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EC169

SOIL-EROSION ECONOMIC DECISION SUPPORT TOOL (SEE-DST) FOR LAND MANAGEMENT IN NEBRASKA

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Link and label for the

SEE-DST Excel Spreadsheet

http://www.ianrpubs.unl.edu/UserFiles/Image/README.doc

SEE-DST Read Me file

http://www.ianrpubs.unl.edu/UserFiles/Image/SEEDST.xls

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Soil-Erosion Economic Decision Support Tool (SEE-DST) for Land Management in Nebraska

Contents

How to Use This Guide

This publication is comprised of two main chapters:

- Chapter 1 explains the technical aspects, assumptions, and supporting data used in the development of SEE-DST. While we hope this chapter is helpful to soil scientists, state and federal agencies, and other developers, an understanding of its elements is not required for use of the software.

- Chapter 2 is a User's Manual that guides the user through each step of data input to customize the results to individual fields. It explains how to compare the calculations of reduced pollutant load and economic benefit and assess the alternative practices suggested. It also includes examples of data input and results for three farms.

Background

Pollutants from soil erosion and pesticide and nutrient runoff in creeks and rivers cause "off farm" water quality impairment that costs millions of dollars for dredging and abatement of surface water problems. Farming systems that apply best management practices (BMPs) and soil-water conservation programs (SWCPs) have been proposed to reduce soil erosion and improve water quality off-farm. Biophysical computer models have been developed to evaluate soil erosion and water quality effects of the BMPs and SWCPs. Model complexities and the lack of integrated economic aspects has limited widespread use of these models by agricultural practitioners.

Previously, no decision support software considered both potential pollution and the economics to assess the cost-effectiveness of BMPs for water-quality protection in Nebraska. The Soil-Erosion Economic Decision Support Tool (SEE-DST) has been developed to analyze economical and environmental factors and compare pollutant reduction and economic benefits of the farmer's current system with a wide range of alternative BMPs and SWCPs. SEE-DST serves as both an educational resource and an assessment tool for selecting BMPs that are environmentally sound and economically sustainable. This document describes the methodology for estimating soil erosion, nutrient load, and crop budgeting used in SEE-DST for BMP selection in Nebraska.

Soil erosion accelerated by agricultural practices has resulted in soil degradation, loss of productivity on-farm, and environmental degradation off-farm. The associated loss of nutrients, pesticides, and other chemicals applied for crop production are economical losses of efficiency in farm inputs. Pollutant leaving the field by surface runoff into channels and eventually into streams and lakes poses a significant water quality problem. Therefore, environmental concerns and the economics of agricultural practices are interwoven.

The intersection between economical and environmental aspects of agricultural BMPs rests on the cost implications of their adoption. Costs are typically carried by farmers, who may not be willing to implement an expensive BMP. Farmers need a method for evaluating alternative BMPs for pollutant load and costs and comparing these alternative practices with their current system on a field-size watershed. This method could be provided in a computer-based, easy-to-use tool for farmers.

Environmental concerns and the economics of farming are interwoven. Nutrients, pesticides, and other chemicals that are applied for crop production and move off-target are economical losses of efficiency as well as environmental hazards.

Farmers and crop consultants can use SEE-DST to select farming practices tailored to an operation to reduce off-target losses and the resulting water quality problems.

The solution points to simultaneous multi-comparisons of the pollutant load reduction and economic benefits of alternative practices with the farmer's current practice. In practical terms, only a limited number of alternative agricultural practices (BMPs or non-BMPs) can be implemented in the field, tested, and evaluated because experiments are usually done over a short term (five years or less) and at a limited number of locations. This limitation is commonly addressed by using models to simulate erosion and erosion reduction BMPs. The simulation results are organized in a database to provide for speedy retrieval. When available in sufficient detail, measured data from individual fields can replace the simulated pollutant load data.

This database of BMPs for reducing pollutant load can be coupled with a crop-budget calculator. Together, the pollutant load database and the crop-budget calculator make a computer tool that enables the user to compute overall effectiveness (in terms of pollutant load and economics) of the current practice relative to alternative practices. To be useful the tool has to be flexible to meet farm-specific conditions such as current climate, geographical location, land conditions, management system, existing farm equipment, costs, and the farmer criteria of acceptable pollutant reduction and economic loss/gain.

Chapter I SEE-DST Concept

This chapter describes the methodology for estimating soil erosion and associated nutrient losses (N and P) and crop budgeting in the construction of the Soil Erosion Economic Decision Support Tool (SEE-DST) for Nebraska. This software serves as both an educational and decision support tool for selecting farming practices that are environmentally sound and economically sustainable. This document does not attempt to explain every detail of the parameters used in simulation to develop the pollutant load database of various field management operations. The selected topics explained below are considered to be the most important ones to selecting these best management practices.

The scope focuses on management systems (crop rotation, irrigation, and tillage systems) used in the production of major Nebraska crops such as corn, soybean, wheat, and alfalfa. The results emphasize the long-term differences among practices and are not intended to accurately predict the short-term and long-term absolute value for each practice. Crop budgeting considers only items that directly relate to BMPs and excludes items commonly included in more detailed crop-budgeting or farm-enterprise software. Costs of these items were excluded because they are constant (or minimally dependent on agricultural practice) and the resulting difference would be zero. SEE-DST offers a means of synthesizing the economic and environmental benefits of a wide range of alternative farming practices.

SEE-DST Components

SEE-DST has four basic components:

1. Simulated pollutant load data for various management schedules that defined agricultural practices of major crop rotations in Nebraska
2. An economic database that can be updated for such things as commodity and agricultural input prices
3. Crop budget calculator
4. Searching protocol to identify the best alternative practices for a given set of farm operation criteria

SEE-DST calculates the pollutant load of a farmer's current system based on watershed information, management, and conservation practices. From the SEE-DST database, farmers select management and conservation practices that are closest to their farming conditions. Based on their erosion target, tolerance of economic loss, and other search criteria, SEE-DST analyzes the pollutant database and crop budgets for alternative management and conservation practices. The program then presents all alternatives that meet the farmer's criteria. *Figure 1.1* illustrates basic components in the development of SEE-DST.

Many computer models can simulate soil-erosion and nutrient-loss, including the Soil and Watershed Assessment Tool (SWAT), Annualized Agricultural Non-Point Source (AnnAGNPS), and Groundwater Loading Effects of Agricultural Management Systems (GLEAMS). However, SEE-DST focuses on relative differences rather than the absolute value of soil erosion and associated soil nutrient loss. One model, AnnAGNPS, uses details of various management systems and was used to simulate soil-erosion and nutrient loss data from an experimental watershed for various management scenarios. The simulated data was then structured into the SEE-DST database. SEE-DST extrapolates the soil- and nutrient-loss values for different locations, land characteristics, conservation practices, and other crop management systems. By combining these extrapolated values with the economic database and a crop-budget calculator, users can make simultaneous comparisons of the environmental and economical effectiveness of the current practice with alternative practices.

Estimating Pollutant Yield with the AnnAGNPS Model

General Description of the AnnAGNPS Model

The detailed hydrology, erosion, and chemical components of the AnnAGNPS model are described by R.L. Bingner and F.D. Theurer in the *Technical Process Documentation*. The model and documentation are available online on the USDA Natural Resources Conservation Service Web site at *www.ars.usda.gov/Research/docs.htm?docid=5222*. The documentation describes features and general use of AnnAGNPS to estimate pollutant loads of various best management practices on a watershed. The model is a continuous simulation on a daily time step and has been widely used to evaluate the effects of fertilizer, pesticide, irrigation, alternative cropping, and tillage systems on runoff and water quality leaving a watershed.

The model accounts for spatial variability of soils, land use, and topography within a watershed by dividing the watershed into homogenous subwatersheds (cells). Pollutant loads leaving each homogenous subwatershed are routed through connected streams to the watershed outlet. Runoff from each cell is predicted for precipitation (snowmelt, rainfall, irrigation) using the Curve Number Method described in the Hydrology Section

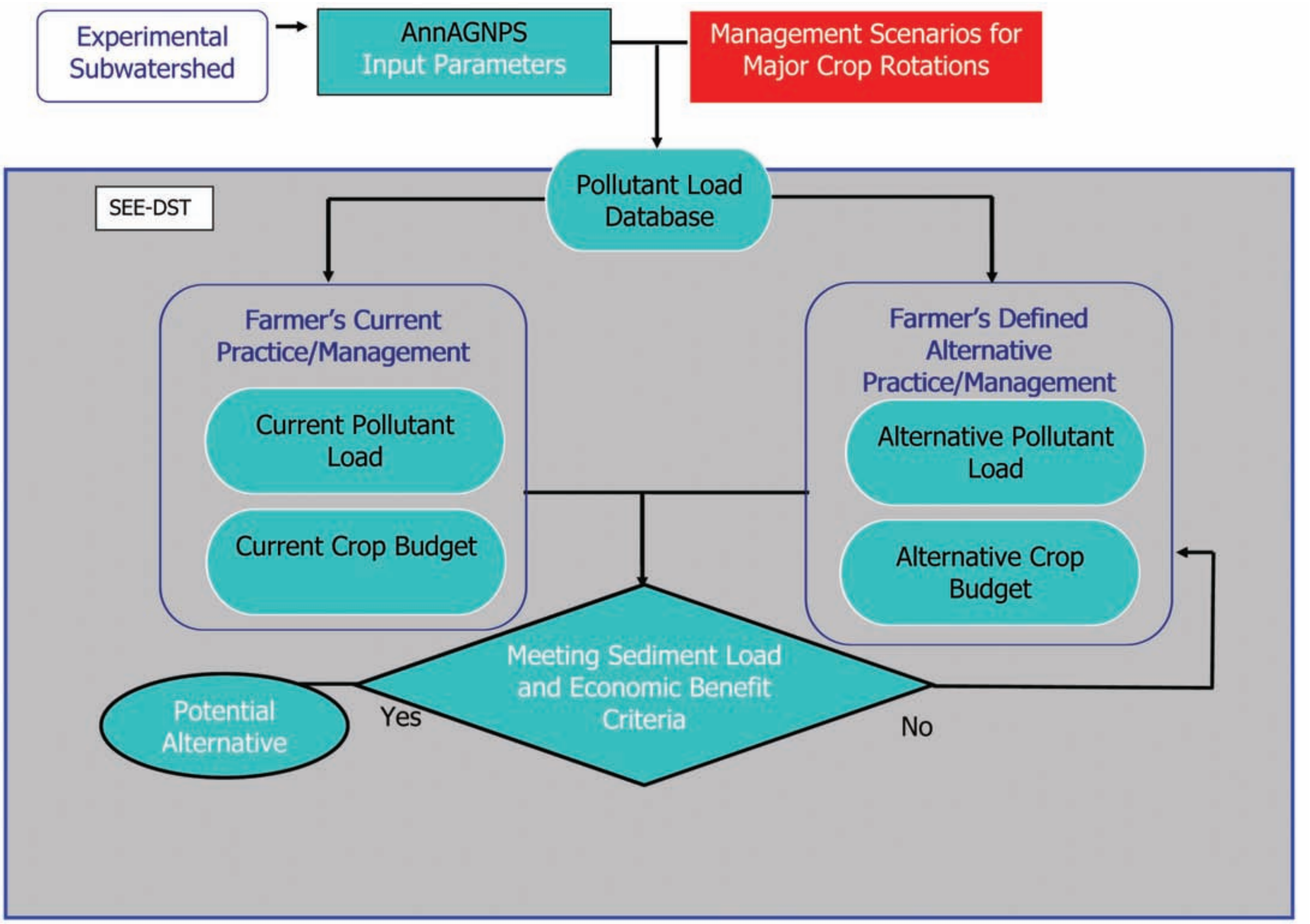


Figure 1.1 Major components and decision-making process in the Soil-Erosion Economic Decision Support Tool (SEE-DST).

of the 1972 *National Engineering Handbook*. Sheet and rill soil erosion in each field is predicted based on the Revised Universal Soil Loss Equation (RUSLE) used by USDA. The model also estimates sediment delivered beyond the field and channel erosion based on sediment size distribution, runoff amount, and peak runoff rate.

Required AnnAGNPS inputs are daily climate data, watershed physical characteristic, and management information. All inputs are organized in a relational database system. To meet the input specification format of the AnnAGNPS model, input parameters can be organized using the AnnAGNPS Input editor. Climate data include precipitation, temperature, solar radiation, monthly sky cover, dew point, and wind speed. Watershed physical characteristics such as the delineation of watershed boundary, homogenous subwatershed boundary, cell slope, direction, reach characteristics, and routing sequences among cells and streams can be generated with TOPAGNPS and AGFLOW tools. These are embedded in the data preparation tool for AnnAGNPS using GIS software. The AnnAGNPS-GIS interface generates soil and land use maps for each cell. Soil and land use for the largest area of a cell are used to represent the cell. Detailed management schedules — the hub for any field activities in the subwatershed — are linked to various databases such as irrigation schedules, crop characteristics, fertilizer application and characteristics, pesticide application and characteristics, and implement operation characteristics *(Figure 1.2)*.

Estimating Pollutant Loadings for Various Practice Scenarios on Experimental Subwatershed

Precipitation, management inputs, crop output, and pollutant loads (sediment and nutrients) from a 14-acre, dryland, corn-soybean subwatershed were measured from 2004 to 2006 (*Figure 1.3*). The measurements in the subwatershed were collected as part of a larger Wagon Train Watershed study to evaluate loads and sources (on-farm and off-farm) of pollutant into the Wagon Train Lake, located in Lancaster County, Nebraska (*Figure 1.3*).

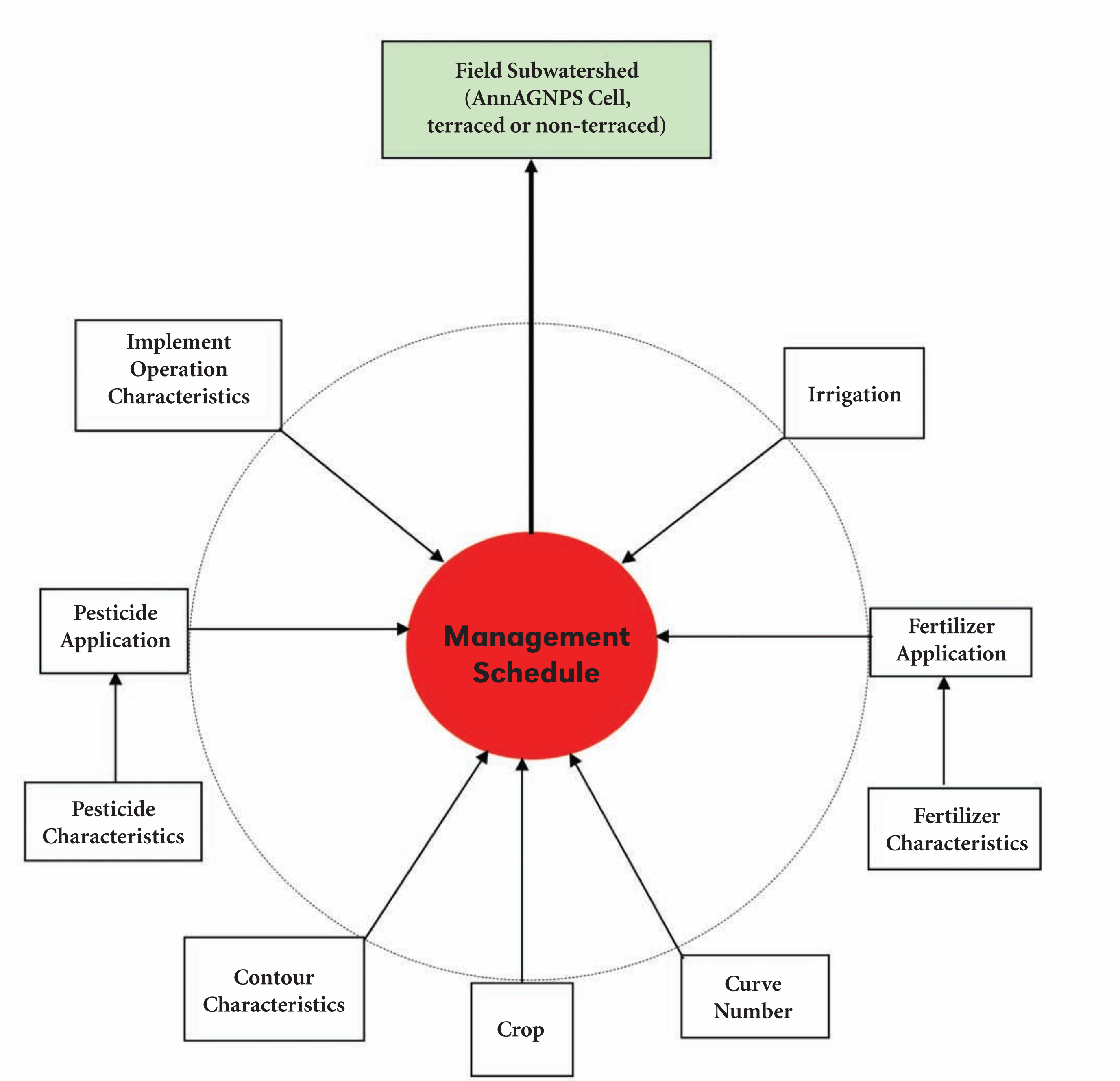
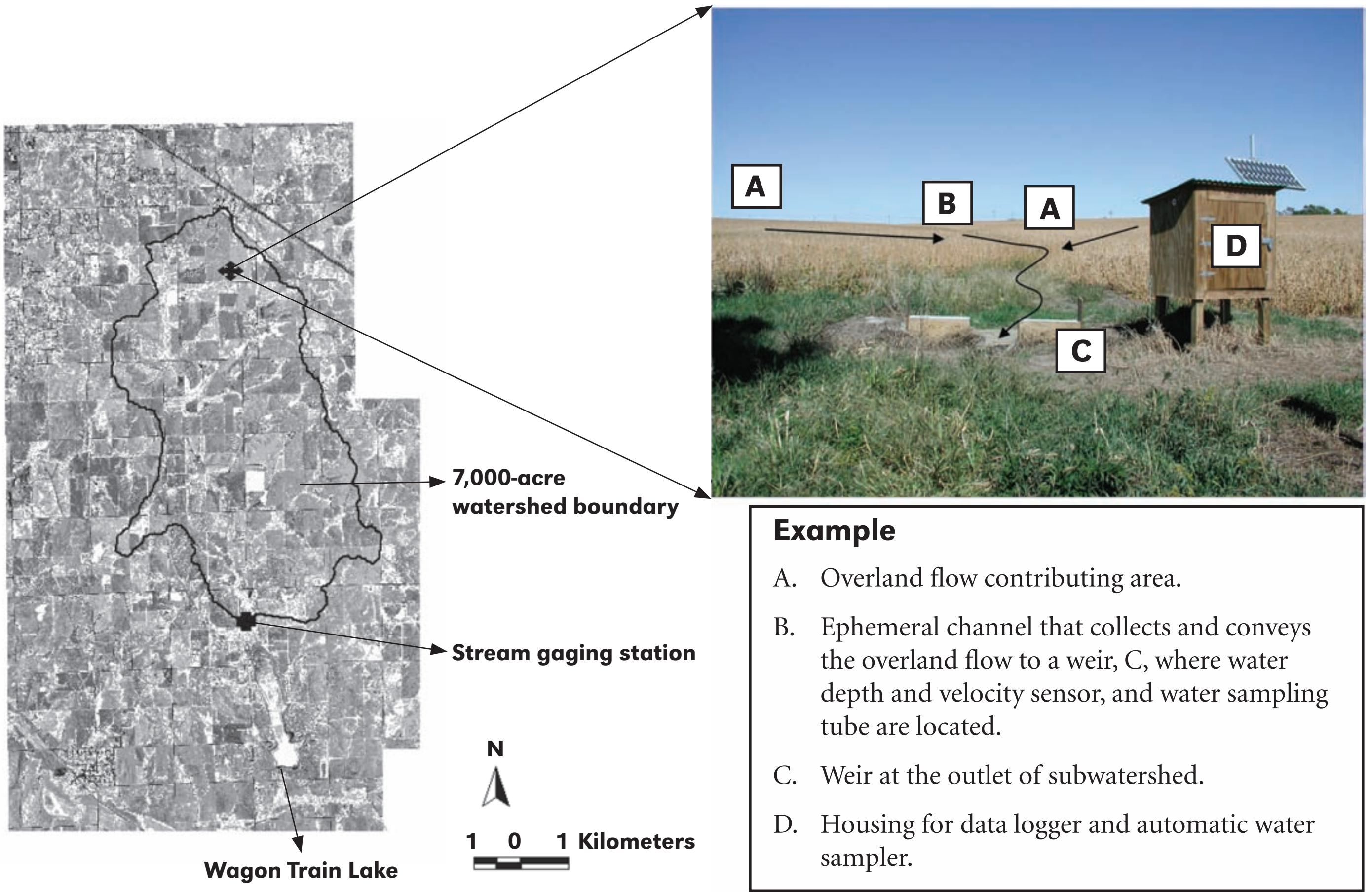


Figure 1.2. A management schedule contains sequences and dates of all field activities and operations made on the fields and subwatershed, terraced or non-terraced.

The experimental subwatershed had no conservation practices or conservation structures and was managed with a conventional tillage system. Field observation, confirmed by analyzing a digital elevation model developed from topographical surveys, demonstrated that overland flow converges into an ephemeral channel leading to the outlet of the watershed (*Figure 1.3*). The measurements from the subwatershed were used to calibrate AnnAGNPS input parameters.

Input parameters were then modified to simulate management schedule scenarios and estimate pollutant loads of various agricultural practices. Each management schedule represents a practice system, either BMP or non-BMP, as a combination of tillage system (conventional tillage, ridge till, or no-till system), agricultural input application, crop rotation, and irrigation (*Figure 1.2*). Management practices for the combinations of crop rotation, tillage system, and irrigation varied while other variables remained constant. This was done because alternative practices are selected based on sediment load, not nutrient or pesticide load. Estimates of nutrient loads in runoff were given to demonstrate additional benefits (if any) of a management practice.

For the current version of SEE-DST, five major cropping systems were simulated for dryland and irrigated conditions: corn-soybean, continuous corn, continuous



Example

A. Overland flow contributing area.

B. Ephemeral channel that collects and conveys the overland flow to a weir, C, where water depth and velocity sensor, and water sampling tube are located.

C. Weir at the outlet of subwatershed.

D. Housing for data logger and automatic water sampler.

Figure 1.3. Aerial orthophoto and photograph showing location and detail set-up of 14-acre experimental watershed within the larger watershed draining into Wagon Train Lake, Lancaster County, Nebraska.

soybean, soybean-winter wheat, five-year continuous alfalfa, and five-year alfalfa-one-year corn. Since irrigation was to supply crop need, only minimal runoff loss was assumed from irrigation. The growing season water-application rate is assumed to be 9 acre-inches for growing corn and 6 acre-inches for growing soybean. The model used a historical climate record (1984-2005) from the UNL Institute of Agriculture and Natural Resources weather station (latitude 40.83, longitude -96.65), 15 miles north of the watershed. Simulations were organized in a table by crop rotation, irrigation, and management system. Simulation results are total sediment yield, total phosphorus yield (in terms of mass ratio to sediment yield), and total nitrogen yield at the outlet of the subwatershed.

Extrapolating Estimated Pollutant Loadings for Other Subwatersheds

Field watersheds have distinct geographical locations, climate, physical characteristics (size, topographical characteristics, length of ephemeral channel), and soils. The management schedule on each field watershed also differs and each farmer will have a different schedule of field operations as well as differing machinery, and rate of fertilizer and chemical applications. Computer simulations to derive pollutant load for each field subwatershed within a county or state were impractical; therefore, a simplification was necessary. A strategy for estimating pollutant load for other watersheds based on the estimated pollutant loads for various management scenarios is described here.

Sheet and Rill Erosion

The AnnAGNPS model uses the Revised Universal Soil Loss Equation (RUSLE) to estimate sheet and rill erosion.

$$A=R*K*L*S*C*P \qquad \text{(Equation 1)}$$

where:

A is the long-term average soil loss per unit area (expressed in tons/acre/year);

R is the rainfall/runoff factor;

K is the soil erodibility factor, which is the rate of soil loss per unit of R for a given soil under continuous fallow with uphill and downhill cultivation on a slope of 9 percent and slope length of 72.6 feet;

L is the slope length factor, which is the ratio of soil loss from a defined slope length relative to that from a slope length of 72.6 feet;

S is the slope steepness factor, which is the ratio of soil loss from a slope with a given steepness relative to that from a 9 percent slope;

C is the cover and management factor, which is the ratio of loss from an area with a given cover and management relative to that from an identical area in continuous fallow;

P is the supporting conservation practice factor which is the ratio of soil loss from a field with a conservation practice relative to that with straight-row farming uphill and downhill.

The resulting erosion ratio of two watershed scenarios under the same management (the same C factor) can be expressed as:

$$A_i = \frac{R_i}{R_o} * \frac{K_i}{K_o} * \frac{L_i}{L_o} * \frac{S_i}{S_o} * \frac{P_i}{P_o} * A_o \qquad \text{(Equation 2)}$$

where subscripts "i" and "o" identify two different watersheds.

Equation 2 suggests that if values R_i/R_o, K_i/K_o, L_i/L_o, S_i/S_o, P_i/P_o, and A_o are known, then A_i for the same management practice can be derived. The watershed identified with subscript "o" is an experimental subwatershed where R_o, K_o, L_o, S_o, P_o=1, A_o, and detailed management are known. The experimental watershed was used to calibrate AnnAGNPS parameters in estimating A_o for a wide range of management practices. These simulated A_o values were then organized in a database system. SEE-DST uses the database to extrapolate a soil erosion prediction to other subwatersheds with the same management scenarios. Based on *Equation 1*, the factors R, K, L, and S point to the site specificity of a subwatershed. Because the main factor is the difference among combined management and supporting practices on the same subwatershed, the ratios R_i/R_o, K_i/K_o, L_i/L_o, and S_i/S_o factors are constant for all scenarios.

R-ratio. The R-ratio, R_i/R_o, can be derived using weather data closest to the field watershed and the experimental watershed while setting other input parameters the same.

K-ratio. The K-ratio, K_i/K_o, can be derived from the soil database. The value of K for various soils is readily available from soil survey data. The Wymore soil in the experimental watershed has a K value of 0.76; the K ratio equals $K_i/0.76$. Using the predominant soil in a subwatershed, the K_i value can be obtained from the soils database to compute the K-ratio ($K_i/0.76$).

Combined LS-ratio. The LS-ratio, $(L_i{*}S_i)/(L_o{*}S_o)$ can be computed because the $L_o{*}S_o$ (slope length and steepness factor for the experimental watershed) is known; the $L_o{*}S_o$ value determined with AnnAGNPS for the experimental watershed was 0.38. Therefore if the $L_i{*}S_i$ value for a field watershed is known, the LS-ratio can be computed. Slope length (L_i) is defined as the slope distance from the point of origin of overland flow to the point of concentrated flow or the point where deposition occurs. For any given subwatershed, many slope lengths are possible and the determination of slope length requires considerable professional judgment. One approach is to choose a predominant (in area) transect as the representative topography for which the $L_i{*}S_i$ value can be calculated. This approach is practical and provides a generalized estimate. It emphasizes the differences among management and supporting practices and keeps the LS ratio constant for all these possible scenarios.

SEE-DST provides an LS calculator of a representative transect, assuming that a transect is made of one or more segments of slopes to acquire representation of slope shapes (uniform, convex, concave, and convex-concave) because soil erosion is affected by the slope shape. (A detailed description of the calculation for the S and L factors is available in the 1994 edition of *Design Hydrology and Sedimentology for Small Catchments.)*

S-factor. For a slope length greater than 15 feet, S_i was calculated as

$$S_i = 10.8 \sin\theta + 0.03;\ \textit{if} \sin\theta < 0.09 \qquad \text{(Equation 3)}$$

or

$$S_i = 16.8 \sin\theta - 0.50;\ \textit{if} \sin\theta \geq 0.09 \qquad \text{(Equation 4)}$$

whereas for a slope length less than 15 feet,

$$S_i = 3.0\ (\sin\theta\ )^{0.8} = 0.56 \qquad \text{(Equation 5)}$$

Where θ is the slope angle in degree units.

L-factor. The slope length factor is calculated as

$$L = \left[\frac{\lambda}{72.6}\right]^m \qquad \text{(Equation 6)}$$

(λ = horizontal slope length.)

where the exponent m is related to the ratio of rill to interrill erosion, β, as

$$m = \frac{\beta}{1+\beta} \qquad \text{(Equation 7)}$$

For soils that are moderately susceptible to rilling, it is calculated as

$$\beta_{mod} = \frac{11.16 \sin\theta}{3.0\,(\sin\theta)^{0.8} + 0.56} \qquad \text{(Equation 8)}$$

whereas for soils with low susceptibility to rilling, it is

$$\beta_{low} = 0.5\,\beta_{mod} \qquad \text{(Equation 9)}$$

and for soils with high susceptibility to rilling,

$$\beta_{high} = 2\,\beta_{mod} \qquad \text{(Equation 10)}$$

To account for the effect of slope shape, the slope is divided into n segments (maximum n = 4 is set for SEE-DST) with its corresponding value as calculated with equations 3 to 10. The combined factor for all slope segments (the combined LS factor) is calculated as

$$LS = \frac{1}{n}\sum_{j=1}^{n} S_j L_j\,(SAF)_j \qquad \text{(Equation 11)}$$

where SAF_j, slope adjustment factor for slope segment j, is calculated as

$$SAF_j = \frac{j^{m+1} - (j-1)^{m+1}}{n^m} \qquad \text{(Equation 12)}$$

P-ratio. The P-ratio, P_i/P_o, is the same as P_i values because the value of P_o=1. Values of P_i for various supporting practices such as contour farming and terracing, are available from the *USDA Agricultural Handbook No. 537*. Terracing reduces the slope length from the entire field slope length to the length of the terrace interval, reducing the LS factor. Terracing also causes all field operations to follow the contour farming; therefore, the P value for a terraced field results from multiplying the P values for terraces and contour farming.

Effects of Crop Yield on Sheet and Rill Sediment Yield, Y-Ratio

Higher productivity would produce more crop residue (above and below ground) and potentially will reduce soil erosion. Farmers know their soil's productivity and long-term crop yields. Crop yield information provided by the user is the sole source of income in the crop budget. Because each subwatershed will have a different productivity, running a simulation for each potential crop yield is nearly impossible. Therefore, the effect of productivity on reducing sediment yield is derived by calculating the yield ratio (Y-ratio) for each crop rotation. This is the ratio of simulated sediment loss for a yield level to the experimental watershed standard crop yield. For a corn-soybean rotation, the Y-ratio was derived by:

$$Y - ratio = \left(\frac{Y}{175}\right)^{-0.858} \qquad \text{(Equation 13)}$$

where:

Y is the sum of corn and soybean yields in bushels per acre.

For continuous corn, the Y ratio was derived by equation:

$$Y - ratio = \left(\frac{Y}{135}\right)^{-1.228} \qquad \text{(Equation 14)}$$

where:

Y is corn yield in bushels per acre

For continuous soybean, the Y-ratio was derived by equation:

$$Y - ratio = \left(\frac{Y}{40}\right)^{-1.228} \qquad \text{(Equation 15)}$$

where:

Y is soybean yield in bushels per acre.

For soybean-wheat rotation, the Y ratio was derived by equation:

$$Y - ratio = \left(\frac{Y}{80}\right)^{-0.6514} \qquad \text{(Equation 16)}$$

where:

Y is the sum of soybean and wheat yields in bushels per acre.

For five-year continuous alfalfa with or without one-year corn, the Y ratio was derived by equation:

$$Y - ratio = \left(\frac{-0.4811Y + 3.7477}{1.8233}\right) \qquad \text{(Equation 17)}$$

where:

Y is the average annual alfalfa yield in tons per acre.

Channel Erosion

It is assumed that overland flow is drained by an ephemeral channel. Erosion and sediment yield in the channel depends on the size of the subwatershed. A larger subwatershed will have a longer channel, more runoff volume flowing through the channel, and potentially more channel erosion. Based on the AGFLOW analysis on the Wagon Train Watershed, the relationship between channel parameter and area of headwater in subwatersheds of less than 100 acres is represented by:

$$\text{Len} = 25.74A - 108.3 \quad \text{(Equation 18)}$$

$$\text{Per} = 0.9912A^{0.3499} \quad \text{(Equation 19)}$$

Where

Len is channel length in feet,
Per is channel perimeter in feet, and
A is the area of subwatershed in acres.

Per is the distance along the channel cross section measured from top left bank to the top right bank, through the thalweg, the lowest point in the channel bed. The product of Len and Per equals the channel area. Based on field measurements using erosion pins in the Wagon Train Lake Watershed and published by N.D. Mueller in 2007, it is assumed that the average soil loss from the channel was 0.0492 feet per year. Assuming the average soil bulk density of 0.046695 tons/feet^3, the channel erosion equals:

$$CE = Len * Per * 0.0492 * 0.046695 \quad \text{(Equation 20)}$$

where:

CE is channel erosion in tons per year.

Total Erosion and Pollutant Load

Total sediment yield is the sum of sediment yield from overland flow and channel erosion. (Delivery ratio in the channel is assumed to be 1.) Load of total N and total P is derived by multiplying total sediment yield by sediment total-N and total-P concentration.

Crop Budget

The intersection of AnnAGNPS parameters and the economic parameters in the SEE-DST crop budget calculation lies on the schedules of management scenarios (*Figure 1.2*). Items considered in the SEE-DST crop budgeting are directly related to BMPs such as one-time structure installation (irrigation system, terracing), field operation, and material inputs; therefore, the SEE-DST crop budget does not consider some items commonly included in a more detailed crop budgeting protocol or farm-enterprise software. Some items are excluded because the emphasis is on the difference among agricultural practices. Differences in costs that are constant (or minimally dependent on agricultural practice) between two practices (BMPs or non-BMPs) will be zero. *Nebraska Crop Budgets* (2004), a University of Nebraska–Lincoln Extension Circular, provides examples of management schedule and crop budget for various cropping systems.

Considerations of Other Aspects in the Crop Budget Database of SEE-DST

1. Farm equipment and labor. SEE-DST assumes that the farmer owns all necessary equipment and provides all necessary labor.
2. Equipment rental and custom services should be included in the cost/price database as if these were owned and done by the farmer (see point 1).
3. Land cost of ownership or renting is assumed to be independent of farming practices. It is assumed that the landowner is managing the farm and that decisions about installing BMP-related structures are solely dependent on costs and not an issue of ownership. Land cost is not included because the difference in land cost among BMPs is zero.
4. Overhead includes accounting, liability insurance, office expense, and vehicle cost. Overheads are assumed to be independent of farming practices and therefore are not included in the calculation. In calculating cost differences of various BMPs, the differences in overhead among the BMPs will become zero.
5. Machinery taxes, housing, insurance, and interest are assumed to be independent of farming practices and are not included.

The best crop budget information comes from farmers who are taking creative approaches to minimize costs. SEE-DST is designed to give users the flexibility to enter their own cost and prices in the database to more realistically reflect their specific crop budgeting. Income, expenses, and net income calculations are set to be annualized and distributed and are given in terms $/(acre-year). Annualizing and distributing crop budget for a multi-year of crop rotation provides a mean of linking the crop budget with the annualized and distributed pollutant load (expressed in terms of mass/(acre-year).

Expenses

Implement and Power Unit Costs

Operating cost of machinery (implement and power unit) is calculated for each field operation in the management schedule scenario used with the AnnAGNPS simulation. The user must provide implement and power unit cost. Calculation of machinery operating costs (labor, repairs and maintenance, fuel and lube) is beyond the scope of SEE-DST. The user can select the implement used from a generic list and then input implement cost (expressed in \$/acre) and speed of implement operation (acre/hour). Implement speed is needed because it determines the power unit hours. Power units are classified generically as "tractor" and "combine." Tractor is needed for all implement operations and combine is only for harvest operation. Power unit operating cost is given in terms of \$/hour. To convert to power unit cost in \$/acre, speed of operation (depending on implement speed of operation in acre/hour) must be known.

$$\text{Power Unit Operational Cost (\$/acre)} = \frac{\text{Power Unit Cost (\$/hour)}}{\text{Implement Operational Speed (acre/hour)}} \quad \text{(Equation 21)}$$

The annualized field-operation cost is the sum of the costs of operating the power unit and implements for all field operations in a rotation divided by number of years in the rotation.

Material and Seed Cost

Materials considered are common fertilizers, herbicides, and insecticides. The user provides the fertilizer cost in terms of elemental N and P and the herbicide and insecticide costs in terms of dollars per unit mass of active ingredient. Seed information is given in terms of \$/lb or \$/bag, depending on the crop. The application rate of material and seed were set in the simulation to follow the typical application rate for each crop.

Irrigation Cost

Irrigation cost includes the variable costs of operating the irrigation system, annualized and distributed cost of installation (well and delivery system), annual cost of irrigation system taxes, insurance, and interest. To calculate the cost of operating the irrigation system, the user provides the cost to supply one acre-inch of irrigation water. Annualized irrigation-water volume (acre-inch) for a crop rotation multiplied by the operating cost for one acre-inch irrigation equals the annualized cost of operating irrigation. Irrigation cost for a dryland system is zero.

Conservation Practice Cost

Cost of the conservation practice includes annualized installation of structures, loss of yield due to taking land out of production (set aside for grass waterways), and an increase in operational time for contour farming. The conservation practice reference point is the subwatershed with uphill and downhill field operations (no-contour farming), no waterways, and no terracing. The cost of conservation practice by contouring is expressed in terms of loss of time (compared to uphill and downhill operation). It is widely known that maneuvering equipment in contour farming can increase operational time up to 30 percent, which can result in increased machinery operational cost. Loss of land for grass waterways results in loss of yield, based on the assumption that the yield in waterways now planted to grass would have been similar to the rest of the subwatershed.

Income

Farm revenue is solely derived from crop yield. Program payments and incentives are not included.

Resources

The following resources were referenced in developing Chapter 1 and provide more detail of specific topics.

GIS-Based Generation of AGNPS Watershed Routing and Channel Parameters by R.L. Bingner, R.W. Darden, F.D. Theurer, and J. Garbrecht, 1997, American Society of Agricultural Engineers (ASAE) Paper No. 97-2008. St. Joseph, Mich.

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Predicting Rainfall Erosion Losses — A Guide to Conservation Planning. W.H. Wischmeier and D.D. Smith, 1978. U.S. Department of Agriculture, *Agriculture Handbook No 537*, Washington, D.C.

Chapter II User's Manual

Terms of Use

By accessing or using this program, you agree to these terms of use. If you do not agree to these terms, you may not use this software.

Citation: Mamo, M., D. Ginting, K. Schoengold, C. Wortmann, and R. Renken. 2009. Soil-Erosion Economic Decision Support Tool (SEE-DST) for Land Management in Nebraska. A User's Manual. Lincoln, Nebraska: University of Nebraska–Lincoln.

Disclaimer: Although this program has been developed by the cooperation between the University of Nebraska–Lincoln and the U.S. Geological Survey (USGS), no warranty, expressed or implied, is made by UNL, USGS, or the Nebraska and U.S. Governments as to the accuracy and functioning of the program and related program material nor shall the fact of distribution constitute any such warranty, and no responsibility is assumed by the UNL and USGS agencies in connection therewith.

This User Manual provides guidelines for use of the Soil Erosion Economic Decision Support Tool (SEE-DST). SEE-DST is a spreadsheet-based computer program developed cooperatively by the University of Nebraska–Lincoln and the U.S. Geological Survey (USGS). The program works within Excel® version 2003 and 2007 in Windows®. The program will not work for other operating system platforms.

SEE-DST offers a means of synthesizing environmental and economical analysis to evaluate the benefits of a wide range of alternative farming practices. The tool compares pollution reduction and economic effects for the farmer's current system and multiple alternative practices. This evaluation can be helpful in guiding farmers and regulatory agencies in the planning process. The tool also can be used for educational purposes in formal or informal settings. Three examples of its use for different farm operations are provided in *Chapter 2: The User's Guide.*

Soil erosion accelerated by agricultural practices has resulted in soil degradation and loss of productivity on-farm and environmental degradation off-farm. The associated loss of nutrients, pesticide, and other chemicals applied for crop production are economic and reduce the efficiency of farm inputs. Pollutants from field surface runoff enter streams and lakes and cause significant water quality problems.

The adoption of agricultural best management practices (BMPs) depends on the cost implication of establishing or changing to BMPs. The BMPs that meet pollutant load reduction also should not result in an economic burden to the farmer and/or the farmer should know the cost in $/acre to implement the practice(s).

Computer calculations could allow the user to compare and evaluate pollutant load and related impacts for the farmer's current practice and multiple alternative practices. A database of best management practices to reduce pollutant load could be coupled with a crop-budget calculator to make an effective decision support tool. To be practical, the tool has to be flexible to meet farmer-specific conditions in terms of current climate, geographical location, land conditions, management system, existing farm equipment, costs, and farmers' criterion of acceptable pollutant reduction and economic loss/gain.

SEE-DST is designed to serve as both an educational and useful tool for selecting farming practices that are environmentally sound and economically acceptable. The scope focuses on the management (crop rotation, irrigation, and tillage system) of major crops produced in Nebraska such as corn, soybean, wheat, and alfalfa. The tool emphasizes *differences* among practices, not the absolute value of estimates for each practice. Crop budgeting considers only items that are directly related to BMPs and excludes items commonly included in a more detailed crop budgeting protocol or software. The computer output lists BMPs and the associated benefit ratio of each BMP.

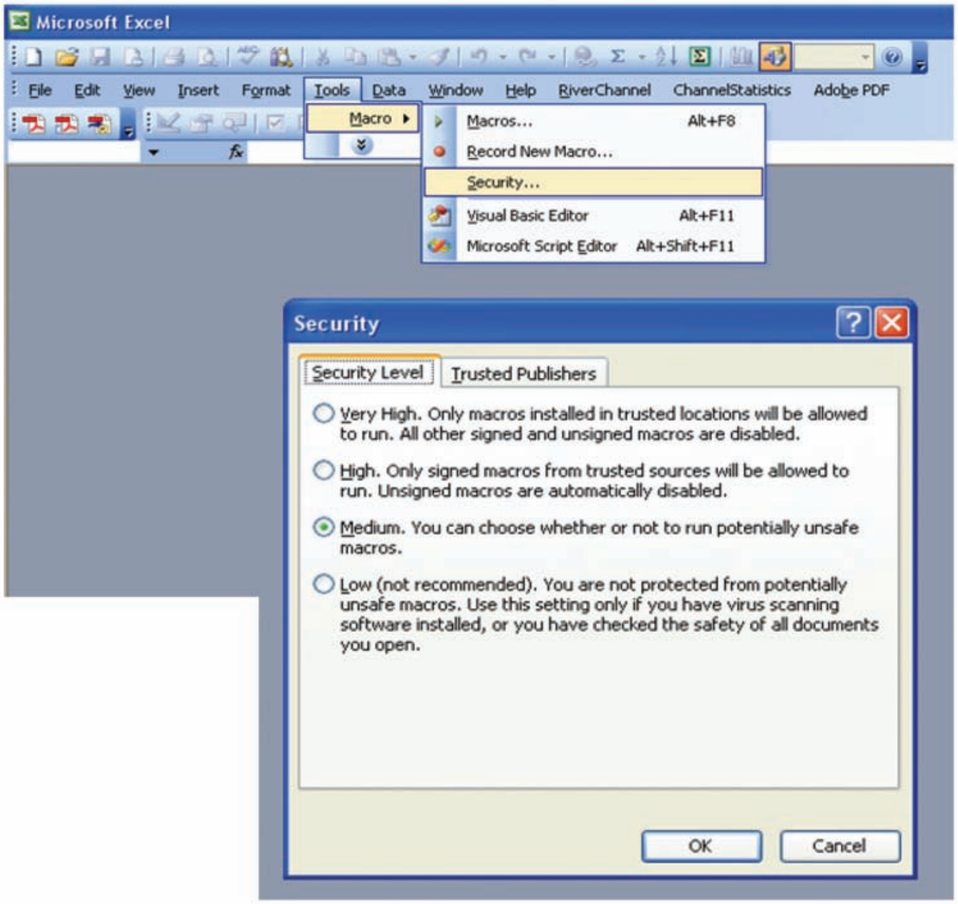
Getting Started

The SEE-DST software, along with this publication, can be downloaded from the University of Nebraska–Lincoln Extension Publications Web site at *http://www.extension.unl.edu/publications.* It also is available in the soil fertility section of the UNL CropWatch Web site at *http://cropwatch.unl.edu.*

To begin, open the Excel® 2003 version in Windows® and set the security level to "Medium" to enable running the macros (*Figure 2.1*). To change the security level, from the Excel menu, select **Tools, Macro, Security**, then select the **Medium** option and click the **OK** button.

When using Excel® 2007 in Windows®, setting the security level is not needed.

On inserting the SEE-DST program disk in your computer, the opening page with information about the developers and the program should appear (*Figure 2.2*) as well as the **Launch** and **Exit** buttons.



○ Very High. Only macros installed in trusted locations will be allowed to run. All other signed and unsigned macros are disabled.

○ High. Only signed macros from trusted sources will be allowed to run. Unsigned macros are automatically disabled.

● Medium. You can choose whether or not to run potentially unsafe macros.

○ Low (not recommended). You are not protected from potentially unsafe macros. Use this setting only if you have virus scanning software installed, or you have checked the safety of all documents you open.

Figure 2.1. Before starting SEE-DST, open Excel version 2003 and set the security level to medium to enable running of the program macros.

Version 1.0-February 2009

Developed by:
Ginting Daniel , U.S. Geological Survey, Nebraska Water Science Center, Lincoln
Mamo Martha, Department of Agronomy and Horticulture, University of Nebraska-Lincoln
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About the SEE-DST

The SEE-DST is a tool for selection of best management practices (BMPs) of major crop rotations in Nebraska to reduce pollutant loss to surface waters with no or minimal increase in cost. The SEE-DST, an educational resource for study of alternative practices for water quality protection, provides estimates of long-term mean effects of BMPs on sediment load (and associated nutrients, and organic matter) to drainage outlets of fields. The SEE-DST estimates the crop budget and income with current management practice based on information provided by users. The SEE-DST aids evaluation of alternative management by providing both potential reduction in sediment loss and potential gain/loss of income for each of the alternative scenarios. The user can evaluate alternative conservation, crop management, and irrigation practices relative to the current practices.

Development of SEE-DST was funded by USDA-CSREES, the U.S. Geological Survey, the Nebraska Department of Environmental Quality, and the Lower Platte South Natural Resources District (U.S. EPA grant), and the UNL-Williamson and Irene Endowment.

Figure 2.2. SEE-DST was developed by the University of Nebraska–Lincoln and the U.S. Geological Survey Nebraska Water Science Center.

Using the Soil-Erosion Economic Decision Support Tool

General Overview of SEE-DST

The SEE-DST user navigates through the software by clicking buttons from left to right on the opening screen. Each button will open a box or series of boxes where the user can input data best describing the current field operation.

Land use descriptive data is entered into SEE-DST, which then suggests best management practices predicted to reduce soil and chemical losses from the field. Descriptive data to input includes:

1) economic costs for a given land use and field,
2) physical descriptions of the field,
3) soil conservation practices used on the field, and
4) the current crop management system being employed.

For some descriptive data, SEE-DST provides default values that are typical for field operations in Nebraska. SEE-DST also provides drop-down menus for the user to select the best descriptive data for the current field and operation.

The screen (*Figure 2.3*) will show four buttons that open windows where the user can enter descriptive data and two buttons to calculate solutions based on that data.

When all descriptive data has been entered, click on the **Calculate Current Pollutant and Budget** button to initiate SEE-DST to calculate and return pollutant loading and economic results in the **Current System** box (*Figure 2.4*).

Clicking the **Alternative Practice** button opens a box where the user can enter erosion rate goals and economic tolerance limits that can be met by alternative practices (*Figure 2.5*). It also allows for a change in crop management system. Clicking the **Search** button will then return alternative practice options based on the criteria set by the user (erosion goal, economic loss tolerance). The list of options can then be viewed and possibly adopted.

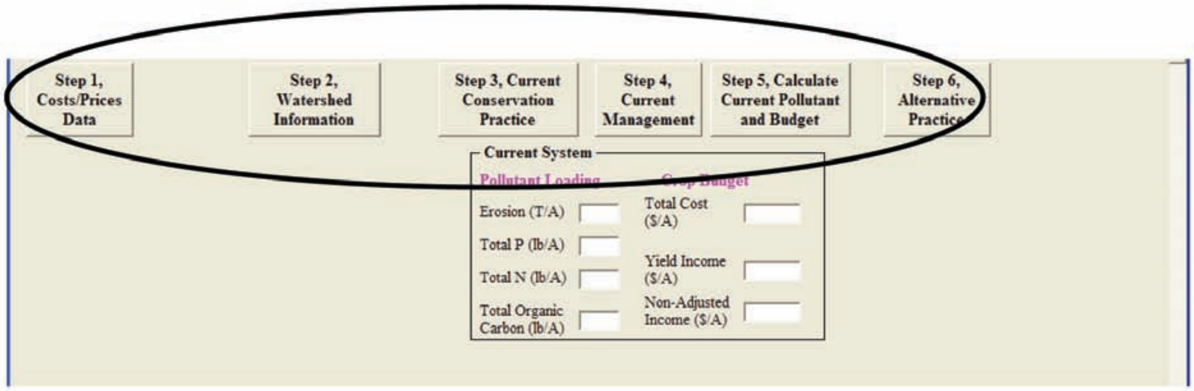


Figure 2.3. The SEE-DST opening menu leads you through the steps for inputting data and calculating alternative practices and how they would affect pollutant loading.

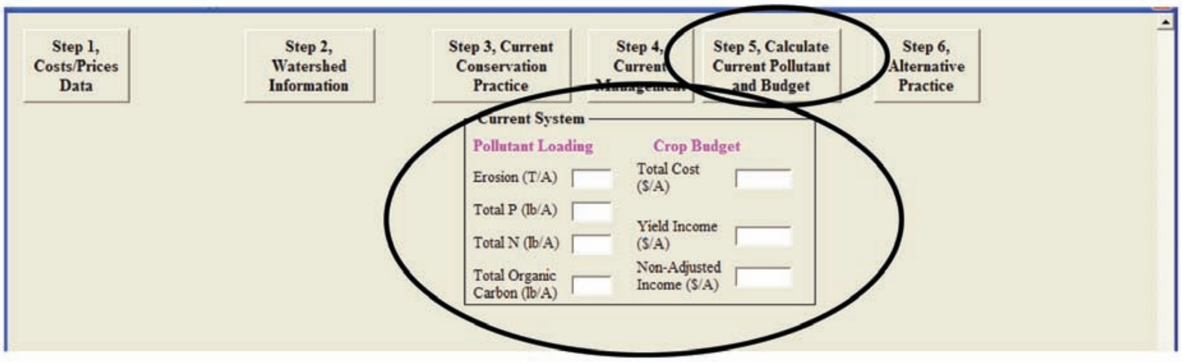
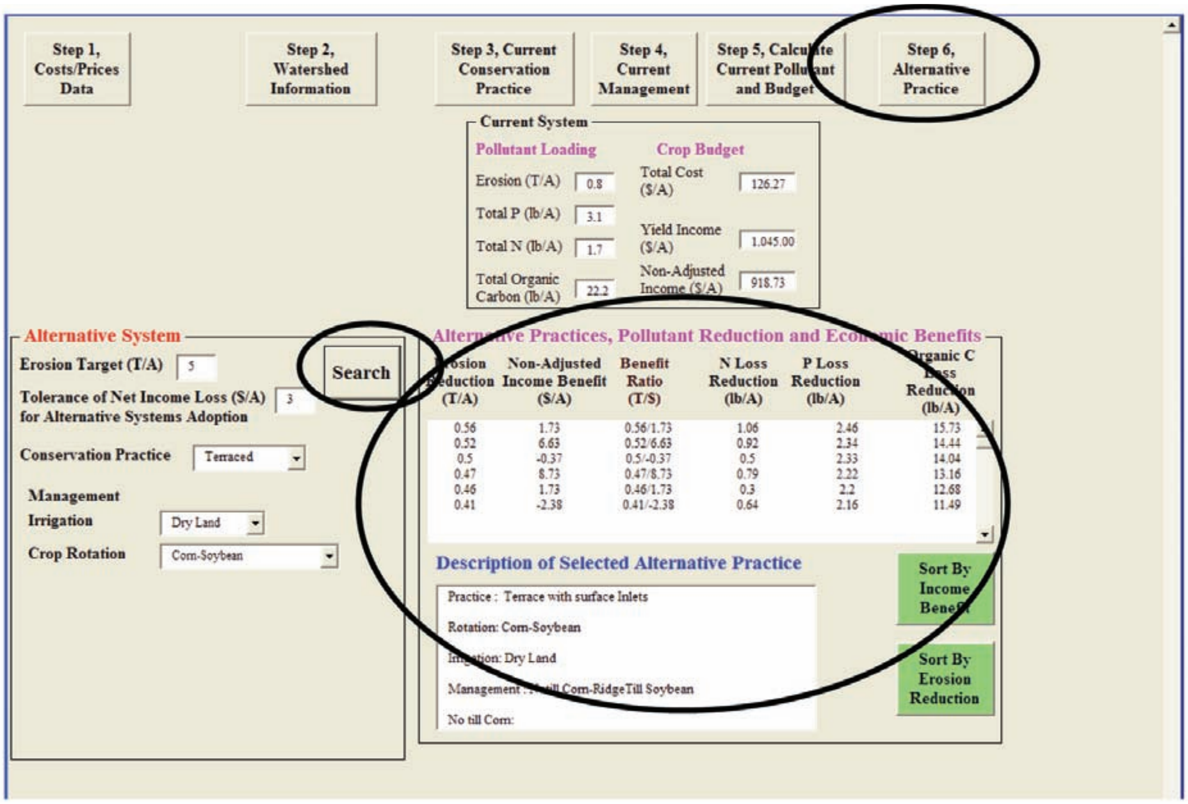


Figure 2.4. After entering descriptive data for your operation, SEE-DST pollutant loading and economics are calculated.



Current System

Pollutant Loading

Erosion (T/A) 0.8
Total P (lb/A) 3.1
Total N (lb/A) 1.7
Total Organic Carbon (lb/A) 22.2

Crop Budget

Total Cost ($/A) 126.27
Yield Income ($/A) 1,045.00
Non-Adjusted Income ($/A) 918.73

Alternative System

Erosion Target (T/A) 5
Tolerance of Net Income Loss ($/A) for Alternative Systems Adoption 3
Conservation Practice Terraced
Management
Irrigation Dry Land
Crop Rotation Corn-Soybean

Alternative Practices, Pollutant Reduction and Economic Benefits

Erosion Reduction (T/A)	Non-Adjusted Income Benefit ($/A)	Benefit Ratio (T/$)	N Loss Reduction (lb/A)	P Loss Reduction (lb/A)	Organic C Loss Reduction (lb/A)
0.56	1.73	0.56/1.73	1.06	2.46	15.73
0.52	6.63	0.52/6.63	0.92	2.34	14.44
0.5	-0.37	0.5/-0.37	0.5	2.33	14.04
0.47	8.73	0.47/8.73	0.79	2.22	13.16
0.46	1.73	0.46/1.73	0.3	2.2	12.68
0.41	-2.38	0.41/-2.38	0.64	2.16	11.49

Description of Selected Alternative Practice

Practice : Terrace with surface Inlets

Rotation: Corn-Soybean

Irrigation: Dry Land

Management : Notill Corn-RidgeTill Soybean

No till Corn:

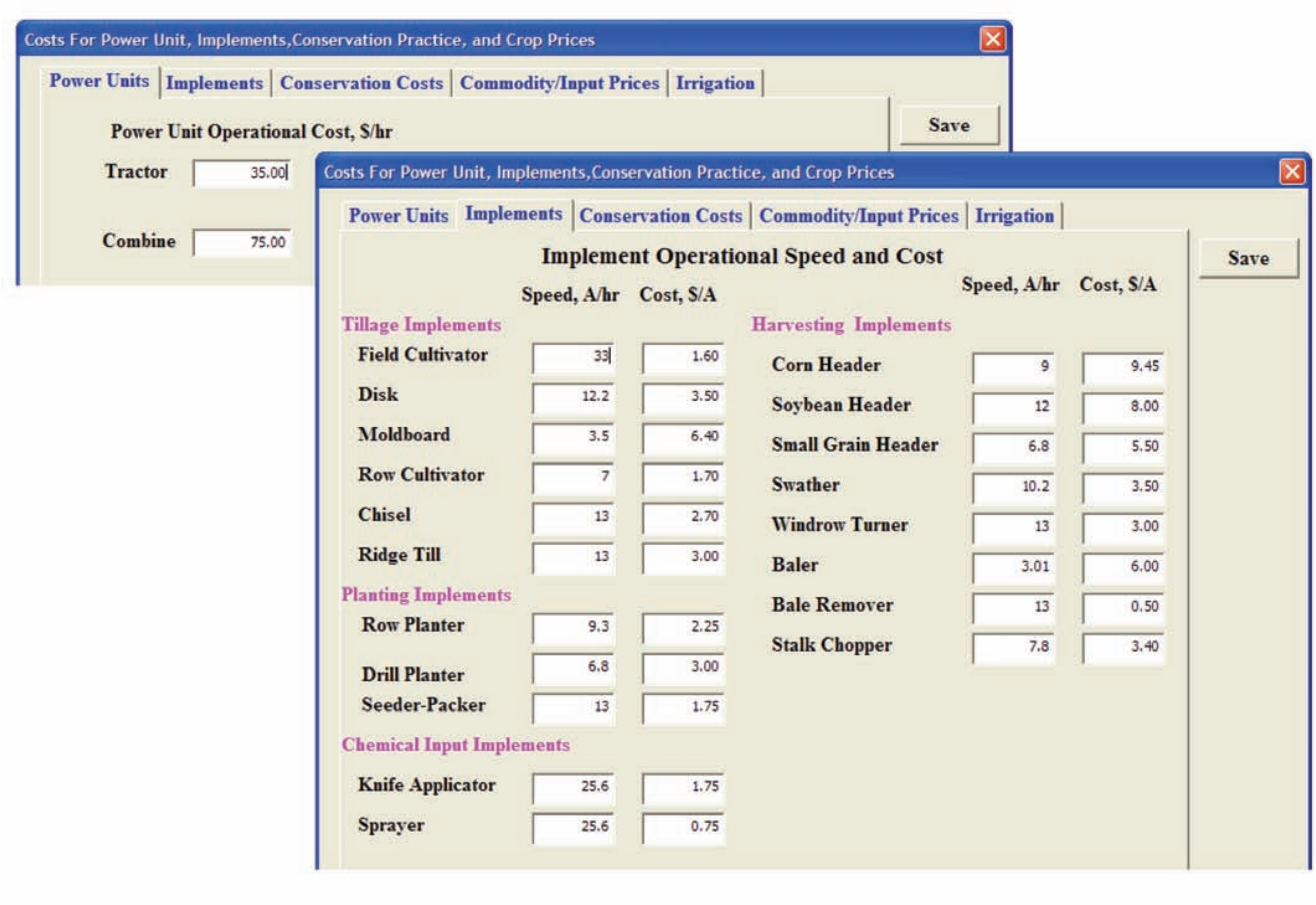
Figure 2.5. Click the **Alternative Practice** button to input erosion rate goals and economic tolerance limits. It will suggest alternative practices that fit your goals and your farming operation. Different crop management systems can be input at this stage so the user can compare options.

Instructions for Inputting Descriptive Data

Step 1. Costs/Prices Data

This section considers the various input costs associated with a given field operation (i.e. machinery, implements, seed, chemicals, irrigation, etc.). The current sale price for the harvested commodity can also be entered. In this section, default cost and price values are provided. The user can choose to leave these values unchanged or change them to values which are more representative of the costs associated with the user's current system.

a. Click on the **Costs/Prices Data** button to open this menu and enter data into the fields. For each submenu — Power Units, Implements, Conservation Costs, Yield and Inputs Prices, and Irrigation — user data should be entered or the current default values could be used (*Figures 2.6 and 2.7*). When all data have been entered, click **Save** to close menu.



Power Unit Operational Cost, $/hr

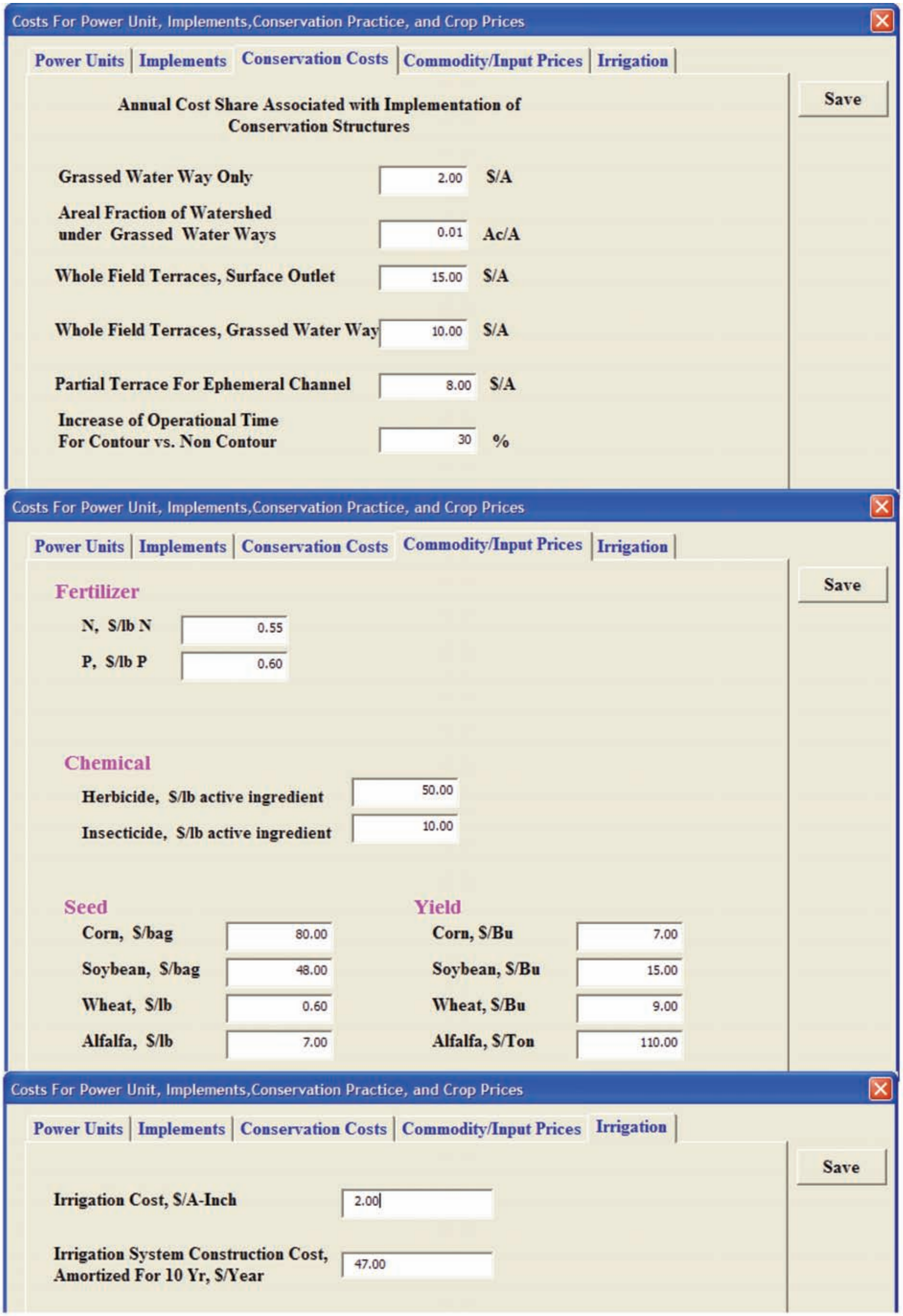
Tractor	35.00
Combine	75.00

Implement Operational Speed and Cost

	Speed, A/hr	Cost, $/A
Tillage Implements		
Field Cultivator	33	1.60
Disk	12.2	3.50
Moldboard	3.5	6.40
Row Cultivator	7	1.70
Chisel	13	2.70
Ridge Till	13	3.00
Planting Implements		
Row Planter	9.3	2.25
Drill Planter	6.8	3.00
Seeder-Packer	13	1.75
Chemical Input Implements		
Knife Applicator	25.6	1.75
Sprayer	25.6	0.75

	Speed, A/hr	Cost, $/A
Harvesting Implements		
Corn Header	9	9.45
Soybean Header	12	8.00
Small Grain Header	6.8	5.50
Swather	10.2	3.50
Windrow Turner	13	3.00
Baler	3.01	6.00
Bale Remover	13	0.50
Stalk Chopper	7.8	3.40

Figure 2.6. In Step 1 of inputting your description data, fill in the input costs associated with a given field operation, such as machinery, implements, seed, chemicals, and irrigation costs.



Annual Cost Share Associated with Implementation of Conservation Structures

Grassed Water Way Only 2.00 $/A

Areal Fraction of Watershed under Grassed Water Ways 0.01 Ac/A

Whole Field Terraces, Surface Outlet 15.00 $/A

Whole Field Terraces, Grassed Water Way 10.00 $/A

Partial Terrace For Ephemeral Channel 8.00 $/A

Increase of Operational Time For Contour vs. Non Contour 30 %

Fertilizer

N, $/lb N 0.55

P, $/lb P 0.60

Chemical

Herbicide, $/lb active ingredient 50.00

Insecticide, $/lb active ingredient 10.00

Seed		Yield	
Corn, $/bag	80.00	Corn, $/Bu	7.00
Soybean, $/bag	48.00	Soybean, $/Bu	15.00
Wheat, $/lb	0.60	Wheat, $/Bu	9.00
Alfalfa, $/lb	7.00	Alfalfa, $/Ton	110.00

Irrigation Cost, $/A-Inch 2.00

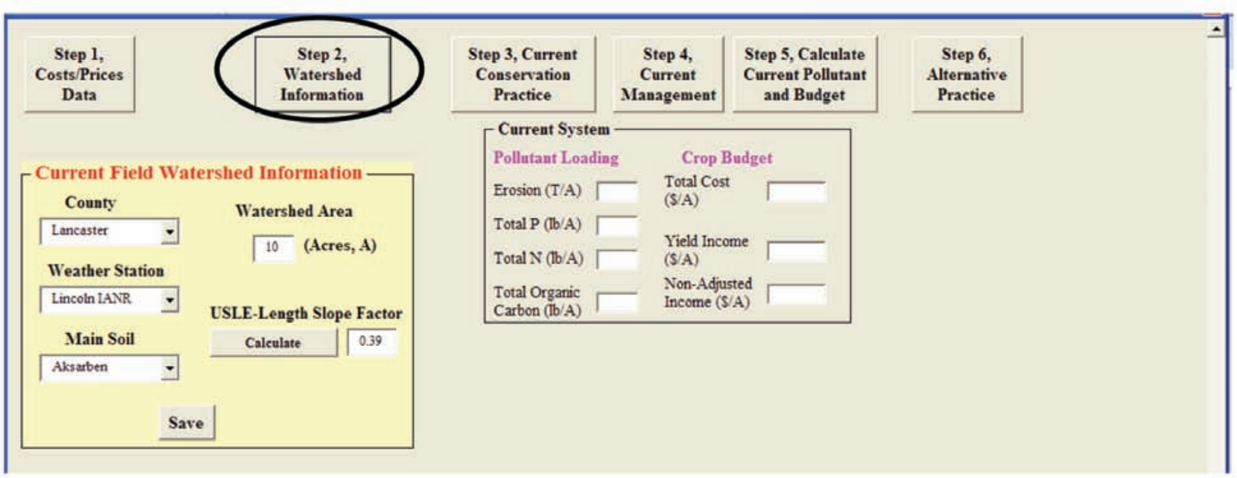
Irrigation System Construction Cost, Amortized For 10 Yr, $/Year 47.00

Figure 2.7. Users can input data or use default data for the annual cost share associated with implementation of conservation structures; commodity and input prices, and irrigation costs, to customize the recommendations to their operation.

Step. 2 Watershed Information

This section considers the physical characteristics of the field, including the main soil series, rainfall amount, and size and shape of the field. The Universal Soil Loss Equation (USLE) — Length Slope factor describes the shape and is calculated from the length, slope, and shape of the field.

1. Click on the **Field Watershed Information** button to enter the field details (*Figure 2.8*).
2. Select the **county** where the field is located from the drop-down list.
3. Select the **weather station** nearest to the field.
4. Select the **main soil series** present in the field.
5. Enter the size of the field in acres under the **watershed area**.
6. If the USLE Length Slope Factor value is known, enter it and click **Save**.
7. If the USLE Length Slope Factor value is not known, click **Calculate**. The window shown in *Figure 2.9* will be displayed.



County: Lancaster

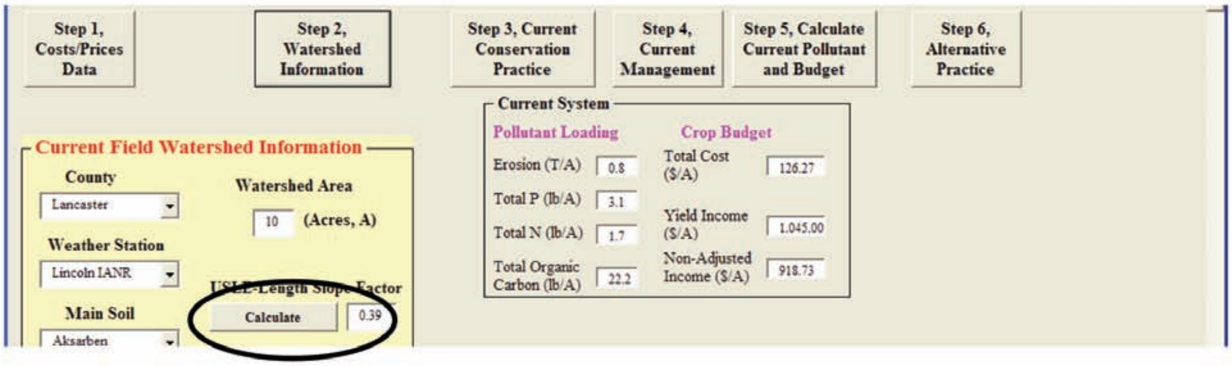
Weather Station: Lincoln IANR

Main Soil: Aksarben

Watershed Area: 10 (Acres, A)

USLE-Length Slope Factor: 0.39

Figure 2.8. In Step 2, fill in descriptive data about the field's watershed, including location, closest weather station, watershed area size and slope.



County: Lancaster

Weather Station: Lincoln IANR

Main Soil: Aksarben

Watershed Area: 10 (Acres, A)

USLE-Length Slope Factor: 0.39

Erosion (T/A): 0.8

Total P (lb/A): 3.1

Total N (lb/A): 1.7

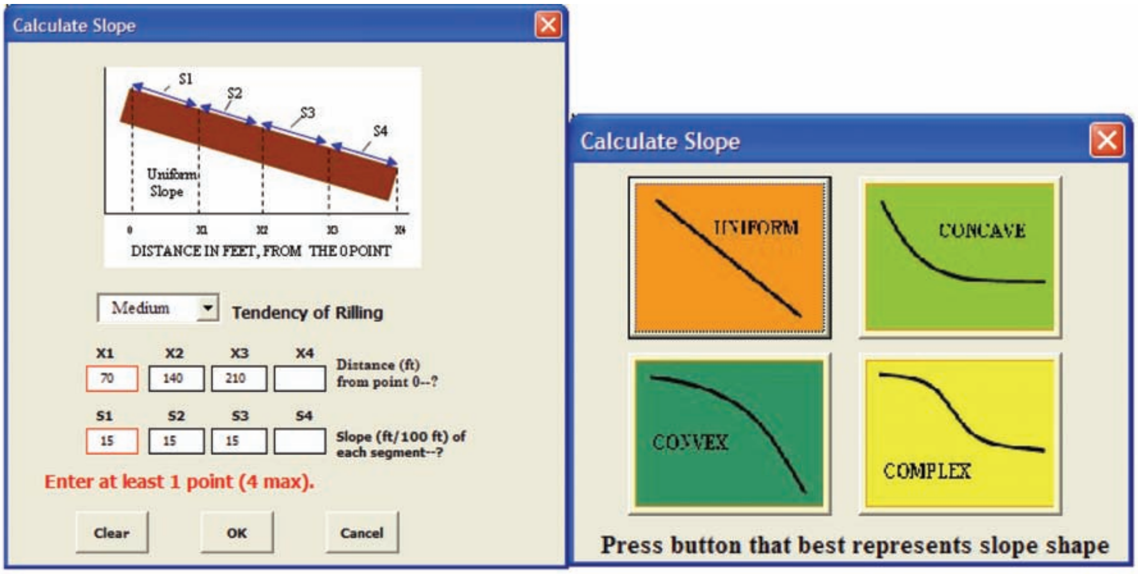
Total Organic Carbon (lb/A): 22.2

Total Cost ($/A): 126.27

Yield Income ($/A): 1,045.00

Non-Adjusted Income ($/A): 918.73

Figure 2.9. If the slope is unknown, click **Calculate** and the software will ask for further information and calculate the USLE-Length Slope Factor.



Medium Tendency of Rilling

X1	X2	X3	X4	
70	140	210		Distance (ft) from point 0--?

S1	S2	S3	S4	
15	15	15		Slope (ft/100 ft) of each segment--?

Enter at least 1 point (4 max).

Press button that best represents slope shape

Figure 2.10. To calculate the slope factor, the program will ask for further details describing your field, including slope shape, rilling, and distance between points on the slope.

8. Click on the diagram that best describes the major surface shape of the field — uniform, concave, convex, or complex (*Figure 2.10*). For example, if the surface is linear (uniform), then add data to this window:
    a. Rilling can be *Low, Medium* or *High*
    b. Enter distance in feet from the zero (0) reference point to the other points on the surface, as shown in the diagram. All distances must increase in equal length as the points get farther from the zero reference point (ex. 50, 100, 150 feet).
    c. Slope value for each increment can be obtained from a soil survey or measurement in the field.

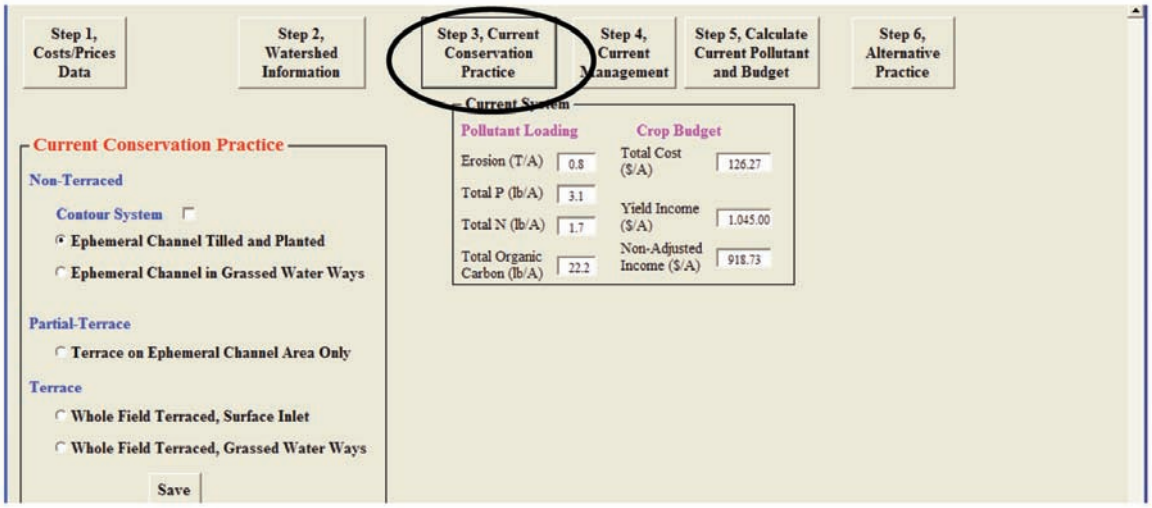
Note: A minimum of two data pairs are needed for the concave and convex shapes. Three data pairs are required for the complex shape.

9. Click **OK** to close the window and return to the previous window with the new LS value calculated.
10. After the LS factor has been calculated, click **Save**.

Step 3. Current Conservation Practices

This section addresses the soil conservation practices presently being used in the field. Conservation practices can influence soil erosion rates, chemical loss rates, and input costs.

1. Click on the **Current Conservation Practice** to enter this information (*Figure 2.11*).
2. Select the appropriate practice and click **Save**.



Current Conservation Practice

Non-Terraced

Contour System ☐

● Ephemeral Channel Tilled and Planted

○ Ephemeral Channel in Grassed Water Ways

Partial-Terrace

○ Terrace on Ephemeral Channel Area Only

Terrace

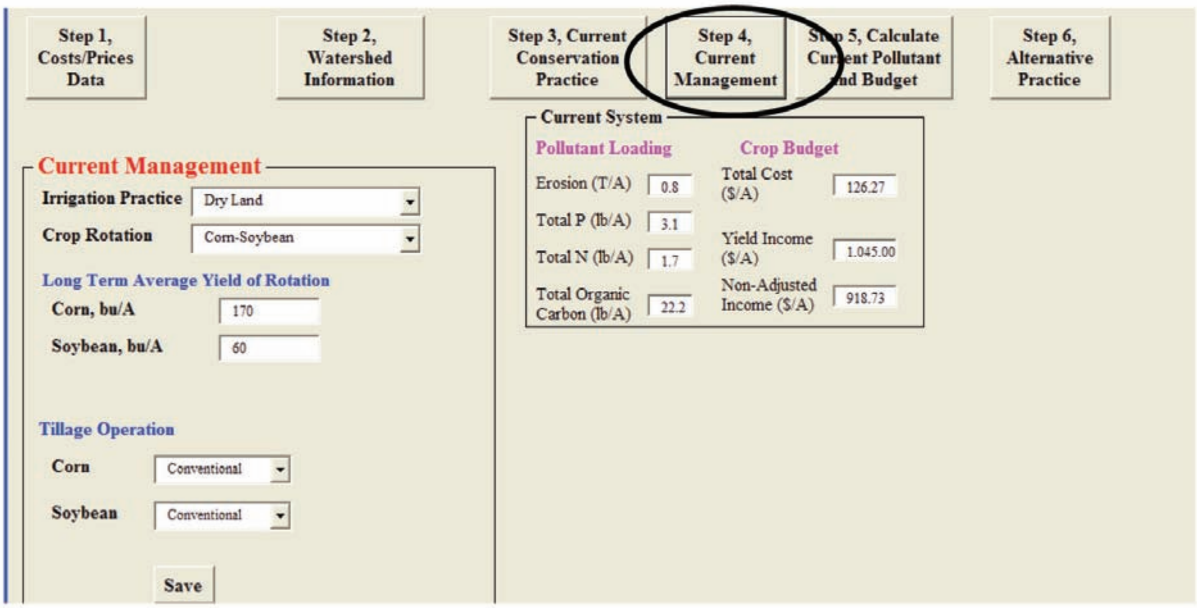
○ Whole Field Terraced, Surface Inlet

○ Whole Field Terraced, Grassed Water Ways

Current System

Pollutant Loading		Crop Budget	
Erosion (T/A)	0.8	Total Cost ($/A)	126.27
Total P (lb/A)	3.1		
Total N (lb/A)	1.7	Yield Income ($/A)	1,045.00
Total Organic Carbon (lb/A)	22.2	Non-Adjusted Income ($/A)	918.73

Figure 2.11. In Step 3, check the conservation practices currently used on this field from the options provided.



Current Management

Irrigation Practice: Dry Land

Crop Rotation: Corn-Soybean

Long Term Average Yield of Rotation

Corn, bu/A: 170

Soybean, bu/A: 60

Tillage Operation

Corn: Conventional

Soybean: Conventional

Current System

Pollutant Loading		Crop Budget	
Erosion (T/A)	0.8	Total Cost ($/A)	126.27
Total P (lb/A)	3.1		
Total N (lb/A)	1.7	Yield Income ($/A)	1.045.00
Total Organic Carbon (lb/A)	22.2	Non-Adjusted Income ($/A)	918.73

Figure 2.12 In Step 4, fill in the attributes that best describe current management operations and yields for this field.

Step 4. Current Management

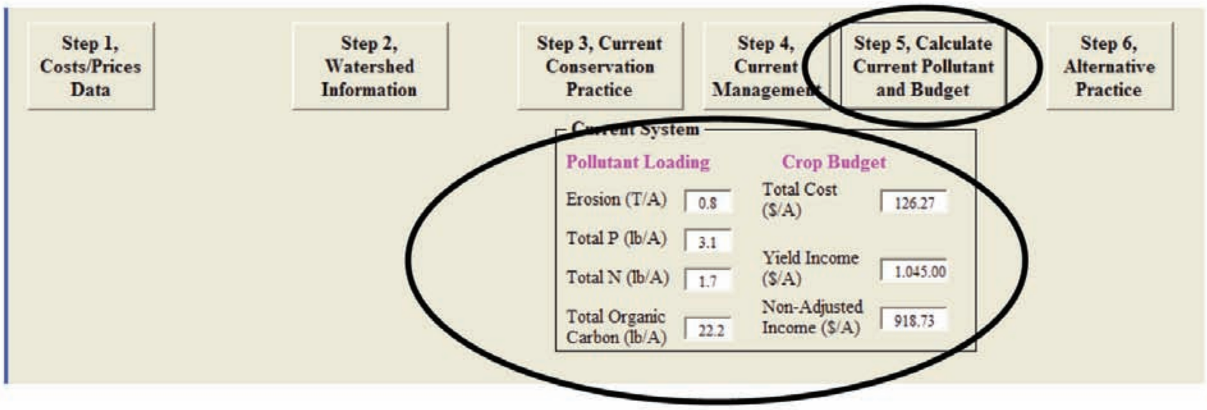
The management system currently used on the field is entered here. Common crop rotations and tillage operations are provided for selection.

1. Click on the **Current Management** button to enter this information (*Figure 2.12*).
2. Select the appropriate information and click **Save**.

Step 5. Calculate Current System's Pollutant Loading and Crop Budget

SEE-DST predicts soil and chemical losses from the field and economics based on the descriptive data provided by the user.

1. Click the **Calculate Current Pollutant and Budget** (*Figure 2.13*) button, and the results based on input data will be displayed. (**Note:** Current system data can be changed or revised at any time and the resulting effect on the final loading and budget can be recalculated.)



Current System

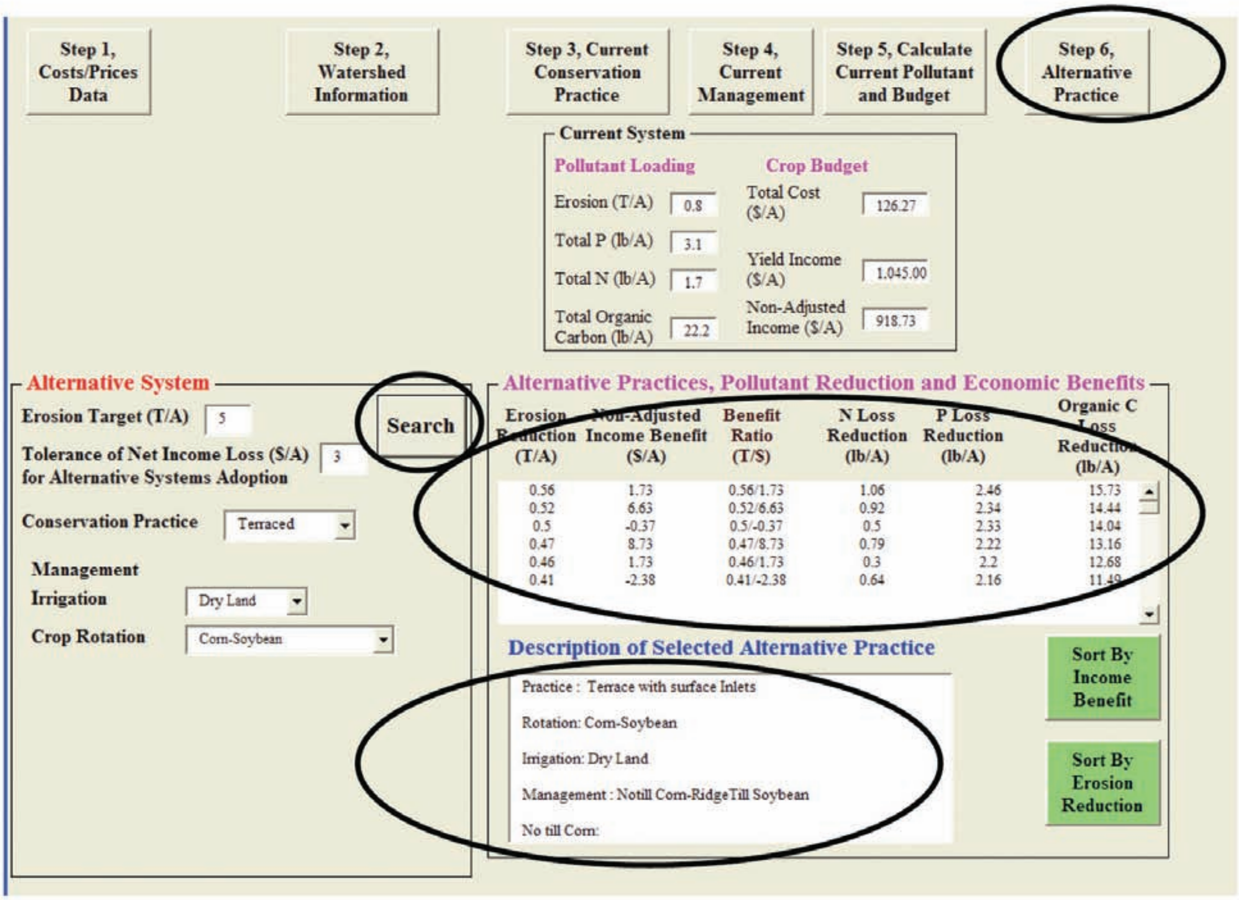
Pollutant Loading		Crop Budget	
Erosion (T/A)	0.8	Total Cost ($/A)	126.27
Total P (lb/A)	3.1		
Total N (lb/A)	1.7	Yield Income ($/A)	1.045.00
Total Organic Carbon (lb/A)	22.2	Non-Adjusted Income ($/A)	918.73

Figure 2.13. After you've input all the required descriptive data about your field, move to Step 5 to calculate current pollutant loading and the budget.

Step 6. Alternative Practice

In this section, the user provides a goal for changing soil erosion levels, the level of tolerance for economic costs associated with potential alternative practices, and suggestions for changes in soil conservation structures and management systems. SEE-DST then displays alternative practices based on these inputs. The number of alternatives provided depends on the magnitude of goals (levels of reduced erosion rate and net income loss tolerance) and the suggested management changes (conservation practice, irrigation, and crop rotation) selected by the user.

1. Click the **Alternative Practice** button to open the input window where the user's goals and suggested changes are entered (Erosion Target, Tolerance of Income Loss, Conservation Practice, Management).
2. Click the **Search** button to have SEE-DST search for and return suggested alternative practices.
3. In the **Alternative Practices** window, each line in the reduction and benefits box represents the benefits from one practice alternative. If there are no values in the box, no alternative practices could be found to meet the user-defined goals and suggestions. When a row of values is selected, the **Description of Selected Alternative Practices** box contains the details for the given practice. Practices can be ranked by erosion or cost benefits by clicking on the appropriate sort button.
4. *Figure 2.14* shows six alternative practices that were suggested, based on the user's data and input. These six are sorted and ranked by economic benefit. The highlighted best management practice indicated is a dryland, corn-soybean rotation using field terraces and grassed waterways (details given in the description). In this case, the **benefit ratio** (0.56 tons/$1.73) is a reduction of erosion by 0.56 tons/acre from 0.8 tons/acre and the non-adjusted income benefit is $1.73/acre.



Current System

Pollutant Loading

Erosion (T/A) 0.8

Total P (lb/A) 3.1

Total N (lb/A) 1.7

Total Organic Carbon (lb/A) 22.2

Crop Budget

Total Cost ($/A) 126.27

Yield Income ($/A) 1,045.00

Non-Adjusted Income ($/A) 918.73

Alternative System

Erosion Target (T/A) 5

Tolerance of Net Income Loss ($/A) for Alternative Systems Adoption 3

Conservation Practice Terraced

Management

Irrigation Dry Land

Crop Rotation Corn-Soybean

Alternative Practices, Pollutant Reduction and Economic Benefits

Erosion Reduction (T/A)	Non-Adjusted Income Benefit ($/A)	Benefit Ratio (T/$)	N Loss Reduction (lb/A)	P Loss Reduction (lb/A)	Organic C Loss Reduction (lb/A)
0.56	1.73	0.56/1.73	1.06	2.46	15.73
0.52	6.63	0.52/6.63	0.92	2.34	14.44
0.5	-0.37	0.5/-0.37	0.5	2.33	14.04
0.47	8.73	0.47/8.73	0.79	2.22	13.16
0.46	1.73	0.46/1.73	0.3	2.2	12.68
0.41	-2.38	0.41/-2.38	0.64	2.16	11.49

Description of Selected Alternative Practice

Practice : Terrace with surface Inlets

Rotation: Corn-Soybean

Irrigation: Dry Land

Management : Notill Corn-RidgeTill Soybean

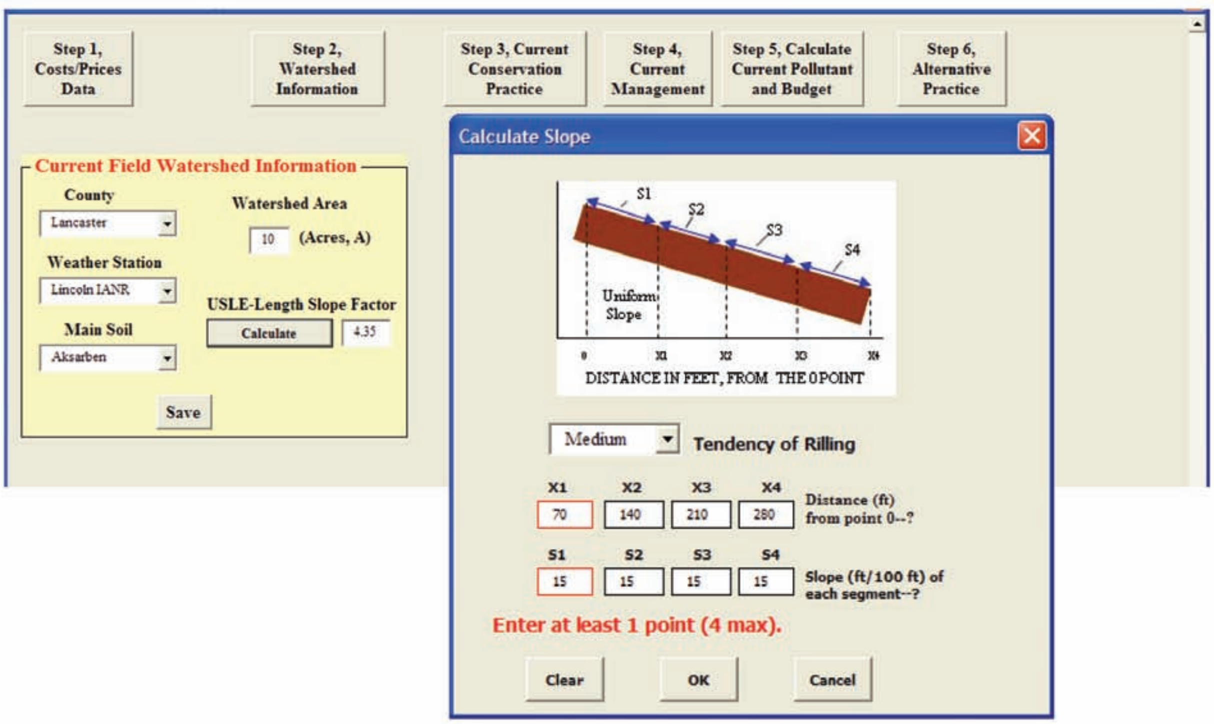
No till Corn:

Figure 2.14. In Step 6, SEE-DST will suggest alternative practices, including the estimated reduction in erosion and nutrient loss, and the income benefit per acre based on user's erosion reduction target and income loss tolerance.

Examples of Data Input and Results for Three Farms

Example 1: Jane Field, near Lincoln, Nebraska

1. Default **Cost/Price** values are used for this example.
2. **Field Watershed Information** is entered. The Jane field is linear (uniform) in shape. The gully is tilled and planted. The calculated length-slope factor is 4.35 (*Figure 2.15*).
3. The field is not terraced and is not contoured. The ephemeral channel is tilled and planted (*Figure 2.16*).
4. The **Current Management** system is corn-soybean rotation with conventional tillage operation (*Figure 2.17*).
5. Click **Calculate Current Pollutant and Budget** and the predicted pollutant loading and cost savings will be displayed (*Figure 2.18*). The erosion loss from Jane field is 7.1 tons/acre/year. The total phosphorus loss is 27.3 lb/acre/year, and total nitrogen loss is 15.5 lb/acre/year. The non-adjusted income ($/acre) is the difference between total cost and yield income.
6. **Alternative Practices** *have an erosion target* of 5 tons/acre and a $3/acre income loss tolerance. The cropping system will remain a corn-soybean rotation and with the terrace conservation practice option.
7. Click **Search** to produce alternative practice suggestions (*Figure 2.19*). Scrolling through the eight, ranked by erosion reduction, shows that contour planted corn-soybean rotation with grass waterways and no terraces results in the most erosion reduction — 4.52 tons/acre from the current rate of 7.1 tons/acre.



Current Field Watershed Information

County: Lancaster

Watershed Area: 10 (Acres, A)

Weather Station: Lincoln IANR

Main Soil: Aksarben

USLE-Length Slope Factor: 4.35

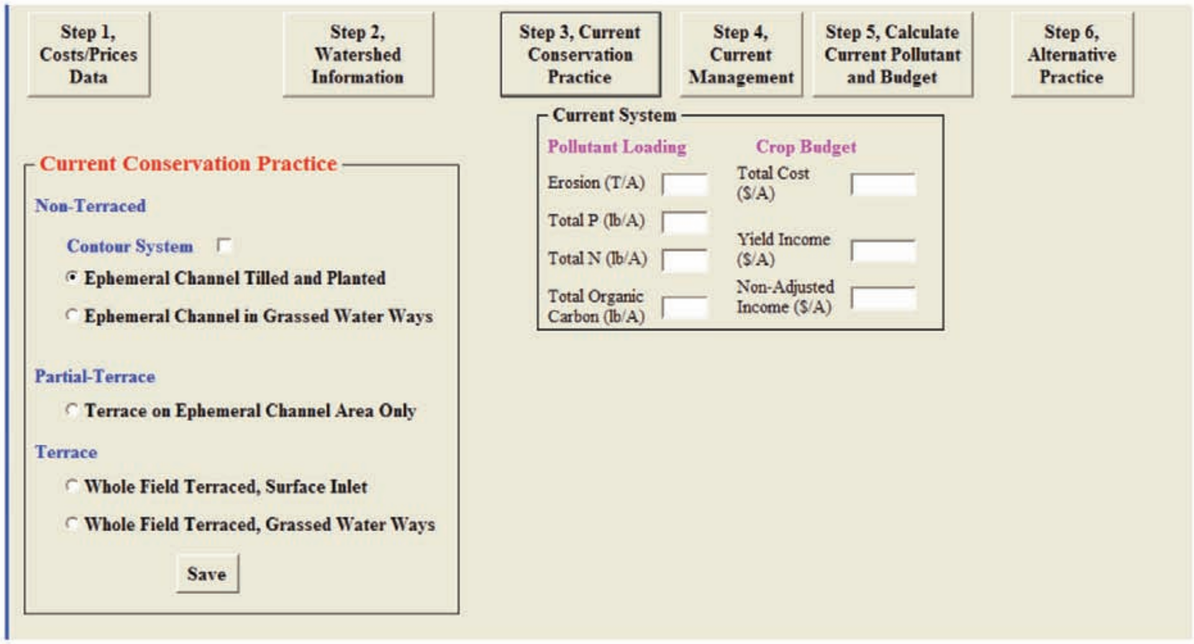
Tendency of Rilling: Medium

	X1	X2	X3	X4
Distance (ft) from point 0--?	70	140	210	280

	S1	S2	S3	S4
Slope (ft/100 ft) of each segment--?	15	15	15	15

Enter at least 1 point (4 max).

Figure 2.15. Example data input for *Example 1*, Jane Field near Lincoln.



Current Conservation Practice

Non-Terraced

Contour System ☐

● Ephemeral Channel Tilled and Planted

○ Ephemeral Channel in Grassed Water Ways

Partial-Terrace

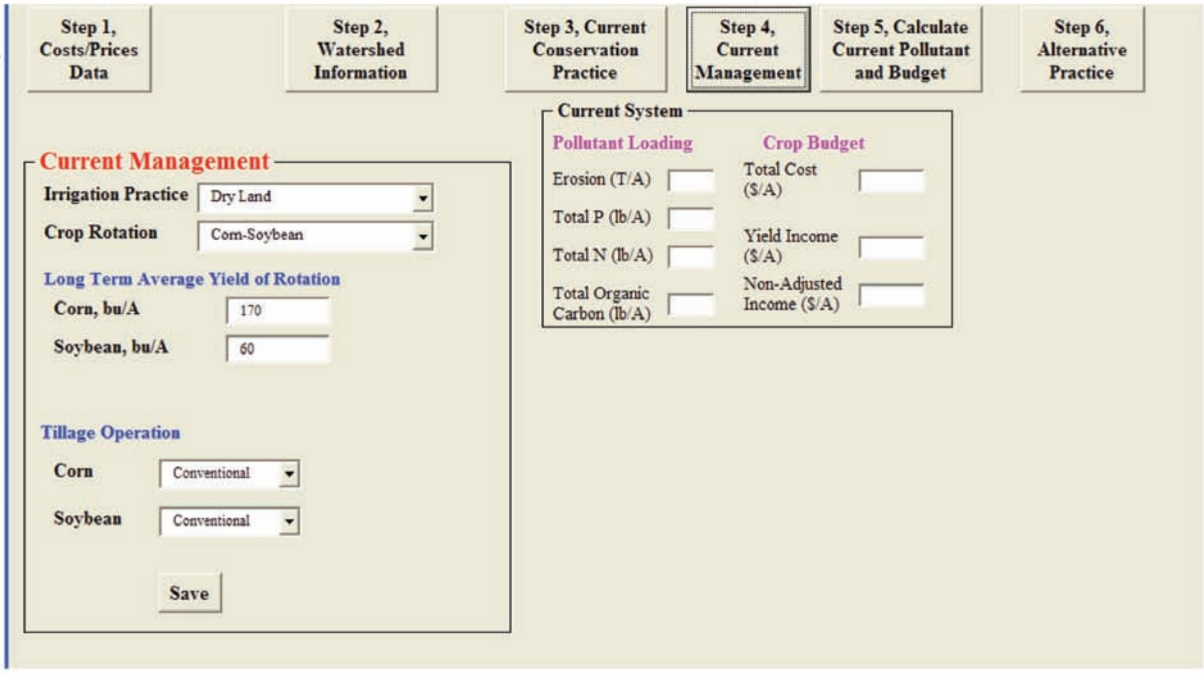
○ Terrace on Ephemeral Channel Area Only

Terrace

○ Whole Field Terraced, Surface Inlet

○ Whole Field Terraced, Grassed Water Ways

Figure 2.16. Data input for current conservation practices used for the Jane Field in *Example 1*.



Current Management

Irrigation Practice: Dry Land

Crop Rotation: Corn-Soybean

Long Term Average Yield of Rotation

Corn, bu/A: 170

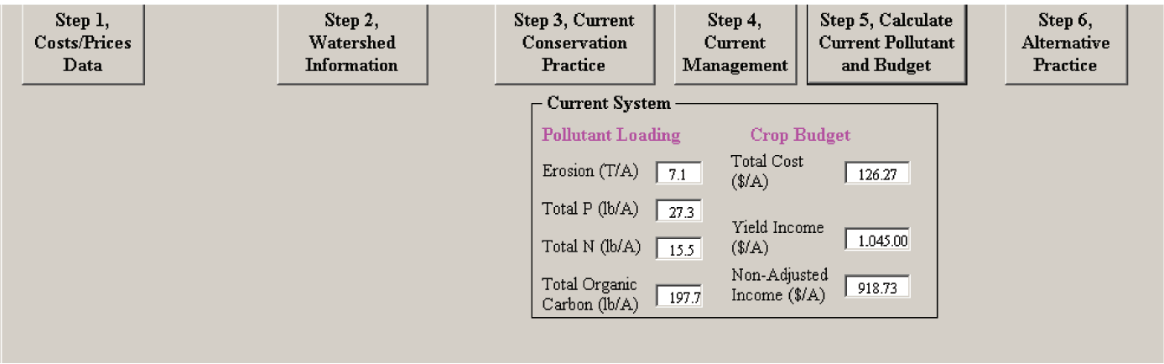
Soybean, bu/A: 60

Tillage Operation

Corn: Conventional

Soybean: Conventional

Figure 2.17. Data input for current management practices being used for the Jane Field in *Example 1*.



Current System

Pollutant Loading

Erosion (T/A) 7.1

Total P (lb/A) 27.3

Total N (lb/A) 15.5

Total Organic Carbon (lb/A) 197.7

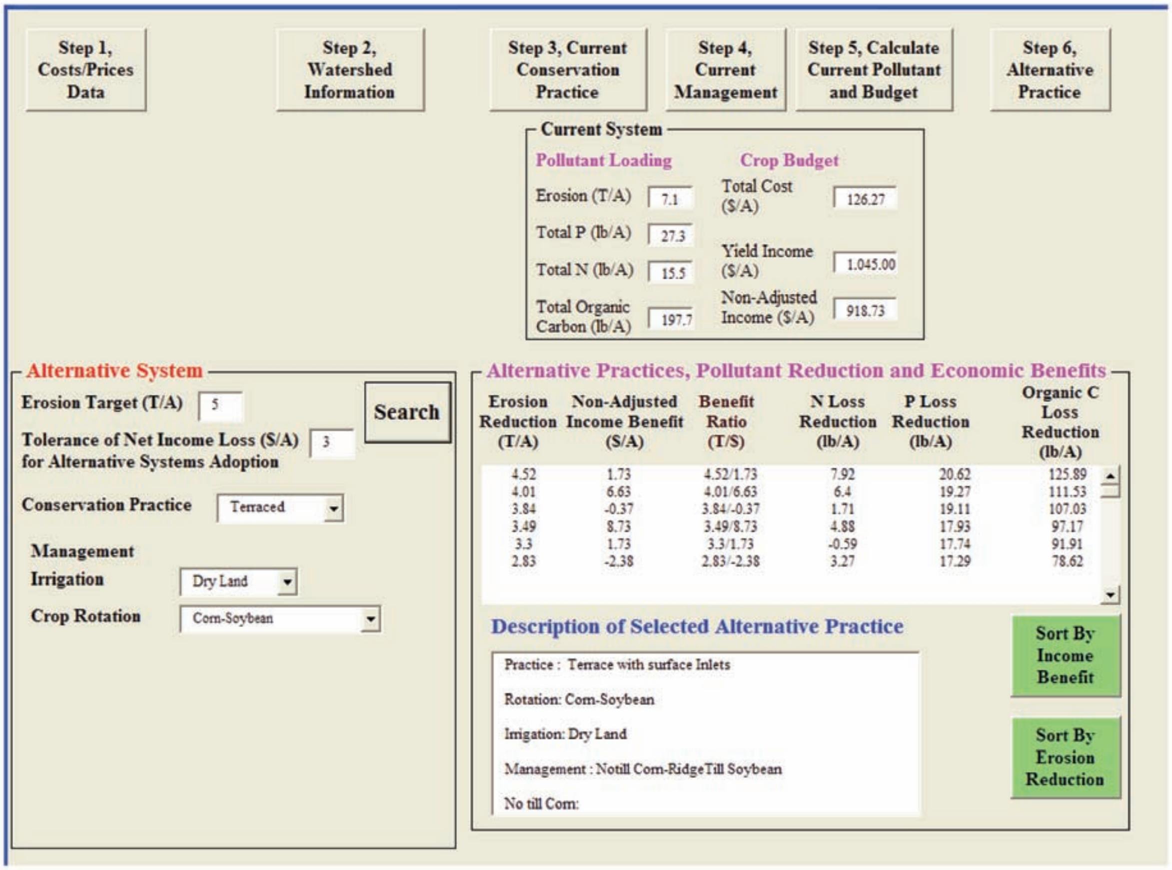
Crop Budget

Total Cost ($/A) 126.27

Yield Income ($/A) 1.045.00

Non-Adjusted Income ($/A) 918.73

Figure 2.18. Current pollutant loading and crop budget calculated for the Jane Field in *Example 1*.



Current System

Pollutant Loading

Erosion (T/A) 7.1

Total P (lb/A) 27.3

Total N (lb/A) 15.5

Total Organic Carbon (lb/A) 197.7

Crop Budget

Total Cost ($/A) 126.27

Yield Income ($/A) 1.045.00

Non-Adjusted Income ($/A) 918.73

Alternative System

Erosion Target (T/A) 5

Tolerance of Net Income Loss ($/A) for Alternative Systems Adoption 3

Conservation Practice: Terraced

Management

Irrigation: Dry Land

Crop Rotation: Corn-Soybean

Alternative Practices, Pollutant Reduction and Economic Benefits

Erosion Reduction (T/A)	Non-Adjusted Income Benefit ($/A)	Benefit Ratio (T/$)	N Loss Reduction (lb/A)	P Loss Reduction (lb/A)	Organic C Loss Reduction (lb/A)
4.52	1.73	4.52/1.73	7.92	20.62	125.89
4.01	6.63	4.01/6.63	6.4	19.27	111.53
3.84	-0.37	3.84/-0.37	1.71	19.11	107.03
3.49	8.73	3.49/8.73	4.88	17.93	97.17
3.3	1.73	3.3/1.73	-0.59	17.74	91.91
2.83	-2.38	2.83/-2.38	3.27	17.29	78.62

Description of Selected Alternative Practice

Practice : Terrace with surface Inlets

Rotation: Corn-Soybean

Irrigation: Dry Land

Management : Notill Corn-RidgeTill Soybean

No till Corn:

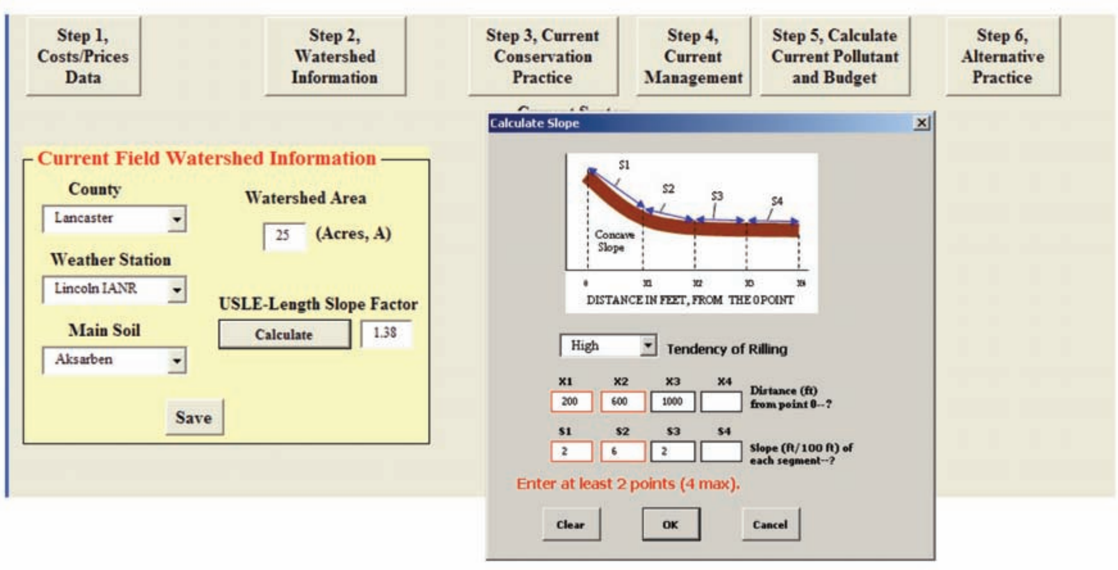
Figure 2.19. Alternative practices suggested for the Jane Field in *Example 1*. The best option suggested was a rotation of no-till corn and ridge-till soybean contour planted with terrace and grass waterway.

Interpretation of the Results of the Jane Field

The most erosion reduction may not necessarily be the best option economically, thus the erosion benefit to non-adjusted income ratio should be evaluated to determine the best potential option both in erosion reduction and income benefit. In this example, the best option based on the reduction to income benefit ratio is the second row, where the most reduction in erosion is made while increasing income (4.01 tons/$6.63). This best option has a suggested practice of a rotation of no-till corn and ridge-till soybean contour planted with terrace and grass waterway. The worst option is the last row, where erosion reduction decreases the non-adjusted income.

Example 2: Jones Field, near Lincoln, Nebraska

1. Default **Cost/Price** values are used for this example.
2. **Field Watershed Information** is entered (*Figure 2.20*). Much of the soil information is taken from the Lancaster County Soil Survey. The calculated length-slope factor is 1.38.
3. This field has no terraces but has a grassed waterway, utilizing a contour planting of a corn/soybean rotation (*Figure 2.21*).
4. The management system is dryland and both crops are no-tilled.



Current Field Watershed Information

County: Lancaster

Watershed Area: 25 (Acres, A)

Weather Station: Lincoln IANR

Main Soil: Aksarben

USLE-Length Slope Factor: 1.38

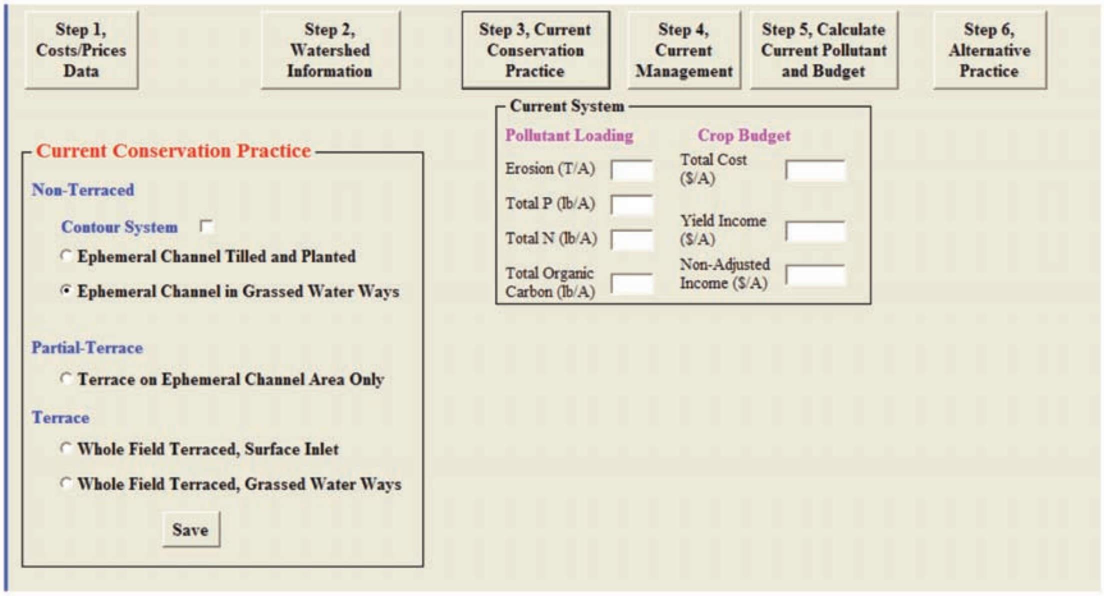
High — Tendency of Rilling

X1	X2	X3	X4	
200	600	1000		Distance (ft) from point 0--?

S1	S2	S3	S4	
2	6	2		Slope (ft/100 ft) of each segment--?

Enter at least 2 points (4 max).

Figure 2.20. Inputting data for *Example 2* for the Jones Field near Lincoln, Nebraska.



Current Conservation Practice

Non-Terraced

Contour System ☐

○ Ephemeral Channel Tilled and Planted

● Ephemeral Channel in Grassed Water Ways

Partial-Terrace

○ Terrace on Ephemeral Channel Area Only

Terrace

○ Whole Field Terraced, Surface Inlet

○ Whole Field Terraced, Grassed Water Ways

Current System

Pollutant Loading		Crop Budget	
Erosion (T/A)		Total Cost ($/A)	
Total P (lb/A)			
Total N (lb/A)		Yield Income ($/A)	
Total Organic Carbon (lb/A)		Non-Adjusted Income ($/A)	

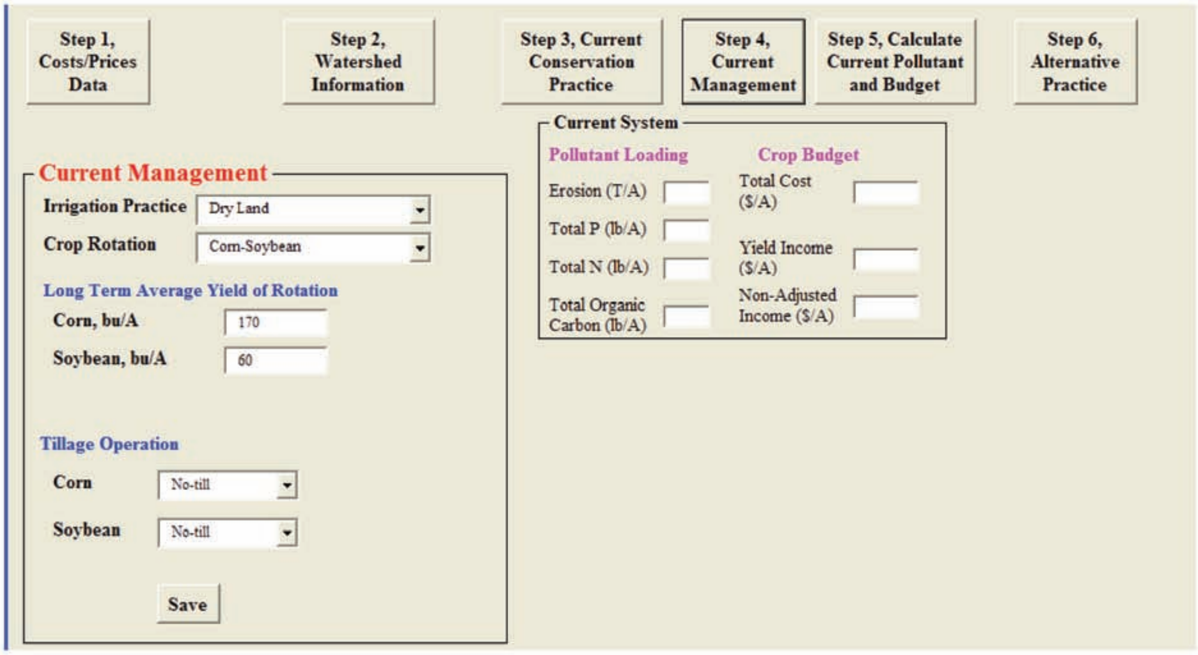
Figure 2.21. Inputting current conservation practices for the Jones Field, *Example 2*.

5. Click **Calculate Current Pollutant and Budget** and the predicted pollutant loading and costs/savings will be displayed (*Figure 2.22*).

6. **Alternative Practices** suggested have an erosion target of 0.5 tons/acre and a $5/acre income loss tolerance (*Figure 2.24*). The cropping system will remain a dryland corn-soybean rotation with the terrace conservation practice option.

7. Click **Search** to produce alternative practice suggestions. In this case, no practices met the desired goals so the suggestion box is empty (*Figure 2.25*).

8. By changing the corn-soybean rotation system to **Any** and clicking **Search**, five alternatives are returned (*Figure 2.26*). These five are ranked by **Income Benefit**. Scroll through the suggested practices and you'll see that continuous corn is the only system that meets the established goals.



Current Management

Irrigation Practice: Dry Land

Crop Rotation: Corn-Soybean

Long Term Average Yield of Rotation

Corn, bu/A: 170

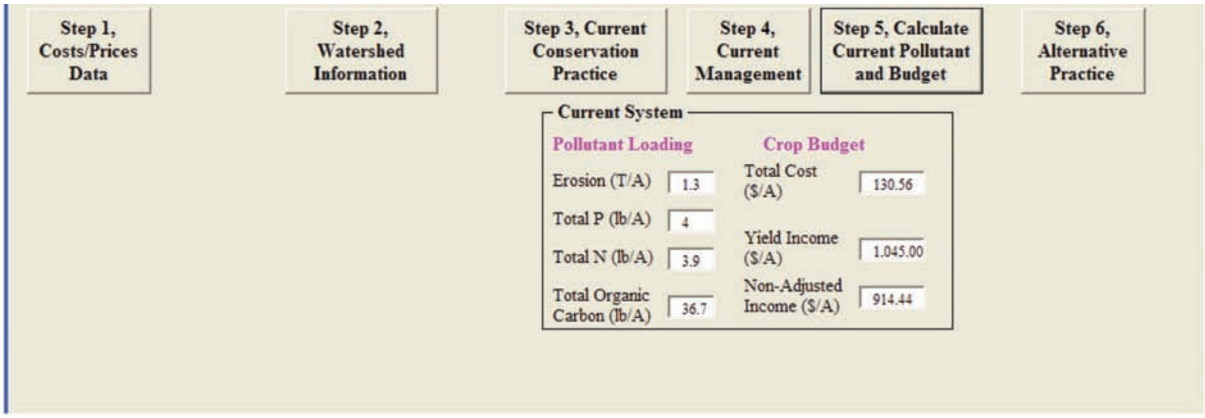
Soybean, bu/A: 60

Tillage Operation

Corn: No-till

Soybean: No-till

Figure 2.22 In Step 4, current management practices are input for the Jones Field.



Erosion (T/A): 1.3

Total P (lb/A): 4

Total N (lb/A): 3.9

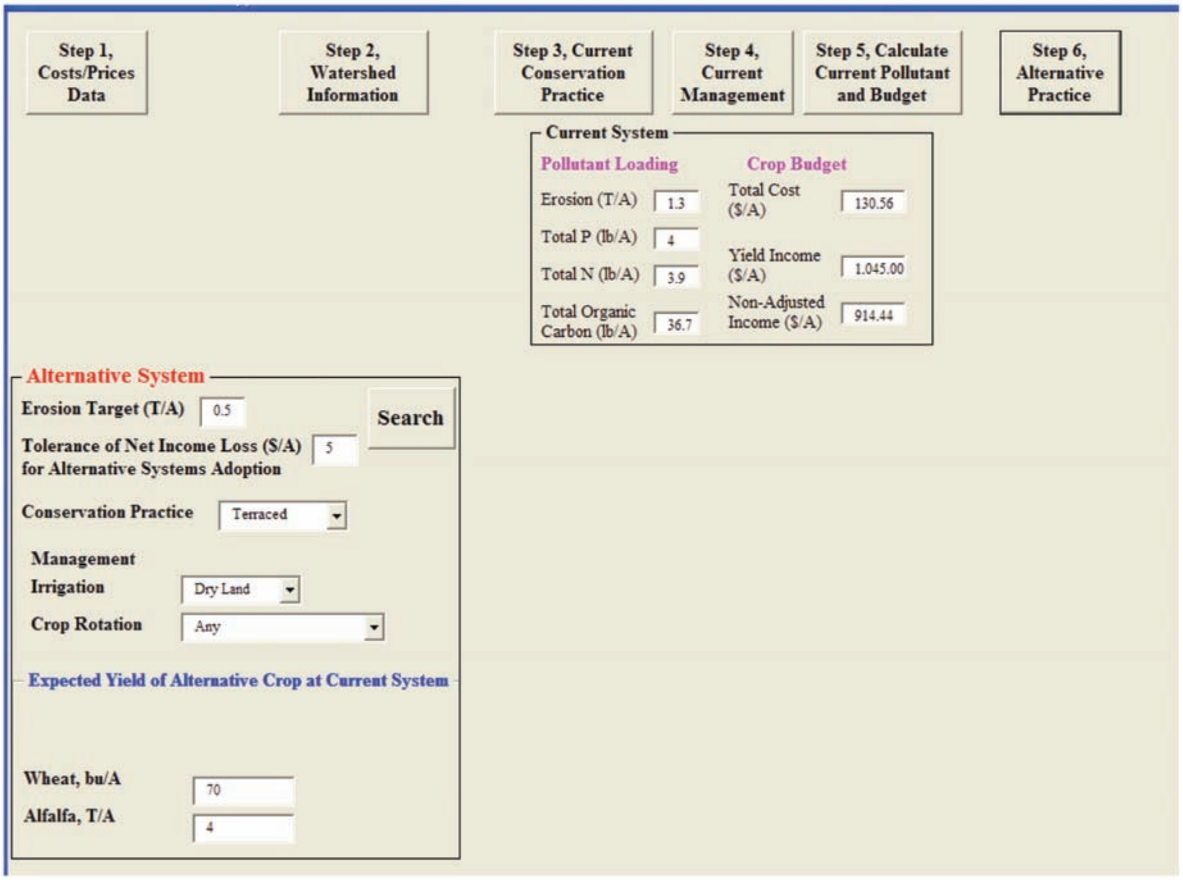
Total Organic Carbon (lb/A): 36.7

Total Cost ($/A): 130.56

Yield Income ($/A): 1,045.00

Non-Adjusted Income ($/A): 914.44

Figure 2.23. Pollutant loading and the crop budget is calculated for the Jones Field.



Current System

Pollutant Loading

Erosion (T/A) 1.3
Total P (lb/A) 4
Total N (lb/A) 3.9
Total Organic Carbon (lb/A) 36.7

Crop Budget

Total Cost ($/A) 130.56
Yield Income ($/A) 1,045.00
Non-Adjusted Income ($/A) 914.44

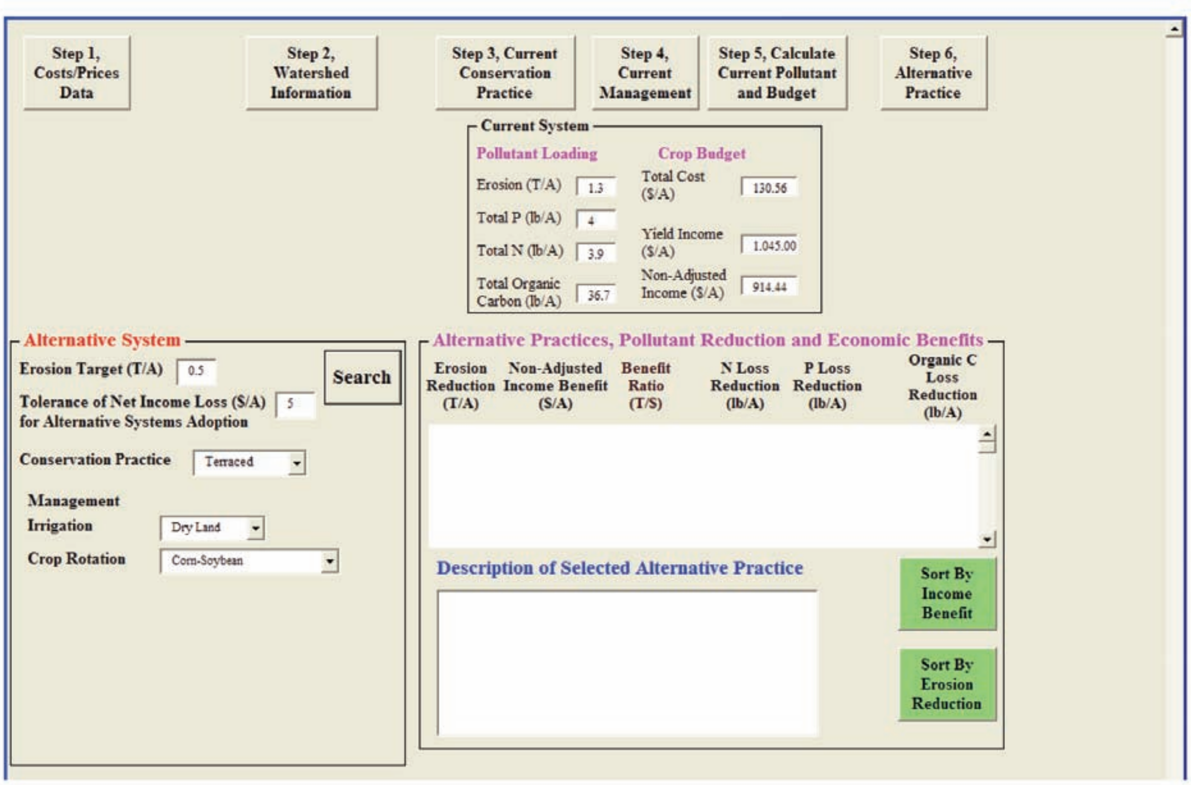
Alternative System

Erosion Target (T/A) 0.5
Tolerance of Net Income Loss ($/A) for Alternative Systems Adoption 5
Conservation Practice Terraced

Management
Irrigation Dry Land
Crop Rotation Any

Wheat, bu/A 70
Alfalfa, T/A 4

Figure 2.24. *Example 2* used an erosion target of 0.5 ton per acre and an income loss tolerance of $5/acre.



Current System

Pollutant Loading

Erosion (T/A) 1.3
Total P (lb/A) 4
Total N (lb/A) 3.9
Total Organic Carbon (lb/A) 36.7

Crop Budget

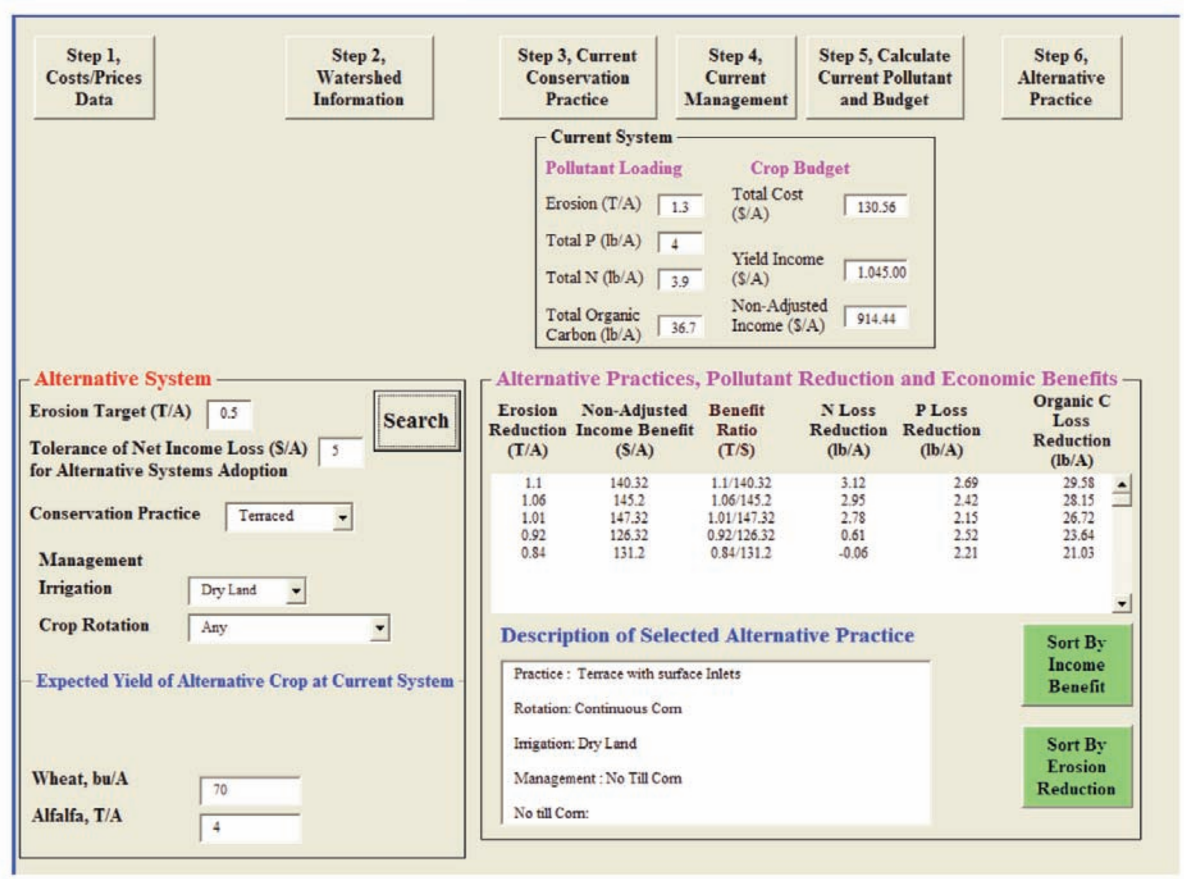
Total Cost ($/A) 130.56
Yield Income ($/A) 1,045.00
Non-Adjusted Income ($/A) 914.44

Alternative System

Erosion Target (T/A) 0.5
Tolerance of Net Income Loss ($/A) for Alternative Systems Adoption 5
Conservation Practice Terraced

Management
Irrigation Dry Land
Crop Rotation Corn-Soybean

Figure 2.25. With the information provided, no alternative practices were suggested for this field.



Current System

Pollutant Loading

Erosion (T/A) 1.3

Total P (lb/A) 4

Total N (lb/A) 3.9

Total Organic Carbon (lb/A) 36.7

Crop Budget

Total Cost ($/A) 130.56

Yield Income ($/A) 1,045.00

Non-Adjusted Income ($/A) 914.44

Alternative System

Erosion Target (T/A) 0.5

Tolerance of Net Income Loss ($/A) for Alternative Systems Adoption 5

Conservation Practice: Terraced

Management

Irrigation: Dry Land

Crop Rotation: Any

Expected Yield of Alternative Crop at Current System

Wheat, bu/A 70

Alfalfa, T/A 4

Alternative Practices, Pollutant Reduction and Economic Benefits

Erosion Reduction (T/A)	Non-Adjusted Income Benefit ($/A)	Benefit Ratio (T/$)	N Loss Reduction (lb/A)	P Loss Reduction (lb/A)	Organic C Loss Reduction (lb/A)
1.1	140.32	1.1/140.32	3.12	2.69	29.58
1.06	145.2	1.06/145.2	2.95	2.42	28.15
1.01	147.32	1.01/147.32	2.78	2.15	26.72
0.92	126.32	0.92/126.32	0.61	2.52	23.64
0.84	131.2	0.84/131.2	-0.06	2.21	21.03

Description of Selected Alternative Practice

Practice : Terrace with surface Inlets

Rotation: Continuous Corn

Irrigation: Dry Land

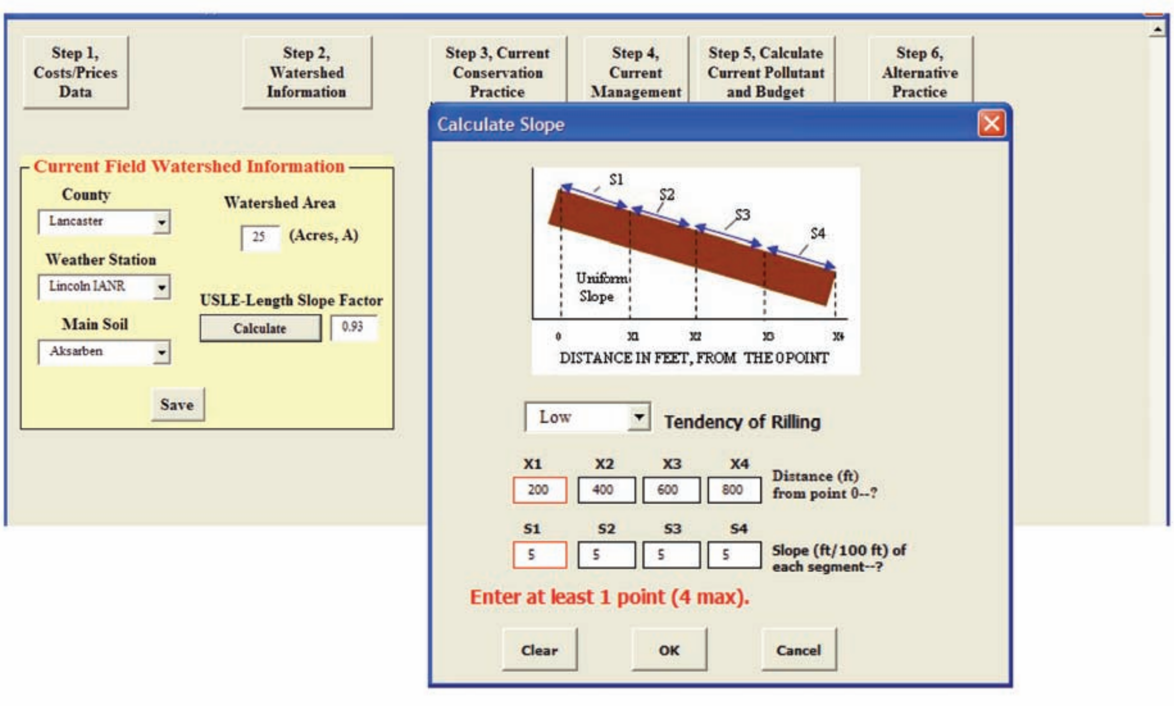
Management : No Till Corn

No till Corn:

Figure 2.26 By changing the corn-soybean rotation system and then clicking **Search**, five alternative practices are recommended for the Jones Field used in *Example 2*.

Example 3: Smith Field, near Lincoln, Nebraska

1. Default **Cost/Price** values are used for this example.
2. **Field Watershed Information** is entered (*Figure 2.27*). Much of the soil information is taken from the Lancaster County Soil Survey. The Smith field is similar to the Jones field in terms of soil type and slope, but the Smith field is terraced and linear (uniform) in shape, while the Jones field is not. The calculated length-slope factor for Smith is 0.93.
3. The field is terraced with outlet drains (*Figure 2.28*).
4. The **Current Management** system is the same as the Jones field.



Current Field Watershed Information

County: Lancaster

Watershed Area: 25 (Acres, A)

Weather Station: Lincoln IANR

Main Soil: Aksarben

USLE-Length Slope Factor: 0.93

Calculate Slope

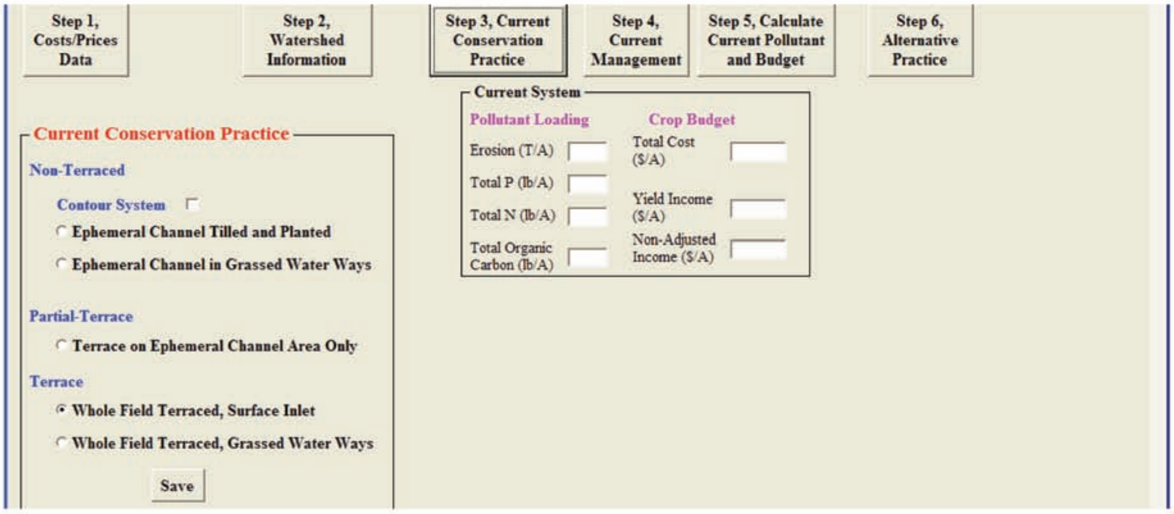
Tendency of Rilling: Low

	X1	X2	X3	X4
Distance (ft) from point 0--?	200	400	600	800

	S1	S2	S3	S4
Slope (ft/100 ft) of each segment--?	5	5	5	5

Enter at least 1 point (4 max).

Figure 2.27. Using information from the Lancaster County Soil Survey, the length-slope factor is calculated for the Smith Field used in *Example 3*.



Current Conservation Practice

Non-Terraced

Contour System ☐

- ○ Ephemeral Channel Tilled and Planted
- ○ Ephemeral Channel in Grassed Water Ways

Partial-Terrace

- ○ Terrace on Ephemeral Channel Area Only

Terrace

- ● Whole Field Terraced, Surface Inlet
- ○ Whole Field Terraced, Grassed Water Ways

Current System

Pollutant Loading		Crop Budget	
Erosion (T/A)		Total Cost ($/A)	
Total P (lb/A)			
Total N (lb/A)		Yield Income ($/A)	
Total Organic Carbon (lb/A)		Non-Adjusted Income ($/A)	

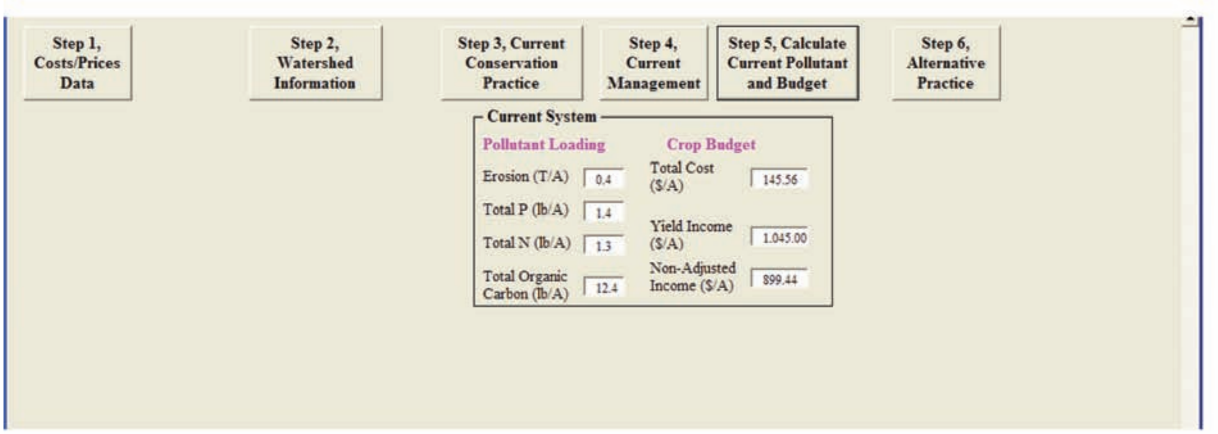
Figure 2.28. For *Example 3*, Step 3 the user inputs data indicating that the Smith Field is terraced without outlet drains.

5. Click **Calculate Current Pollutant and Budget** and the predicted pollutant loading and cost savings will be displayed (*Figure 2.29*).

6. **Alternative Practices** have an erosion target of 0.5 tons/acre and a $5/acre income loss tolerance (*Figure 2.31*). The cropping system will be any no-till crop option.

7. Click **Search** to produce alternative practice suggestions. Scrolling through the seven options, ranked by income alternatives, shows that continuous corn, with various soil erosion control measures, is suggested as an alternative (*Figure 2.32*).

In both the Jones and Smith examples, the erosion rate was rather low prior to exploring alternative practices. To further lessen the rate (Jones) or keep it at the present rate (Smith), the main alternative was to grow continuous corn or, in the Jones case, to install terraces.



Current System

Pollutant Loading

Erosion (T/A) 0.4

Total P (lb/A) 1.4

Total N (lb/A) 1.3

Total Organic Carbon (lb/A) 12.4

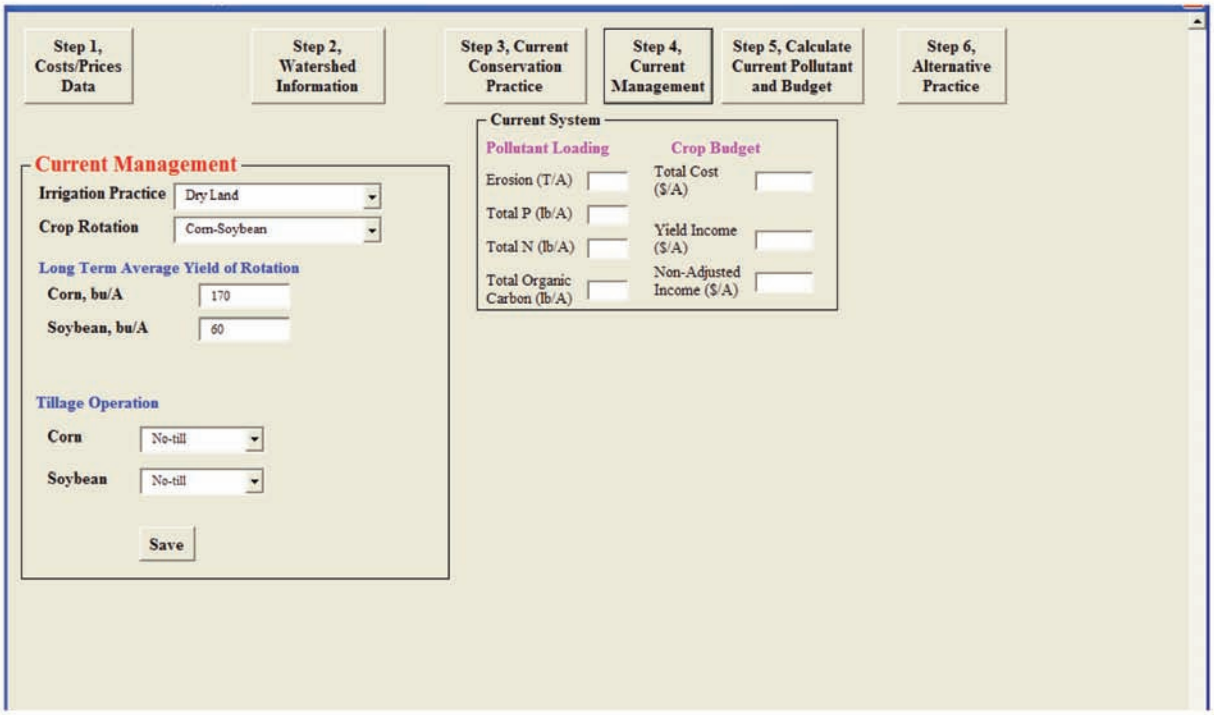
Crop Budget

Total Cost ($/A) 145.56

Yield Income ($/A) 1,045.00

Non-Adjusted Income ($/A) 899.44

Figure 2.29. In Step 4, current management practices are input for *Example 3*.



Current Management

Irrigation Practice: Dry Land

Crop Rotation: Corn-Soybean

Long Term Average Yield of Rotation

Corn, bu/A: 170

Soybean, bu/A: 60

Tillage Operation

Corn: No-till

Soybean: No-till

Current System

Pollutant Loading

Erosion (T/A)

Total P (lb/A)

Total N (lb/A)

Total Organic Carbon (lb/A)

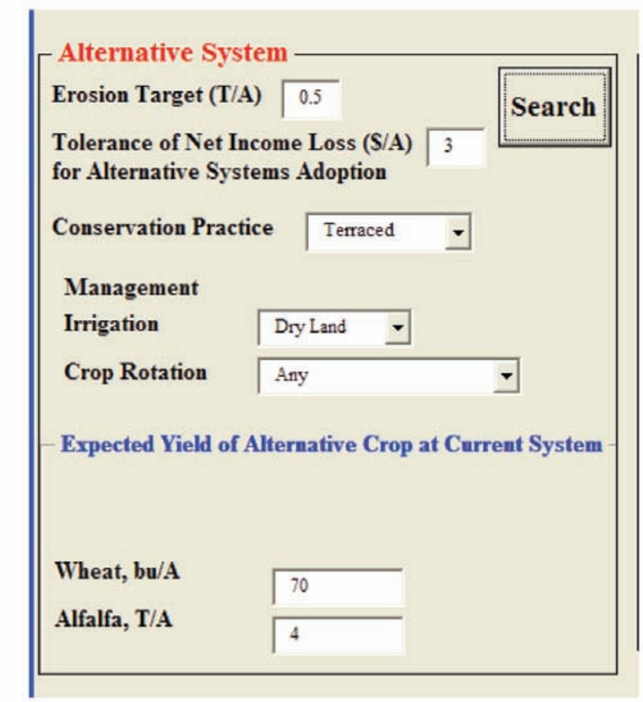
Crop Budget

Total Cost ($/A)

Yield Income ($/A)

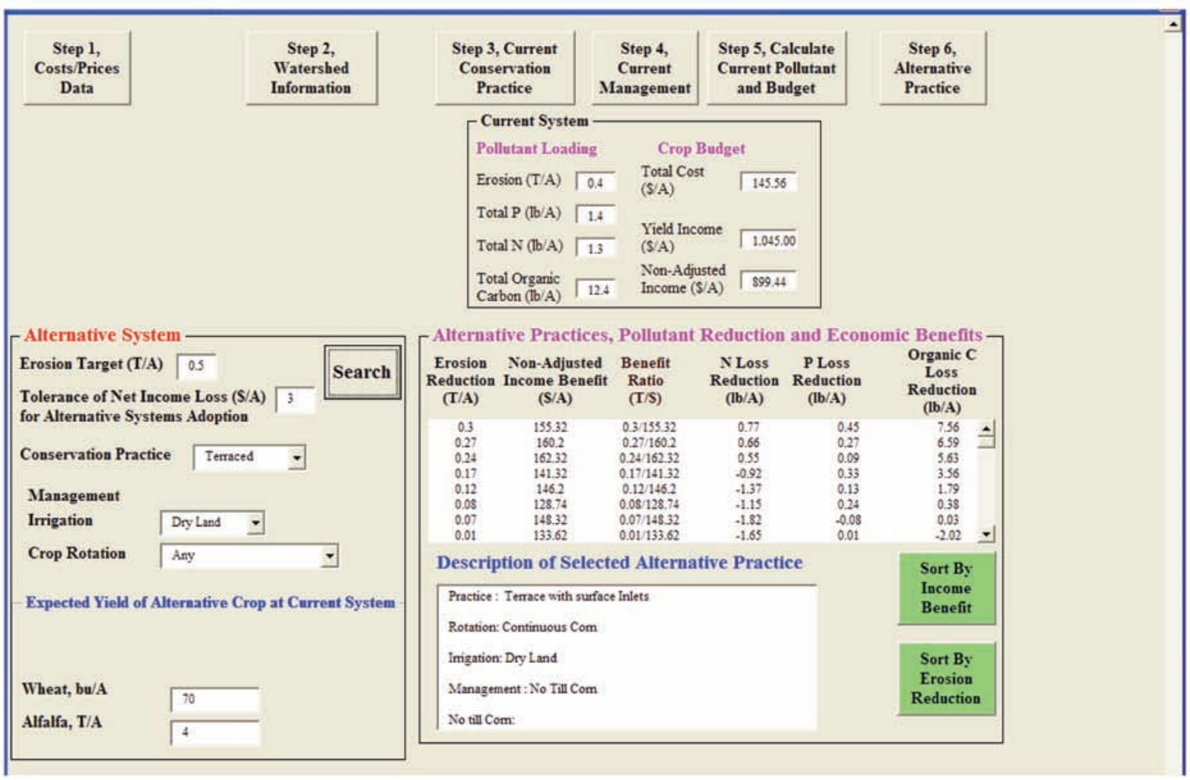
Non-Adjusted Income ($/A)

Figure 2.30. In Step 5, click calculate to see the predicted pollutant loading and economics for the current practice.



Erosion Target (T/A): 0.5
Tolerance of Net Income Loss ($/A) for Alternative Systems Adoption: 3
Conservation Practice: Terraced
Management
Irrigation: Dry Land
Crop Rotation: Any
Wheat, bu/A: 70
Alfalfa, T/A: 4

Figure 2.31. In *Example 3* under alternative practices, an erosion target of 0.5 tons per acre and an income loss tolerance of $3 per ton were input.



Erosion (T/A): 0.4
Total P (lb/A): 1.4
Total N (lb/A): 1.3
Total Organic Carbon (lb/A): 12.4
Total Cost ($/A): 145.56
Yield Income ($/A): 1.045.00
Non-Adjusted Income ($/A): 899.44

Erosion Target (T/A): 0.5
Tolerance of Net Income Loss ($/A) for Alternative Systems Adoption: 3
Conservation Practice: Terraced
Management
Irrigation: Dry Land
Crop Rotation: Any
Wheat, bu/A: 70
Alfalfa, T/A: 4

Erosion Reduction (T/A)	Non-Adjusted Income Benefit ($/A)	Benefit Ratio (T/$)	N Loss Reduction (lb/A)	P Loss Reduction (lb/A)	Organic C Loss Reduction (lb/A)
0.3	155.32	0.3/155.32	0.77	0.45	7.56
0.27	160.2	0.27/160.2	0.66	0.27	6.59
0.24	162.32	0.24/162.32	0.55	0.09	5.63
0.17	141.32	0.17/141.32	-0.92	0.33	3.56
0.12	146.2	0.12/146.2	-1.37	0.13	1.79
0.08	128.74	0.08/128.74	-1.15	0.24	0.38
0.07	148.32	0.07/148.32	-1.82	-0.08	0.03
0.01	133.62	0.01/133.62	-1.65	0.01	-2.02

Practice : Terrace with surface Inlets
Rotation: Continuous Corn
Irrigation: Dry Land
Management : No Till Corn
No till Corn:

Figure 2.32 In Step 6, clicking **Search** under **Alternative Practices** will bring up a list of suggested practices meeting the erosion target and income tolerance level.

Glossary of Terms

Best Management Practices (BMPs): Structural, non-structural and managerial techniques to control non-point source pollutants of land areas.

Conservation Practice: Any reshaping of the land surface to reduce water erosion of soil. Examples include field terraces, grassed waterways, and holding ponds (NRCS).

Ephemeral: An ephemeral water body is a creek or stream that flows for a short time after rainfall and/or snowmelt.

Eutrophication: Enrichment of surface waters with nutrients, primarily phosphorus, causing abundant aquatic plant growth. The subsequent death of the aquatic plants causes oxygen depletion affecting aquatic animals.

Pollutant: Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems. (U.S. EPA)

Rill: A steep-sided channel resulting from accelerated water erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery. (NRCS Soil Survey)

Slope: The inclination of the soil surface from the horizontal. Slope percent is the vertical distance divided by the horizontal distance then multiplied by 100. (NRCS)

Slope-length factor (L factor - USLE): The ratio of soil loss from the field slope length to that from a 72.6-foot length under identical conditions. (NRCS)

Terrace: An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. (NRCS Soil Survey)

Thalweg: The deepest part of a river or waterway.

USLE: The Universal Soil Loss Equation is an erosion model designed to predict the long-term average soil losses in runoff from specific field areas in specified cropping and management systems (NRCS)

Watershed: The land area that drains water to a particular stream, river, or lake.

Table of Conversion Factors

English Units to Metric Units

Multiply	by	To obtain
Length		
inch (in) inch (in) foot (ft)	2.54 25.4 0.3048	centimeter (cm) millimeter (mm) meter (m)
Area		
acre acre square foot (ft^2)	4,047 0.4047 0.09290	square meter (m^2) hectare (ha) square meter (m^2)
Volume		
acre-foot (acre-ft)	1,233	cubic meter (m^3)
Mass		
pound, avoirdupois (lb) ton, short (2,000 lb) ton per year (ton/yr)	0.4536 0.9072 0.9072	kilogram (kg) megagram (Mg) megagram per year (Mg/yr)
Density		
pound per cubic foot (lb/ft^3) pound per cubic foot (lb/ft^3)	16.02 0.01602	kilogram per cubic meter (kg/m^3) gram per cubic centimeter (g/cm^3)
Application Rate		
pounds per acre per year [(lb/acre)/yr]	1.121	kilograms per hectare per year [(kg/ha)/yr]