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Economic Research Service

> Technical Bulletin Number 1659

# A Computerized System for Estimating and Displaying Shortrun Costs of Soil Conservation **Practices**

Daryll D. Raitt



A COMFUTERIZED SYSTEM FOR ESTIMATING AND DISPLAYING SHORTRUN COSTS OF SOIL CONSERVATION PRACTICES, Daryll D. Raitt. Natural Resource Economics Division, Economic Research Service, U.S. Department of Agriculture. Technical Bulletin No. 1659.

#### Abstract

A computerized system is presented for estimating and displaying shortrun costs of alternative combinations of soil conservation practices for specific soils. Erosion rates, costs per acre, and costs per ton reduction of erosion are displayed in a schematic diagram that permits one to observe the cumulative effects of adding practices to an initial practice. Combinations of practices are ranked by the cost per ton reduction and cost per acre. The reduction in erosion versus cost per acre or per ton reduction can also be displayed. The model also computes the effects of incremental changes in underlying conservation input costs on per acre practice costs.

Keywords: Computerized system, economics of conservation, soil conservation costs, soil erosion, erosion control, conservation management, conservation practices, land treatment

#### Acknowledgments

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#### Summary

The report describes a computer system which can be used for rapidly estimating and displaying the shortrun annual ensite costs of soil conservation practices by soil types. Basic inputs consist of crop budget data, engineering data, and soil erosion data. This information is entered for each type of soil and location and the computer outputs erosion rates, costs per acre, and costs per ton reduction of erosion.

The base from which annual conservation costs are computed is continuous row cropping without conservation practices. Examples of output with the base crop of corn or soybeans as well as a combination of half corn and half soybeans are presented. Combinations of practices are ranked by cost per acre and cost per ton of reduced erosion.

Another capability is to graphically plot the reduction in erosion versus cost per acre or cost per ton. Erosion rates, costs per acre, and costs per ton reduction of erosion are displayed in a schematic diagram that permits one to observe the cumulative effects of adding practices to a single initial practice. The model also computes the effect of incremental changes in underlying conservation input costs on per acre practice costs.

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# A Computerized System for Estimating and Displaying Shortrun Costs of Soil Conservation Practices

#### Daryll D. Raitt Agricultural Economist

#### Introduction

Increased exports of food and fiber have placed heavy demands on our soil resources, fostering renewed concern about soil depletion. Economic data for analyzing the soil depletion problem and potential alternative solutions are needed by decisionmakers as they assess the extent of soil erosion, the adequacy of present policy and programs, and the economic and environmental impacts of soil erosion. The most basic of these needs is data relating costs of conservation practices to levels of erosion.

The number of alternative conservation practices available for reducing erosion is relatively small. Practices can be applied in various combinations and degrees, however, resulting in several alternatives for a given soil and location. Since erosion rates and conservation costs vary by soils and location, a large amount of information is required to consider all viable combinations and soils for an area. Computers are an efficient means for generating and displaying these conservation costs and erosion data.

This report describes a computer system developed for rapidly estimating and displaying the shortrun annual onsite costs of soil conservation practices by soil types. The system can also be used to estimate future onsite costs and benefits by projecting the underlying variables through time. The basic purpose of the system, however, is to provide a consistent method for estimating relative costs of various combinations of practices in reducing soil erosion. Data can be entered for a single type of soil representing a particular field or a soil group representing a broader aggregation of soils. The computer system provides the following output for a particular soil:

- Comparison of conservation costs. Costs of incremental reductions in erosion are used to rank 50 combinations of soil conservation practices, providing a means to identify the least costly mix of practices for a given level of soil erosion.
- Display of erosion reduction vs. costs. Costs of erosion reduction for 50 combinations of conservation practices are plotted by levels of erosion reduction, providing a graphic display of dispersion.
- Comparison of practice sequence. Erosion rates and costs for 50 combinations of conservation practices are displayed in a manner permitting observation of the cumulative effects of adding various practices to a single initial practice.
- Incremented analysis of costs. Changes in costs of conservation can be estimated and displayed for incremental changes in underlying cost data. The system is flexible enough to provide a range of outputs for any change in inputs. This feature also permits periodic updating as underlying input costs, yields, product prices, or other variables change.

The explicit and systematic way in which data must be specified allows specialists from disciplines such as soils, agronomy, and engineering to constructively evaluate and improve the data base. The educational aspects of the system should be especially useful in working with farm groups. Groups can specify the variables for their particular situations and the cost and erosion data can be generated for various combinations of practices. This report presents the basic data needs, operations, and capability of the computer system. The sources and form of basic inputs are indicated and examples of output are presented. A complete documentation of the computer programs is available from the author (see p. 12).

#### Input Data

Basic inputs consist of crop budget data, engineering data, and soil erosion data (fig. 1). Crop budgets are used to estimate the net annual income per acre associated with various annual conservation practices. Engineering data are used to compute the annual cost of capital expenditures and maintenance per acre for practices such as terraces. Soil erosion factors are used to estimate the annual erosion rates per acre for each combination of conservation practices. These data are entered on the worksheet (app. A) for each type of soil.

#### **Soil Erosion Factors**

Gross annual sheet and rill erosion is defined as the tons of soil moved yearly by surface water and is estimated by a computer program using the Universal Soil Loss Equation (USLE) (1):1 A = R K (LS) C P

where:

A = annual soil loss in tons per acre R = rainfall factor K = soil erodability factor L = slope length factor S = slope gradient factor C = cover factor P = conservation practice factor (LS) = slope gradient length (LS) =  $\left(\frac{L}{72.6}\right)^{M} = \frac{430X^{2} + 30X + 0.43}{6.57415}$ 

Where:

m = 0.5 if S = 5% or greater = 0.4 if S = 4% = 0.3 if S = 3% or less

And:

 $X = Sin \Theta$  $\Theta = Angle of slope degrees$  The factors for each soil type are entered into the computer from the worksheet forms (app. A). The R, K, and P factors are usually readily available from specialists at Soil Conservation Service (SCS) State offices. The L and S factors can be estimated by technicians for each soil type. These factors can be quite precise when data are for a specific field or represent an average when a typical soil for an area is the unit of interest.

Separate C factors can be obtained from agronomists for each type of tillage practice and crop residue management practice being considered. Three types of tillage practices for corn and two for soybeans are considered in this example. The tillage practices are defined by the operations used in the crop budgets. Separate C factors are required for each crop, rotation, and set of tillage operations used in the system.

#### Soils Data

The contemplated use of estimates will determine the basic level of soils aggregation. For farm-level analysis, the basic soil mapping units might be used. A soil mapping unit is described as a portion of the landscape that has similar characteristics and qualities whose limits are fixed by precise definitions (2). The soil maps used by technicians working with farmers on conservation plans usually show the location and extent of the soil mapping units. For an analysis of larger areas, aggregations of soil mapping units may be used. For example, ten soil resource groups (SRG's) consisting of aggregations of soil mapping units were used to represent the range of upland soils in the Northern Missouri River Tributaries Basin Study.<sup>2</sup> The soil mapping units in each SRG are relatively homogeneous with respect to crop yields. costs of production, and erosion hazards. The acreage and attributes (K, L, and S factors) of soils within SRG 124, the most prevalent SRG in the basin, are shown in table 1. Examples in this report are for this particular SRG.

#### **Crop Budgets**

The Oklahoma Crop Budget Computer Generator is used to estimate costs of production and net income for each crop and tillage operation (3, 4). Use of a budget generator is not necessary to estimate annual practice costs but the systematic output facilitates documentation and provides details of

<sup>-</sup> Italicazed numbers in parentheses refer to items listed in Bibliography.

<sup>&</sup>lt;sup>2</sup>This study is currently underway as a cooperative effort of the State of Missouri and the U.S. Department of Agriculture.

#### **Estimating Shortrun Coste of Conservation (schematic)**



P = conservation practice factor

فتع

Land capability class	Soil name	Total in	ventory	K factor	Slope	Length of slope
		Acres	Percent		Percent	Feet
3E05	Lagonda SICL	449,641	0.253	0.37	0.070	282.6
3E05	Shelby CL	406,292	.229	.28	.068	241.3
3E05	Adair CL	146,480	.083	.32	.067	267.3
3E05	Grundy SICL	140,618	.079	.37	.070	300.0
3E05	Grundy SICL	119,818	.068	.37	.030	300.0
3E05	Seymour SIL	62,987	.036	.37	.067	227.7
3E04	Ladoga SIL	61,046	.034	.37	.070	250.0
3E05	Mexico SIL	48,457	.027	.43	.060	300.0
3E01	Winfield SIL	47,045	.027	.37	.070	299.3
3E05	Grundy SIL	44,574	0.25	.37	.068	291.7
3E05	Pershing SIL	30,312	.017	.37	.070	250.5
3E05	Adair CL	27,237	.015	.32	.039	289.4
3E02	Lineville SIL	25,524	.014	.37	.063	283.4
3E05	Weldon SIL	23,062	.013	.43	.070	289.7
3E05 8E05	Lagonda SICL	21,533	.012	.37	.040	295.6
3EU5	Keswick L	21,495	.012	.37	.080	200.0
3505	Seymour SIL	17,982	.010	.37	.030	300.0
3505	Sampsei SICL	15,325	.009	.37	.070	215.7
3503	Greenton SIL	14,348	.008	.37	.070	215.7
3505		8,824	.005	.32	.069	200.0
3505	Persning SiL	6,911	.004	.37	.040	249.6
3603		5,297	.003	.37	.060	294.3
3505		4,596	.003	.37	.070	200.0
3503	Dala CU	4,392	.002	.32	.030	250.0
3604	Viluinaina CH	3,591	.002	.32	.070	200.0
3605	Corp Stl	2,988	.002	.43	.060	300.0
3205	Sayton SIL	2,871	.002	.43	.060	200.0
3205	Colo SIL	2,544	.001	.43	.040	200.0
3203	Maying Ell	2,164	.001	.43	.062	279.2
3203	Stalamata SII	2,071	.001	.43	.030	304.0
3505	Corio SU	009	.000	.37	.070	300.0
3505	Waldan SII	729	.000	.32	.040	300.0
3505	Calwoods GU	363	000.	.43	.040	200.0
3505	Clasinda SU	309	.000	.43	.060	200.0
3E05		020 260	.000	.37	.030	300.0
3E08	Sevmour SII	200	.000	.32	.070	250.0
3E05		200	.000	.37	.030	300.0
3E08		104	.000	.43	.040	300.0
3E08	Adair CL	56	.000	.u/ ac	.040	300.0
3E07	Sharnsburg SICI	25	.000	.34	.040	300.0
Tetal	Suchaon's proc	4.0	.000	. 32	.000	200.0
10[3]		1,773,757	1.000			
Average)				.347	.064	269.2

#### Table 1—Attributes of soil mapping units aggregated to SRG 124, Northern Tributaries River Basin, Missouri

\*Weighted by total inventory acres

machine operations and inputs that are useful in synthesizing alternative management practices. All SCS State offices and most land-grant universities have access to a crop budget generator and have personnel familiar with the operation of the system. Once a basic crop budget for an area is generated, changes in inputs and yields to represent different soil types and management practices can be rapidly simulated.

Examples of output from the crop budget generator are presented in sample printouts 1 and 2. Two other similar corn budgets representing minimum and zero tillage are required. The budgets represent the farming operations and inputs for the various practices. In general, conventional tillage consists of moldboard plowing, cultivation, and use of some herbicides. Minimum tillage consists of chisel plowing, less tillage, and increased use of herbicides so that at least 2,000 pounds of top residue per acre are maintained. Zero tillage relies on chemicals for control of weeds and diseases and a 15-percent increase in applied nitrogen [5].<sup>3</sup> In practice, periodic tillage is recommended to prevent weed and disease buildup.

It was assumed that crop yields remain the same in the shortrun for all conservation practices. This assumption can easily be changed if information is available showing a significant difference in yields by conservation practices for a given soil. Input costs are for 1979-80 and product prices are current normal prices published by the U.S. Water Resources Council [6].

Eight crop budgets were generated for this analysis. Budgets for wheat, alfalfa, pasture, and conventional tillage and minimum tillage soybeans were developed in addition to the three corn budgets.

The base from which annual conservation costs are computed is continuous row cropping without conservation practices. Conservation costs are computed by subtracting the net income associated with each practice or set of practices from the base net income. Continuous row cropping is used as the base because it usually results in the highest shortrun net income in the study area. The cost of practices involving changes in land use to rotations, pasture, or idle is the value of foregone income. The cost of practices such as minimum tillage, zero tillage, winter cover crops, contouring, and terracing is reflected primarily by changes in input costs.

A summary of the net income and machine and labor costs from the various budgets is presented in table 2. The net income data are used to compute tillage and rotation costs. For example, the cost of minimum tillage is the difference in net income per acre between corn with conventional tillage (\$27.73) and minimum tillage (\$31.23), or -\$3.50 per acre. The negative value indicates that minimum tillage is \$3.50 more profitable than conventional tillage due to reduced costs of production. Minimum tillage of soybeans is even more profitable with savings of \$13.72 per acre. Zero tillage results in savings of \$0.67 per acre for corn but was not considered as a practical alternative for soybeans.

Cost of the rotation practice alone varies from \$0.27 per acre if used with corn as the base crop to \$21.89 per acre if the base crop is soybeans. The rotation used in this example is 3 years row crop, 1 year wheat, and 4 years alfalfa. This rotation was the most profitable of those alternatives with a forage or grass base which were considered. Other rotations can be easily substituted.

Contour and stripcropping costs are based on the field efficiency losses in machine and labor time. Ten percent of the machine and labor costs from the crop budgets was used to estimate contour costs and 5 percent was used to estimate stripcropping costs. These percentages can be changed to reflect alternative assumptions. The rotation is required before stripcropping can be practiced.

Seed, machinery, and labor costs for broadcasting rye as a winter cover were estimated at \$9 per acre. Cost of returning land to pasture is the forgone income or \$20.94 per acre if corn is the base crop and \$55.54 per acre if the base crop is soybeans. Similar costs for idling the land are \$27.73 for corn and \$62.33 for soybeans.

#### **Terrace Costs**

Annual terrace costs consist of an annual capital cost for construction, a maintenance cost, and, if backslopes are permanently seeded to grass, a cost for the loss of income on the backslopes. Parallel gradient terraces with tile outlets were the types considered in this example. Estimates of initial construction costs, annual capital and maintenance costs, and the percentage of area used

About 15 percent more nitrogen is required with zero tillage to obtain yields similar to those with conventional or minimum tillage [5].

CORN SRG 124 Conventional țil 84 BU yield				
CATEGORY	UNITS	PRICE	QUANTITY	VALUE
PRODUCTION: Corn Total Receipts	BU.	2.310	84.000	194.04 194.04
OPERATING INPUTS: CORN SEED ADMONIUM NIT# SUPER PHOS# POTASH# ANHY AMMONIA# LIME BLADEX FURADAN GRAIN DRYING TRACTOR FUEL & LUBE TRACTOR FUEL & LUBE TRACTOR REPAIR COST EQUIP. RUEL & LUBE EQUIP. REPAIR COST	LBS. LBS. LBS. LBS. TONS QT. LBS. BU. ACRE ACRE ACRE	0.848 0.212 0.204 0.097 0.113 8.600 2.330 0.680 0.060	12.508 40.000 44.000 42.000 89.000 0.740 2.640 8.000 84.000	10.60 8.48 8.98 4.07 10.06 6.36 6.15 5.44 5.04 7.89 2.52 7.12 7.52 90.23
RETURNS TO LAND, LABOR, CAPITAL, MACHINERY, DVERHEAD, RISK, AND MANAGEMENT	,			103.81
CAPITAL COST: ANNUAL OPERATING CAPITAL TRACTOR INVESTMENT EQUIPMENT INVESTMENT TOTAL INTEREST CHARGE		0.120 0.120 0.120 0.120	33.635 41.890 180.085	4.04 5.03 21.61 30.67
RETURNS TO LAND, LABOR, MACHINERY, OVERHEAD, RISK AND MANAGEMENT				73.14
OWNERSHIP COST: (DEPRECIATION, TAXES, INSURANCE) TRACTOR EQUIPMENT TOTAL OUNERSHIP COST	HR. HR.			5.97 26.73 31.80
RETURNS TO LAND, LABOR, OVERHEAD, RISK AND MANAGEMENT			*****	41.34
LABOR COST: MACHINERY LABOR TOTAL LABOR COST	HR .	3.090	4,404 4.404	13.61 13.61
RETURNS TO LAND, OVERHEAD, RISK AND MANAGEMENT				27.73

### Sample printout 1—Summary of inputs and costs from crop budget generator<sup>3</sup>

\* LB. OF ACTIVE INGREDIENT OPERATIONS-SHRED STALKS, PLOW, DISK TWICE, FERTILIZE, PLANT, CULTIVATE,

<sup>&#</sup>x27;Output from computer program as cited in (3).

Sample printout 2—Summary of machinery operations from crop budget generator
--

CORN SRG 124 CONVENTIONAL TIL 84 BU YIELD

OPERATION	ITEM NO.	DATE	TIMES OVER	LABOR HOURS	MACHINE Hours	FUEL,OIL, LUB.,REP. PER ACRE	FIXED COSTS PER ACRE
PICKUP 3/4 T. PICKUP 3/4 T. PICKUP 3/4 T. PICKUP 3/4 T. PICKUP 3/4 T. MB PLOW 5-16" TANDEM DISK DRY FERT. SPDR PICKUP 3/4 T. TANDEM DISK HARROW 3-SEC. LIQ. FERT. SPDR. PLANT W/FERT 6R SPRAYER PICKUP 3/4 T. PICKUP 3/4 T. PICKUP 3/4 T. PICKUP 3/4 T. SHREDDER 4R SI COMB-CORN 4R TRUCK 2 T. PICKUP 3/4 T.	10 100 100 5,460 5,610 5,610 5,658 100 100 100 100 100 100 100 100 100 10	NOC JABR APPRRAYYYYEEEY MAAPPRRAYYYYEEEY T JUULGPT JUULG CCT T CC O CCT	0.05 0.055 0.055 1.000 0.055 1.000 1.000 0.055 1.000 1.000 0.055 0.005 1.000 0.005 0.005 0.005 0.005 0.005 0.000 1.000 0.005 0.005 0.000 0.005 0.0000 0.0000 0.0000 0.0000 0.0000 0.00000 0.00000 0.0000000000	$\begin{array}{c} 0.060\\ 0.060\\ 0.060\\ 0.060\\ 0.060\\ 0.414\\ 0.191\\ 0.207\\ 0.060\\ 0.191\\ 0.310\\ 0.310\\ 0.310\\ 0.205\\ 0.320\\ 0.060\\ 0.211\\ 0.060\\ 0.060\\ 0.060\\ 0.281\\ 0.393\\ 0.960\\ 0.60\\ 0.60\\ 0.60\\ 0.060\\ 0.281\\ 0.393\\ 0.960\\ 0.00\\ 0.00\\ 0$	$\begin{array}{c} 0.050\\ 0.050\\ 0.050\\ 0.050\\ 0.050\\ 0.342\\ 0.153\\ 0.153\\ 0.158\\ 0.158\\ 0.158\\ 0.158\\ 0.158\\ 0.257\\ 0.264\\ 0.050\\ 0.050\\ 0.050\\ 0.050\\ 0.050\\ 0.320\\ 0.320\\ 0.8050\\ 0.050\\ 0$	$\begin{array}{c} 0.21\\ 0.21\\ 0.21\\ 0.21\\ 0.21\\ 2.69\\ 1.03\\ 0.97\\ 0.21\\ 1.03\\ 0.97\\ 1.551\\ 1.551\\ 1.551\\ 1.551\\ 0.21\\ 0.21\\ 0.21\\ 0.21\\ 1.329\\ 6.12\\ 3.59\\ 6.12\\ 0.21\\ $	$\begin{array}{c} 0.18\\ 0.18\\ 0.18\\ 0.18\\ 0.18\\ 0.18\\ 1.52\\ 1.48\\ 1.48\\ 1.48\\ 1.48\\ 1.84\\ 1.2.47\\ 2.89\\ 1.58\\ 0.1$
TOTALS				4.404	3.781	25.05	58.44
¥ LB. OF ACTIVE Operations-shrei March 80 based (	INGREDI D STALKS DN CURRE	ENT , Ploi Nt Nor	, DISK MALIZE	TWICE D PRIC	, FERTIL ES,1979-	IZE, PLAN 80 COST	T, CULTIV F
BUDGET IDENTIFIC/	ATION NU	MBER	- 72	000000	1201 7		

ANNUAL CAPITAL MONTH 10

Output from computer program as cited in (3).

for grass backslopes are presented in table 3 for eight SRG's used in the river basin study. Note that three different terrace intervals are used on SRG 124 for the three types of tillage practices.

Annual costs for terraces for SRG 124 are \$43, \$42, and \$37 per acre for the three types of tillage practices assuming a 15-percent annual charge for capital and maintenance. Actual cost data for recently constructed terraces from SCS field offices can be used to replace these estimates.

#### **Computer Output**

The objective of the computer output is to array the data so that the shortrun costs of reducing erosion by incremental amounts is readily discernible. Three basic printouts are generated and an additional program is available for simulating effects of incremental changes in basic inputs on conservation practice costs.

		Corn	Soybeans		
Item	Conven- tional tillage	Minimum tillage	Zero tillage	Conven- tional tillage	Minimum tillage
		Ľ	ollars per acı	e	
Net returns: <sup>1</sup> Without rotation With rotation <sup>2</sup>	27.73 27.46	31.23 28.78	28.40 27.72	62.33 * 40.44	76.05 45.58
Tillage practice costs: Tillage alone Rotation alone Tillage and rotation	0 .27 .27	-3.50 2.45 -1.05	67 .68 .01	0 21.89 21.89	-13.72 30.47 16.75
Machine and labor costs: <sup>1</sup> Without rotation With rotation <sup>3</sup>	38.86 17.42	34.03 15.61	33.36 15.36	34.24 15.69	26.12 12.65
Contour costs:" Without rotation With rotation	3.87 1.73	3.40 1.57	3.34 1.54	3.42 1.57	2.61 1.26
Stripcropping costs <sup>5</sup>	1.84	1.75	1.74	1,76	1.60
Winter cover costs	9.00	9.00	9.00	9.00	9.00
Terrace costs	43.00	42.00	37.00	43.00	42.00

#### Table 2-Summary of practice costs for SRG 124, northwest Missouri

<sup>1</sup>From budget generator. Machinery and labor costs include the following items: tractor fuel and lube, tractor repair, equipment fuel and lube, equipment repair, and machine labor.

<sup>2</sup>Net income for rotation RRRGMMMM computed as follows: row crop (R) net income X 0.375 + wheat (G) net income (-17.24) X 0.125 + alfalfa (M) net income (38.44) X 0.5.

<sup>3</sup>Machine and labor cost for rotation RRRGMMM computed as follows: cost for row crop X 0.375 + wheat cost (22.85) X 0.125. <sup>4</sup>Contour costs are 10 percent of machine and labor costs.

\*Stripcropping costs are 5 percent of machine and labor costs. Stripcropping can be practiced only if a rotation is practiced.

#### **Comparison of Conservation Costs**

The first printout ranks the 50 practice combinations by the cost per ton of reduced erosion (sample printout 3). The title indicates that the data are for corn as the base crop with a price of \$2.31 per bushel; the soil is SRG 124, input costs are for year 1978, and the area is land resource area (LRA) 109A in Missouri. The last column shows the cost per ton of reduced erosion and is computed by dividing the cost per acre (column 3) by the reduction in erosion (column 4). The second column indicates the remaining annual erosion in tons per acre for the various practices.

The three tillage practices—conventional, minimum, and zero tillage—are listed in column 5 and alternatives of continuous corn, rotations, or stripcropping in column 6. The rotation used in this example is 3 years corn, 1 year wheat, and 4 years alfalfa. The program is written in such a way that other rotations can be easily substituted. It was assumed that stripcropping could be practiced only when the rotation was used. Terraces, contour farming, winter cover, or retiring land to other uses are indicated by 1's in the respective columns. The alternatives of retiring land to pasture or idle are represented by P and I, respectively.

The lowest cost combinations of practices for incrementally reducing erosion can be traced by moving down column 2 to successively lower erosion rates. For example, minimum tillage alone would reduce erosion from 40.4 to 15.5 tons per acre at a negative cost (savings) of \$3.50 per acre. The next lowest combination of practices that would reduce erosion below 6.9 tons per acre is zero tillage and rotations with an erosion rate of 2.5 tons per acre and a cost of \$0.01 per acre.

Soi	l and prac	tice	Construction			Cost			Grass backslope	
Soil resource group	Average slope	Tillage <sup>1</sup> practice	Terrace interval	Cost <sup>2</sup>	Cost <sup>2</sup>	Tile	Total	Annual³	Width	Area
Code number	Percent	Code	Feet	Dollars per foot		—Dollars	per acre-	-	Feet	Percent
122	3.1	С	113	0.18	69	150	219	33	0	
122	3.1	M,Z	126	.18	62	150	212	32	0 '	
104	3.8	Ć	113	.19	73	150	223	34	Ó	_
104	3.8	М	126	.19	66	150	216	32	0	·
104	3.8	Z	150	.19	55	150	205	31	0	—
124	6.4	С	93	.24	112	175	287	43	0	
124	6.4	M	98	.24	107	175	282	42	0	—
124	6.4	Z	150	.24	70	175	245	37	0	—
106	7.1	С	93	.26	122	175	297	45	0	—
106	7.1	М	98	.26	116	175	291	44	0	_
106	7.1	Z	150	.26	76	175	251	38	0	_
126	8.2	С	90	.28	136	200	336	50	12	13.3
126	8.2	M,Z	150	.28	81	200	281	42	12	8.0
108	10.8	С	90	.33	160	200	360	54	15	16.7
108	10.8	M,Z	150	.33	96	200	296	44	15	10.0
7054	14.2	C,M,Z	90	³.76	368	300	668	100	21	23.3
706⁴	21.8	C,M,Z	90	\$1.21	586	300	886	133	24	26.7

#### Table 3-Estimated costs of parallel gradient terraces with tile outlets, northwest Missouri, 1979-80

C = conventional tillage; M = minimum tillage; Z = zero tillage.

\*Cost per foot based on \$0.60 per yard from Jim Gregory, University of Missouri, Agricultural Engineering.

Based on 15-percent annual charge for capital and maintenance.

\*Terraces are not recommended by SCS on these soils.

\*Pushup terraces.

## Sample printout 3—Ranking of conservation practices by cost per ton erosion reduction for base crop corn

REDUCTION IN EROSION TONS PER ACRE SORTED BY COST PER TON REDUCTION, CORN, SRG 124 PRICE 2.31, 1978 COSTS, LRA 109A, MO

	REMAINING	COST	REDUCTION							COST PER
	EROSION	PER	IN EROSION	TILLAGE	CROPPING			WINTER		TON
CBS	TONS/ACRE	ACRE	TONS/ACRE	PRACTICE	SYSTEM	TERRACE	CONTOUR	COVER	RETIRÉ	REDUCTION
1	40.4	0.00	0.0	CONV	CONT	D	0	0	0	
2	15.5	-3.50	24.9	MINI	CONT	0	0	¢	0	14045
5	6.9	-1.05	33.5	MINI	ROTA	0	0	0	0	03133
4	12.0	-0.67	28.4	ZERO	CONT	0	0	0	٥	02362
5	7.7	-0.10	32.'7	MINI	CONT	0	1	0	Ō	00306
6	2.5	0.01	37.9	ZERO	ROTA	0	0	Ó	Ō	0.00026
7	10.3	0.27	30.1	COHV	ROTA	0	0	Ō	Ō	0.00898
8	3.4	0.52	36.9	MINI	ROTA	0	1	Ō	Ō	0.01407
. ?	1.7	0.71	38.7	MINI	STRP	C	٥	Ď	ò	0.01836
10	0.6	1.75	39.8	ZERD	STRP	0	0	Ö	ò	0.04400
11	2.6	2.11	37.8	CONV	STRP	0	0	Ó	ō	0.05581
12	5.2	2.00	35.2	CONV	ROTA	0	1	ò	ō	0.05677
13	0.9	2.27	39.5	MINI	STRP	0	1	õ	ō	0.05742
14	1.3	3.84	39.1	CONV	STRP	0	ī	ŏ	ā	0.09321
15	11.6	5.50	28.8	MINI	CONT	Ó	ō	i	ő	0.19104
16	20.2	3.87	20.2	CONV	CONT	Ō	ī	ō	ů.	0.19168
17	5.2	7.95	35.2	MINI	ROTA	0	ō	1	ů	0 22544
18	1.9	9.01	38.5	ZERO	ROTA	Ō	Ō	1	ů	0.23390
19	1.3	9.71	39.1	MINI	STRP	Ó	Ō	ī	0	0 24834
20	2.6	9.52	37.8	MINI	ROTA	Ō	i	ī	ň	0 25170
21	5.8	8.90	34.6	MINI	CONT	Ō	ī	ī	ò	0 25730
22	9.0	8.33	31.4	ZERO	CONT	Ō	ō	ī	ò	1 26554
23	0.5	10.75	39.9	ZERO	STRP	ō	Ō	ĩ	ő	0.26029
24	0.6	11.27	39.7	MINI	STRP	ō	ĭ	ī	ň	0 28352
25	7.7	9.27	32.7	CONV	ROTA	Ó	ā	ī	ŏ	0 29787
26	1.9	11.11	38.5	CONV	STRP	ō	õ	ī	ő	0.28887
27	3.9	11.00	36.5	COHV	ROTA	ō	i	1	ň	0.700007
28	1.0	12.84	39.4	CONV	STRP	ò	ī	ī	ő	0.30120
29	15.1	12.87	25.2	CONV	CONT	ŏ	ī	ī	ñ	0 50990
30	1.1	20.94	39.3	RETI	0000	Ď	0	ō	Ď	0.50770
31	0.1	27.73	40.3	RETI	0000	Ō	Ō	ň	T	0 68900
32	30.3	9.00	10.1	CONV	CONT	Ó	ō	ī	ā	0.000007
33	0.9	38.55	39.5	ZERO	ROTA	i	i	ñ	ň	0.07107
34	0.2	40.29	40.2	ZERO	STRP	ī	ĩ	ñ	ň	1 00324
35	4.5	39.67	35.9	ZERO	CONT	ī	ī	ň	ň	1 10671
36	2.1	42.52	38.3	MINI	ROTA	ī	ī	ŏ	ő	1 109/1
37	0.5	44.27	39.9	MINI	STRP	ī	1	ň	ň	1 11074
38	4.7	41.90	35.7	MINI	CONT	ī	ĩ	ň	ŏ	1 17940
39	0.8	46.84	39.6	CONV	STRP	ī	ĩ	ñ	õ	3 10107
40	0.7	47.55	39.7	ZËRO	ROTA	ī	ĩ	ĩ	ă	1.10173
41	3.0	45.00	37.4	CONV	ROTA	ī	1	ñ	õ	1 20450
42	0.2	49.29	40.2	ZERO	STRP	ī	ĩ	ĩ	ŏ	1 99551
43	3.4	48.67	37.0	ZERO	CONT	ī	ī	ī	ň	1 11676
44	1.5	51.52	38.8	MINI	ROTA	ī	ĩ	i	ő	1 32447
45	0.4	53.27	40.0	MINI	STRP	ī	ī	i	ő	1 11176
45	3.5	50.90	36.9	MINI	CONT	ī	ī	ī	ŏ	1 17040
47	0.6	55.84	39.8	CONV	STRP	ī	ī	ĩ	õ	1 60211
48	2.3	54.00	38.1	CONV	ROTA	ī	ī	î	ő	1 41450
49	11.8	46.87	28.5	CONV	CONT	ī	ī	ō	ň	1 66994
50	8.9	55.87	31.5	CONV	CONT	ī	ī	ī	ñ	1 77768
							-	<u> </u>	<u> </u>	1.77309

See text for explanation of codes.

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If only those practice combinations that limit erosion to a certain level are of interest, similar printouts which list only those combinations of practices with erosion rates below a given level can be printed.

A similar printout for soybeans as the base row crop on this same soil is shown in sample printout 4. Note that zero tillage has been eliminated as an alternative for soybeans and the base erosion rate for continuous soybeans (47.3 tons per acre) is higher than that for corn. Minimum tillage is also the lowest cost practice for soybeans with savings of \$13.72 per acre. However, the lowest cost set of practices that would reduce erosion to less that 5 tons is \$18.35 per acre and consists of minimum tillage, a ro' tion, and stripcropping.

#### **Display of Erosion Reduction Versus Costs**

The relationship between erosion reduction and costs can be illustrated by plotting the data (sample printouts 5 and 6). Erosion reduction is plotted on the horizontal axis and cost per acre on the vertical axis. The amount of erosion reduction necessary to meet the 5-ton annual restraint is indicated by the dashed vertical line. Note that a cluster of practice combinations occur to the right of the vertical line and below a cost of \$12 per acre when corn is the base crop (sample printout 5). The same type of clustering occurs in the \$18 to \$30 range when the base crop is soybeans (sample printout 6).

A minimum cost supply function for reducing erosion can be constructed by connecting the lowest cost points for attaining less erosion. The supply curve is a step function because each practice is associated with a specific cost and erosion rate. All practices to the left of this function are economically inferior because they are more costly to those represented on the function. However, some of the more costly combinations of practices might be relevant from an individual farmer's viewpoint. The graph displays the dispersion of costs for various levels of erosion control and illustrates the rapid increase in costs associated with progressively higher rates of erosion reduction. A further capability is to represent different practices by different symbols. For example, if those sets of practices including terraces were of interest, a different symbol could be used in the graph for all those sets including terracing (sample printout 7).

#### **Comparison of Practice Sequence**

To observe the cumulative effects of adding a succession of practices, the erosion-cost data are printed out in a schematic diagram (sample printouts 8 and 9 for corn and soybeans as base crops). Erosion rates, costs per acre, and costs per ton reduction are printed in blocks for each set of practices. The diagrams can be coded manually for easier visual interpretation. Boxes are shaded in those instances where erosion rates are 5 tons or less, annual costs are \$25 or less, and where the 10 least costly sets of practices occur. Such coding allows one to rapidly locate sets of practices meeting prescribed erosion and cost criteria. (In practice, one could use three distinct colors instead of the single shade. The printing process of this bulletin precluded use of colors.) For corn, it is readily observed that 5 of the 10 least costly sets of practices meet all three criteria while only three are met for soybeans.

The range in costs for the five least costly sets meeting all three criteria for corn is from \$0.01 to \$2.11 per acre and the range for three sets of soybeans is from \$18.08 to \$19.61 per acre. In both cases, only two single practices, retiring to pasture or idle, would reduce erosion to less than 5 tons per acre.<sup>4</sup> At least two practices are required to meet the 5-ton limit and maintain land in row crop production.

Rather than using a single crop as the base, as in these examples, a diagram representing a base such as half corn and half soybeans could be printed if that is the typical cropping pattern for a particular soil (sample printout 10).

#### Sensitivity Analysis of Other Input Costs

Another capability is to simulate changes in conservation costs associated with assumed changes in basic inputs. In this example, energy costs for fuel, chemicals, and fertilizer were assumed to increase up to 50 percent by 10 percentage point increments (sample printouts 11 and 12). The resulting changes in costs of conservation practices are indicated. This type of analysis is useful in exploring the sensitivity of practice costs to changes in basic inputs.

<sup>\*</sup>The cost of retiring land to idle represents the net income for the row crop continuously tilled with no conservation practices. This is the amount of forgone income if the land is idled.

#### **Use of Output**

This system provides a means of collecting, storing, and displaying erosion and conservation practice cost data by soils and areas. Once collected and stored, the underlying basic data can be easily updated as conditions change or better data become available. Data collected at the field level can be used at the local level in working with farmers on their conservation plans, at the State level for program planning and budgeting, and at the area, regional, and national level for program and policy analysis. A complete documentation of the computer programs for this system is available by contacting Daryll D. Raitt, ERS, U.S. Department of Agriculture, 705 Hitt Street, Columbia, MO 65201.

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# Sample printout 4—Ranking of conservation practices by cost per ton erosion reduction for base crop soybeans

REDUCTION IN EROSION TONS PER ACRE SORTED BY COST PER TON REDUCTION, SOYBEANS, SRG 124 PRICE 5.96, 1978 COSTS, LRA 109A, MO

	REMAINING	COST	REDUCTION							COST PER
	EROSION	PER	IN EROSION	TILLAGE	CROPPING			WINTER		TON
.085	TONS/ACRE	ACRE	TONS/ACRE	PRACTICE	SYSTEM	TERRACE	CONTOUR	COVER	RETIRE	REDUCTION
1				ZERO	CONT	0	Ð	0	0	•
2			•	ZÉRŰ	CONT	1	1	3	0	•
3			•	ZERO	CONT	0	0	1	0	•
4		•	•	ZERO	CONT	.1	1	1	0	•
5	•	•		ZERO	ROTA	0	0	Ó	0	•
6			•	ZERO	ROTA	1	1	C	0	•
7			•	ZERD	ROTA	0	0	1	0	•
8		•	•	ZERD	ROTA	, 1	1	1	0	•
9	•	•		ZERO	STRP	0	Û	0	0	•
10	•	•		ZERO	STRP	1	1	0	0	•
11				ZERO	STRP	0	6	1	0	•
12	-			ZERO	STRP	1	1	1	0	•
13	47.3	0.00	0.0	CONV	CONT	Ð	0	0	D	•
14	19.8	-13.7	27.5	MINI	CONT	0	Ó	0	O	49891
15	9.9	-11.1	37.4	MINI	CONT	0	1	D	0	29714
16	14.8	-4.72	32.4	HINI	CONT	0	0	1	0	14545
17	7.4	-2.11	39.9	MINI	CONT	o	1	1	0	05294
18	23.6	3.42	23.6	CONV	CONT	D	1	C	0	0.14467
29	2.2	18.35	45.1	MINI	STRP	0	0	D	0	0.40705
20	4.4	18.01	42.9	MINI	ROTA	0	1	0	0	0.41991
21	17.7	12.42	29.6	CONV	CONT	0	1	1	0	0.42030
22	1.1	19.61	46.2	MINI	STRP	0	1	Û	0	0.42473
23	8.8	16.75	38.5	MINI	ROTA	0	D	0	Û	0.43506
24	3.0	23,65	44.3	CONV	STRP	Û	0	0	D	0.53434
25	1.5	25.22	45.8	CONV	STRP	0	1	0	0	0.55102
26	6.0	23.46	43.2	CONV	ROTA	0	1	Û	0	0.56873
27	1.6	27.35	45.6	MINI	STRP	0	0	1	0	0.59939
28	3.3	27.01	44.0	MINI	ROTA	a	1	1	0	0.61414
29	0.8	28.61	46.4	MINI	STRP	0	1	1	0	0.61593
30	12.0	21.89	35.2	CONV	ROTA	0	Û	0	D	0.62117
31	6.6	25.75	40.7	MINÍ	ROTA	O	0	1	0	0.63268
32	2.3	32.65	45.0	CONV	STRP	0	0	1	0	0.72539
33	1.1	34.22	46.1	CONV	STRP	0	1	1	0	0.74166
34	5.9	30.89	41.3	MINI	CONT	1	1	0	a	0.74758
35	4.5	32.46	42.8	CONV	ROTA	0	1	1	D	0.75912
36	35.4	9.00	11.8	CONV	CONT	0	0	1	0	0.76142
37	9.0	30.89	38.2	CONV	ROTA	¢	o	1	0	0.80758
38	4.5	39.89	42.8	MINI	CONT	1	1	1	0	0.93201
39	1.1	55.54	46.1	RETI	0000	0	0	0	P	1.20347
40	0.1	62.33	47.2	RETI	0000	0	0	0	I	1.32111
41	0.7	61.61	46.6	MINI	STRP	1	1	0	0	1.32182
42	2.6	60.01	44.6	MINI	ROTA	1	1	0	0	1.34461
43	13.9	46.42	33.4	CONV	CONT	1	1	D	0	1.38982
44	0.9	68.22	46.4	CONA	STRP	3	1	0	0	1.47058
45	10.4	55.42	36.9	CONV	CONT	1	1	1	0	1.50312
46	0.5	70.61	46.8	MINI	STRP	1	1	1	0	1.509/3
47	3.5	66.46	43.7	CONV	ROTA	1	1	0	0	1.51943
48	2.0	69.01	45.3	MINI	ROTA	1	1	1	0	1.523/4
49	0.7	77.22	46.6	CONV	STRP	1	1	1	0	1.656/3
50	2.6	75.46	44.6	CONV	ROTA	<u> </u>	1			1.04111
-										

See text for explanation of codes.



## Sample printout 5—Reduction in erosion versus cost per acre for base crop corn

#### Sample printout 6-Reduction in erosion versus cost per acre for base crop soybeans

RELATIONSHIP BETWEEN REDUCTION IN TONS PER ACRE EROSION AND



NOTE: 12 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

15

#### Sample printout 7—Reduction in erosion for practices including and excluding terraces versus cost per acre for base crop corn



#### Sample printout 8—Remaining erosion, cost per acre, and per ton reduction of erosion for base @op corn (schematic)



#### Sample printout 9-Remaining erosion, cost per acre, and per ton reduction of erosion for base crop soybeans (schematic)

SOYBEANS

LRA



Sample printout 10—Remaining erosion, costs per acre, and per ton reduction of erosion for base crops half corn and half soybeans (schematic)

MIX CROP LRA 9A SRC 124 0.50 CORN 0.50SOYBEANS1979 COSTS



PRACTICE COSTS PER ACRE WITH ENERGY COST INCREASES, CORN

PRICE 2.31 1979-80 COSTS SRG 124

	PRESENT COSTS	10% Cost increase	20% COST INCREASE	30% COST INCREASE	40% COST INCREASE	50% Cost increase
MINIMUM TILLAGE ZERC TILLAGE CONTOUR-CT CONTOUR-MT TERRACE & CONTOUR-CT TERRACE & CONTOUR-CT TERRACE & CONTOUR-CT NINTER COVER ROTATION-CT ROTATION-CT ROTATION-CT STRIP CROPPING-CT* STRIP CROPPING-CT* STRIP CROPPING-ZT* RETIRE TO PASTURE* RETIRE TO IDLE*	$ \begin{array}{r} -3.50 \\ -0.67 \\ 3.87 \\ -0.10 \\ 46.87 \\ 41.90 \\ 39.67 \\ 9.00 \\ .27 \\ -1.05 \\ 0.01 \\ 2.11 \\ 0.71 \\ 1.75 \\ 20.94 \\ 27.73 \\ \end{array} $	-2.65 0.56 4.02 0.89 47.02 42.88 41.03 9.00 0.40 -0.62 0.58 2.21 1.20 2.39 17.01 21.74	-1.80 1.79 4.17 1.87 47.17 43.87 42.39 9.00 0.53 -0.20 1.15 2.41 1.69 3.02 13.08 15.75	-0.95 3.02 4.32 2.85 47.32 44.85 43.75 9.00 0.66 0.23 1.72 2.61 2.18 3.66 9.15 9.76	-0.10 4.25 4.47 3.83 47.47 45.83 45.11 9.00 0.79 0.65 2.29 2.81 2.67 4.29 5.22 3.77	0.75 5.48 4.62 4.81 47.62 46.81 46.81 46.47 9.00 0.93 1.08 2.85 3.01 3.16 4.92 1.29 -2.22

.

CT: CONVENTIONAL TILLAGE MT: MINIMUM TILLAGE ZT: ZERO TILLAGE

\* EROSION LESS THAN 5 TONS PER ACRE

# Sample printout 12—Sensitivity of conservation practice costs to increase in energy prices for base crop soybeans

#### PRACTICE COSTS PER ACRE WITH ENERGY COST INCREASES, SOYBEANS

#### PRICE 5.96 1979-80 COSTS SRG 124

	PRESENT COSTS	10% COST INCREASE	20% Cost increase	30% COST INCREASE	40% COST INCREASE	50% COST INCREASE
MININUM TILLAGE	-13.72	-13.92	-14.12	-14.32	-14.52	-14.72
CONTOUR-MT	-11.11	3.56 -11.20	3.70 -11.30	-11.40	-11.50	-11.59
TERRACE & CONTOUR-CT TERRACE & CONTOUR-MT	46.42	46.56	46.70	46.83	46.97	47.10 30.41
WINTER COVER	9.00	9.00	9.00	9.00	9.00	9.00
ROTATION-MT	16.75	23.02	24.15 18.82	25.28	20.90	21.93
STRIP CROPPING-CTX STRIP CROPPING-MTX	23.65	24.86	26.07	27.28 21.65	28.49 22.74	29.70 23.84
RETIRE TO PASTUREX	55.54	53.22	50.90	48.58	46.26	43.94
	02.33	21.72	23.21	· · · · · · · · · · · · · · · · · · ·	·	1

CT: CONVENTIONAL TILLAGE MT: MINIMUM TILLAGE

\* EROSION LESS THAN 5 TONS PER ACRE

#### Appendix-Data Sheet for Conservation Practices

IDENTIF	ICATION
County	Soil resource group
Land resource area	Soil name
Land capability class	Soil mapping unit

SOIL LOSS FACTORS									
Crop	C factor			Factor	Value				
	Conv.	Min.	Zero	K					
Corn Soybeans				S L					
Pasture		Idle		P - Contour P - Strip crop P - Winter cover P -					

TERRACES									
Type: Spacing: Construction cost: Tile outlet cost: Grass outlet cost: Other cost: Total cost per scre:	Parallel Conv Cu. yd Lin. ft Per acre	Gradient Min. till Lin. ft Per acre	Push up Zero till Per acre						

CROP BUDGET DATA									
Стор	Yields/acre			Product	Net income/acre				
Grop	Conv.	Min.	Zero	prices	Conv.	Min.	Zero		
Corn	t t								
Soybeans	1								
Wheat			Ī						
Alfalfa									
Pasture				· ·					
	ļł		ļ						
	<u>}·</u>	•	1						
	<u> </u>			<u></u>					
	<u> </u>				<b> </b> -				
<b></b>				<u> </u>					
Mashinany annalay	manti Nivunha	m	Vaca						
Machinery complement: Number Year									
Dercent increase in	machine and	labor coste:	iear	· · ·					
Contour farming	machine anu	Striperopp	ina						
Cost of cover crop	r	ron	····ຮ Γ.	net/anne					
Cost of cover crop.	0	· · · · · · · · · · · · · · · · · · ·							

#### Appendix-Data Sheet for Conservation Practices—Continued

\*U.S. COVERIMENT PRINTING OFFICE : 1981 0-341-177/44





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