application in partial doses near the time of plant utilization is more efficient and lessens opportunity for surface transport
formulation	M	M	nitrate-N form of nitrogen more soluble, organic material (like manure) less dense, so mores more readily than soil
soil erodibility runoff special restrictions	H	H	soluble N and P moves with runoff, sediment-attached nutrients with erosion restrict N and P applications, soil test levels, on fields susceptible to runoff and erosion
soil incorporation	M	H	reduces surface runoff contact and sediment enrichment of nutrients, organics
application timing	H	H	application before expected precipitation event can create situation for nutrient and organic erosion and runoff
no-till	M	M	erosion greatly reduced; runoff of surface applied or stratified nutrients may increase
conservation tillage	M	H	runoff reduction for first storm after application enhances infiltration and percolation; erosion also reduce
subsurface drainage	M	H	lowers antecedent soil moisture, improves infiltration, reduces runoff and erosion, percolates more water, higher crop production and transformation of nitrogen to plant available form; nutrients reaching tile lines will appear in surface waters
less soil scaling compaction	H	H	non-crusted, non compacted soils increase nutrient movement into the soil profile

Practice	Potential reduction of Runoff transport		Comments
	Nitrogen	Phosphorus	
FIELD LOSS REDUCTIONS			
irrigation management	H	H	irrigation lowers water use, lowers tail water losses with associated nutrients light water applications can move nutrients into soil profile
contour strip cropping	M	M	infiltration within close growing crop strip reduces runoff slightly; moderate erosion reduction
crop rotation	M	M	deep rooted crops returns soil nutrients to the soil surface, legumes capture atmospheric nitrogen, less erosion and runoff infiltration improves soil moisture
TRANSPORT REDUCTIONS			
terraces/detention ponds	H	H	sediment-borne nutrients and organic deposited in channels and ponds, soluble nutrients infiltrate soil profile
constructed wetlands	H	H	surface transported nutrients can be removed and treated
buffer strip	M	H	small, untreated buffer area reduces application field; enhanced infiltration in buffer; erosion is reduced and sediment deposited in crop field
set-back	M	M	more distance to surface water entry points; less inadvertent application directly into water course
vegetated filter strip	M	H	enhanced infiltration; filter reduces application area of field , entraps sediment and contaminated runoff
grassed waterway	L	M	some infiltration and entrapment of nutrients

The rough estimates of the likely effects are based on limited research, and professional judgment.
It should be possible to predict a more consistent estimate for specific nutrients using a mathematical model for a specific set of soil, climate, and environmental conditions.

Table 6.2. I :e Summary Guide for Pesticide Runoff Losses to Surface Water

Practice	Potential reduction of Runoff transport		Comments
	*Strongly adsorbed	Weakly adsorbed	
FIELD LOSS REDUCTIONS			
lower application rate	M	M	loss reduction should correspond directly to rate reduction
partial substitution	M	M	lesser environmental concerns may exist for other pesticides; cultural practices may lower runoff risk
partial treatment	H	M	concentrated bands of will lower amount of pesticides and surface area treated; other cultural practice will be necessary
formulation	L	L	varied on potential to move with surface runoff and erosion
soil erodibility runoff special restrictions	M	M	restrictions should be targeted to more strongly adsorbed pesticides on highly erodible and high runoff land
soil incorporation	M	H	mechanical incorporation reduces the amount in surface mixing zone; less soluble loss
application timing	M	H	loss decreases with time between application and storm runoff
no-till	H	M	great erosion control; runoff volume much less; higher pesticide runoff from surface residue
conservation tillage	M	M	runoff reduction for first storm after application; enhances infiltration and percolation
subsurface drainage	L	M	improved infiltration and percolation moves water into profile; reduces surface concentration of more soluble pesticides; leached pesticide can be transported to surface waters
less soil sealing compaction	L	M	non crusted, non compacted soils allow increased pesticide movement into soil profile; less in surface mixing zone
irrigation management	H	H	irrigation management lowers water use, lowers runoff and erosion; greater infiltration lowers concentration of more soluble pesticides in the soil mixing zone

Practice	Potential reduction of Runoff transport		Comments
	*Strongly adsorbed	Weakly adsorbed	
FIELD LOSS REDUCTIONS			
contour strip cropping	H	H	infiltration within close growing crop strip decreases runoff slightly; sediment is deposited in the field; less over treated with some pesticide
crop rotation	H	H	pesticide use can be reduced due to rotational effects on pest
TRANSPORT REDUCTIONS			
terraces/detention ponds	H	M	erosion and sediment transport reduction; infiltration and ponding deposits sediment in channels and ponds
constructed wetlands	H	M	deposition of sediment and treatment of runoff
buffer strip	M	M	small, untreated buffer area reduces application field; some infiltration in buffer and sediment deposition
set-back	M	M	more distance to surface water entry points; less inadvertent application directly to water course
vegetated filter strip	H	M	enhanced infiltration; sediment deposited above filter area; filter reduces application area of field
grassed waterway	M	L	concentrated flow restricts treatment; some infiltration and entrapment of pesticides

The rough estimates of the likely effects are based on limited research, and professional judgment.
It should be possible to predict a more consistent estimate for specific pesticides using a mathematical model for a specific set of soil, climate, and environmental conditions.
*Partition coefficient (Kd or Koc) typically > 100

Table 6.3. Practice Summary Guide for Nutrient Leaching Losses to Ground Water

Practice	Potential reduction of Leaching transport		Comments
	Nitrogen	Phosphorus	
FIELD LOSS REDUCTIONS			
lower application rate	H	H	loss reduction should correspond directly to rate reduction
partial substitution	L	M	organic waste substituted for fertilizer will slow leaching losses, but increase potential during non crop season
partial treatment	L	L	no substitution for other nutrients in plant metabolism; some ? concentrated bands of nutrients increase localized areas of leaching
formulation	M	M	nitrate-N readily leaches: ammonium n and fertilizer P less mobile; organic more mobile than fertilizer P
soil leachability special restrictions	H	H	highly leachable soils can be targeted for application, management restriction soils low in iron and aluminum leach more P
soil incorporation	L	L	builds soil nitrate-N by speeding mineralization and nitrification rate; places nitrate-N lower in soil profile; reduces macropore flow
application timing	H	L	application before expected precipitation event can drive nutrient lower in profile, thus encourages leaching; less leaching when application matches timing of crop uptake
no-till	L	L	macropores created in soil profile speeds leaching, higher soil moisture
conservation tillage	L	L	runoff reduction enhances infiltration and percolation
subsurface drainage	M	L	improved infiltration: percolates more water; leached nutrient can be transported to surface waters
Less soil sealing Compaction	L	L	Non crusted, non compacted soils allow increased infiltration and percolation
Irrigation management	H	L	Irrigation management lowers water use, lowers leaching losses

Practice	Potential reduction of Leaching transport		Comments
	Nitrogen	Phosphorus	
FIELD LOSS REDUCTIONS			
Contour strip cropping	L	L	Infiltration within close growing crop strip increases leaching slighl\tly; alternate deep rooted with shallow rooted crops retrieves soil nutrients
Crop rotation	M	L	Deep rooted crops bring up nutrients from lower soil profile; legumes provide nitrogen from the atmosphere
TRANSPORT REDUCTIONS			
Terraces Detention ponds	L	L	Some enhanced leaching below terrace channel and bottom of pond
Constructed wetlands	L	L	Leaching can be expected below wetlands
Buffer strip	L	L	Small, untreated buffer area reduces application field; enhanced infiltration in buffer; lengthens flow path through soil
Set-back	M	L	More distance to ground water entry point like wells and sink holes
Vegetated filter strip	L	L	Enhanced infiltration; filter reduces application area of field
Grassed waterway	L	L	Concentrated flow restricts infiltration
The rough estimates likely effects are based on limited research, and professional judgment. It should be possible to predict a more consistent estimate for specific pesticides using a mathematical model for a specific set of soil, climate, and environmental conditions.			

Table 6.4. Practice Summary Guide for Pesticide Leaching Losses to Ground Water

Practice	Potential reduction of Leaching transport		Comments
	*Highly Soluble	Slightly Soluble	
FIELD LOSS REDUCTIONS			
lower application rate	H	M	loss reduction should correspond directly to rate reduction
partial substitution	H	H	substitution of cultural practices for pesticides will reduce leaching loss substitution of less soluble, lower (higher?) kd and persistent pesticide reduces loss
partial treatment	M	M	reduction of quantity and ? of pesticide used will reduce leaching
formulation	H	M	less soluble, lower (higher ?) kd pesticides will move slower through soil profile
soil leachability special restrictions	H	L	highly leachable soils can be targeted for application, management restriction
soil incorporation	M	L	moves pesticide into soil profile, reduces macropore flow
application timing	H	L	application before expected precipitation event can drive pesticide lower in profile pre-emergent, thus encourages leaching; post-emergent susceptible to leaching than pre-planted
no-till	L	L	macropores created in soil profile speeds leaching, higher water infiltration as percolation
conservation tillage	M	L	runoff reduction enhances infiltration and percolation, reduces macropores
subsurface drainage	M	L	improved infiltration percolates more water, leached pesticide can be transported to surface waters
less soil sealing compaction	L	L	non crusted, non compacted soils allow increased pesticide movement into soil profile
irrigation management	H	L	management lowers water use, lowers leaching losses

Practice	Potential reduction of Leaching transport		Comments
	*Highly Soluble	Slightly Soluble	
FIELD LOSS REDUCTIONS			
Contour strip cropping	L	L	Infiltration within close growing crop strip increases leaching slightly
crop rotation	M	L	rotating pesticide with crop reduces any one chemical to carry over and build up in soil profile
TRANSPORT REDUCTIONS			
terraces detention ponds	L	M	some enhanced leaching below terrace channel and bottom of pond
constructed wetlands	L	L	leaching can be expected below wetlands
buffer strip	L	L	small, untreated buffer area reduces application field; enhanced infiltration in buffer; lengthens flow path through soil
set-back	M	L	more distance to ground water entry point like wells and sink holes
vegetated filter strip	L	L	enhanced infiltration; filter reduces application area of field
grassed waterway	L	L	concentrated flow restricts infiltration

The rough estimates of the likely effects are based on limited research and professional judgment.
It should be possible to predict a more consistent estimate for specific pesticides using a mathematical model for a specific set of soil, climate, and environmental conditions.
* Partition coefficient (Kd or Koc) typically <300 and solubility >30 ppm for highly soluble pesticides.