

PESTICIDE SCREENING SPREADSHEET – (PSS) EXPLANATION AND BACKGROUND

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INTRODUCTION

The Pesticide Screening Spreadsheet (PSS) is a screening tool in Excel, which can be used to help determine the potential for specific pesticides to move towards water resources. PSS was developed as a general planning tool and utilizes soil and pesticide property databases, including toxicity ratings, generated through various algorithms in the Windows Pesticide Screening Tool - WIN-PST (national pesticide screening tool). WIN_PST and PSS are designed to serve as an informational tool to assist producers and consultants with pesticide related environmental concerns; however, PSS was specifically designed to be used prior to making pesticide recommendations. In addition, PSS was designed to have minimal user input and to limit possible user errors. PSS does not have the flexibility for user input possible in WIN_PST. Users of PSS need to understand the limitations of the spreadsheet so that WIN_PST can be utilized in situations where PSS does not adequately address the situation.

PSS utilizes database information from WIN_PST and is similar in that it uses interaction matrixes to determine potential pesticide movement and the associated risk. Differences between PSS and WIN_PST will be explained further when appropriate within the following program explanation. The differences between PSS and WIN_PST are listed in this manner so that the user of PSS would know when it is appropriate to use WIN_PST. WIN_PST is located at:

<http://www.wcc.nrcs.usda.gov/water/quality/wst.html>. for those individuals interested in utilizing the program.

PSS allows the user to evaluate the differing characteristics of pesticides and soils that affect pesticide movement. Pesticides have varying potentials to move offsite. Similarly, soils vary in potential to move chemical offsite. Thus, a pesticide applied to two different soils may have different potentials for movement. The initial work on this procedure was reported on at the Third National Research Conference on Pesticides in November 1990 (Goss and Wauchope).

The final evaluation of the site and the pesticide evaluated is reported as the pesticides potential to move offsite through leaching, in solution as runoff, or adsorbed to soil leaving the site, as well as, the associated hazard (toxicity) of the pesticide leaving the site. The databases utilized by the tool can be characterized into selected soil properties, selected pesticide properties and site and management conditions, which affect pesticide movement with water.

SOIL PROPERTIES

The following information provides the screening tool user an explanation of the soil properties used in evaluating a chosen soil. A more complete explanation is available through a review of the reference paper by Goss and Wauchope (1990).

Soil Leaching Potential (SLP)

The SLP characterizes those soil properties that would increase or decrease the tendency of a pesticide to move in solution with water and leach below the root zone. The ratings are listed as high, intermediate, low, and very low with a high rating having the greatest potential for leaching. The soil leaching potential algorithm in WIN_PST utilizes the following soil properties: soil hydrologic group, soil organic matter in the surface horizon, the depth of the surface horizon, and the soil erodibility factor (K).

Soil Hydrologic Group – Is a group of soils having similar runoff potential under similar storm and cover conditions. Soil properties that influence runoff potential are those that influence the minimum rate of infiltration for a bare soil after prolonged wetting and when not frozen. These properties are depth to a seasonally high water table, intake rate and permeability after prolonged wetting, and depth to a very slowly permeable layer.

Soil Organic Matter – Is the organic fraction of the soil that includes plant and animal residues at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population.

Soil Erodibility Factor (K) – Is the rate of soil loss per rainfall erosion index unit [ton*acre*h(hundreds of acre*ft-tonf*in)⁻¹] as measured on a unit plot. The unit plot is 72.6 ft. long, 6 ft. in width, has a 9 percent slope, and is continuously in a clean-tilled fallow condition with tillage performed upslope and downslope. The soil

properties that influence assigned K factor values to specific soils are soil texture, organic matter content, structure, and permeability.

Soil Solution Runoff Potential (SSRP)

The SSRP characterizes those soil properties that would increase or decrease the tendency of a pesticide to move in surface runoff in the solution phase. The ratings are listed as high, intermediate, and low with a high rating having the greatest potential for solution surface loss. The SSRP algorithm in WIN_PST utilizes the soil hydrologic group to determine solution surface loss potential.

Soil Adsorbed to Runoff Potential (SARP)

The SARP characterizes those soil properties that would increase or decrease the tendency of a pesticide to move in surface runoff attached to soil particles. The ratings are listed as high, intermediate, and low with a high rating having the greatest potential for sediment/pesticide transport. The soil adsorbed to runoff algorithm in WIN_PST utilizes the soil hydrologic group and soil K factor to determine the adsorbed surface loss potential.

Site Conditions that Modify the Initial Soil Rating

Certain site conditions may increase or decrease the initial soil rating (SLP, SSRP, SARP). PSS does not allow the user to modify site condition information. However, the modifications listed below for slope and for high water table are tied directly to the soil map unit. If a chosen map unit is >15 percent slope or has a high water table during the growing season the modification is inherent for the map unit. PSS does not address macropores. WIN_PST allows the user to select one of the site conditions listed below or change the selected site condition if they exist onsite. In addition, PSS allows the user to only select the primary named component within the map unit. WIN-PST allows the planner to select named components other than the primary component, within the map unit for evaluation. WIN_PST also provides the user with the opportunity to output a soil report. The adjusted rating for PSS or WIN_PST is then carried forward to the appropriate interaction matrixes. Screening tool users that wish to modify soil site conditions listed below must use WIN_PST to do so.

Site Conditions

Slope >15 percent - increases SARP by one class
Macropores or soil cracks deeper than 24" – increases SLP by one class.
High water table during the growing season < 24" – increases SLP directly to High.

PESTICIDE PROPERTIES

The following information provides the screening tool user an explanation of the pesticide properties used in evaluating a chosen pesticide. A more complete explanation is available through a review of the reference paper by Goss and Wauchope (1990).

Pesticide Leaching Potential (PLP)

The PLP indicates the tendency of a pesticide to move in solution with water and leach below the root zone. The ratings are listed as high, intermediate, low, and very low

with a high rating having the greatest potential for leaching. To calculate the pesticide leaching potential, the algorithm described by Goss and Wauchope(1990) and used in WIN_PST utilize the following pesticide properties: half-life, soil sorption index (Koc), and solubility.

Half-life: Half-life, given in days, is the time required for pesticides in the soil to degrade to one-half of their previous concentration. Each successive elapsed half-life will decrease the pesticide concentration by half. For example, a period of two half-lives will reduce a pesticide concentration to one-fourth of the initial amount. Half-life can vary by a factor of three or more from reported values depending on soil moisture, temperature, oxygen status, soil microbial population, and other factors. Additionally, resistance to degradation can change as the initial concentration of the chemical decreases. It may take longer to decrease the last one-fourth of a chemical to one-eighth than it took to decrease the initial concentration to one-half. **In general, the longer the half-life, the greater the potential for pesticide movement.**

Koc - Soil Sorption Index: Koc or the soil organic carbon sorption coefficient measures the tendency of the pesticide to attach to soil particle surfaces. The higher the Koc value, the stronger the tendency to attach to soil.

Solubility: The solubility of the pure active ingredient of the pesticide in water at room temperature is given in mg/l or ppm. Solubility is a fundamental physical property of a chemical and affects the ease of wash off and leaching through soil. In general, the higher the solubility value, the greater the likelihood for movement.

Pesticide Solution Runoff Potential (PSRP)

The pesticide surface loss indicates the tendency of a pesticide to move in surface runoff in the solution phase. To calculate the PSRP the algorithm described by Goss and Wauchope (1990) and used in WIN_PST, utilizes the following pesticide properties: solubility, half-life, and Koc.

Pesticide Adsorbed to Runoff Potential (PARP)

The PARP indicates the tendency of a pesticide to move in surface runoff attached to soil particles. To calculate the PARP the algorithm described by Goss and Wauchope(1990) and used in WIN_PST, utilizes the following pesticide properties: half-life, Koc, and solubility.

Management Techniques that Modify the Initial Pesticide Rating

Different management techniques may increase or decrease the initial pesticide rating (PLP, PSRP, and PARP). PSS allows the user to select banding, low or ultra low application rates for preemergence applications. Management rating adjustments for preplant incorporated, postemergence (foliar) applications, and low or ultra low rate applications are incorporated into the program and are reflected in the final output for these applications. These

management adjustments to PSS reflect the most common use of the product in South Dakota.

Rating adjustments due to management are interactive; however, rating adjustments will not increase or decrease a rating more than one class, with the exception of ultra low application rates (i.e., PARP will be reduced one class for foliar applications even if a low application rate is also used). In addition, PSS posts unknown pesticide ratings as high, whereas WIN_PST will not provide an output for unknown ratings. To view the unknown pesticide ratings in PSS, go to the appropriate crop worksheet in the program (i.e., cornherb). The pesticides with unknown ratings have an associated rating of zero in the database. WIN_PST allows the user to select one or more of the management techniques listed below if they exist onsite. WIN_PST also provides the user the opportunity to output a pesticide report by active ingredient in the product selected. The adjusted rating for PSS or WIN_PST are carried forward to the appropriate interaction matrixes (i.e., ILP, ISRP, or IARP).

Management Techniques:

Banding – reduces PLP, PSRP, and PARP by one class.

Soil Incorporation – reduces PSRP and PARP by one class. Also, increases PLP by one class.

Foliar application - reduces PLP, PSRP, and PARP by one class.

Low Application Rate (<1/4lb. Ai/Acre) - reduces PLP, PSRP, and PARP by one class.

Ultra Low Application Rate (<1/10lb. Ai/Acre) - reduces PLP, PSRP, and PARP by two classes.

SOIL/PESTICIDE INTERACTION

This procedure combines a pesticide's runoff or leaching potential with a soil rating developed for individual soil mapping units. PSS utilizes the primary map unit component whereas WIN_PST produces interaction ratings for all listed components. The individual soil and pesticide ratings generated in WIN_PST, that are appropriate for South Dakota, can also be found in Section II, Water Quality, of the South Dakota Technical Guide (SDTG). Combining the pesticide rating and the soil rating simulates the interaction of soil/pesticide properties and results in a relative rating for a soil/pesticide combination. Soil/pesticide interaction ratings are developed for both pesticide movement below the root zone (leaching) and pesticide movement in runoff in solution or with sediment transported to the field's edge. PSS will generate interactions for all pesticides listed in each worksheet with a given crop name (i.e. corn, soybean, small grain, or oilseed), for a chosen soil. WIN_PST will only generate interactions for chosen pesticides and for the soil map unit or component selected. WIN_PST posts these results in a soil/pesticide interaction report under "Loss Potential" for each active ingredient in the compound. PSS does not post the soil/pesticide interaction results, but instead carries this information forward through the toxicity matrix.

Soil/Pesticide Interaction Leaching Potential (ILP)

ILP Interaction Matrix

SLP	PLP			
	High	Intermediate	Low	Very Low
High	High	High	Intermediate	Low
Intermediate	High	Intermediate	Low	Very Low
Low	Intermediate	Low	Low	Very Low
Very Low	Low	Low	Very Low	Very Low

Soil/Pesticide Interaction Solution Runoff Potential (ISRP)

ISRP Interaction Matrix

SSRP	PSRP		
	High	Intermediate	Low
High	High	High	Intermediate
Intermediate	High	Intermediate	Low
Low	Intermediate	Low	Low

Soil/Pesticide Interaction Adsorbed to Runoff Potential (IARP)

IARP Interaction Matrix

SARP	PARP		
	High	Intermediate	Low
High	High	High	Intermediate
Intermediate	High	Intermediate	Low
Low	Intermediate	Low	Low

Conditions or Management Techniques that Modify the Soil/Pesticide Interaction Rating

Differing environmental conditions or management techniques may increase or decrease the soil/pesticide interaction rating (ILP, ISRP, IARP). PSS does not allow the user to modify environmental conditions; however, the user can select for high residue management. PSS assumes in all cases a high probability of rainfall, no irrigation. WIN_PST allows the user to select one of the environmental conditions listed below if they exist onsite and residue management if present. WIN_PST posts the soil/pesticide interaction rating on the final output with additional ratings adjusted for toxicity. The rating in PSS or the adjusted rating in WIN_PST is then carried forward to be used in the toxicity (ITOX) matrix.

Environmental Conditions:

- High Probability of Rainfall, No Irrigation – no effect on ratings.
- High Probability of Rainfall, High Efficiency Irrigation – no effect on ratings.
- High Probability of Rainfall, Low Efficiency Irrigation – increases ILP, ISRP, and IARP by one class.
- Low Probability of Rainfall, No Irrigation – decreases ILP, ISRP, and IARP by one class.
- Low Probability of Rainfall, High Efficiency Irrigation – decreases ILP, ISRP, and IARP by one class.
- Low Probability of Rainfall, Low Efficiency Irrigation – no effect on ratings.

Management Techniques:

High Residue/Conservation Tillage - reduces ISRP, and IARP by one class.

SOIL/PESTICIDE INTERACTION AND TOXICITY RATING

This procedure combines a pesticide's runoff or leaching interaction rating with its potential toxicity or risk to the environment (ITOX). The individual pesticide toxicity ratings generated in WIN_PST that are appropriate for South Dakota, can also be found in Section II (Water Quality) of the SDTG. Combining the pesticide toxicity and the Soil/Pesticide Interaction ratings in the ITOX rating matrix below provides an evaluation of the relative risk to the environment by a pesticide with respect to toxicity. The chronic ranges were based on acute ranges established by the Environmental Protection Agency (EPA). The ITOX ratings are developed for both pesticide movement below the root zone and pesticide movement in runoff in solution or with sediment transported to the field's edge. PSS posts in the ITOX rating in the printed report by crop and in sheet 2 for the user to access. In addition, PSS ITOX ratings are adjusted for human toxicity only in pesticide leaching and only for fish toxicity in surface runoff or as sediment transport runoff. WIN_PST posts the ITOX rating along with soil/pesticide interaction rating on the soil/pesticide interaction report under the human hazard and fish hazard headings.

The soil/pesticide/toxicity interaction ratings are approximations of pesticide movement potential and should not be used by themselves to make pest

management decisions. They can; however, assist in the decision-making process.

ITOX INTERACTION MATRIX
Soil/Pesticide Interaction Rating – (SPISP)
(ILP, ISRP, IARP only)

Toxicity Rating	High	Intermediate	Low	Very Low
High	High	High	Intermediate	Low
Intermediate	High	Intermediate	Low	Low
Low	Intermediate	Low	Low	Very Low
Very Low	Low	Very Low	Very Low	Very Low

APPLICATION OF WIN-PST or PSS

WIN_PST - Windows Pesticide Screening Tool

WIN-PST (Windows Pesticide Screening Tool) is a NRCS national pesticide screening tool. Instructions for downloading, operation and evaluations are located at: <http://www.wcc.nrcs.usda.gov/water/quality/wst.html>. WIN_PST provides the user with three reports: Pesticide Active Ingredient Rating Report; Soil Sensitivity to Pesticide Loss Rating Report; and the Pesticide Interaction Loss Potential and Hazard Ratings Report. Users of the model need to be informed as to the use and management of each pesticide selected and the rates associated with each of the active ingredients in the application. The output in the Pesticide Interaction Loss Potential and Hazard Ratings Report is posted as Loss Potential (i.e., ILP, ISRP, and IARP rating with management adjustments), Human Hazard, (i.e., ILP, ISRP, and IARP rating with management adjustments, as well as, adjustments for human toxicity), and Fish Hazard (i.e., ILP, ISRP, and IARP rating with management adjustments, as well as, adjustments for fish toxicity).

Pesticide Screening Spreadsheet (PSS)

The PSS is a screening tool in Excel that can be used to help determine the potential for specific pesticides to move towards water resources. PSS was developed as a general planning tool and utilizes soil and pesticide property databases, including toxicity ratings, generated through various algorithms in the Windows Pesticide Screening Tool -WIN-PST (national pesticide screening tool). PSS is designed to serve as an informational tool to assist producers and consultants with pesticide related environmental concerns; however, PSS was specifically designed to be used prior to making pesticide recommendations. In addition, PSS was designed to have minimal user input and to limit possible user errors. PSS does not have the flexibility for user input possible in WIN_PST. Users of PSS need to understand the limitations of the spreadsheet so that WIN_PST can be utilized in situations where PSS does not adequately address the situation.

In the proper application of PSS, the planner must make decisions on soils and field management. Preplant incorporate and postemergence applications effects are

inherent in these applications. In addition to management, the planner must select the soil of concern. The selection of soils for PSS should be based on the primary map unit for the field unless there is an identified area of concern within or adjacent to the field (i.e., lake, river, stream, or groundwater aquifer). If an area of concern exists, the planner should use the corresponding map units associated with these areas. Evaluations can be run on more than one map unit within a field if the operator is willing to manage these areas separately.

In PSS, the final evaluation of the site and the pesticide evaluated is reported in the pesticides potential to move offsite through leaching, surface runoff, or sediment transport, as well as, the associated hazard (toxicity) of the pesticide leaving the site. The leaching output in PSS incorporates the human toxicity rating such that this rating should equate to the human hazard rating provided in WIN_PST. The surface runoff or sediment transport output in PSS incorporates the fish toxicity rating such that this rating should equate to the fish hazard rating provided in WIN_PST.

Operation of PSS

PSS utilizes the soil and pesticide interaction matrixes to achieve a hazard rating for each field under evaluation. The use of all pesticides in accordance with the product label is the responsibility of the applicator. It is a violation of federal and state law to apply any pesticide inconsistent with the product label. PSS evaluations do not constitute or imply the recommendation of any pesticide. The environmental evaluations in the PSS printout are designed to use in conjunction with the SDSU extension publications for corn (FS 525C), soybeans (FS 525B), oilseeds (FS 525 OS), small grains/millet (FS 525A), and grass either (FS 525 CRP or FS 525P).

PSS is an Excel workbook and can be accessed going into Excel, selecting the workbook (Pest Screening Spreadsheet), and enabling the macros.

PSS users should then select the button (Push for Operator Info. Input) and complete the producer information. Select (OK) when the information is complete.

Step two in PSS is to select the button (Push for Soils and Mgmt. Input). The first screen prompts the user to select

the appropriate preemergence management option. The default on this screen is "None." Banding, low and ultra low application rates is the other option. The selection of these options should only be chosen if the user has a specific pesticide application in mind. "Warning" the selection of a preemergence option may change the ratings for all preemergence applications. Again, select (OK) when the information is complete. The next screen that will appear is the "Soils Information." Scroll through the list and select the appropriate soil map unit, then select (OK). The final management screen that appears is "Residue Management Options." Again, the default on this screen is "None." The option for "High Residue/Conservation Tillage" should only be selected if conservation practices: 329A-Residue Management, No-Till and Strip-Till, 329B-Residue Management, Mulch Till, or 329C-Residue Management, Ridge-Till, have been established on the field for three to five years. Again, select (OK) when the information is complete.

The final step in operating PSS is to select the button to view (Grass, Corn, Soybeans, Oilseeds, or Small Grains). This output can be reviewed or printed by selecting the (i.e., Print Corn) or the (Home) button to take the user back to the initial input screen.

The printout in PSS is presented as producer, soils, and management information on the top of the page. Under this information, the crop and Extension publication reference is posted. The main portion of the output lists the specific herbicide information on the left side of the page and the application method across the top of the page Pesticide Loss Potential, Hazard Ratings (Leaching, Surface Runoff, Sediment Transport) Grass Control, and Broadleaf Control.

In the body of the table, the rating for each herbicide/application method are listed as Extra High, High, Intermediate, Low, and Very Low; under the headings for Pesticide Loss Potential and Hazard Ratings (Leaching, Surface Runoff, Sediment Transport). The ratings reflect the soil and pesticide characteristics, as well as, the common use methods and rates in South Dakota. Use rates that are used in the program for specific herbicides are listed in the Cornherb, Soyherb, Smgrherb, Grassherb and Oilherb worksheets.

An example of the process is as follows: A herbicide application is planned in a field over a shallow aquifer in Beadle County, South Dakota. Atrazine is proposed to be applied postemergence in corn, under conventional tillage, and the soil map unit is EnA (Enet loam). The correct rating as read in the PSS printout is "High." To locate this rating in the printout the user should move down the left hand column under "Herbicide" to Atrazine, then right across the printout through "post"(postemergence application) and over under the heading "Pesticide Loss Potential and Hazard Ratings – Leaching.

To calculate the rating PSS located the soil leaching rating of "Intermediate" for Enet in the soil database. It also located the pesticide leaching rating of "High" in the pesticide database, and reduced it to "Intermediate," because it is a foliar application at a standard application rate (>0.25 lbs. act/ac). These soil and pesticide ratings will then run through the "Soil/Pesticide Interaction Leaching Potential (ILP)" matrix to produce an interaction rating of "Intermediate." PSS then locates the human toxicity rating of "High" for atrazine and runs this through the interaction toxicity (ITOX) matrix with the ILP rating of "Intermediate" to come up with the final posted rating of "High."

REFERENCES

Goss, D. and Wauchope, R. D. 1990. The SCS/ARS/CES pesticides properties database: II Using it with soils data in a screening procedure. Proc. Third Nat. Res. Conf. On Pesticides (pg. 471)

OFFICIAL VERSION

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