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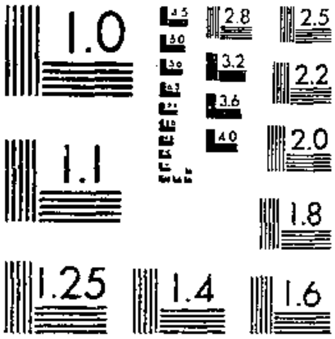
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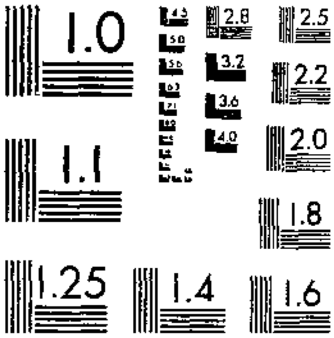
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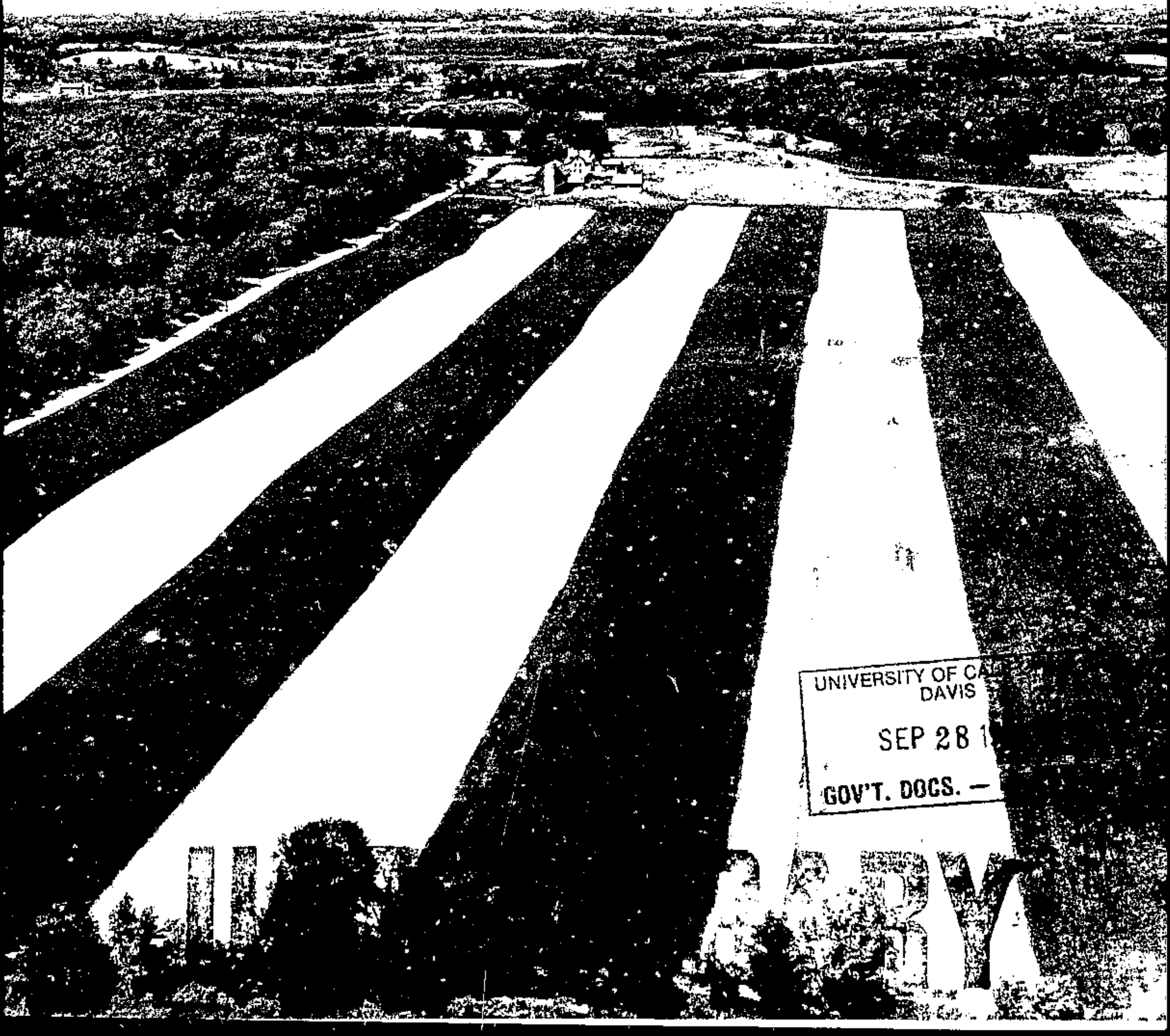
A Computerized System for Estimating and Displaying Shortrun Costs of Soil Conservation Practices

Daryll D. Raitt



A COMPUTERIZED 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

The State and river basin staffs of the Soil Conservation Service, Columbia, Missouri, especially Dallas Schafer and John McCarthy, provided data and technical expertise for this report. Truman Wiles, graduate student, Agricultural Economics Department, University of Missouri, Columbia, did the computer programming. David Ervin, professor, Agricultural Economics Department, University of Missouri, Columbia, provided support and information.

Washington, D.C. 20250 August 1981

Summary

The report describes a computer system which can be used for rapidly estimating and displaying the shortrun annual onsite 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 Θ
Θ = 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.[2] 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

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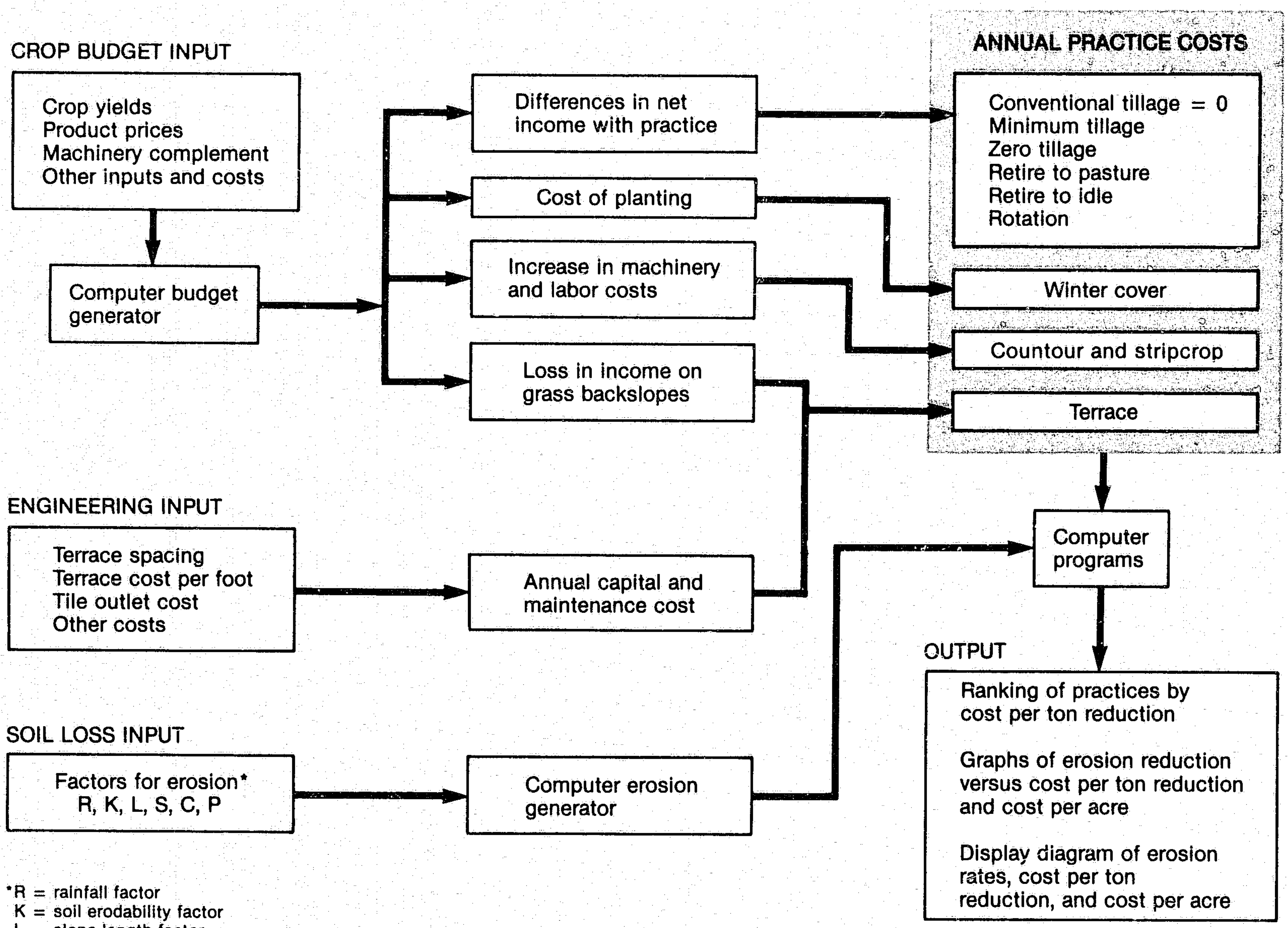
[1] Italicized numbers in parentheses refer to items listed in Bibliography.

[2] This study is currently underway as a cooperative effort of the State of Missouri and the U.S. Department of Agriculture.

Figure 1

Estimating Shortrun Costs of Conservation (schematic)



*R = rainfall factor
K = soil erodability factor
L = slope length factor
S = slope gradient factor
C = cover factor
P = conservation practice factor

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

Land capability class	Soil name	Total inventory		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	Lagonda SICL	21,533	.012	.37	.040	295.6
3E05	Keswick L	21,495	.012	.37	.080	200.0
3E05	Seymour SIL	17,982	.010	.37	.030	300.0
3E05	Sampsel SICL	15,325	.009	.37	.070	215.7
3E05	Greenton SIL	14,348	.008	.37	.070	215.7
3E05	Gorin SIL	8,824	.005	.32	.069	200.0
3E05	Pershing SIL	6,911	.004	.37	.040	249.6
3E05	Clarinda SIL	5,297	.003	.37	.060	294.3
3E01	Audha MO	4,596	.003	.37	.070	200.0
3E05	Lamoni SIL	4,392	.002	.32	.030	250.0
3E04	Polo SIL	3,591	.002	.32	.070	200.0
3E05	Kilwinning SIL	2,988	.002	.43	.060	300.0
3E05	Sapp SIL	2,871	.002	.43	.060	200.0
3E05	Sexton SIL	2,544	.001	.43	.040	200.0
3E05	Colp SIL	2,164	.001	.43	.062	279.2
3E05	Mexico SIL	2,071	.001	.43	.030	304.0
3E02	Steinmetz SIL	859	.000	.37	.070	300.0
3E05	Gorin SIL	729	.000	.32	.040	300.0
3E05	Weldon SIL	583	.000	.43	.040	200.0
3E05	Calwoods SIL	359	.000	.43	.060	200.0
3E05	Clarinda SIL	325	.000	.37	.030	300.0
3E05	Lamoni SIL	268	.000	.32	.070	250.0
3E08	Seymour SIL	253	.000	.37	.030	300.0
3E05	Colp SIL	164	.000	.43	.040	300.0
3E08	Lagonda SICL	111	.000	.37	.040	300.0
3E08	Adair CL	56	.000	.32	.040	300.0
3E07	Sharpsburg SICL	25	.000	.32	.030	300.0
Total		1,773,757	1.000			
Average[1]				.347	.064	269.2

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[1] 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).[3] 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

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

Sample printout 1—Summary of inputs and costs from crop budget generator[1]

```
CORN   SRG 124
CONVENTIONAL TIL
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
  AMMONIUM NIT*                           LBS.       0.848     12.500    10.60
  SUPER PHOS*                             LBS.       0.212     40.000     8.48
  POTASH*                                 LBS.       0.204     44.000     8.98
  ANHY AMMONIA*                           LBS.       0.097     42.000     4.07
  LIME                                    LBS.       0.113     89.000    10.06
  BLADEX                                  TONS       8.600      0.740     6.36
  FURADAN                                 QT.        2.330      2.640     6.15
  GRAIN DRYING                            LBS.       0.680      8.000     5.44
  TRACTOR FUEL & LUBE                     BU.        0.060     84.000     5.04
  TRACTOR REPAIR COST                     ACRE                            7.89
  EQUIP. FUEL & LUBE                      ACRE                            2.52
  EQUIP. REPAIR COST                      ACRE                            7.12
TOTAL OPERATING COST                      ACRE                            7.52
                                                                         90.23
------------------------------------------------------------------------------
RETURNS TO LAND,LABOR,CAPITAL,MACHINERY,
    OVERHEAD,RISK,AND MANAGEMENT                                        103.81
------------------------------------------------------------------------------
CAPITAL COST:
  ANNUAL OPERATING CAPITAL
  TRACTOR INVESTMENT                                 0.120     33.635     4.04
  EQUIPMENT INVESTMENT                               0.120     41.890     5.03
TOTAL INTEREST CHARGE                                0.120    180.085    21.61
                                                                         30.67
------------------------------------------------------------------------------
RETURNS TO LAND, LABOR, MACHINERY,
    OVERHEAD, RISK AND MANAGEMENT                                        73.14
------------------------------------------------------------------------------
OWNERSHIP COST: (DEPRECIATION,
TAXES, INSURANCE)
  TRACTOR
  EQUIPMENT                               HR.                             5.07
TOTAL OWNERSHIP COST                      HR.                            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    13.61
                                                                4.404    13.61
------------------------------------------------------------------------------
RETURNS TO LAND, OVERHEAD,
    RISK AND MANAGEMENT                                                  27.73
------------------------------------------------------------------------------

* LB. OF ACTIVE INGREDIENT
OPERATIONS-SHRED STALKS, PLOW, DISK TWICE, FERTILIZE, PLANT, CULTIVATE,
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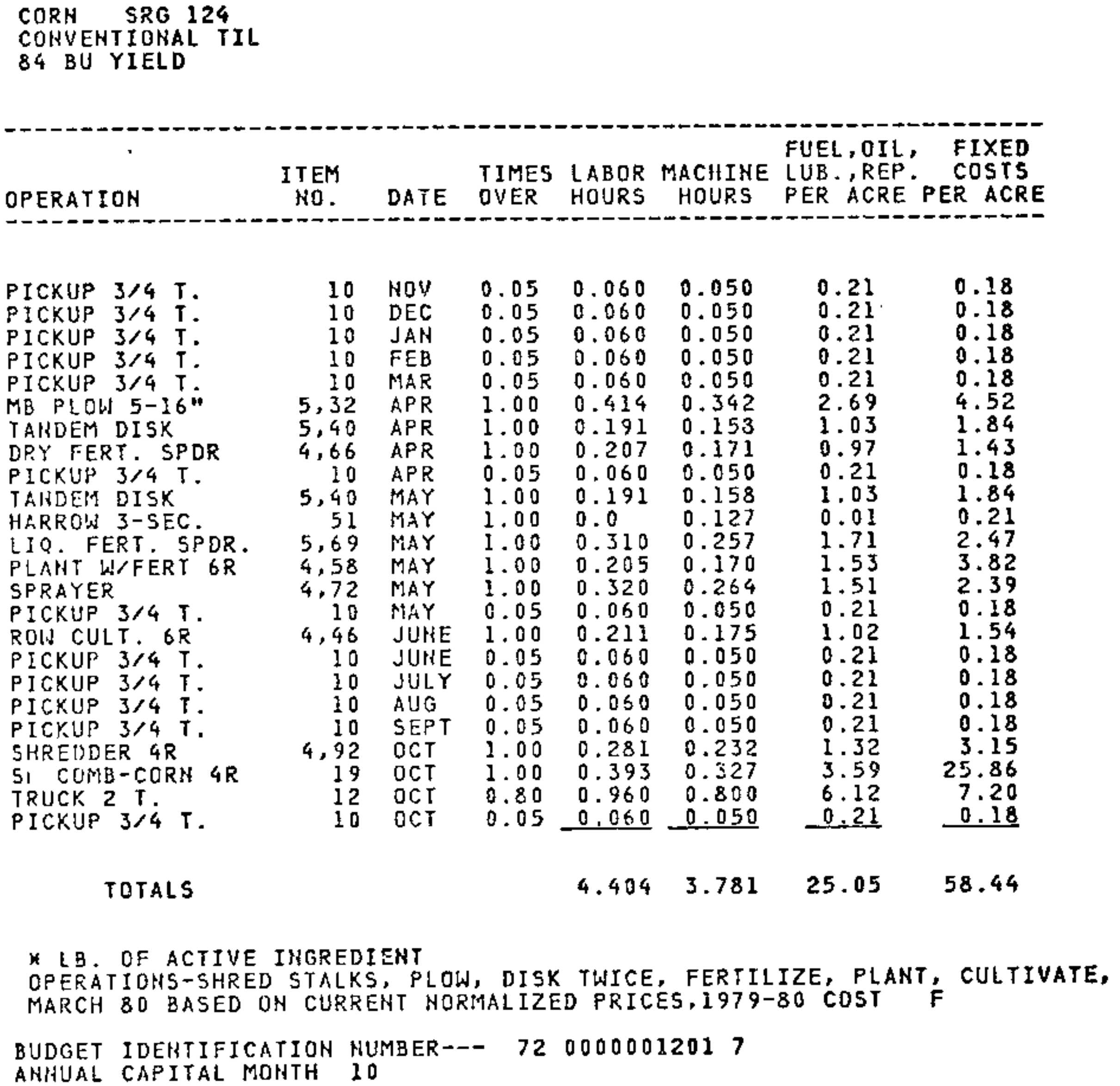
[1] Output from computer program as cited in (3).

Sample printout 2—Summary of machinery operations from crop budget generator[1]



```
CORN   SRG 124
CONVENTIONAL TIL
84 BU YIELD

-----------------------------------------------------------------------------
                                                          FUEL,OIL,  FIXED
                      ITEM          TIMES  LABOR  MACHINE LUB.,REP.  COSTS
OPERATION              NO.   DATE   OVER   HOURS   HOURS  PER ACRE PER ACRE
-----------------------------------------------------------------------------


PICKUP 3/4 T.           10   NOV    0.05   0.060   0.050    0.21     0.18
PICKUP 3/4 T.           10   DEC    0.05   0.060   0.050    0.21     0.18
PICKUP 3/4 T.           10   JAN    0.05   0.060   0.050    0.21     0.18
PICKUP 3/4 T.           10   FEB    0.05   0.060   0.050    0.21     0.18
PICKUP 3/4 T.           10   MAR    0.05   0.060   0.050    0.21     0.18
MB PLOW 5-16"         5,32   APR    1.00   0.414   0.342    2.69     4.52
TANDEM DISK           5,40   APR    1.00   0.191   0.153    1.03     1.84
DRY FERT. SPDR        4,66   APR    1.00   0.207   0.171    0.97     1.43
PICKUP 3/4 T.           10   APR    0.05   0.060   0.050    0.21     0.18
TANDEM DISK           5,40   MAY    1.00   0.191   0.158    1.03     1.84
HARROW 3-SEC.           51   MAY    1.00   0.0     0.127    0.01     0.21
LIQ. FERT. SPDR.      5,69   MAY    1.00   0.310   0.257    1.71     2.47
PLANT W/FERT 6R       4,58   MAY    1.00   0.205   0.170    1.53     3.82
SPRAYER               4,72   MAY    1.00   0.320   0.264    1.51     2.39
PICKUP 3/4 T.           10   MAY    0.05   0.060   0.050    0.21     0.18
ROW CULT. 6R          4,46   JUNE   1.00   0.211   0.175    1.02     1.54
PICKUP 3/4 T.           10   JUNE   0.05   0.060   0.050    0.21     0.18
PICKUP 3/4 T.           10   JULY   0.05   0.060   0.050    0.21     0.18
PICKUP 3/4 T.           10   AUG    0.05   0.060   0.050    0.21     0.18
PICKUP 3/4 T.           10   SEPT   0.05   0.060   0.050    0.21     0.18
SHREDDER 4R           4,92   OCT    1.00   0.281   0.232    1.32     3.15
SP COMB-CORN 4R         19   OCT    1.00   0.393   0.327    3.59    25.86
TRUCK 2 T.              12   OCT    0.80   0.960   0.800    6.12     7.20
PICKUP 3/4 T.           10   OCT    0.05   0.060   0.050    0.21     0.18
                                           _____   _____    ____     ____

      TOTALS                               4.404   3.781   25.05    58.44

 * LB. OF ACTIVE INGREDIENT
 OPERATIONS-SHRED STALKS, PLOW, DISK TWICE, FERTILIZE, PLANT, CULTIVATE,
 MARCH 80 BASED ON CURRENT NORMALIZED PRICES,1979-80 COST    F

BUDGET IDENTIFICATION NUMBER---  72 0000001201 7
ANNUAL CAPITAL MONTH  10
```

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[1] 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.

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

Item	Corn			Soybeans	
	Conventional tillage	Minimum tillage	Zero tillage	Conventional tillage	Minimum tillage
			Dollars per acre		
Net returns:[1]					
Without rotation	27.73	31.23	28.40	62.33	76.05
With rotation[2]	27.46	28.78	27.72	40.44	45.58
Tillage practice costs:					
Tillage alone	0	-3.50	-.67	0	-13.72
Rotation alone	.27	2.45	.68	21.89	30.47
Tillage and rotation	.27	-1.05	.01	21.89	16.75
Machine and labor costs:[1]					
Without rotation	38.86	34.03	33.36	34.24	26.12
With rotation [3]	17.42	15.61	15.36	15.69	12.65
Contour costs:[4]					
Without rotation	3.87	3.40	3.34	3.42	2.61
With rotation	1.73	1.57	1.54	1.57	1.26
Stripcropping costs[5]	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

[1] 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.

[2] 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.

[3] Machine and labor cost for rotation RRRGMMMM computed as follows: cost for row crop X 0.375 + wheat cost (22.85) X 0.125.

[4] Contour costs are 10 percent of machine and labor costs.

[5] 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.

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

Soil and practice			Construction			Cost			Grass backslope	
Soil resource group	Average slope	Tillage[1] practice	Terrace interval	Cost[2]	Cost[2]	Tile	Total	Annual[3]	Width	Area
Code number	*Percent*	*Code*	*Feet*	*Dollars per foot*	*—Dollars per acre—*				*Feet*	*Percent*
122	3.1	C	113	0.18	69	150	219	33	0	—
122	3.1	M,Z	126	.18	62	150	212	32	0	—
104	3.8	C	113	.19	73	150	223	34	0	—
104	3.8	M	126	.19	66	150	216	32	0	—
104	3.8	Z	150	.19	55	150	205	31	0	—
124	6.4	C	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	C	93	.26	122	175	297	45	0	—
106	7.1	M	98	.26	116	175	291	44	0	—
106	7.1	Z	150	.26	76	175	251	38	0	—
126	8.2	C	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	C	90	.33	160	200	360	54	15	16.7
108	10.8	M,Z	150	.33	96	200	296	44	15	10.0
705[4]	14.2	C,M,Z	90	[5].76	368	300	668	100	21	23.3
706[4]	21.8	C,M,Z	90	[5]1.21	586	300	886	133	24	26.7

[1] C = conventional tillage; M = minimum tillage; Z = zero tillage.

[2] Cost per foot based on $0.60 per yard from Jim Gregory, University of Missouri, Agricultural Engineering.

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

[4] Terraces are not recommended by SCS on these soils.

[5] 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
OBS  TONS/ACRE   ACRE   TONS/ACRE  PRACTICE   SYSTEM  TERRACE  CONTOUR   COVER   RETIRE  REDUCTION

  1     40.4     0.00      0.0       CONV      CONT      0        0        0       0
  2     15.5    -3.50     24.9       MINI      CONT      0        0        0       0      -.14045
  3      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       0      -.02362
  5      7.7    -0.10     32.7       MINI      CONT      0        1        0       0      -.00306
  6      2.5     0.01     37.9       ZERO      ROTA      0        0        0       0      0.00026
  7     10.3     0.27     30.1       CONV      ROTA      0        0        0       0      0.00898
  8      3.4     0.52     36.9       MINI      ROTA      0        1        0       0      0.01407
  9      1.7     0.71     38.7       MINI      STRP      0        0        0       0      0.01836
 10      0.6     1.75     39.8       ZERO      STRP      0        0        0       0      0.04400
 11      2.6     2.11     37.8       CONV      STRP      0        0        0       0      0.05581
 12      5.2     2.00     35.2       CONV      ROTA      0        1        0       0      0.05677
 13      0.9     2.27     39.5       MINI      STRP      0        1        0       0      0.05742
 14      1.3     3.84     39.1       CONV      STRP      0        1        0       0      0.09321
 15     11.6     5.50     28.8       MINI      CONT      0        0        1       0      0.19104
 16     20.2     3.87     20.2       CONV      CONT      0        1        0       0      0.19168
 17      5.2     7.95     35.2       MINI      ROTA      0        0        1       0      0.22566
 18      1.9     9.01     38.5       ZERO      ROTA      0        0        1       0      0.23390
 19      1.3     9.71     39.1       MINI      STRP      0        0        1       0      0.24834
 20      2.6     9.52     37.8       MINI      ROTA      0        1        1       0      0.25179
 21      5.8     8.90     34.6       MINI      CONT      0        1        1       0      0.25730
 22      9.0     8.33     31.4       ZERO      CONT      0        0        1       0      0.26554
 23      0.5    10.75     39.9       ZERO      STRP      0        0        1       0      0.26929
 24      0.6    11.27     39.7       MINI      STRP      0        1        1       0      0.28352
 25      7.7     9.27     32.7       CONV      ROTA      0        0        1       0      0.28383
 26      1.9    11.11     38.5       CONV      STRP      0        0        1       0      0.28887
 27      3.9    11.00     36.5       CONV      ROTA      0        1        1       0      0.30120
 28      1.0    12.84     39.4       CONV      STRP      0        1        1       0      0.32572
 29     15.1    12.87     25.2       CONV      CONT      0        1        1       0      0.50990
 30      1.1    20.94     39.3       RETI      0000      0        0        0       P      0.53323
 31      0.1    27.73     40.3       RETI      0000      0        0        0       I      0.68809
 32     30.3     9.00     10.1       CONV      CONT      0        0        1       0      0.89109
 33      0.9    38.55     39.5       ZERO      ROTA      1        1        0       0      0.97694
 34      0.2    40.29     40.2       ZERO      STRP      1        1        0       0      1.00324
 35      4.5    39.67     35.9       ZERO      CONT      1        1        0       0      1.10471
 36      2.1    42.52     38.3       MINI      ROTA      1        1        0       0      1.10960
 37      0.5    44.27     39.9       MINI      STRP      1        1        0       0      1.11036
 38      4.7    41.90     35.7       MINI      CONT      1        1        0       0      1.17268
 39      0.8    46.84     39.6       CONV      STRP      1        1        0       0      1.18193
 40      0.7    47.55     39.7       ZERO      ROTA      1        1        1       0      1.19803
 41      3.0    45.00     37.4       CONV      ROTA      1        1        0       0      1.20450
 42      0.2    49.29     40.2       ZERO      STRP      1        1        1       0      1.22551
 43      3.4    48.67     37.0       ZERO      CONT      1        1        1       0      1.31434
 44      1.5    51.52     38.8       MINI      ROTA      1        1        1       0      1.32647
 45      0.4    53.27     40.0       MINI      STRP      1        1        1       0      1.33175
 46      3.5    50.90     36.9       MINI      CONT      1        1        1       0      1.37940
 47      0.6    55.84     39.8       CONV      STRP      1        1        1       0      1.40231
 48      2.3    54.00     38.1       CONV      ROTA      1        1        1       0      1.41658
 49     11.8    46.87     28.5       CONV      CONT      1        1        0       0      1.64226
 50      8.9    55.87     31.5       CONV      CONT      1        1        1       0      1.77365
```

See text for explanation of codes.

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 rotation, 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.[4] 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.

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[4] 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

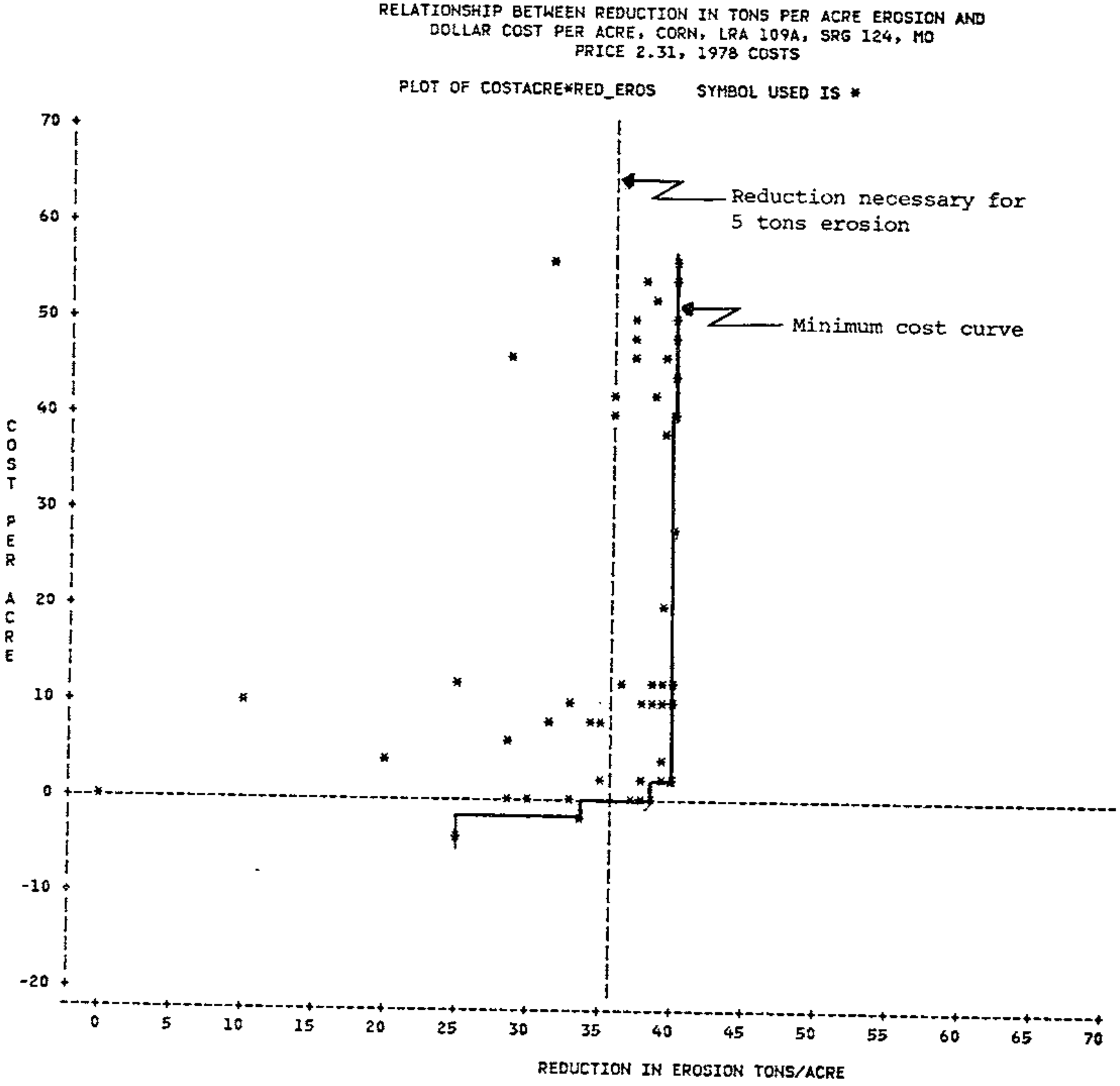
```
                         REDUCTION IN EROSION TONS PER ACRE
                  SORTED BY COST PER TON REDUCTION, SOYBEANS, SRG 124
                          PRICE 5.96, 1978 COSTS, LRA 109A, MO

                                                                                                  COST PER
      REMAINING    COST    REDUCTION                                                WINTER           TON
       EROSION     PER     IN EROSION  TILLAGE    CROPPING                           COVER        REDUCTION
OBS   TONS/ACRE    ACRE    TONS/ACRE   PRACTICE    SYSTEM     TERRACE   CONTOUR               RETIRE

  1       .          .          .        ZERO       CONT         0         0          0         0           .
  2       .          .          .        ZERO       CONT         1         1          0         0           .
  3       .          .          .        ZERO       CONT         0         0          1         0           .
  4       .          .          .        ZERO       CONT         1         1          1         0           .
  5       .          .          .        ZERO       ROTA         0         0          0         0           .
  6       .          .          .        ZERO       ROTA         1         1          0         0           .
  7       .          .          .        ZERO       ROTA         0         0          1         0           .
  8       .          .          .        ZERO       ROTA         1         1          1         0           .
  9       .          .          .        ZERO       STRP         0         0          0         0           .
 10       .          .          .        ZERO       STRP         1         1          0         0           .
 11       .          .          .        ZERO       STRP         0         0          1         0           .
 12       .          .          .        ZERO       STRP         1         1          1         0           .
 13     47.3       0.00        0.0       CONV       CONT         0         0          0         0           .
 14     19.8     -13.7        27.5       MINI       CONT         0         0          0         0       -.49891
 15      9.9     -11.1        37.4       MINI       CONT         0         1          0         0       -.29714
 16     14.8      -4.72       32.4       MINI       CONT         0         0          1         0       -.14545
 17      7.4      -2.11       39.9       MINI       CONT         0         1          1         0       -.05294
 18     23.6       3.42       23.6       CONV       CONT         0         1          0         0       0.14467
 19      2.2      18.35       45.1       MINI       STRP         0         0          0         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          0         0       0.42473
 23      8.8      16.75       38.5       MINI       ROTA         0         0          0         0       0.43506
 24      3.0      23.65       44.3       CONV       STRP         0         0          0         0       0.53434
 25      1.5      25.22       45.8       CONV       STRP         0         1          0         0       0.55102
 26      6.0      23.46       41.2       CONV       ROTA         0         1          0         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         0         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         0          0         0       0.62117
 31      6.6      25.75       40.7       MINI       ROTA         0         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         0       0.74758
 35      4.5      32.46       42.8       CONV       ROTA         0         1          1         0       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         0         0          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          0         0       1.38982
 44      0.9      68.22       46.4       CONV       STRP         1         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       1.50973
 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       1.52374
 49      0.7      77.22       46.6       CONV       STRP         1         1          1         0       1.65673
 50      2.6      75.46       44.6       CONV       ROTA         1         1          1         0       1.69117
```

See text for explanation of codes.

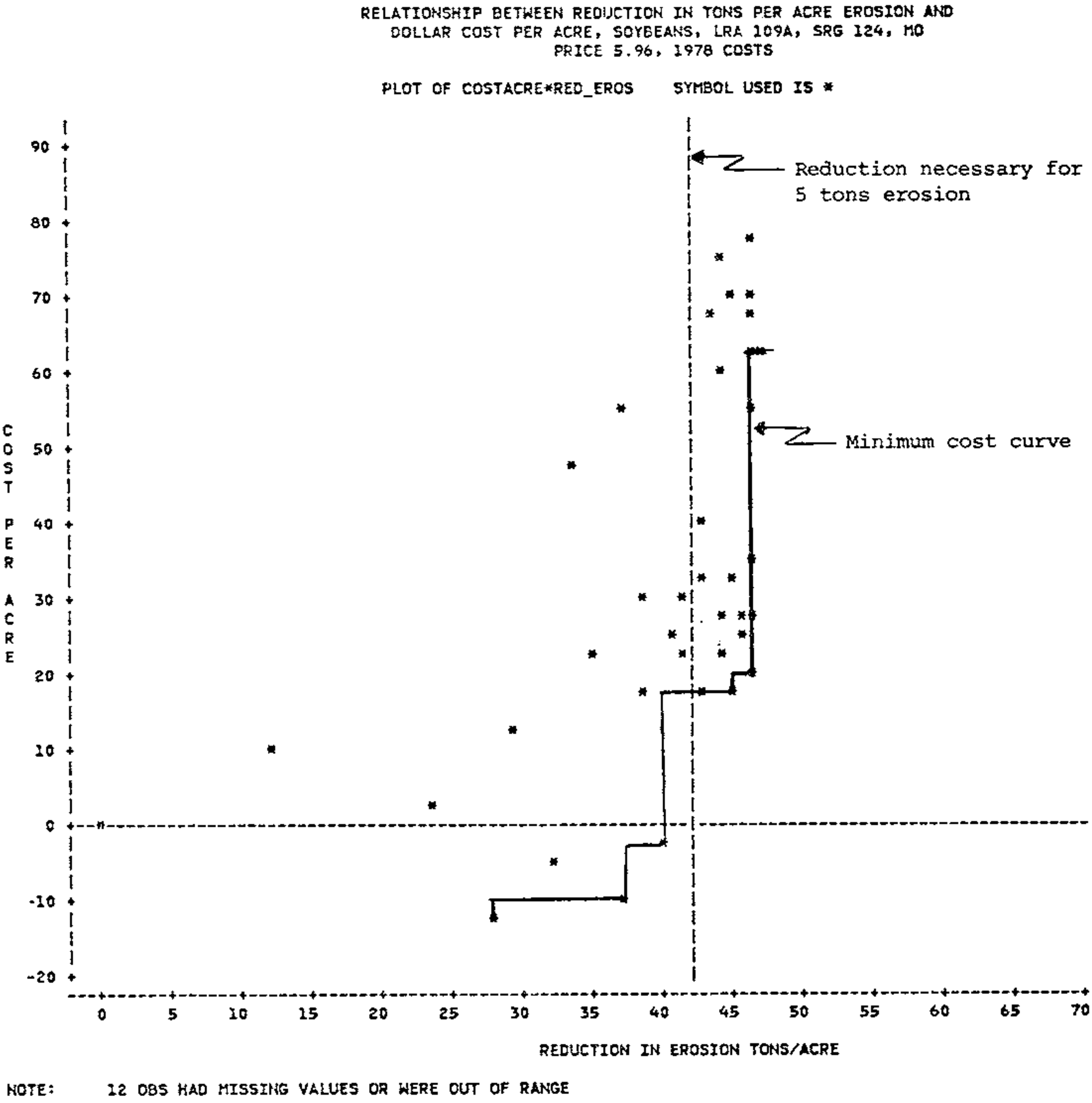
Sample printout 5—Reduction in erosion versus cost per acre for base crop corn



Reduction necessary for 5 tons erosion

Minimum cost curve

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

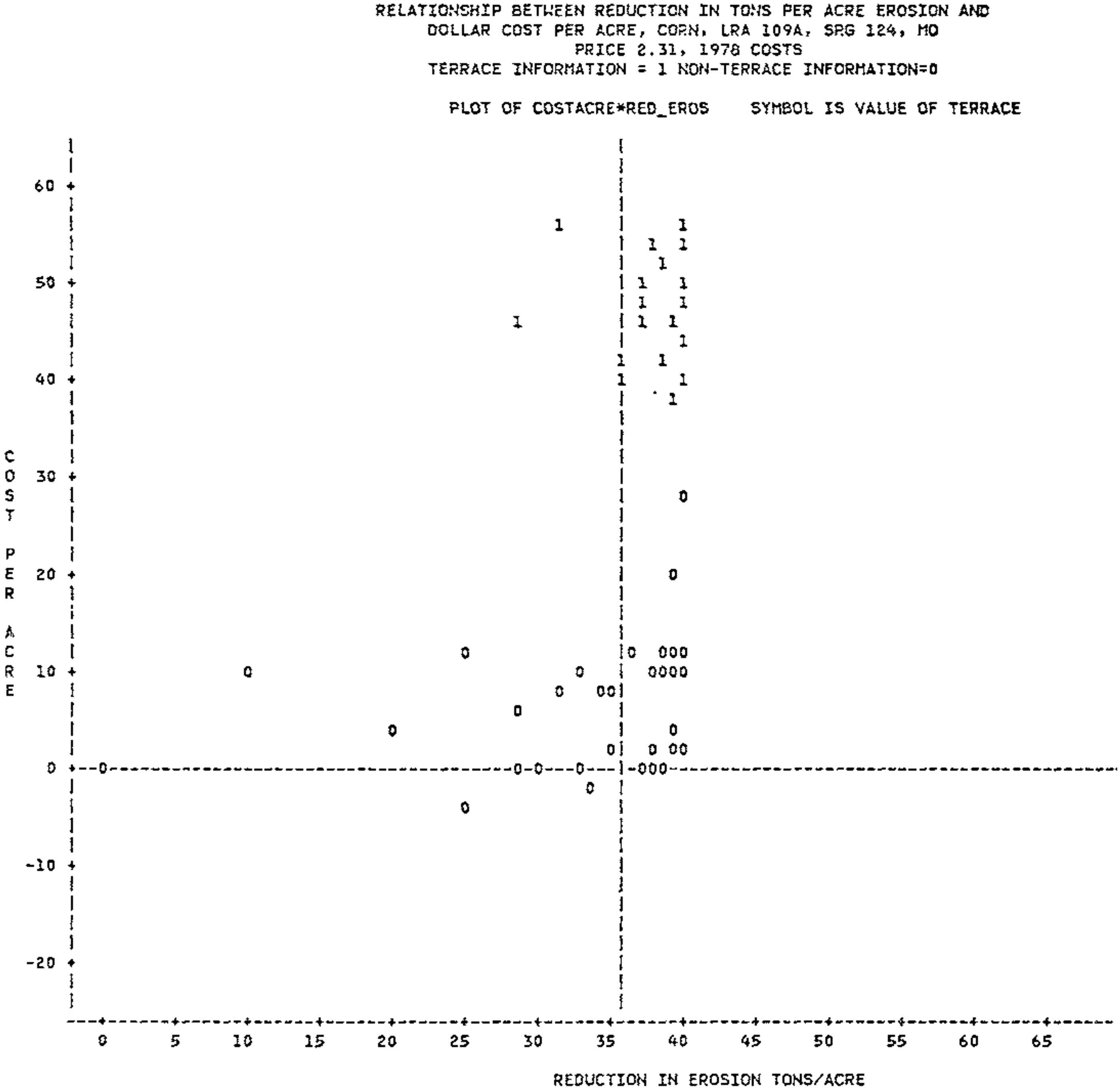


```
RELATIONSHIP BETWEEN REDUCTION IN TONS PER ACRE EROSION AND
DOLLAR COST PER ACRE, SOYBEANS, LRA 109A, SRG 124, MO
PRICE 5.96, 1978 COSTS

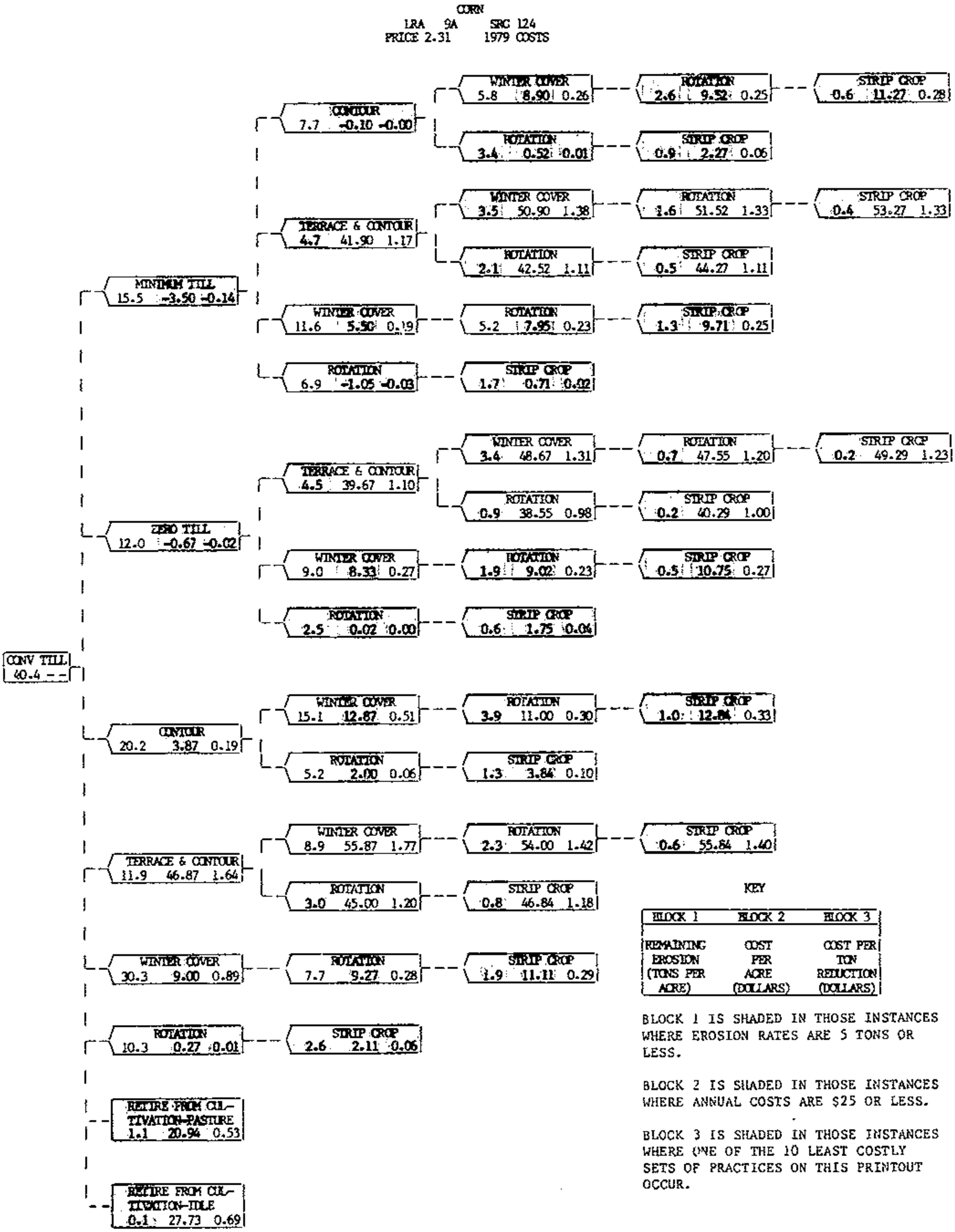
PLOT OF COSTACRE*RED_EROS    SYMBOL USED IS *
```

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

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 crop corn (schematic)



KEY

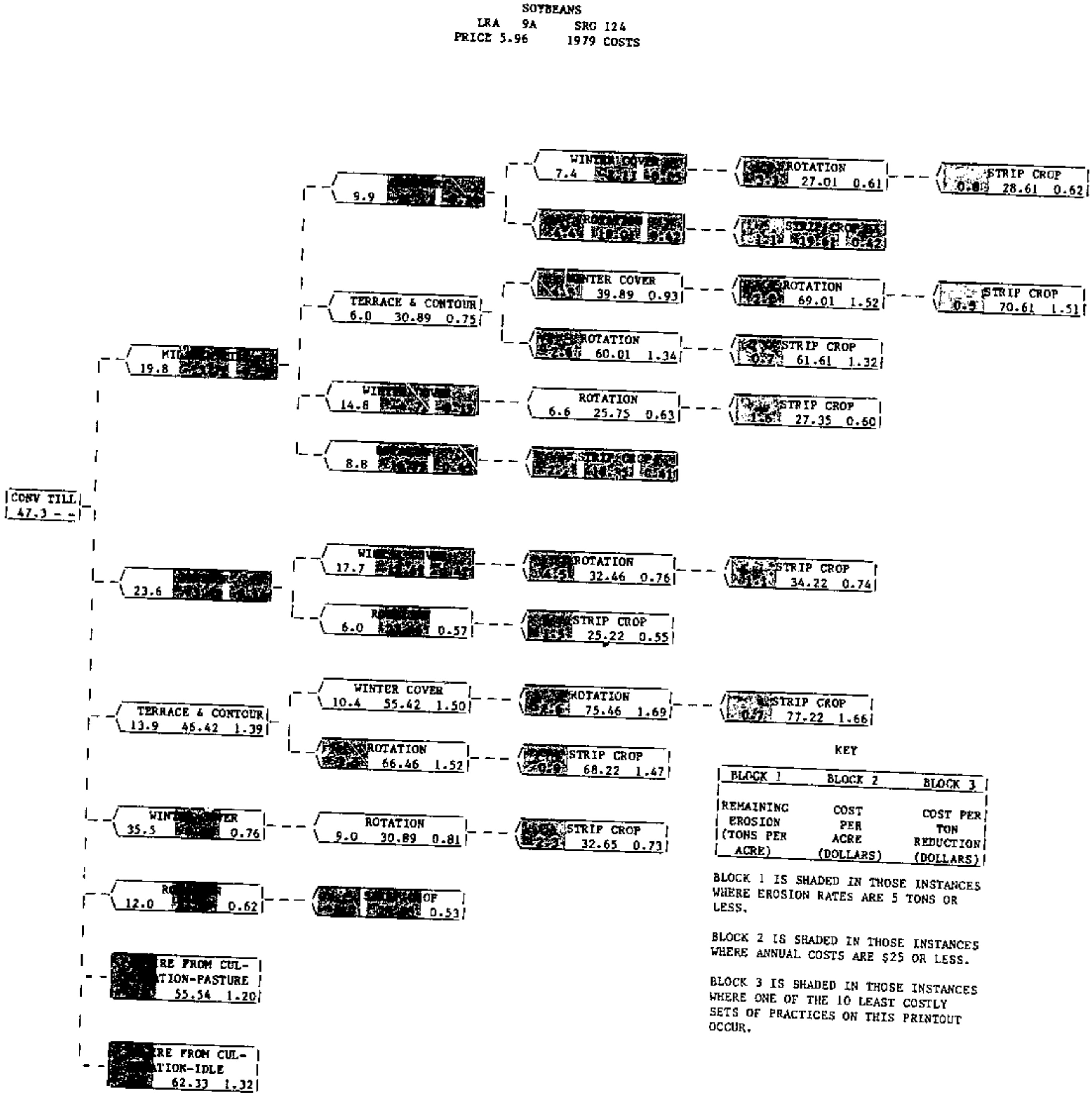
BLOCK 1	BLOCK 2	BLOCK 3
REMAINING EROSION (TONS PER ACRE)	COST PER ACRE (DOLLARS)	COST PER TON REDUCTION (DOLLARS)

BLOCK 1 IS SHADED IN THOSE INSTANCES WHERE EROSION RATES ARE 5 TONS OR LESS.

BLOCK 2 IS SHADED IN THOSE INSTANCES WHERE ANNUAL COSTS ARE $25 OR LESS.

BLOCK 3 IS SHADED IN THOSE INSTANCES WHERE ONE OF THE 10 LEAST COSTLY SETS OF PRACTICES ON THIS PRINTOUT OCCUR.

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



SOYBEANS
LRA 9A SRG 124
PRICE 5.96 1979 COSTS

KEY

BLOCK 1	BLOCK 2	BLOCK 3
REMAINING EROSION (TONS PER ACRE)	COST PER ACRE (DOLLARS)	COST PER TON REDUCTION (DOLLARS)

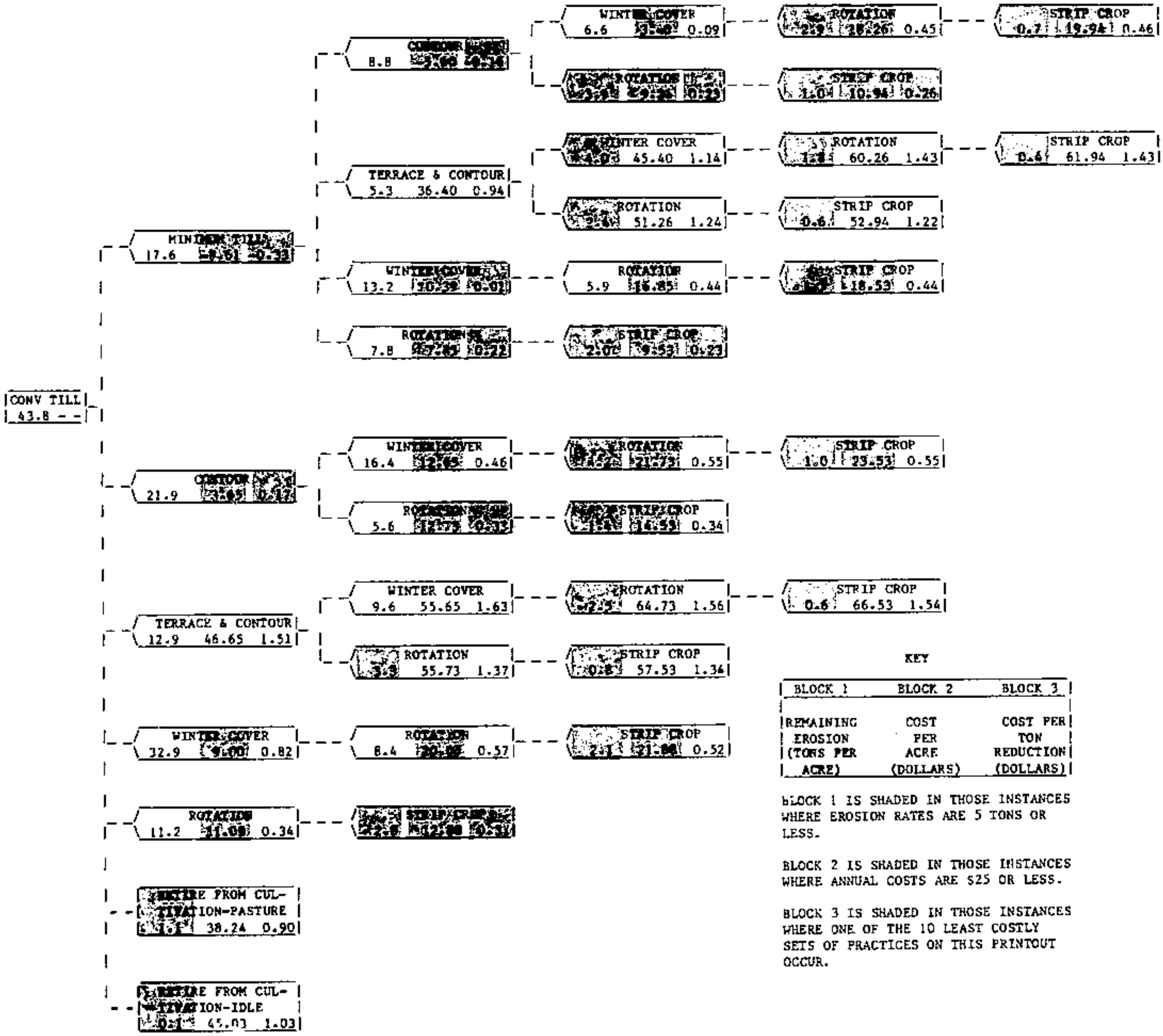
BLOCK 1 IS SHADED IN THOSE INSTANCES WHERE EROSION RATES ARE 5 TONS OR LESS.

BLOCK 2 IS SHADED IN THOSE INSTANCES WHERE ANNUAL COSTS ARE $25 OR LESS.

BLOCK 3 IS SHADED IN THOSE INSTANCES WHERE ONE OF THE 10 LEAST COSTLY SETS OF PRACTICES ON THIS PRINTOUT OCCUR.

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



KEY

BLOCK 1	BLOCK 2	BLOCK 3
REMAINING EROSION (TONS PER ACRE)	COST PER ACRE (DOLLARS)	COST PER TON REDUCTION (DOLLARS)

bLOCK 1 IS SHADED IN THOSE INSTANCES WHERE EROSION RATES ARE 5 TONS OR LESS.

BLOCK 2 IS SHADED IN THOSE INSTANCES WHERE ANNUAL COSTS ARE $25 OR LESS.

BLOCK 3 IS SHADED IN THOSE INSTANCES WHERE ONE OF THE 10 LEAST COSTLY SETS OF PRACTICES ON THIS PRINTOUT OCCUR.

Sample printout 11—Sensitivity of conservation practices costs to increase in energy prices for base crop corn

```
                                  PRACTICE COSTS PER ACRE WITH ENERGY COST INCREASES, CORN

                                                   PRICE 2.31
                                                 1979-80 COSTS
                                                    SRG 124

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

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              PRACTICE COSTS PER ACRE WITH ENERGY COST INCREASES, SOYBEANS

                                     PRICE 5.96
                                   1979-80 COSTS
                                      SRG 124

                                            10%            20%            30%            40%            50%
                         PRESENT COSTS  COST INCREASE  COST INCREASE  COST INCREASE  COST INCREASE  COST INCREASE

 MINIMUM TILLAGE            -13.72         -13.92         -14.12         -14.32         -14.52         -14.72
 CONTOUR-CT                   3.42           3.56           3.70           3.83           3.97           4.10
 CONTOUR-MT                 -11.11         -11.20         -11.30         -11.40         -11.50         -11.59
 TERRACE & CONTOUR-CT        46.42          46.56          46.70          46.83          46.97          47.10
 TERRACE & CONTOUR-MT        30.89          30.79          30.70          30.60          30.50          30.41
 WINTER COVER                 9.00           9.00           9.00           9.00           9.00           9.00
 ROTATION-CT                 21.89          23.02          24.15          25.28          26.41          27.54
 ROTATION-MT                 16.75          17.78          18.82          19.86          20.90          21.93
 STRIP CROPPING-CT*          23.65          24.86          26.07          27.28          28.49          29.70
 STRIP CROPPING-MT*          18.35          19.45          20.55          21.65          22.74          23.84
 RETIRE TO PASTURE*          55.54          53.22          50.90          48.58          46.26          43.94
 RETIRE TO IDLE*             62.33          57.95          53.57          49.19          44.81          40.43

CT:  CONVENTIONAL TILLAGE
MT:  MINIMUM TILLAGE

* EROSION LESS THAN 5 TONS PER ACRE
```

Appendix-Data Sheet for Conservation Practices

IDENTIFICATION

County ____________ Land resource area ____________ Land capability class ____________	Soil resource group ____________ Soil name ____________ Soil mapping unit ____________

SOIL LOSS FACTORS

Crop	C factor		
	Conv.	Min.	Zero
Corn Soybeans			
Pasture	________	Idle	________
________	________	________	________
________	________	________	________
________	________	________	________

Factor	Value
K	____________
R	____________
S	____________
L	____________
P - Contour	____________
P - Strip crop	____________
P - Winter cover	____________
P - ________	____________

TERRACES

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

Grass back slope width, if applicable, feet: ____________

Appendix-Data Sheet for Conservation Practices—Continued

CROP BUDGET DATA

Crop	Yields/acre			Product prices	Net income/acre		
	Conv.	Min.	Zero		Conv.	Min.	Zero
Corn							
Soybeans							
Wheat							
Alfalfa							
Pasture							

Machinery complement: Number ________ Year ________
Input prices: Source ________ Year ________
Percent increase in machine and labor costs:
Contour farming ________ Stripcropping ________
Cost of cover crop: Crop ________ Cost/acre ________

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END