TR- 88
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An Economic Analysis of Erosion and Sedimentation in Lavon Reservoir Watershed

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The work upon which this publication was based was supported in large part by a grant from the Texas Soil and Water Conservation Board and the Texas Department of Water Resources.

Technical Report No. 88

Texas Water Resources Institute

Texas A&M University

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ACKNOWLEDGMENTS

This report is one in a series of watershed studies funded by the Texas Soil and Water Conservation Board and the Texas Department of Water Resources on "Economic Impacts of Various Non-point Source Agricultural Pollution Controls in Texas." The research was conducted under the auspices of the Texas Water Resources Institute, the Texas Agricultural Experiment Station and the Texas Agricultural Extension Service. The authors would like to express their appreciation to Dr. Jack Runkles, Director of the Water Resources Institute, for assistance in organizing and carrying out the research project. Dr. Peggy Glass and Mr. Tom Remaley, Department of Water Resources, and Mr. G. E. Kretzschmar, Jr., and Mr. Charles Rothe of the Soil and Water Conservation Board were instrumental in organizing the project.

Credit is due a great number of people for assistance with the research itself. In particular, A. Ed. Colburn, Extension Agronomist, and Jack W. Stevens, John Kazda and Cliff Williams, Soil Conservation Service agronomists, are to be thanked for providing soils information, yield data, and soil loss factors. Dr. David Kissell, TAMU Soil chemist at the Blackland Research Center, provided valuable input into the determination of the relationship between topsoil eroded and crop yield. Terrace cost data were furnished by Mr. Charles Rothe. Pat Rich and Joe Cole provided useful information on the yield of crops grown in rotation with other crops. Appreciation is expressed to Mickey Melton, Phil Mueller, and Robert Wharton, Research Assistants in the Department of Agricultural Economics, for crunching numbers and carrying out many of the other tedious aspects of this research.

CONTENTS

INTRODUCTION

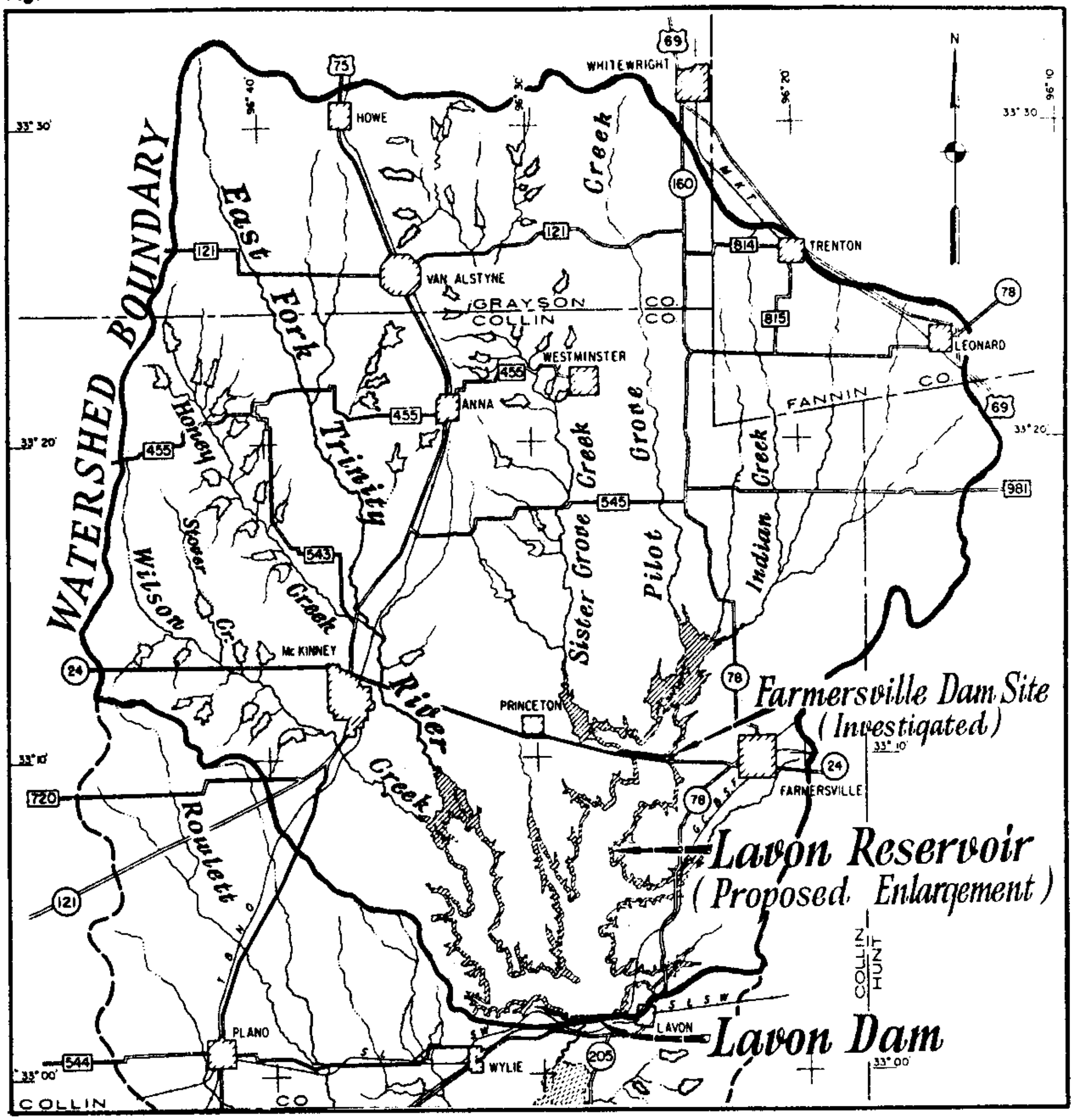
Public Law 92-500 - the 1972 Federal Water Pollution Control Act Amendments - mandates the analysis of agricultural non-point source (NPS) pollution controls. This report presents the results of a study of the economic impact of implementing potential agricultural NPS pollution controls in the watershed above Lavon Reservoir. The study focuses on: (a) effects of erosion controls on farm income; (b) off-side sediment damages in the watersheds; (c) costs of administering and enforcing alternative erosion-sedimentation controls; and (d) effects of adopting cotton pest management methods. Erosion controls considered include possible regulatory programs as well as voluntary programs combined with economic incentives.

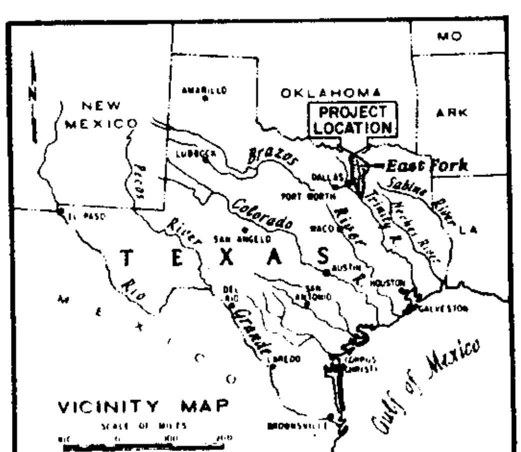
While the stimulus for this study was concern over pollution (an off-site problem) it can not, because of long-run farm income consequences, be separated from conservation problems (an on-farm problem). Thus, the study is as much an analysis of conservation economics as it is an analysis of environmental economics. Accordingly, the report contains substantial information on the short and long-run on-farm benefits and costs of various soil conservation practices for all soil mapping units in Lavon watershed. The results are applicable to much of the Blackland Prairies Land Resource area.

DESCRIPTION OF THE WATERSHED

Lavon Reservoir watershed (Figure 1) covers an area of 477,613 acres, which is primarily in Collin county, but also includes part

Figure 1. Lavon watershed





of Grayson, Fannin and Hunt counties. The watershed lies entirely in the Blackland Prairies Land Resource Area. Soils in this nearly level to rolling prairie can be divided into three principal soil groups: (1) bottomlands or alluvial soils (fine textured, slowly and moderately permeable) that are highly productive; (2) black, waxy upland soils (slowly permeable) that are used primarily for the production of small grains and pasture, and (3) light-colored, deep and shallow upland soils over limestone and marble (moderately permeable). Individual soil mapping units and their extent in the watershed are given in Table 1.

In the past four years, 10 percent of the land in the watershed has been planted to cotton, 16 percent to small grains, 19 percent to feed grains, and the remainder to hay, pasture, and minor crops. Table 2 gives the approximate land use for the 1972-75 period. A very small smount of the cropland is irrigated.

Lavon dam, which is located about 25 miles northwest of Dallas, was constructed for water supply, flood control and recreational purposes in 1953. The dam was modified in 1974 to increase its capacity. The North Texas Municipal Water District has authorization to divert 50,000 acre-feet of water for municipal use, 8,000 acre-feet for industrial purposes, and 2,000 acre-feet for domestic use. Since the reservoir was designed with a large sediment pool, silt has not diminished the water supply and flood control capacity of the reservoir although it could in the future.

Table 1. Acreages of soils and percent cropped by soil series in the Lavon watershed.[a]

Soil Mapping Unit	Table Abbrev.	Acreage	Percent Now Cropped
Austin silty clay, 1 - 3% slopes	AS13	31,000	40
Austin silty clay, 3 - 5% slopes, eroded	AS35	43,000	20
Austin silty clay, 5 - 8% slopes, eroded	AS58	19,000	0
Brackett soils	BRAC	8,500	5
Burleson clay, 0 - 1% slopes	BC01	2,500	60
Burleson clay, 1 - 3% slopes	BC13	5,600	60
Burleson clay, 2 - 4% slopes, eroded	BC24	1,500	50
Crockett soils, 2 - 5% slopes, eroded	CR25	1,000	0
Fairlie soils	FARL	37,000	50
Ferris clays, 5 - 12% slopes, severely eroded	F512	7,600	0
Frio clay loam, frequently flooded	FCLF	1,500	0
Frio clay loam, occasionally flooded	FCLC	4,400	30
Heiden clay, 3 - 5% slopes, eroded	HC35	31,000	40
Heiden clay, 5 - 8% slopes, eroded	HC58	23,000	0
Houston-Black clay, 0 - 1% slopes	HB01	36,000	60
Houston-Black clay, 2 - 3% slopes	HB23	137,000	60
Houston-Black clay, 2 - 4% slopes, eroded	HB24	19,000	30
Trinity clay, frequently flooded	TCFF	19,400	0
Trinity clay, occasionally flooded	TCOF	15,900	40
Wilson clay loam, 0 - 1% slopes	WC01	650	50
Wilson clay loam, 1 - 3% slopes	WC13	3,700	50
Total Acreage		448,250	

[a]Source: Soil and Water Conservation Service. Acreage estimates exclude land not used for crop production.

Table 2. Approximate average land use in Lavon watershed for the 1972-1975 period.[a]

Land Use	Acreage	Percentage
Cropland		
Cotton	49,843	10.4
Wheat, Small Grains	76,888	16.1
Grain Sorghum	91,641	19.2
Minor Crops	2,468	.5
	220,840	46.2
Hay	50,976	10.7
Pasture	167,524	35.1
Woodland	8,911	1.9
Miscellaneous[b]	29,362	6.1
Total	477,613	100.0

[a]Source: Soil and Water Conservation Service

[b]Includes roads, highways, railroad right-of-ways, towns, farmsteads, stream channels, etc.

Lavon watershed is comprised of three Public Law 566 watershed protection project areas. These are Pilot Grove Creek, Sister Grove Creek, and the East Fork of the Trinity River. Construction of 191 flood control structures has been approved for these watersheds with 147 of the structures in place as of October, 1976. These flood control structures along with land treatment have reduced the siltation of Lavon Reservoir.

In a 1976 survey of conservation problems in Texas, agricultural non-point source pollutants in the Blackland Prairies were judged by Soil and Water Conservation District Directors to be a problem of moderate proportions. However, water erosion was classified as presently a problem of somewhat greater proportions, although it was noted that the erosion problem had improved in the past ten years. On the surface, this classification of problem severity may appear contradictory; however, the non-point problem is generally off-farm, while the erosion problem is on-farm. Thus, it is possible that erosion is a serious on-farm productivity problem, while the resulting sediment damages are less serious in effects. The complete survey results for the Blackland Prairie Area are given in Table 3.

Approximately 14 percent of the land is now terraced. However, in recent years much of the terraced land has not been farmed on the contour, thus reducing the effectiveness of the terraces. Reduced tillage systems are not feasible on most of the soils because of their high clay content. For this reason, reduced tillage systems were not considered in this study.

Table 3. Soil and Water Conservation District Directors' rating of conservation problems in the Blackland Prairie Land Resource Area.[a]

	Rank	Present[1/] Severity	Change in Condition in Past[2/] 10 Years
Water-Related Problems			
1 Non-Point Source Pollution			
i Agricultural Non-Point Source Pollutants	15	1.61	+0.22
ii Silvicultural Non-Point Source Pollutants	25	0.70	+0.22
iii Mining Operations Non-Point Source Pollutants	19	1.00	+0.09
iv Construction Site Non-Point Source Pollutants	18	1.45	-0.11
V Waste Disposal Non-Point Source Pollutants	15	1.61	0
vi Salt Water Intrusion	23	0.79	+0.13
vii Hydrologic Modifications	19	1.00	+0.09
2 Floods	8	2.22	+0.40
3 Inadequate Drainage	14	1.68	+0.09
4 Inefficient Irrigation Systems	24	0.72	+0.11
5 Improper use of Ground Water	22	0.81	+0.11
Soil Management Problems			
6 Water Erosion	5	2.40	+0.70
7 Wind Erosion	21	0.86	+0.29
8 Soil Compaction	9	2.18	+0.31
9 Inefficient Tillage Systems	16	1.56	+0.59
10 Salinity	20	0.97	+0.09
11 Loss of Soil Moisture	12	1.77	+0.40
Plant Management Problems			
12 Undesirable Brush & Weeds	7	2.25	+0.02
13 Weeds on Cropland	11	1.84	+0.52
14 Difficulty of Grass Establishment	10	1.93	+0.47
15 Overgrazing	4	2.45	+0.34
Other Problems, Issues, and Policies			
16 Economics of Conservation	2	2.68	-1.02

Scale of Present Severity[1/]

0 - 1.5	Slight to None
1.5 - 2.5	Moderate
2.5 - 3.5	Severe
3.5 - 4.5	Very Severe

Scale of Change in Condition[2/] in Past 10 Years

-1.5 to -2.5	Much Worse
-0.5 to -1.5	Worse
-0.5 to 0	Slight decline
0 to 0.5	Slight improvement
0.5 to 1.5	Better
1.5 to 2.5	Much Better

[a]Source: Association of Texas Soil and Water Conservation Districts.

Table 4 gives recent nitrate concentrations in three locations in Lavon Reservoir. Since the US Public Health standard for nitrates in drinking is 10 p.p.m. of NO_3- N, nitrates do not appear to pose a public health threat in Lavon watershed. Data are not available to determine whether nitrates or other plant nutrients in the watershed are causing euthrophication problems, however.

DISCOUNTING OF FUTURE BENEFITS AND COSTS

Conservation practices and erosion controls affect NPS pollution and the agricultural economy far into the future. In particular, erosion lowers future crop yields because of the associated loss of plant nutrients and the loss of soil as a growing medium. Any reduction in current erosion would thus give a relatively higher yield and associated higher gross benefit in the future. Consequently, it is imperative that a long time horizon be used in a study of the erosion-sedimentation issue, either from a conservation or environmental viewpoint. Time horizons of 10, 100, and 200 years were considered in this study.

To make all future benefits and costs comparable to 1976 dollars, standard discounting procedures were used. The interest rate used for all parts of the study was 7.3 percent, which is a ten year average of the private rate charged by banks. An annual inflation rate of 5.8 percent was built into the computation of future prices and costs. This is a ten year average of the U.S. inflation rate. Using a 7.3 percent interest rate and a 5.8 percent inflation rate gives a <u>real</u> interest rate of 1.5 percent.

Table 4. Nitrate concentrations in Lavon Reservoir.[a]

NO_3-N Concentration	Lake Lavon- Near Dam	Lake Lavon- East Fork Arm	Lake Lavon- Pilot Grove Arm
Average	.22	.21	.19
Maximum	.59	.49	.50
Minimum	.01	.03	.03
Sampling Period	5/72 to 7/77	9/73 to 4/77	9/73 to 1/77

[a]Source: Texas Water Quality Board

The present values of net returns associated with particular crop production activities are given in this study. Present value of net returns was computed as:

$$PV = \sum_{t=1}^{T} [B_t(\frac{1}{1+i})^t - C_t(\frac{1}{1+i})^t]$$

where

Σ = summation of discounted benefits and costs over time.

t = time, in years

B_t = gross benefits in year t

C_t = gross costs in year t

i = interest rate minus inflation rate

$(\frac{1}{1+i})$ = discount rate

T = length of planning horizon

ON FARM ECONOMICS OF SOIL CONSERVATION

Examination of the on-farm economics of soil conservation and thus the farm income consequences of non-point pollution controls requires an immense amount of technical and economic information specific to the watershed. The major types of data required for an analysis of this type include: (a) expected yields of the relevant crops of each soil; (b) soil loss associated with each cropping practice on each soil; (c) the effects of erosion on future crop yield; (d) effects of crop rotations on the yield of individual crops; (e) basic production cost information; (f) additional cost for relevant conservation practices; and (g) expected current and future prices for the crops. These data were combined to estimate the present value net return associated with a particular crop rotation-conservation practice-soil series combination for various time horizons up to 200 years. Before considering present value figures, consider the data that went into their calculation.

Crop Yield

Table 5 gives the yield of the major crops for each soil in Lavon watershed. The yields are for a typical management level, with the crop grown in continuous cultivation. All yields were furnished by Soil Conservation Service and Texas Agricultural Extension Service personnel familiar with the area.

Production costs and Crop Prices

A basic set of 1976 crop budgets for the Blackland Prairie Land Resource Area that were prepared by the Texas Agricultural Extension Service were modified for use in this study. The basic cost information is given in Table 6. The modification consisted of: (a) changing any harvest costs that were proportional to yield to reflect the yield on each soil and for each rotation; and (b) adding the appropriate costs of conservation practices. Terracing construction costs are given in Table 7 for each soil series. In addition to these costs, pre-harvest machinery and labor costs (Table 6) were increased by 10 percent on terraced land. For contouring pre-harvest machinery and labor costs were increased by 15 percent. Total costs attributal to terraces over a long period was assumed to be the discounted sum of: (a) initial construction costs (Table 6); (b) an annual maintanance cost equal to 5 percent of the construction

Table 5. Crop yields for each soil mapping unit.[a]

Soil	Cotton Lint (lbs)	Grain Sorghum (bu)	Wheat (bu)	Bermuda Hay (ton)	Common Bermuda Pasture (AUM)	Coastal Bermuda Pasture (AUM)	Native Pasture (AUM)
AS13	300.0	53.6	32.0	3.3	4.0	5.5	2.0
AS35	200.0	32.1	32.0	2.4	3.0	4.0	1.5
AS58	0.0	0.0	0.0	2.4	3.0	4.0	1.5
BRAC	0.0	0.0	8.0	0.6	0.6	1.0	0.3
BC01	320.0	53.6	25.0	3.3	3.5	5.5	1.8
BC13	300.0	53.6	28.0	3.3	3.5	5.5	1.8
BC24	0.0	35.7	20.0	2.4	3.0	4.0	1.5
CR25	0.0	32.1	15.0	2.4	3.0	4.0	1.5
FARL	380.0	50.0	30.0	4.2	5.0	7.0	2.5
F512	0.0	0.0	0.0	2.1	2.2	3.5	1.0
FCLF	0.0	0.0	0.0	5.1	6.0	8.5	3.0
FCLC	400.0	80.4	30.0	5.1	6.0	8.5	3.0
HC35	200.0	32.1	18.0	3.3	4.8	5.5	2.4
HC58	0.0	0.0	15.0	3.0	4.8	5.0	2.4
HB01	400.0	80.4	30.0	4.2	5.0	7.0	2.5
HB23	400.0	75.0	30.0	4.2	5.0	7.0	2.5
HB24	0.0	53.6	24.0	3.0	3.5	5.0	1.8
TCFF	0.0	0.0	0.0	4.8	5.8	8.0	2.9
TCOF	400.0	80.4	30.0	5.4	5.8	8.5	2.9
WC01	380.0	50.0	20.0	2.4	3.5	4.0	1.8
WC13	340.0	50.0	20.0	2.4	3.5	4.0	1.8

[a]Source: Soil Conservation Service and Texas Agricultural Extension Service

Table 6. Crop production costs, expected prices, and fertilization rates.[a]

Crop	Pre-harvest Variable Costs ($/acre)	Harvest Costs ($/acre)	Equipment Depreciation Costs ($/acre)	Price per Unit ($)	Pre-harvest Machinery and Labor Costs[b] ($/acre)	Insecticide Costs[b] ($/acre)	Herbicide Costs[b] ($/acre)	Fertilization Rates (lbs/acre) N	P
Cotton	80.36	67.69	19.61	.52/lb lint .05/lb seed	37.19	13.32	7.13	60	60
Grain Sorghum	66.51	20.25	12.84	3.65/cwt.	19.02	2.56	3.83	100	60
Wheat, Small Grains	53.57	9.00	7.00	3.36/bu. 14.73/AUM	15.65	2.43	0.00	80	60
Common Bermuda	33.84	0.00	2.50	14.73/AUM	6.15	2.43	2.21	100	40
Coastal Bermuda	42.30	0.00	7.55	14.73/AUM	7.69	2.43	2.21	100	40
Native Pasture	2.86	0.00	0.70	14.73/AUM	0.00	0.00	0.00	0	0
Hay	54.19	85.78	7.42	49.11/ton	9.08	2.43	2.21	180	40

[a]Source: Texas Agricultural Extension Service Crop Budgets for the Blacklands Prairie Area.

[b]These costs are included in the pre-harvest variable costs given in column 1.

Table 7. Terrace construction costs, percent of acreage presently terraced, average thickness of topsoil and yield loss equation by soil mapping unit.[a]

Soil	Terrace Construction Costs For: Close Grown Crops ($/acre)	Row Crops ($/acre)	Now Terraced (%)	Average Topsoil Thickness (inches)	Soil Loss Equation (See Figure 2)
AS13	37.75	45.31	12	15	C
AS35	56.63	64.35	2	12	C
AS58	68.22	75.50	0	10	C
BRAC	62.92	70.79	0	6	C
BC01	22.65	28.31	0	22	C
BC13	37.75	45.31	21	20	C
BC24	48.40	56.63	18	12	C
CR25	48.40	56.63	0	6	A
FARL	37.75	45.31	20	24	C
F512	68.22	75.50	0	6	C
FCLF	22.65	28.31	0	24	C
FCLO	22.65	28.31	0	22	C
HC35	56.63	64.35	16	16	C
HC58	68.22	75.50	0	10	C
HB01	22.65	28.31	0	20	C
HB23	37.75	45.31	30	16	C
HB24	48.40	56.63	20	10	C
TCFF	22.65	28.31	0	16	C
TCOF	22.65	28.31	0	14	C
WC01	22.65	28.31	0	9	A
WC13	37.75	45.31	15	7	A

[a]Source: Texas Soil and Water Conservation Board, Soil Conservation Service, and Texas Agricultural Extension Service.

costs; (c) the cost of rebuilding terraces every 10 years, assumed to be one-third of the construction cost; and (d) the added pre-harvest machinery and labor costs.

Expected prices were defined as the average price received by Texas farmers for the specified crop between 1958 and 1975 adjusted to 1977 dollars by the index of prices paid for production items.

Crop Rotations

Crop rotations rather than just single crops were considered in this study for two reasons. One reason is that the previous crop influences erosion from the current crop, and average erosion for a rotation is not a simple average of erosion of the crops grown continuously. The second reason that rotations were considered is that the yield of some crops will be higher (or lower) when grown in rotation with another crop.

Table 8 shows the crop rotations that were considered and the additional (or lower) yield of some of the crops that are grown in rotation. The yield of grain sorghum grown after cotton was increased by 23 percent over the yield of sorghum following sorghum. This yield increase is attributal to: (a) plant nutrients carried over from growing cotton; and (b) Johnson grass control in the cotton crop, which reduced this weed problem in sorghum the following year. Wheat, when grown after cotton or grain sorghum, was estimated to have a 5 percent lower yield than wheat after wheat because cotton or sorghum withdraws more moisture late in the growing season than wheat. Thus, there is less moisture carried over for the wheat grown in rotation and therefore a lower crop yield. The yield of

Table 8. Crop rotations considered in the analysis, associated USLE "C" factors and the additional yield resulting from growing a crop in rotation with another crop.[a]

Rotation and added yield (in percent)	Table Abbreviation	"C" factor
Cotton	C	.60
Grain Sorghum	S	.40
Wheat, Small Grains	W	.20
Coastal Bermuda hay	H	.01
Common Bermuda pasture	P	.02
Coastal Bermuda pasture	CP	.01
Native pasture	NP	.04
Cotton/Cotton/Sorghum (23)	C/C/S	.53
Cotton/Sorghum (23)/Sorghum	C/S/S	.45
Cotton/Wheat (-5)/Wheat	C/W/W	.30
Sorghum/Wheat (-5)/Wheat	S/W/W	.23
Cotton/Sorghum (23)	C/S	.49
Cotton/Sorghum (23)/Wheat (-5)	C/S/W	.35

[a]Source: Soil Conservation Service and Texas Agricultural Extension Service.

cotton in rotation was estimated to be the same as yield in continuous cultivation.

Soil Loss Factors

The universal soil loss equation was used to calculate gross soil loss in the watershed. This equation is:

$$A = RK(LS)CP$$

where A is gross erosion in tons per acre; R is a rainfall erosivity index; K is a soil-erodibility factor; LS is a topographic factor that represents the combined effects of slope, length, and steepness; C is a cover and management factor; and P is a conservation practice factor. Values for all of these factors were furnished by the Soil Conservation Service and are reported in Table 8 and 9. Also shown in Table 9 are the erosion tolerance limits, or "T" values, that have been eatablished for each soil. Theoretically, if erosion is less than this T value, little or no yield reduction results from the soil loss. These T values are treated as potential constraints on erosion in part of the economic analysis that is presented in a later section of this report.

Table 10 shown estimated per acre erosion rates for each soil series-conservation practice-crop rotation combination considered in the study.

Yield loss attributal to erosion

In a long-run analysis of soil conservation the relationship between erosion and future crop yield is critical. This is because the benefits from conservation practices arise from the relatively

Table 9. USLE factors by soil mapping unit for Lavon watershed.[a]

Soil	USLE Factors				
	K	LS	LS	P	T
		Without Terraces	With Terraces	Contouring or Terracing	Ton/Acre/ Year
A513	0.32	0.34	0.21	0.60	2.0
AS35	0.32	0.76	0.37	0.50	2.0
AS58	0.32	0.67	0.67	1.00	2.0
BRAC	0.32	0.66	0.66	1.00	2.0
BC01	0.32	0.17	0.17	1.00	4.0
BC13	0.32	0.31	0.21	0.60	4.0
BC24	0.32	0.32	0.29	0.50	4.0
CR25	0.43	0.32	0.30	0.50	5.0
FARL	0.32	0.33	0.21	0.60	5.0
F512	0.32	0.67	0.67	1.00	4.0
FCLF	0.32	0.20	0.20	1.00	5.0
FCLD	0.32	0.20	0.20	1.00	5.0
HC35	0.32	0.47	0.37	0.50	5.0
HC58	0.32	0.67	0.60	0.50	5.0
HB01	0.32	0.17	0.17	1.00	5.0
HB23	0.32	0.33	0.21	0.50	5.0
HB24	0.32	0.35	0.29	0.50	5.0
TCFF	0.32	0.20	0.20	1.00	5.0
TCOF	0.32	0.20	0.20	1.00	5.0
WC01	0.43	0.17	0.17	1.00	5.0
WC13	0.43	0.33	0.21	0.60	5.0

[a]Source: Soil Conservation Service and Texas Agricultural Extension Service.

Table 10. Expected soil loss (tons/acre/year) for each crop rotation, soil type, and conservation practice.

Soil	Conservation Practice	Crop Rotations												
		C	S	W	H	P	CP	NP	C/C/S	C/S/S	C/W/W	S/W/W	C/S	C/S/W
AS13	SR	19.91	13.27	6.64	0.33	0.66	0.33	1.33	17.59	14.93	9.96	7.63	16.26	11.61
	C	11.95	7.96	3.98	0.20	0.40	0.20	0.80	10.55	8.96	5.97	4.58	9.76	6.97
	T	7.38	4.92	2.46	0.12	0.25	0.12	0.49	6.52	5.53	3.69	2.83	6.03	4.30
AS35	SR	44.51	29.67	14.84	0.74	1.48	0.74	2.97	39.31	33.38	22.25	17.06	36.35	25.96
	C	22.25	14.84	7.42	0.37	0.74	0.37	1.48	19.66	16.69	11.13	8.53	18.17	12.98
	T	10.83	7.22	3.61	0.18	0.36	0.18	0.72	9.57	8.13	5.42	4.15	8.85	6.32
AS58	SR	39.24	26.16	13.08	0.65	1.31	0.65	2.62	34.66	29.43	19.62	15.04	32.04	22.89
BRAC	SR	38.65	25.77	12.88	0.64	1.29	0.64	2.58	34.14	28.99	19.32	14.82	31.56	22.55
BC01	SR	9.96	6.64	3.32	0.17	0.33	0.17	0.66	8.79	7.47	4.98	3.82	8.13	5.81
BC13	SR	18.15	12.10	6.05	0.30	0.61	0.30	1.21	16.04	13.62	9.08	6.96	14.83	10.59
	C	10.89	7.26	3.63	0.18	0.36	0.18	0.73	9.62	8.17	5.45	4.18	8.90	6.35
	T	7.38	4.92	2.46	0.12	0.25	0.12	0.49	6.52	5.53	3.69	2.83	6.03	4.30
BC24	SR	18.74	12.49	6.25	0.31	0.62	0.31	1.25	16.55	14.05	9.37	7.18	15.30	10.93
	C	9.37	6.25	3.12	0.16	0.31	0.16	0.62	8.28	7.03	4.68	3.59	7.65	5.47
	T	8.49	5.66	2.83	0.14	0.28	0.14	0.57	7.50	6.37	4.25	3.25	6.93	4.95
CR25	SR	25.18	16.79	8.39	0.42	0.84	0.42	1.68	22.24	18.89	12.59	9.65	20.56	14.69
	C	12.59	8.39	4.20	0.21	0.42	0.21	0.84	11.12	9.44	6.30	4.83	10.28	7.34
	T	11.80	7.87	3.93	0.20	0.39	0.20	0.79	10.43	8.85	5.90	4.52	9.64	6.89
FARL	SR	19.32	12.88	6.44	0.32	0.64	0.32	1.29	17.07	14.49	9.66	7.41	15.78	11.27
	C	11.59	7.73	3.86	0.19	9.39	0.19	0.77	10.24	8.70	5.80	4.44	9.47	6.76
	T	7.38	4.92	2.46	0.12	0.25	0.12	0.49	6.52	5.53	3.69	2.83	6.03	4.30
F512	SR	39.24	26.16	13.08	0.65	1.31	0.65	2.62	34.66	29.43	19.62	15.04	32.04	22.89

Table 10 (continued).

Soil	Conservation Practice	Crop Rotations												
		C	S	W	H	P	CP	NP	C/C/S	C/S/S	C/W/W	S/W/W	C/S	C/S/W
FCLF	SR	11.71	7.81	3.90	0.20	0.39	0.20	0.78	10.35	8.78	5.86	4.49	9.56	6.83
FCLO	SR	11.71	7.81	3.90	0.20	0.39	0.20	0.78	10.35	8.78	5.86	4.49	9.56	6.83
HC35	SR	27.52	18.35	9.17	0.46	0.92	0.46	1.83	24.31	20.64	13.76	10.55	22.48	16.06
	C	13.76	9.17	4.59	0.23	0.46	0.23	0.92	12.16	10.32	6.88	5.28	11.24	8.03
	T	10.83	7.22	3.61	0.18	0.36	0.18	0.72	9.57	8.13	5.42	4.15	8.85	6.32
HC58	SR	39.24	26.16	13.08	0.65	1.31	0.65	2.62	34.66	29.43	19.62	15.04	32.04	22.89
	C	19.62	13.08	6.54	0.33	0.65	0.33	1.31	17.33	14.71	9.81	7.52	16.02	11.44
	T	17.57	11.71	5.86	0.29	0.59	0.29	1.17	15.52	13.18	8.78	6.73	14.35	10.25
HB01	SR	9.96	6.64	3.32	0.17	0.33	0.17	0.66	8.79	7.47	4.98	3.82	8.13	5.81
HB23	SR	19.32	12.88	6.44	0.32	0.64	0.32	1.29	17.07	14.49	9.66	7.41	15.78	11.27
	C	9.66	6.44	3.22	0.16	0.32	0.16	0.64	8.54	7.25	4.83	3.70	7.89	5.64
	T	6.15	4.10	2.05	0.10	0.20	0.10	0.41	5.43	4.61	3.07	2.36	5.02	3.59
HB24	SR	20.50	13.66	6.83	0.34	0.68	0.34	1.37	18.10	15.37	10.25	7.86	16.74	11.96
	C	10.25	6.83	3.42	0.17	0.34	0.17	0.68	9.05	7.69	5.12	3.93	8.37	5.98
	T	8.49	5.66	2.83	0.14	0.28	0.14	0.57	7.50	6.37	4.25	3.25	6.93	4.95
TCFF	SR	11.71	7.81	3.90	0.20	0.39	0.20	0.78	10.35	8.78	5.86	4.49	9.56	6.83
TCOF	SR	11.71	7.81	3.90	0.20	0.39	0.20	0.78	10.35	8.78	5.86	4.49	9.56	6.83
WC01	SR	13.38	8.92	4.46	0.22	0.45	0.22	0.89	11.82	10.03	6.69	5.13	10.92	7.80
WC13	SR	25.97	17.31	8.66	0.43	0.87	0.43	1.73	22.94	19.48	12.98	9.95	21.21	15.15
	C	15.58	10.39	5.19	0.26	0.52	0.26	1.04	13.76	11.69	7.79	5.97	12.72	9.09
	T	9.91	6.61	3.30	0.17	0.33	0.17	0.66	8.76	7.44	4.96	3.80	8.10	5.78

higher future crop yield resulting from that conservation practice. Unfortunately, very little experimental or field data on this important relationship are available. Consequently, for purposes of this study it was necessary to develop estimates of this relationship for each soil mapping unit.

Yield loss attributal to topsoil loss depends to a certain extent on the suitability of the subsoil for crop production. Soils in the watershed were classified into one of two groups. Group A consists of soil series that have subsoil that is unsuitable for field crop production. For this group, crop yield was assumed to be zero after all topsoil was eroded. Group C consists of soil series with subsoils that are somewhat suitable for field crop production. It was assumed that crop yield on group C soils would be 50 percent of the yield attainable on the current topsoil. The group to which each soil series belongs and initial average topsoil depth for each series are shown in Table 7.

Due to paucity of experimental or field data on the relationship between topsoil thickness and yield, it was necessary to subjectively specify this relationship for each soil group. After considerable discussion with Soil Conservation Service and Texas A&M University scientists, the two relationshps shown in Figure 2 were specified. The functions in Figure 2 have two important characteristics. One is that each function is expressed in terms of percent of topsoil lost and percent of initial yield attainable after erosion. This reflects the fact that the loss of one inch on an initially shallow soil will decrease yield more than the loss

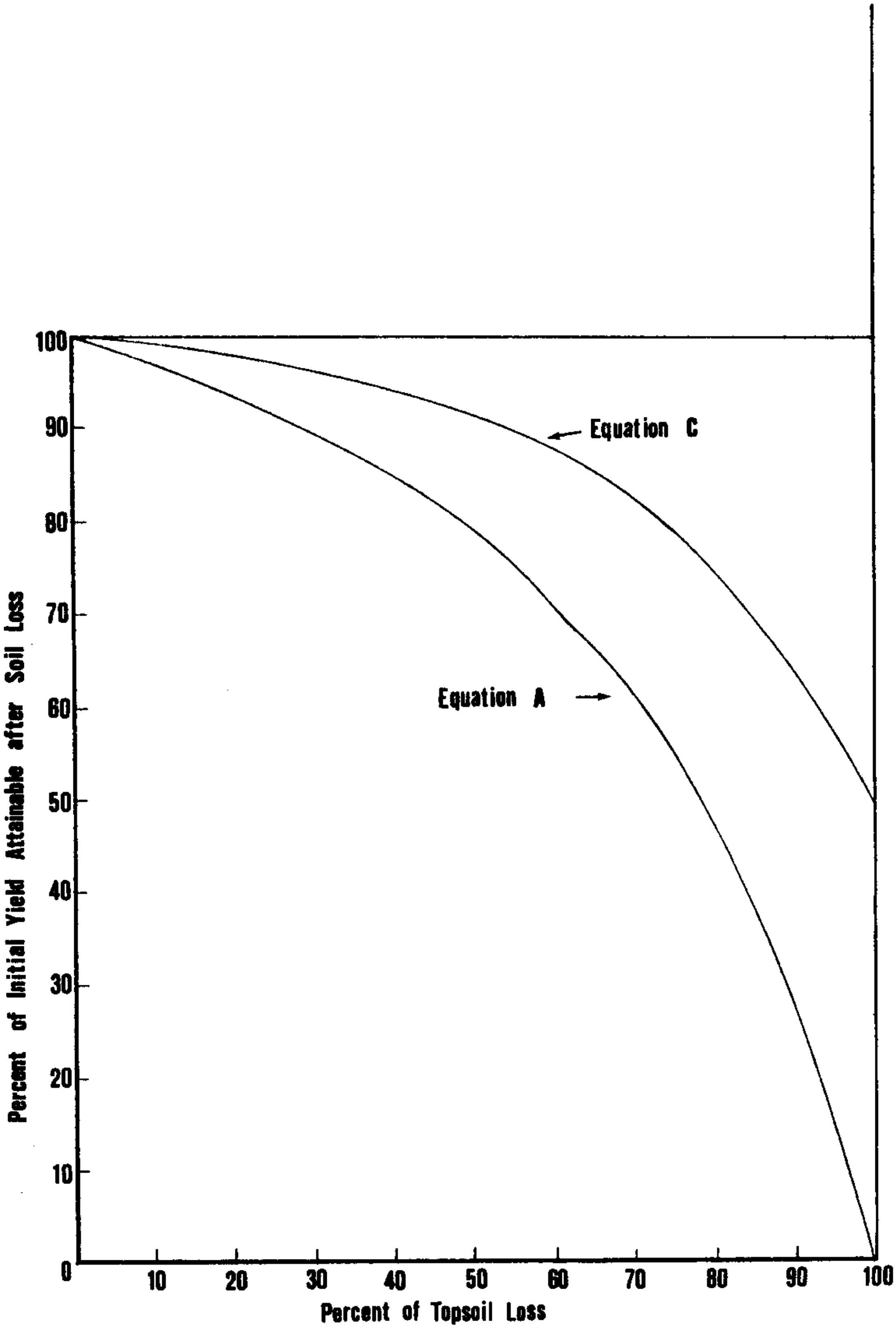


Figure 2. Relationships between yield and topsoil eroded, Lavon watershed.

of one inch of an initially deep soil. For example, the loss of one inch on a soil in Group A with an initial depth of 20 inches will reduce yield by about 2 percent, while the loss of one inch on a soil with an initial depth of 5 inches will decrease yield by about 8 percent.

The second important characteristic of the functions in Figure 2 is that the loss of the last remaining topsoil will reduce yield by more than the loss of the upper portions of initial topsoil. For instance, the loss of the first 20 percent of topsoil in Group A will reduce yield by about 8 percent, while the loss of the last 20 percent of topsoil will reduce yield by about 46 percent. Because of the critical nature of the relationships shown in Figure 2, additional experimental and field research is warranted.

In determining the effects of erosion on yield, the bulk density of soil is important. Since erosion typically occurs when the soil is saturated with water, the bulk density of saturated soil was used. Based on unpublished field data, a bulk density of 100 tons per acre inch was used for all soils in the Lavon watershed except the following. Crockett soils were assumed to have a bulk density of 140 tons per acre inch, Fairlie soils 135 tons per inch, and Wilson clay loam soil 135 tons per acre inch.

Natural formation of topsoil over time was not considered in the model, as this is an extremely slow process for most soil situations. To the extent that topsoil formation occurs, the on-farm cost of erosion is slightly over-stated.

<u>Appropriate planning horizon</u>

Farmers make many short-run decisions because they are concerned with next year's income. On the surface this suggests that farmers would use a short time horizon for planning conservation practices. However, most farmers are concerned about the future value of their land in addition to income flow. Inasmuch as the agricultural component of land values is the capitalized value (present value) of a highest and best use profit stream into perpetuity, a very long time horizon is appropriate for determining what conservation practice a landowner should employ. However, the situation for a renter is different because he cannot capture the land value effect. Thus, the appropriate time horizon for the renter would be no longer than the time span covered by the lease.

Profitability of conservation practices

Profitability information for crop rotation-conservation practice combinations for each soil mapping unit in Lavon watershed is given in Appendix A, Table 17 through 3. All figures are based on the assumption that the producer pays the full cost of the conservation practices; that is, there is no Federal cost sharing.

As an illustration of the information given in these Tables, consider Table 17 which gives the data for Austin silty clay soils with 1 to 3 percent slopes. The first column of this Table gives the crop rotations considered for this soil, while the second column gives the conservation practice considered. Column 3 gives estimated annual topsoil lost (percent) for each respective crop rotation-conservation practice combination. Column 4 gives the per acre profit in year 1. The next block of columns gives annual yield as a percent of initial yield, and profit for years 10, 100, and 200. The final block of columns gives the present value of a profit stream to year 10, 100, and 200.

As a specific example, consider continuous cotton on Austin silty clay soil with 1 to 3 percent slopes (Table 17). With straight row cultivation, 1.327 percent of the topsoil would be lost annually. In year 1, net profit from cotton with straight row cultivation will be $22.01, which declines to $19.85 in year 10 and -$38.98 in year 200. With this system, yield in year 10 is 98.2 percent of initial yield, and yield declines to 50 percent in years 100 and 200. This yield decline is attributed to erosion. Present value of profit for a 10 year period is $194, while present value of profit over a 200 year period is -$281. Present value is negative over the 200 year period because losses in the later years are greater than initial gains. Most farmers would switch land use when annual profit becomes zero or less than the profit associated with an alternative use.

Comparing straight row cultivation of cotton with contouring and terracing (Table 17), we see that straight row cultivation is more profitable over a 10 year period ($194 versus $148 or $88). However, with a 200 year planning horizon, it is more profitable to terrace ($458 versus -$281 or $69).

The information given in Table 17 through 37 can also be used to select the most profitable crop rotation-conservation practice combination for each soil series. Table 17 shows that with a 200 year horizon wheat grown on contoured Austin silty clay soil with 1 to 3 percent slopes is more profitable than any alternative, given the crop prices and production cost data assumed for the study.

Table 11 shows the most profitable (or least costly) conservation practice for each crop rotation (excluding hay and pasture) and each soil series, for a 100 year planning horizon. For most soils with slopes greater than one percent, straight row cultivation of row crops or small grains is less profitable than contouring or terracing.

Most profitable conservation practices for a 200 year planning horizon are shown in Table 12. By comparing these results with Table 11 (100 year horizon), one sees that extending the horizon makes conservation profitable in a few more situations.

Cost-sharing for terrace construction cost

Profitability estimates for conservation practices shown in Tables 17 through 37 were based on the assumption that farmers would pay the full cost of adopting a conservation practice. The Agricultural Stabilization and Conservation Service (ASCS) presently makes a limited number of payments to farmers for 50 percent of the initial cost of constructing terraces. This type of payment would obviously make terracing a more attractive alternative to the farmer. To determine if this would make terracing more profitable than contouring or straight row farming, one can determine the amount of such a payment by taking 50 percent of the appropriate terrace cost figure in Table 7 and add it to the present value figures (Table 17 through 37).

There are no instances where 50 percent cost-sharing payments would make terracing profitable where it would not otherwise be profitable. However, the payments may induce farmers to terrace where it is already profitable because such payments greatly ease the initial

Table 11. Most profitable conservation practice by soil mapping unit and crop rotation with a 100 year planning horizon.

Soil	Most Profitable Conservation Practice For Crop Rotation:								
	C	S	W	C/C/S	C/S/S	C/W/W	S/W/W	C/S	C/S/W
AS13	T	C	SR	C	C	SR	SR	C	SR
AS35	T	T	C	T	T	T	C	T	T
AS58	--	--	--	--	--	--	--	--	--
BRAC	--	--	SR	--	--	--	--	--	--
BC01	SR	SR	SR	SR	SR	SR	SR	SR	SR
BC13	SR	SR	SR	SR	SR	SR	SR	SR	SR
BC24	--	C	C	--	--	--	C	--	--
CR25	--	TZ	CZ	--	--	--	CZ	--	--
FARL	SR	SR	SR	SR	SR	SR	SR	SR	SR
F512	--	--	--	--	--	--	--	--	--
FCLF	--	--	--	--	--	--	--	--	--
FCLC	SR	SR	SR	SR	SR	SR	SR	SR	SR
HC35	C	C	SR	C	C	C	SR	C	C
HC58	--	--	C	--	--	--	--	--	--
HB01	SR	SR	SR	SR	SR	SR	SR	SR	SR
HB23	C	C	SR	C	C	SR	SR	C	C
HB24	--	C	SR	--	--	--	C	--	--
TCFF	--	--	--	--	--	--	--	--	--
TCOF	SR	SR	SR	SR	SR	SR	SR	SR	SR
WC01	SR	SR	SR	SR	SR	SR	SR	SR	SR
WC13	Z	TZ	C	TZ	TZ	CZ	CZ	TZ	CZ

[a] T denotes terracing, C contouring, SR straight row, Z means yield in year 100 is zero for all systems, TZ means yield is zero in year 100 for all practices except terracing, and CZ means yield is zero in year 100 for straight row cultivation.

Table 12. Most Profitable conservation practice by soil mapping unit and crop rotation with a 200 year planning horizon.

Soil	Most Profitable Conservation Practice for Crop Rotation								
	C	S	W	C/C/S	C/S/S	C/W/W	S/W/W	C/S	C/S/S
AS13	T	T	C	T	T	C	C	T	C
AS35	T	T	T	T	T	T	T	T	T
AS58	--	--	--	--	--	--	--	--	--
BRAC	--	--	SR	--	--	--	--	--	--
BC01	SR	SR	SR	SR	SR	SR	SR	SR	SR
BC13	T	C	SR	T	C	SR	SR	C	C
BC24	--	C	C	--	--	--	C	--	--
CR25	--	Z	TZ	--	--	--	Z	--	--
FARL	C	SR	SR	C	SR	SR	SR	SR	SR
F512	--	--	--	--	--	--	--	--	--
FCLF	--	--	--	--	--	--	--	--	--
FCLC	SR	SR	SR	SR	SR	SR	SR	SR	SR
HC35	C	C	C	C	C	C	C	C	C
HC58	--	--	C	--	--	--	--	--	--
HB01	SR	SR	SR	SR	SR	SR	SR	SR	SR
HB23	T	C	C	T	T	C	C	T	C
HB24	--	C	C	--	--	--	C	--	--
TCFF	--	--	--	--	--	--	--	--	--
TCOF	SR	SR	SR	SR	SR	SR	SR	SR	SR
WC01	SR	SR	SR	SR	SR	SR	SR	SR	SR
WC13	Z	Z	TZ	Z	Z	Z	TZ	Z	Z

[a]T denotes terracing, C contouring, SR straight row, Z means yield in year 200 is zero for all systems, TZ means yield is zero in year 200 for all practices except terracing, and CZ means yield is zero in year 200 for straight row cultivation.

financial burden associated with constructing terraces. Therefore, cost sharing for conservation practices may have a much more significant impact than one might surmise from the profitability figures shown in Table 17 through 37.

PUBLIC POLICY OPTIONS FOR NPS CONTROL

The previous section of this report focused on the on-farm economics of conservation aside from the NPS pollution issue. Let us now turn to the pollution question and consider whether controls are justified on economic grounds, on which control is economically the most efficient, and on implementing a control if a problem does indeed exist.

In designing a NPS control plan, it is necessary to define the feasible control methods from a technical perspective. For control of sheet and rill erosion and sediment resulting therefrom, the control methods considered here are the conservation practices of contouring and terracing, and changes in land use such as shifting to a crop which causes less erosion. Reduced tillage systems were not considered because most of the soils have such high clay content that the systems are infeasible.

Once these technical alternatives are specified it is necessary to determine a way of implementing a pollution control method. The standard policy options for implementing a control include regulation, provision of economic incentives, education, and public investment. For point sources of pollutants, regulations are typically directed toward the pollutant at the point of emission into waterways. However, this is not possible with NPS pollutants because they enter waterways at an infinite number of points. Hence, regulations must be directed toward the agricultural practices that cause or influence the NPS pollutants.

The economic incentive option includes alternatives such as Federal or State cost-sharing arrangements for conservation practices, and excise taxes on inputs such as fertilizers and pesticides or even soil loss. Education is a viable policy option in situations where producers or others are misusing inputs that cause pollution, or are not adopting conservation practices that would be profitable. In these situations a successful education program would increase producer's income as well as reducing the environmental damages caused by misuse of agricultural chemicals and production practices. Public investment is appropriate for controls that are not appropriate for individuals, but that can be justified by governmental units. An example would be the construction of municipal waste water treatment plants. In any particular NPS situation, a combination of the above policy options may provide the best solution to the problem.

The specific erosion-sedimentation control options considered for Lavon watershed are:

1. Restricting soil loss to be no greater than the SCS tolerance or "T" limits.
2. Restricting soil loss to be no greater than 2, 5, or 10 tons per acre.
3. Terracing subsidies or cost sharing arrangements for 50 and 100 percent of the annual costs.

4. Contouring subsidies or cost sharing arrangements for 50 and 100 percent of the additional cost for contouring.
5. Cost sharing or subsidies for 50 and 100 percent of the initial construction cost of terraces.
6. Restricting soil loss to be no greater than the SCS tolerance limit combined with a 50 percent terracing, contouring or terrace construction cost sharing arrangement.
7. Restricting soil loss to be no greater than a 5 ton per acre limit combined with a 50 percent terracing, contouring or terrace construction cost sharing arrangement.
8. Taxes on soil loss of 8, 10, 12, 14, 16, 18, and 20 cents per ton.
9. A soil loss tax of X dollars per ton combined with a 50 percent terracing or contouring cost sharing arrangement.

These policy options are expected to cover the relevant range of alternatives. Section 208 of the amended 1972 Federal Water Pollution Control Act, which provided the stimulus for this study, does not specify the policy option that must be used, so decision makers can choose from the above set of options. Specific options considered and their abbreviations are given in Table 13.

The soil loss tax policy, while not practical, was considered because it is an economic efficiency norm for correcting for off-site sediment damages. Economic theory says that in a frictionless economy where all producers maximize profit, the "optimal" way to

Table 13. Alternate Control Options Modeled.

Control	Table Abbrev.
Annual soil loss less than SCS Tolerance limit (T)	SL < T
Annual soil loss less than 2 tons per acre	SL < 2
Annual soil loss less than 5 tons per acre	SL < 5
Annual soil loss less than 10 tons per acre	SL < 10
Subsidy equal to 50 percent of annual terracing costs	TR 50
Subsidy equal to 100 percent of annual terracing costs	TR 100
Subsidy equal to 50 percent of annual contouring costs	C 50
Subsidy equal to 100 percent of annual contouring costs	C 100
Subsidy equal to 50 percent of the initial cost of constructing terraces	ITR 50
Subsidy equal to 100 percent of the initial cost of constructing terraces	ITR 100
Soil loss < T, 50% terracing costs subsidy	SL < T, TR 50
Soil loss < T, 50% contouring costs subsidy	SL < T, C 50
Soil loss < T, 50% initial terrace construction costs subsidy	SL < T, IT 50
Soil loss < 5, 50% terracing costs subsidy	SL < 5, TR 50
Soil loss < 5, 50% contouring costs subsidy	SL < 5, C 50
Soil loss < 5, 50% initial terrace construction costs subsidy	SL < 5, IT 50
A tax on annual soil loss of 8 cents per ton	TX 8
A tax on annual soil loss of 10 cents per ton	TX 10
A tax on annual soil loss of 12 cents per ton	TX 12
A tax on annual soil loss of 14 cents per ton	TX 14
A tax on annual soil loss of 16 cents per ton	TX 16
A tax on annual soil loss of 18 cents per ton	TX 18
A tax on annual soil loss of 20 cents per ton	TX 20
A 8 cent tax on soil loss with a 50% subsidy on terracing or contouring costs	TX 8, 50 T&C
A 10 cent tax on soil loss with a 50% subsidy on terracing or contouring costs	TX 10, 50 T&C
A 12 cent tax on soil loss with a 50% subsidy on terracing or contouring costs	TX 12, 50 T&C
A 14 cent tax on soil loss with a 50% subsidy on terracing or contouring costs	TX 14, 50 T&C
A 16 cent tax on soil loss with a 50% subsidy on terracing or contouring costs	TX 16, 50 T&C
A 18 cent tax on soil loss with a 50% subsidy on terracing or contouring costs	TX 18, 50 T&C
A 20 cent tax on soil loss with a 50% subsidy on terracing or contouring costs	TX 20, 50 T&C

correct for off-site damages is to impose a tax on erosion exactly equal to marginal off-site damages at the socially optimal level of erosion. No other policy option will give a socially more efficient (i.e. less costly from society's viewpoint) allocation of resources to crop production. Other requirements for this to be the most efficient policy for pollution abatement are that: (a) the administrative and enforcement costs be equal for all policies; and (b) the administrative and enforcement costs be less than the gains associated with a tax policy. Under these conditions, the tax policy can be used as a norm against which the other policies (which may be more practical and politically viable) can be evaluated.

To decide whether erosion-sedimentation control is justified on economic grounds and to identify the economically most efficient policy option, the following types of information are needed:

A. The off-site environmental damages that would be abated by the policy;

B. The private and social costs incurred by farmers and society when alternative policy options are implemented at various levels of control; and

C. The implementation, administrative, and enforcement costs associated with each policy.

These benefits and cost components, once combined, indicate whether a particular policy at a specific level of control is justified on economic efficiency grounds. Of course, in deciding between policies, the distributional or equity aspects and political acceptability must also be considered.

Estimates of the above economic impacts for the policy options listed previously are presented in the sections which follow.

OFF-SITE SEDIMENT DAMAGES

A procedure for estimating off-site damages resulting from sediment in a watershed was developed by Lee and Guntermann. This procedure attributes damages to the following factors: (1) an increase in annual cost for a reservoir resulting from a shortened economic life; (2) an increase in the annual cost for flood control structures caused by sediment reducing their economic life; (3) the sediment component of flood damages and damages associated with sediment that remains in the watershed; (4) the increase in sediment damage that occurs after the end of a reservoir's economic life or after the end of a flood control structure's economic life; (5) the loss of recreational benefits resulting from the siltation of a reservoir; and (6) the loss of water supply benefits resulting from sediment displacing the water supply pool in a reservoir.

The Lee and Guntermann procedure implicitly assumes that sediment will not be dredged from a reservoir or removed from a flood control structure. Also implicitly assumed was that a new reservoir or a new flood control structure would not be built to replace an existing one once it is completely filled with silt. These do not appear to be realistic assumptions for Lavon Reservoir or the flood control structures in the watershed. Consequently, the Lee and Guntermann procedure was not used to estimate off-site sediment damages in Lavon watershed. Rather, sediment damages were attributed to the following factors: (a) the cost of removing sediment from 191 flood control structures in the watershed by draining them and then cleaning sediment out; (b) the cost of dredging sediment from Lavon reservoir; and (c) the sediment component of flood damages and damages associated with sediment that remains in the watershed. Computational formula and damage estimates for each of these components follow.

Cost of Removing Sediment from Flood Control Structures

For this component of damages, it was assumed that the sediment pool in a flood control structure would be allowed to completely fill. Then, before sediment reduced the flood control capacity of the structure, the structure would be drained in a dry period and the sediment removed by bulldozing or a similar operation. SCS engineers estimate that this type of operation would cost about $1.01 per ton of sediment removed. With N as the life of the sediment pool, it was assumed that a structure would be cleaned every N years. N was computed by the following formula;

$$N = \frac{K\ C_{RS}}{G_e A_N D_R T_E}$$

where

N is the life of the sediment pool in years;

C_{RS} is the capacity of the sediment pool in acre-feet;

G_e is the gross erosion based on a particular crop rotations, tillage system, conservation practice, and management level for the watershed in tons/acre/year.

A_N is the net drainage area in acres;

D_R is the delivery ratio used to convert gross erosion to sediment delivered.

T_E is trap efficiency of the reservoir; and

K is the conversion constant from acre-feet to tons.

Values for C_{RS}, A_N, and D_R were obtained from the PL-566 watershed work plans for Pilot Grove Creek, Sister Grove Creek, and the East Fork of the Trinity River. K was assumed to equal 1920 tons per acre-foot, and T_E equal to .95.

The present value cost of removing sediment from flood control structures in the watershed into perpetuity is given by the formula:

$$PV = \sum_{S=1}^{191} \sum_{t=1}^{\infty} \left(\frac{1}{1+i}\right)^{N_s t} C_r C_{RS,S} K$$

$$= \sum_{S=1}^{191} \frac{\left(\frac{1}{1+i}\right)^{N_s}}{1 - \left(\frac{1}{1+i}\right)^{N_s}} C_r C_{RS,S} K$$

where

PV = present value cost

C_r = per ton cost of removing sediment from a flood control structure (=\$1.01)

N_s = life of the sediment pool of the S^{th} structure

i = interest rate

$C_{RS,S}$ = capacity of the sediment pool in the S^{th} structure in acre-feet.

The annualized cost of removing sediment from flood control structures is:

$$D_{FS} = i \cdot PV = i \sum_{S=1}^{191} \frac{\left(\frac{1}{1+i}\right)^{N_s}}{1 - \left(\frac{1}{1+i}\right)^{N_s}} C_r C_{RS,S} K$$

where

D_{FS} = annualized cost of removing sediment from all flood control structures in Lavon watershed.

Estimates of D_{FS} for various levels of erosion are given in Table 14.

Cost of Dredging Lavon Reservoir

Annualized off-site sediment damages attributal to the siltation of Lavon Reservoir were based on the cost of dredging the sediment pool each time the pool filled. Computation of the time required for the sediment pool to fill is more complicated than for a flood control structure because the calculation of sediment input is more complicated. Sediment input into the reservoir can be conceptualized as the sum of two components. One component is sediment originating in sub-watersheds that drain into flood control structures, while the other component is that originating in sub-watersheds not protected by flood control structures. Other things equal, sediment input into Lavon from a sub-watershed protected by a flood control structure is much lower than for the other sub-watersheds. This is because the flood control structure is functioning as a sediment trap. Assuming that the trap efficiency of these structures is .95 and that the gross erosion rate is the same for all sub-watersheds, the total annual sediment input into Lavon reservoir can be computed as:

$$S = .05\ D_R A_F G_E + D_R A_{NF} G_E$$

where

S = annual sediment input into Lavon

D_R = delivery ratio

G_E = gross erosion rate in tons per acre

A_F = acreage in Lavon watershed protected by flood control structures other than Lavon Reservoir

A_{NF} = acreage not protected by flood control structures

Based on this, the time required for the sediment pool in Lavon Reservoir to fill can be calculated as:

$$N = \frac{C_{RS} K}{S}$$

where

N = years required for the sediment pool in Lavon to fill, with average gross erosion in the watershed equal to G_E.

C_{RS} = capacity of the Lavon sediment pool in acre-feet.

K = constant for converting acre-feet to tons.

The following values were assumed.

K = 1920 T/AC-FT

C_{RS} = 35,650 AC-FT

D_R = .3

A_F = 203,077 AC

A_{NF} = 274,536 AC

To compute the cost of dredging Lavon, it was assumed that a small portable dredge with a 10" line would be used. Operating costs for this type of dredge are about \$240/hour, with 200 cubic yards/hour dredged.* Assuming that the average density of sediment is 1.19 T/cubic yard, the cost per ton of sediment dredges is \$1.01.

The present value cost of dredging Lavon every N years into perpetuity is given by the formula:

$$PV = \sum_{t=1}^{\infty} \left(\frac{1}{1+i}\right)^{N} C_d C_{RS} K = \frac{\left(\frac{1}{1+i}\right)^{N}}{1 - \left(\frac{1}{1+i}\right)^{N}} C_d C_{RS} K$$

where

PV = present value cost

C_d = per ton cost of dredging sediment

i = interest rate

C_{RS}, and K as previously defined

The annualized cost of dredging sediment from Lavon Reservoir is:

$$D_L = i \cdot PV = iC_d C_{RS} K_i \quad \frac{\left(\frac{1}{1+i}\right)^{N}}{1 - \left(\frac{1}{1+i}\right)^{N}}$$

Table 14 gives estimated value of D_L for different erosion levels.

Sediment Component of Flood Damages and Damages Associated with Sediment that Remains in the Watershed

Estimates of this component of damages (D_S) were obtained directly from the PL566 watershed work plans. In 1976 dollars the damages totaled \$44,462 for a gross erosion rate of 12.8 T/AC.

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*The assistance of the Galveston and Ft. Worth branches of the US Army Corp. of Engineers in obtaining this cost estimate is gratefully acknowledged.

For other erosion rates these damages were assumed proportional to total erosion.

Total Damages

The total off-site damages in Lavon watershed with the average gross erosion rate at 12.8 T/A/year are $971,105 annually. Total damages for other erosion rates are given in Table 14 and the total damage function is shown in Figure 3. In evaluating the off-site sediment damage that would be abated by controls on sheet and rill erosion, it was assumed that erosion due to gullies and streambanks would be about 501 thousand tons per year. Thus, referring to Figure 3, it can be seen that off-site damages would be about $30,000 in the absence of sheet and rill erosion. Damages attributal to sheet and rill erosion must be evaluated with respect to this base level of damages.

It should be noted that the above estimates of off-site damages do not include the social costs of any pollution that may result from factors associated with sediment before it enters a reservoir or flood control structure. However, all available evidence suggests that the potential pollutants associated with sediment are not causing damage in the watershed.

ECONOMIC CONSEQUENCES OF NPS POLICIES

To precisely determine the farm level economic consequences of NPS control policies requires knowledge of the decision or economic value criterion pertaining to each farmer in the watershed. Unfortunately, because of the large number of farmers in Lavon

Table 14. Annualized off-site damages in Lavon reservoir for various gross erosion levels.

	Damages (Dollars) Associated With Gross Erosion (1000 Tons) Of:							
Damage Component	1,194	2,388	3,582	4,776	5,970	7,164	8,358	9,552
Lavon Reservoir (D_L)	6,912	91,856	239,890	413,435	600,180	792,302	990,888	1,189,706
Flood Control Structures (D_{FS})	55,766	238,332	450,014	670,024	894,188	1,118,697	1,344,919	1,576,342
Other (D_S)	8,684	17,368	26,052	34,736	43,420	52,104	60,788	69,472
Total Damages	71,362	347,556	715,956	1,118,195	1,537,788	1,963,103	2,396,595	2,835,520

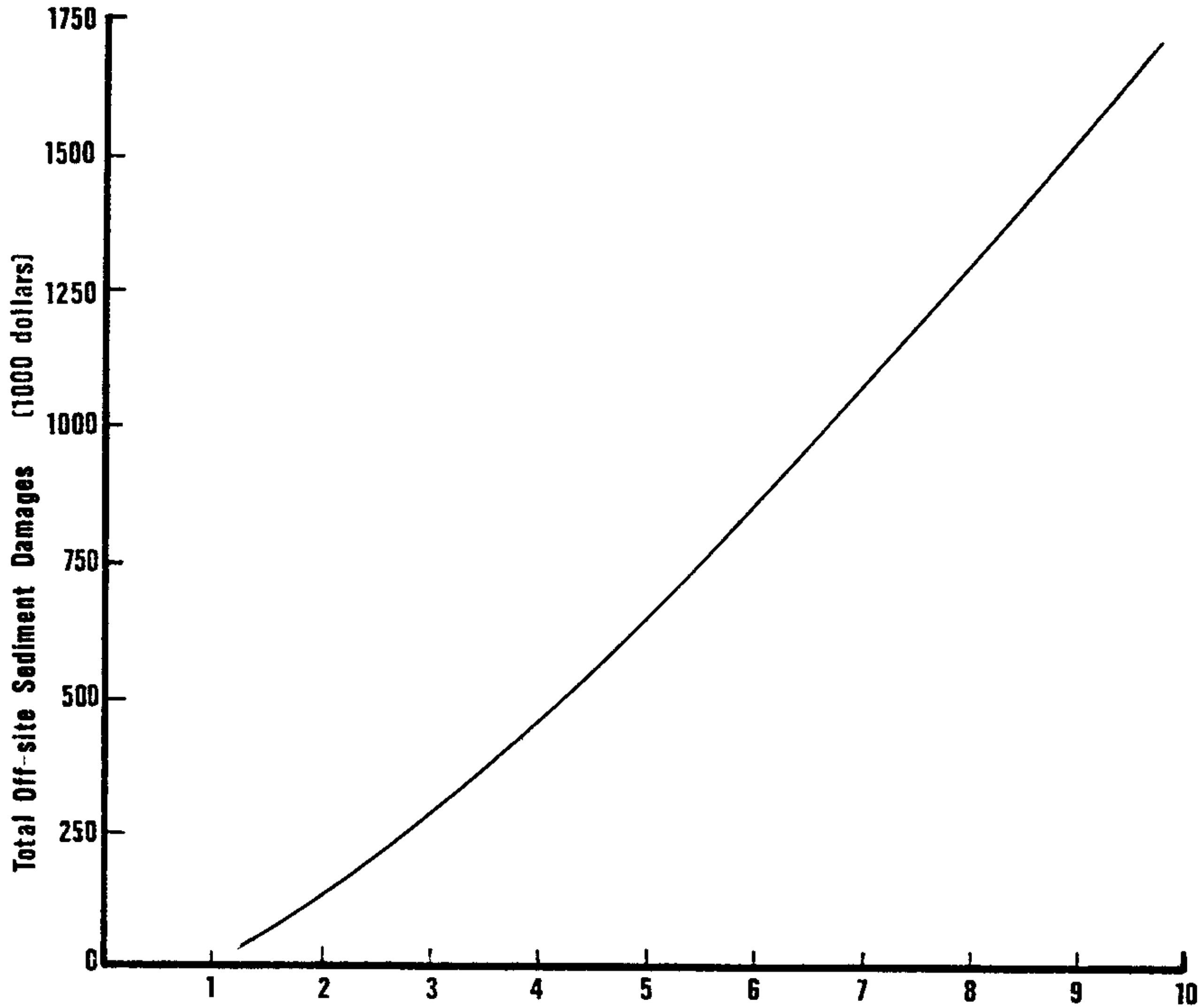

Figure 3. Total off-site sediment damages in Lavon Watershed.

watershed, it was impossible to determine this set of criteria. As a first approximation an expected present value of profit criterion was assumed. Although farmers consider other factors, such as risk and uncertainty, expected profit is perhaps the most important consideration. It should be recognized that the estimated cropping pattern shifts shown in this report may depend in a critical way on this assumed criterion.

Because the benefits of soil conservation accrue over time, rather than immediately, the length of a farmer's planning horizon also influences the crops that will be grown and the conservation practices employed. This, in turn, influences the estimated economic impact of NPS control options. Due to uncertainty about the length of farmers' planning horizon, estimated effects are shown for three horizons. These are 10 years, 100 years, and 200 years. Results based on these planning horizons will likely bracket the actual economic impacts of the erosion controls considered.

Administrative and enforcement costs

The cost of administering and enforcing any of the NPS controls considered here has been estimated to be at least 50 cents per acre of land in Lavon watershed.* For the watershed as a whole, these costs will thus be at least $224,125 annually for the agricultural land in the watershed. The largest component of this cost estimate is based on the amount of technical assistance that would be required to implement the policies. While there will be cost differ-

*G.E. Kretzschmar, Jr. Texas Soil and Water Conservation Board, personal communication.

ences between policies, this figure gives a rough floor to the administration and enforcement costs. This cost figure should be kept in mind when considering the benefit and cost figures given in succeeding tables.

Estimated effects of various erosion-sedimentation control policies on farm income, government cost or revenue, soil loss, off-site sediment damages abated, and net social benefits are shown in Appendix B, Table 38 for a planning horizon of 10 years. Table 39 gives the associated acreage distribution, while Table 40 shows the extent and cost of terracing and contouring by control option. With only a ten year planning horizon, terracing and contouring were found to be unprofitable in the benchmark model solution (Table 38). The distribution of crop acreage in the benchmark solution (Table 39) was reasonably close to actual crop acreages in recent years (Table 2).

The first column of Table 38 gives the estimated farm income effect of the policies. For example, a restriction that per acre soil loss not exceed the SCS tolerance (T) limits, would decrease annualized farm income in the watershed by $4,349,440. Since this policy does not involve a tax or subsidy, the government cost is zero (column 2). The limit to T values would reduce soil loss in the watershed by 3295 thousand tons, which decreases off-site sediment damages by $913,770 annually. The final column gives net social benefits excluding any administrative or enforcement costs. The number in this column is calculated by summing off-site sediment damages abated plus government revenue, minus government cost and the change in annualized farm income.

For the example considered, net social benefits decline by 3,435,670 plus the administration and enforcement costs amounting to roughly $224,125. Net social welfare declines with the restriction because the cost to farmers of the policy exceeds the off-site sediment damages abated.

From Table 38 it can be seen that only three policies show a positive social benefit aside from administration and enforcement costs. These policies are: (a) a subsidy for contouring equal to 50 percent of the additional labor and machinery cost associated with contouring; (b) a tax on soil loss equal to 20 cents per ton; and (c) a tax on soil loss combined with a 50% cost sharing arrangement for conservation practices. However, the benefit figure for any policy is not large enough to offset the associated administration and enforcement costs. Thus, we must conclude that if farmers have a 10 year planning horizon, it would not be to society's advantage to impose a control on erosion.

Model results for a planning horizon of 100 years are given in Tables 41 through 43, while results for a 200 year horizon are given in Tables 44 through 46 (Appendix B). Benchmark model results are similar to those for a 10 year horizon, except that with the longer planning horizon, part of the land was terraced. Consequently, estimated erosion in the watershed was lower.

For either of the long planning horizons, the estimated impact of NPS policies on farm income was not quite as severe as was found for the 10 year horizon. This result was obtained because some conservation was profitable without controls and thus to satisfy a policy, smaller adjustments were required. Also, the longer planning horizon shows the future benefits attributal to conservation.

As with the 10 year planning horizon, the net social benefits excluding administration and enforcement costs are negative for most policies and slightly positive for a few. However, the expected administration and enforcement costs would more than offset the small benefits, suggesting that erosion controls are not warranted under existing economic conditions in the watershed.

EFFECTS OF ADOPTING INTEGRATED PEST MANAGEMENT METHODS

Integrated pest management programs are often suggested as a means of improving environmental quality while at the same time increasing farmer's income. On the surface this is generally true as pest management programs usually require fewer pesticides than do conventional pest control methods. However, the cropping pattern changes that result from adopting pest management strategies may increase the loads of other pollutants, or because of cropping patterns changes the total use of pesticides may increase. These tradeoffs need to be considered before a blanket recommendation to encourage adoption of pest management strategies as a solution to environmental quality problems is made.

This section presents the estimated impacts on farm income and pollution loads of two cotton pest management strategies in Lavon watershed. One strategy would be to adopt a cotton pest scouting program and apply insecticides only when needed. This would be expected to reduce insecticide expenditures on cotton by $2.50 per acre, with no change in yield. Producers would incur a scouting cost of $1.50 per acre. The second strategy considered would involve scouting along with early and uniform destruction of cotton stalks on an area-wide basis for boll weevil control. With this alternative insecticide expenditures on cotton would decrease by $4.50 per acre with no change in yield. Scouting costs would be $1.50 per acre.*

Estimated economic impacts of adopting either of these pest management strategies are presented for planning horizons of 10 and 100 years. The two sets of results should bracket the actual impacts of the strategies. Table 15 presents the estimated impacts for a 10 year planning horizon. Adoption of a scouting program was estimated to increase annualized farm income in the watershed by $119,330. Interestingly, total insecticide use in the watershed was estimated to <u>increase</u> by 3.9 percent. This result was obtained because the lower cotton production cost made it profitable to grow more cotton and less pasture and hay. Thus, while the intensity of insecticide use decreased with scouting, the increased acreage resulted in a net increase in use. If pest management was adopted on a national basis this result would not hold in most situations, as changes in the price of cotton would hold down the shift of more land to cotton. However, on a small area basis the above paradox can indeed occur.

With the scouting program, nitrogen fertilizer use decreased, while herbicide use increased. Gross soil loss in the watershed

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*Ray Frisbie, Extension Entomologist, Texas A&M University, personal communication.

Table 15. Estimated effects of adopting cotton pest management strategies in Lavon watershed, assuming farmers have a 10 year planning horizon.

Item	Cotton Pest Management Alternative: Scouting	Sanitation & Scouting
Change in annualized farm income (1000 dollars)	$119.33	$390.80
Change in insecticide expenditures (%)	3.9	-6.3
Change in herbicide expenditures (%)	14.1	18.1
Change in nitrogen fertilizer use (%)	-10.8	-14.6
Change in phosphorous fertilizer use (%)	3.7	5.3
Change in cotton acreage (%)	8.3	10.1
Change in sorghum acreage (%)	0.0	1.8
Change in wheat acreage (%)	0.0	0.0
Change in soil loss (%)	18.6	22.5

increased by 18.6 percent, which is attributed to the increased cotton acreage.

Table 15 shows that with a 10 year planning horizon, adoption of scouting and sanitation on an area-wide basis would increase annualized farm income by $390,800. While cotton acreage increased with adoption of this strategy, the lower per-acre insecticide requirement for cotton production was large enough to result in a net decrease of 6.3 percent in total insecticide use in the watershed. The other effects of adopting a sanitation with scouting program are similar to the effects of the scouting program.

Table 16 shows the estimated economic impacts based on a 100 year planning horizon. With this long time horizon, no shifts in crop acreages were estimated to occur. Adopting scouting would increase annualized farm income in the watershed by $91,760, while income would increase by $272,040 with scouting combined with a sanitation program. Because cotton acreage did not change, total insecticide use in the watershed decreased by 11.4 percent with scouting and be 20.5 percent with scouting and sanitation.

The information presented in Table 15 and 16 show that farm income in the watershed would be increased by adopting currently available cotton pest management methods. However, it is not clear whether total insecticide use in the watershed would decrease as a result of adopting one of the strategies. This is because the resulting acreage changes may more than offset the reduced insecticide intensity. Adoption of the strategies also had a mixed effect on the loads of other pollutants or potential pollutants in the watershed.

Table 16. Estimated effects of adopting cotton pest management strategies in Lavon watershed assuming farmers have a 100 year planning horizon.

Item	Cotton Pest Management Alternative: Scouting	Sanitation & Scouting
Change in annualized farm income (1000 dollars)	$91.76	$272.04
Change in insecticide expenditures (%)	-11.4	-20.5
Change in herbicide expenditures (%)	0	0
Change in nitrogen fertilizer use (%)	0	0
Change in phosphorous fertilizer use (%)	0	0
Change in cotton acreage (%)	0	0
Change in sorghum acreage (%)	0	0
Change in wheat acreage (%)	0	0
Change in soil loss (%)	0	0

The paradoxes and tradeoffs noted above suggest that very careful consideration must be given to the aggregate effects of certain pest management methods before they are propounded as panaceas for pollution control.

CONCLUSIONS

The estimated farm income consequences of NPS control options that are presented in this report were based on the assumption that crop prices would not change in response to the implementation of a particular policy. This is a reasonable assumption as long as the policy is imposed only in a small area with no changes in outside areas. However, if a pollution control policy is imposed in a large area or for the whole nation, it is expected that crop prices will change in response to implementing a policy that significantly affects crop yield or production cost. Thus, the results presented in this study apply only if NPS controls are not imposed over a large area.

Because of the likely price impacts of national NPS controls and because of regional interdependencies in producton, a national economic assessment is warranted. Such an assessment should account for regional interdependencies and price impacts and should consider policies which differed by region as well as uniform policies. For the above reasons, national coordination of regional NPS control policies would be most appropriate.

Given the estimate of off-site sediment damages (i.e. social costs of sediment) and the estimate of the costs of administering and enforcing a tight NPS control policy, this analysis suggests that controls are not presently warranted from society's viewpoint in Lavon watershed. However, it should be noted that the estimate of off-site damage is imprecise at best and there are many environmental damages that are intangible. Future research should be directed toward obtaining more precise and more quantifiable estimates of environmental damages. Only after exact estimates are available can a complete "social accounting" of NPS policy options by made.

The data presented on the on-farm economics of conservation show that soil conservation does indeed pay in some situations if farmers have a long planning horizon. This suggests that a conservation educational program may increase farmers' income as well as reducing sediment damages. An educational program directed toward encouraging farmers to adopt cotton pest management principles would increase farm income in Lavon watershed. However, if pest management is not adopted nationwide, the policy may backfire from an environmental viewpoint as total insecticide expenditures or the insecticide pollution load may increase in the area. This may happen because the higher profitability of cotton grown with the new system would lead to greater acreage. Of course, the intensity of insecticide use on cotton land would decrease, but the total load nevertheless may increase.

APPENDIX A

Yield loss and per acre returns to land and management for various crop rotation-conservation practice combinations for each soil mapping unit.

TABLE 17. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES AS13.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
C	SR	1.327	22.01	98.2	19.85	50.0	-38.98	50.0	-38.98	194.	173.	-281.
	C	0.796	16.43	99.1	15.29	75.1	-13.89	50.0	-44.56	148.	503.	69.
	T	0.492	13.90	99.6	9.24	92.0	3.99	53.6	-42.74	88.	548.	458.
S	SR	0.885	24.53	98.9	23.40	66.3	-10.51	50.0	-27.41	222.	901.	605.
	C	0.531	21.67	99.5	21.21	90.8	12.07	50.0	-30.26	199.	967.	950.
	T	0.328	18.23	100.0	13.99	95.6	13.46	85.2	2.81	129.	848.	979.
W	SR	0.442	54.28	99.7	53.96	93.3	46.64	66.3	15.55	500.	2669.	3115.
	C	0.265	51.94	100.0	51.94	96.5	47.87	90.8	41.32	479.	2607.	3141.
	T	0.164	49.06	100.0	45.56	97.8	46.38	95.6	43.96	420.	2486.	3023.
H	SR	0.022	29.68	100.0	29.68	100.0	29.68	99.7	29.43	274.	1533.	1878.
P	SR	0.044	22.58	100.0	22.58	99.7	22.42	98.9	21.94	208.	1165.	1424.
CP	SR	0.022	31.17	100.0	31.17	100.0	31.17	99.7	30.94	287.	1609.	1971.
NP	SR	0.088	25.90	100.0	25.90	98.9	25.58	97.6	25.20	239.	1334.	1630.
C/C/S	SR	1.172	30.72	98.5	28.81	50.0	-31.22	50.0	-31.22	276.	783.	419.
	C	0.703	26.05	99.2	25.09	82.3	4.07	50.0	-35.90	237.	1067.	822.
	T	0.435	23.21	99.7	18.69	93.5	15.03	68.0	-16.40	175.	1050.	1135.
C/S/S	SR	0.996	31.70	98.7	30.21	51.9	-25.05	50.0	-27.23	287.	1093.	776.
	C	0.597	27.95	99.4	27.27	88.1	13.93	50.0	-30.98	256.	1240.	1169.
	T	0.369	24.81	99.9	20.45	94.9	18.60	79.9	1.08	190.	1162.	1332.
C/W/W	SR	0.664	41.71	99.3	40.91	84.7	24.09	50.0	-15.93	382.	1919.	1938.
	C	0.398	38.30	99.8	38.08	94.3	31.75	75.1	9.64	353.	1859.	2158.
	T	0.246	35.04	100.0	30.84	96.7	31.09	92.0	25.83	284.	1733.	2085.
S/W/W	SR	0.509	42.54	99.6	42.09	91.5	33.24	50.0	-12.11	391.	2045.	2286.
	C	0.305	40.03	100.0	40.03	95.9	35.55	87.5	26.36	369.	1984.	2367.
	T	0.189	36.47	100.0	32.27	97.5	33.53	94.7	30.71	298.	1828.	2217.
C/S	SR	1.084	35.21	98.6	33.46	50.0	-27.22	50.0	-27.22	318.	1121.	803.
	C	0.650	31.00	99.3	30.16	85.5	12.84	50.0	-31.44	283.	1355.	1226.
	T	0.402	28.01	99.8	23.57	94.2	20.66	74.5	-3.82	219.	1309.	1481.
C/S/W	SR	0.774	39.26	99.1	38.20	77.0	12.05	50.0	-19.95	359.	1710.	1577.
	C	0.465	35.70	99.7	35.32	92.8	27.15	61.0	-10.51	329.	1698.	1896.
	T	0.287	32.50	100.0	28.30	96.2	27.79	89.1	19.61	261.	1586.	1891.

TABLE 18. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES AS35.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
C	SR	3.709	-18.76	94.8	-22.85	50.0	-59.31	50.0	-59.31	-192.	-2399.	-3090.
	C	1.854	-24.23	97.5	-26.26	50.0	-64.89	50.0	-64.89	-233.	-2190.	-2946.
	T	0.903	-28.61	98.9	-35.47	64.2	-57.95	50.0	-69.27	-322.	-1788.	-2569.
S	SR	2.473	-17.14	96.7	-19.19	50.0	-48.24	50.0	-48.24	-168.	-1778.	-2340.
	C	1.236	-19.99	98.4	-21.01	50.0	-51.10	50.0	-51.10	-188.	-1473.	-2068.
	T	0.602	-25.28	99.4	-31.61	87.9	-33.04	50.0	-56.39	-289.	-1425.	-1920.
W	SR	1.236	54.28	98.4	52.40	50.0	-3.14	50.0	-3.14	493.	1988.	1952.
	C	0.618	51.94	99.4	51.23	87.1	37.15	50.0	-5.49	477.	2473.	2666.
	T	0.301	47.23	100.0	41.98	96.0	42.39	87.9	33.33	387.	2342.	2817.
H	SR	0.062	4.79	100.0	4.79	99.4	4.38	98.4	3.70	44.	244.	292.
P	SR	0.124	7.85	100.0	7.85	98.4	7.13	96.7	6.39	72.	395.	475.
CP	SR	0.062	9.07	100.0	9.07	99.4	8.71	98.4	8.10	84.	465.	564.
NP	SR	0.247	18.53	100.0	18.53	96.7	17.81	91.9	16.75	171.	944.	1147.
C/C/S	SR	3.276	-13.47	95.6	-16.97	50.0	-53.30	50.0	-53.30	-141.	-2028.	-2648.
	C	1.638	-18.11	97.8	-19.87	50.0	-57.98	50.0	-57.98	-175.	-1751.	-2426.
	T	0.797	-22.79	99.1	-29.49	75.0	-42.92	50.0	-62.66	-268.	-1414.	-2078.
C/S/S	SR	2.782	-12.85	96.3	-15.57	50.0	-49.50	50.0	-49.50	-131.	-1792.	-2369.
	C	1.391	-16.60	98.1	-17.96	50.0	-53.25	50.0	-53.25	-159.	-1474.	-2095.
	T	0.677	-21.59	99.3	-28.08	83.9	-33.60	50.0	-58.24	-256.	-1280.	-1826.
C/W/W	SR	1.854	28.29	97.5	25.75	50.0	-22.64	50.0	-22.64	249.	284.	20.
	C	0.927	24.88	98.8	23.70	61.2	-14.62	50.0	-26.05	225.	886.	593.
	T	0.451	19.78	99.7	13.51	93.1	12.54	64.2	-16.68	127.	888.	956.
S/W/W	SR	1.422	28.79	98.1	26.97	50.0	-18.99	50.0	-18.99	258.	658.	436.
	C	0.711	26.28	99.2	25.53	81.8	8.85	50.0	-21.50	240.	1138.	1016.
	T	0.346	20.88	99.9	14.83	95.3	16.13	83.0	4.62	137.	982.	1146.
C/S	SR	3.029	-10.74	95.9	-13.95	50.0	-50.20	50.0	-50.20	-114.	-1826.	-2411.
	C	1.514	-14.96	98.0	-16.57	50.0	-54.42	50.0	-54.42	-145.	-1512.	-2146.
	T	0.737	-19.79	99.2	-26.41	79.9	-35.88	50.0	-59.25	-240.	-1226.	-1816.
C/S/W	SR	2.163	8.93	97.1	6.37	50.0	-35.12	50.0	-35.12	70.	-693.	-1102.
	C	1.082	5.37	98.6	4.14	50.0	-38.67	50.0	-38.67	45.	-212.	-663.
	T	0.527	0.32	99.6	-6.03	90.9	-7.92	50.0	-43.73	-53.	-123.	-331.

TABLE 19. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES AS58.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
H	SR	0.065	4.79	100.0	4.79	99.3	4.33	98.3	3.63	44.	243.	291.
P	SR	0.131	7.85	100.0	7.85	98.3	7.08	96.5	6.31	72.	394.	473.
CP	SR	0.065	9.07	100.0	9.07	99.3	8.67	98.3	8.04	84.	465.	563.
NP	SR	0.262	18.53	100.0	18.53	96.5	17.76	91.0	16.55	171.	943.	1145.

TABLE 20. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES BRAC.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
W	SR	2.147	-31.86	97.1	-32.68	50.0	-46.21	50.0	-46.21	-298.	-2019.	-2557.
H	SR	0.107	-45.01	100.0	-45.01	98.6	-45.24	97.1	-45.49	-415.	-2327.	-2855.
P	SR	0.215	-27.50	100.0	-27.50	97.1	-27.76	93.6	-28.06	-254.	-1424.	-1749.
CP	SR	0.107	-35.12	100.0	-35.12	98.6	-35.32	97.1	-35.54	-324.	-1816.	-2228.
NP	SR	0.429	0.86	99.7	0.85	93.6	0.58	69.1	-0.51	8.	39.	43.

TABLE 21. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES BC01.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
C	SR	0.453	30.14	99.7	29.75	93.1	21.15	63.9	-16.77	277.	1401.	1528.
S	SR	0.302	24.53	100.0	24.53	96.0	20.33	87.8	11.89	226.	1189.	1397.
W	SR	0.151	29.16	100.0	29.16	98.0	27.34	96.0	25.53	269.	1478.	1788.
H	SR	0.008	29.68	100.0	29.68	100.0	29.68	100.0	29.68	274.	1533.	1878.
P	SR	0.015	15.22	100.0	15.22	100.0	15.22	100.0	15.22	140.	786.	963.
CP	SR	0.008	31.17	100.0	31.17	100.0	31.17	100.0	31.17	287.	1609.	1972.
NP	SR	0.030	22.22	100.0	22.22	100.0	22.22	99.4	22.07	205.	1147.	1405.
C/C/S	SR	0.400	36.17	99.8	35.92	94.3	28.78	74.9	3.67	333.	1735.	1990.
C/S/S	SR	0.339	34.38	99.9	34.30	95.4	28.81	83.8	14.88	317.	1672.	1962.
C/W/W	SR	0.226	27.98	100.0	27.98	97.0	24.91	93.1	20.97	258.	1390.	1665.
S/W/W	SR	0.173	26.13	100.0	26.13	97.7	23.95	95.3	21.72	241.	1314.	1583.
C/S	SR	0.370	39.28	99.9	39.11	94.9	32.66	79.8	13.20	362.	1907.	2224.
C/S/W	SR	0.264	34.07	100.0	34.07	96.5	30.08	90.9	23.72	314.	1686.	2014.

TABLE 22. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES BC13.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
C	SR	0.908	22.01	98.9	20.64	63.6	-22.36	50.0	-38.98	198.	682.	246.
	C	0.545	16.43	99.5	15.85	90.3	4.56	50.0	-44.56	150.	664.	519.
	T	0.369	13.90	99.9	9.54	94.9	7.49	79.9	-10.66	89.	595.	633.
S	SR	0.605	24.53	99.4	23.91	87.8	11.80	50.0	-27.41	225.	1084.	1012.
	C	0.363	21.67	99.9	21.55	95.0	16.46	80.7	1.64	200.	1023.	1167.
	T	0.246	18.23	100.0	14.04	96.7	14.66	92.0	9.93	129.	872.	1035.
W	SR	0.303	39.93	100.0	39.93	95.9	35.85	87.8	27.62	368.	1986.	2375.
	C	0.182	37.58	100.0	37.58	97.6	35.12	95.0	32.53	347.	1900.	2298.
	T	0.123	34.70	100.0	31.21	98.4	32.93	96.7	31.40	288.	1762.	2147.
H	SR	0.015	29.68	100.0	29.68	100.0	29.68	100.0	29.68	274.	1533.	1878.
P	SR	0.030	15.22	100.0	15.22	100.0	15.22	99.4	14.91	140.	786.	961.
CP	SR	0.015	31.17	100.0	31.17	100.0	31.17	100.0	31.17	287.	1609.	1972.
NP	SR	0.061	22.22	100.0	22.22	99.4	22.07	98.4	21.81	205.	1146.	1402.
C/C/S	SR	0.802	30.72	99.1	29.56	74.7	-0.67	50.0	-31.22	280.	1231.	949.
	C	0.481	26.05	99.6	25.61	92.3	16.54	56.6	-27.69	239.	1186.	1240.
	T	0.326	23.21	100.0	18.96	95.6	17.59	85.4	5.10	175.	1089.	1262.
C/S/S	SR	0.681	31.70	99.3	30.84	83.7	12.49	50.0	-27.23	290.	1387.	1259.
	C	0.408	27.95	99.8	27.70	94.1	21.00	73.3	-3.55	257.	1319.	1485.
	T	0.277	24.81	100.0	20.61	96.3	20.29	89.9	12.94	190.	1193.	1413.
C/W/W	SR	0.454	32.33	99.7	32.01	93.1	24.98	63.6	-6.19	298.	1543.	1735.
	C	0.272	28.92	100.0	28.92	96.4	25.07	90.3	18.61	267.	1423.	1692.
	T	0.184	25.66	100.0	21.47	97.5	22.87	94.9	20.24	198.	1273.	1538.
S/W/W	SR	0.348	33.16	99.9	33.07	95.2	28.40	82.8	15.93	306.	1624.	1914.
	C	0.209	30.65	100.0	30.65	97.2	27.85	93.9	24.56	283.	1534.	1845.
	T	0.141	27.09	100.0	22.90	98.1	25.03	96.2	23.32	211.	1362.	1656.
C/S	SR	0.741	35.21	99.2	34.17	79.6	9.75	50.0	-27.22	321.	1510.	1329.
	C	0.445	31.00	99.7	30.65	93.3	22.61	65.7	-11.77	285.	1455.	1610.
	T	0.301	28.01	100.0	23.81	96.0	22.81	87.9	12.86	220.	1345.	1586.
C/S/W	SR	0.529	34.76	99.6	34.25	90.8	24.28	50.0	-22.20	319.	1629.	1740.
	C	0.318	31.20	100.0	31.17	95.7	26.32	86.3	15.55	288.	1521.	1791.
	T	0.215	28.00	100.0	23.80	97.1	24.55	93.6	20.73	219.	1380.	1661.

TABLE 23. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES BC24.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
S	SR	1.041	-10.16	98.7	-11.09	50.0	-44.76	50.0	-44.76	-97.	-879.	-1400.
	C	0.521	-13.02	99.6	-13.31	91.1	-19.17	50.0	-47.61	-121.	-770.	-1093.
	T	0.472	-17.56	99.7	-23.03	92.6	-22.89	59.1	-45.83	-211.	-1003.	-1330.
W	SR	0.521	11.21	99.6	10.90	91.1	4.83	50.0	-24.68	103.	477.	430.
	C	0.260	8.87	100.0	8.87	96.5	6.37	91.1	2.48	82.	413.	473.
	T	0.236	4.96	100.0	0.47	96.8	2.52	92.6	-0.36	4.	207.	235.
H	SR	0.026	4.79	100.0	4.79	100.0	4.79	99.6	4.50	44.	247.	302.
P	SR	0.052	7.85	100.0	7.85	99.6	7.66	98.7	7.26	72.	404.	491.
CP	SR	0.026	9.07	100.0	9.07	100.0	9.07	99.6	8.82	84.	468.	573.
NP	SR	0.104	18.53	100.0	18.53	98.7	18.24	97.2	17.92	171.	953.	1164.
S/W/W	SR	0.599	2.96	99.4	2.55	88.0	-5.38	50.0	-31.91	26.	32.	-169.
	C	0.299	0.44	100.0	0.44	96.0	-2.35	88.0	-7.89	4.	-29.	-75.
	T	0.271	-4.21	100.0	-9.46	96.4	-6.94	90.3	-10.94	-87.	-274.	-357.

TABLE 24. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES CR25.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
S	SR	2.072	-17.40	91.3	-22.54	0.0	0.0	0.0	0.0	-185.		
	C	1.036	-19.99	95.4	-22.87	0.0	0.0	0.0	0.0	-197.		
	T	0.971	-24.61	95.7	-32.47	9.2	-81.23	0.0	0.0	-287.	-1923.	
W	SR	1.036	-6.73	95.4	-9.22	0.0	0.0	0.0	0.0	-73.		
	C	0.518	-9.08	97.9	-10.23	77.6	-21.12	0.0	0.0	-88.		
	T	0.486	-13.05	98.0	-18.53	79.7	-24.10	9.2	-61.95	-165.	-892.	-1249.
H	SR	0.052	4.79	100.0	4.79	97.9	3.37	95.4	1.72	44.	229.	260.
P	SR	0.104	7.85	100.0	7.85	95.4	5.81	91.3	4.01	72.	371.	430.
CP	SR	0.052	9.07	100.0	9.07	97.9	7.81	95.4	6.35	84.	452.	536.
NP	SR	0.207	18.53	99.6	18.44	91.3	16.62	83.4	14.88	171.	919.	1105.
S/W/W	SR	1.192	-11.07	94.7	-14.02	0.0	0.0	0.0	0.0	-116.		
	C	0.596	-13.58	97.5	-14.99	71.7	-29.36	0.0	0.0	-131.	-976.	
	T	0.559	-18.31	97.7	-24.78	74.7	-32.51	0.0	0.0	-222.	-1207.	

TABLE 25. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES FARL.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
C	SR	0.575	54.54	99.5	53.71	89.1	37.65	50.0	-22.72	501.	2564.	2718.
	C	0.345	48.96	99.9	48.83	95.3	41.68	83.1	22.87	451.	2393.	2817.
	T	0.220	46.43	100.0	42.23	97.1	41.72	93.4	36.26	389.	2309.	2784.
S	SR	0.383	17.55	99.8	17.39	94.6	12.32	77.6	-4.13	162.	811.	902.
	C	0.230	14.70	100.0	14.70	96.9	11.72	92.9	7.81	136.	706.	828.
	T	0.146	11.26	100.0	7.06	98.0	9.19	96.1	7.46	65.	544.	653.
W	SR	0.192	47.11	100.0	47.11	97.4	44.33	94.6	41.30	434.	2385.	2889.
	C	0.115	44.76	100.0	44.76	98.5	43.13	96.9	41.44	413.	2289.	2784.
	T	0.073	41.88	100.0	38.38	99.2	40.86	98.0	39.76	354.	2147.	2626.
H	SR	0.010	54.58	100.0	54.58	100.0	54.58	100.0	54.58	503.	2818.	3454.
P	SR	0.019	37.31	100.0	37.31	100.0	37.31	99.8	37.19	344.	1926.	2361.
CP	SR	0.010	53.26	100.0	53.26	100.0	53.26	100.0	53.26	491.	2750.	3370.
NP	SR	0.038	33.26	100.0	33.26	99.8	33.21	99.1	32.94	307.	1717.	2103.
C/C/S	SR	0.508	49.69	99.6	49.11	91.5	37.57	50.0	-21.74	457.	2368.	2615.
	C	0.305	45.01	100.0	45.01	95.9	39.16	87.5	27.21	415.	2216.	2631.
	T	0.194	42.17	100.0	37.98	97.4	38.28	94.5	34.35	350.	2106.	2546.
C/S/S	SR	0.431	37.22	99.7	36.91	93.6	29.33	68.7	-1.39	343.	1783.	2028.
	C	0.259	33.47	100.0	33.47	96.5	29.21	91.2	22.62	309.	1651.	1967.
	T	0.165	30.33	100.0	26.13	97.8	27.43	95.5	24.82	241.	1514.	1832.
C/W/W	SR	0.288	47.75	100.0	47.75	96.2	43.09	89.1	34.49	440.	2380.	2852.
	C	0.173	44.34	100.0	44.34	97.7	41.52	95.3	38.62	409.	2244.	2715.
	T	0.110	41.09	100.0	36.89	98.6	39.19	97.1	37.52	340.	2091.	2549.
S/W/W	SR	0.220	35.55	100.0	35.55	97.0	32.53	93.4	28.77	328.	1782.	2147.
	C	0.132	33.03	100.0	33.03	98.2	31.23	96.5	29.42	305.	1680.	2035.
	T	0.084	29.48	100.0	25.28	99.0	28.28	97.7	27.16	233.	1503.	1836.
C/S	SR	0.470	47.19	99.7	46.73	92.6	37.12	59.7	-8.01	434.	2266.	2556.
	C	0.282	42.97	100.0	42.97	96.2	37.82	89.5	28.65	396.	2124.	2533.
	T	0.179	39.98	100.0	35.79	97.6	36.51	95.1	33.22	330.	2002.	2423.
C/S/W	SR	0.335	44.91	99.9	44.83	95.4	39.26	84.3	25.41	414.	2214.	2626.
	C	0.201	41.36	100.0	41.36	97.3	38.00	94.2	34.19	381.	2078.	2505.
	T	0.128	38.15	100.0	33.95	98.3	35.87	96.6	33.91	313.	1931.	2350.

TABLE 26. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES F512.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
H	SR	0.109	-3.51	100.0	-3.51	98.6	-4.34	97.1	-5.21	-32.	-192.	-247.
P	SR	0.218	-3.93	100.0	-3.93	97.1	-4.88	93.5	-6.04	-36.	-220.	-281.
CP	SR	0.109	1.71	100.0	1.71	98.6	0.98	97.1	0.20	16.	79.	86.
NP	SR	0.436	12.64	99.7	12.60	93.5	11.59	67.7	7.41	117.	634.	756.

TABLE 27. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES FCLF.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
H	SR	0.008	79.48	100.0	79.48	100.0	79.48	100.0	79.48	733.	4103.	5029.
P	SR	0.016	52.04	100.0	52.04	100.0	52.04	100.0	52.00	480.	2687.	3293.
CP	SR	0.008	75.36	100.0	75.36	100.0	75.36	100.0	75.36	695.	3890.	4768.
NP	SR	0.033	40.63	100.0	40.63	100.0	40.61	99.3	40.33	375.	2098.	2569.

TABLE 28. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES FCLO.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
C	SR	0.532	62.67	99.5	61.93	90.7	47.55	50.0	-18.65	576.	2997.	3302.
S	SR	0.355	76.47	99.9	76.31	95.1	68.86	81.8	48.17	705.	3808.	4543.
W	SR	0.177	47.11	100.0	47.11	97.6	44.53	95.1	41.85	434.	2390.	2897.
H	SR	0.009	79.48	100.0	79.48	100.0	79.48	100.0	79.48	733.	4103.	5029.
P	SR	0.018	52.04	100.0	52.04	100.0	52.04	99.9	51.95	480.	2687.	3293.
CP	SR	0.009	75.36	100.0	75.36	100.0	75.36	100.0	75.36	695.	3890.	4768.
NP	SR	0.035	40.63	100.0	40.63	99.9	40.58	99.2	40.28	375.	2098.	2569.
C/C/S	SR	0.470	79.05	99.7	78.47	92.6	66.35	59.5	9.34	728.	3866.	4460.
C/S/S	SR	0.399	83.92	99.8	83.59	94.3	74.22	75.0	41.32	773.	4158.	4917.
C/W/W	SR	0.266	50.44	100.0	50.44	96.4	46.03	90.7	38.91	465.	2524.	3035.
S/W/W	SR	0.204	54.99	100.0	54.99	97.3	51.65	94.1	47.82	507.	2782.	3368.
C/S	SR	0.435	87.49	99.7	87.02	93.5	76.01	68.0	30.75	806.	4316.	5058.
C/S/W	SR	0.311	71.51	100.0	71.49	95.8	65.22	87.0	51.90	659.	3576.	4290.

TABLE 29. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES HC35.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
C	SR	1.720	-18.65	97.7	-20.54	50.0	-59.31	50.0	-59.31	-180.	-1838.	-2529.
	C	0.860	-24.23	99.0	-25.08	69.0	-49.45	50.0	-64.89	-226.	-1520.	-2249.
	T	0.677	-28.61	99.3	-35.16	83.9	-41.91	50.0	-69.27	-321.	-1660.	-2321.
S	SR	1.147	-17.14	98.5	-18.07	50.0	-48.24	50.0	-48.24	-162.	-1272.	-1834.
	C	0.573	-19.99	99.5	-20.32	89.1	-26.75	50.0	-51.10	-185.	-1133.	-1558.
	T	0.451	-25.28	99.7	-31.43	93.1	-29.79	64.2	-47.55	-288.	-1391.	-1780.
W	SR	0.573	4.04	99.5	3.69	89.1	-2.98	50.0	-28.27	36.	103.	-49.
	C	0.287	1.69	100.0	1.69	96.2	-0.79	89.1	-5.33	16.	42.	17.
	T	0.226	-3.02	100.0	-8.27	97.0	-5.17	93.1	-7.46	-76.	-201.	-258.
H	SR	0.029	29.68	100.0	29.68	100.0	29.68	99.5	29.20	274.	1533.	1876.
P	SR	0.057	34.36	100.0	34.36	99.5	33.99	98.5	33.30	317.	1771.	2164.
CP	SR	0.029	31.17	100.0	31.17	100.0	31.17	99.5	30.73	287.	1609.	1970.
NP	SR	0.115	31.79	100.0	31.79	98.5	31.26	96.9	30.71	293.	1634.	1996.
C/C/S	SR	1.520	-13.43	98.0	-15.06	50.0	-53.30	50.0	-53.30	-131.	-1444.	-2065.
	C	0.760	-18.11	99.1	-18.80	78.2	-35.49	50.0	-57.98	-169.	-1141.	-1741.
	T	0.598	-22.79	99.4	-29.21	88.1	-32.53	50.0	-62.66	-266.	-1326.	-1848.
C/S/S	SR	1.290	-12.85	98.3	-14.10	50.0	-49.50	50.0	-49.50	-124.	-1218.	-1795.
	C	0.645	-16.60	99.3	-17.08	85.7	-27.05	50.0	-53.25	-154.	-999.	-1476.
	T	0.508	-21.59	99.6	-27.84	91.5	-28.03	50.0	-58.24	-255.	-1227.	-1637.
C/W/W	SR	0.860	-4.53	99.0	-5.25	69.0	-25.95	50.0	-39.05	-44.	-463.	-894.
	C	0.430	-7.95	99.7	-8.12	93.6	-12.34	69.0	-29.36	-74.	-488.	-685.
	T	0.339	-13.05	99.9	-19.06	95.4	-16.46	83.9	-24.15	-175.	-744.	-947.
S/W/W	SR	0.659	-4.03	99.3	-4.47	85.0	-13.47	50.0	-35.40	-38.	-335.	-633.
	C	0.330	-6.55	99.9	-6.58	95.5	-9.35	85.0	-15.99	-60.	-390.	-521.
	T	0.260	-11.95	100.0	-17.91	96.5	-14.35	91.2	-17.50	-165.	-668.	-833.
C/S	SR	1.405	-10.74	98.1	-12.23	50.0	-50.20	50.0	-50.20	-105.	-1228.	-1813.
	C	0.702	-14.96	99.2	-15.56	82.3	-28.90	50.0	-54.42	-140.	-949.	-1471.
	T	0.553	-19.79	99.5	-26.14	90.0	-27.95	50.0	-59.25	-238.	-1155.	-1600.
C/S/W	SR	1.003	-6.82	98.7	-7.75	50.7	-42.52	50.0	-42.99	-66.	-692.	-1193.
	C	0.502	-10.38	99.6	-10.67	91.7	-16.37	50.7	-46.07	-96.	-634.	-918.
	T	0.395	-15.43	99.8	-21.53	94.4	-19.73	75.7	-33.01	-197.	-882.	-1140.

TABLE 30. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES HC58.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
W	SR	1.308	-6.73	98.3	-7.67	50.0	-33.65	50.0	-33.65	-66.	-764.	-1156.
	C	0.654	-9.08	99.3	-9.45	85.3	-17.01	50.0	-36.00	-85.	-576.	-894.
	T	0.586	-14.91	99.4	-21.53	88.6	-21.28	50.0	-41.83	-197.	-872.	-1207.
H	SR	0.065	21.38	100.0	21.38	99.3	20.82	98.3	19.94	197.	1099.	1338.
P	SR	0.131	34.36	100.0	34.36	98.3	33.13	96.5	31.90	317.	1757.	2137.
CP	SR	0.065	23.80	100.0	23.80	99.3	23.30	98.3	22.52	219.	1225.	1492.
NP	SR	0.262	31.79	100.0	31.79	96.5	30.56	91.0	28.62	293.	1619.	1968.

TABLE 31. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES HB01.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
C	SR	0.498	62.67	99.6	62.04	91.8	49.39	51.9	-15.64	577.	3017.	3389.
S	SR	0.332	76.47	99.9	76.38	95.5	69.45	84.7	52.64	705.	3818.	4571.
W	SR	0.166	47.11	100.0	47.11	97.8	44.70	95.5	42.26	434.	2394.	2904.
H	SR	0.008	54.58	100.0	54.58	100.0	54.58	100.0	54.58	503.	2818.	3454.
P	SR	0.017	37.31	100.0	37.31	100.0	37.31	99.9	37.27	344.	1926.	2361.
CP	SR	0.008	53.26	100.0	53.26	100.0	53.26	100.0	53.26	491.	2750.	3370.
NP	SR	0.033	33.26	100.0	33.26	99.9	33.24	99.3	33.01	307.	1717.	2104.
C/C/S	SR	0.440	79.05	99.7	78.58	93.4	67.69	66.9	22.03	728.	3883.	4528.
C/S/S	SR	0.373	83.92	99.9	83.68	94.8	75.07	79.2	48.56	774.	4171.	4960.
C/W/W	SR	0.249	50.44	100.0	50.44	96.7	46.32	91.8	40.31	465.	2530.	3047.
S/W/W	SR	0.191	54.99	100.0	54.99	97.4	51.86	94.6	48.47	507.	2787.	3377.
C/S	SR	0.407	87.49	99.8	87.12	94.1	77.12	73.6	40.79	806.	4331.	5114.
C/S/W	SR	0.290	71.51	100.0	71.51	96.1	65.66	88.8	54.69	659.	3584.	4311.

TABLE 32. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES HB23.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
C	SR	1.208	62.67	98.4	60.07	50.0	-18.65	50.0	-18.65	568.	2126.	1909.
	C	0.604	57.09	99.4	56.14	87.8	37.26	50.0	-24.23	524.	2662.	2769.
	T	0.384	54.56	99.8	50.10	94.6	45.60	77.5	17.95	464.	2649.	3101.
S	SR	0.805	66.00	99.1	64.62	74.4	28.72	50.0	-6.67	604.	2987.	3002.
	C	0.403	63.15	99.8	62.86	94.2	54.76	74.4	25.87	582.	3109.	3655.
	T	0.256	59.71	100.0	55.51	96.6	54.57	91.4	47.17	512.	2984.	3603.
W	SR	0.403	47.11	99.8	46.89	94.2	40.89	74.4	19.49	434.	2320.	2728.
	C	0.201	44.76	100.0	44.76	97.3	41.85	94.2	38.54	413.	2261.	2735.
	T	0.128	41.88	100.0	38.38	98.3	39.91	96.6	38.20	354.	2129.	2594.
H	SR	0.020	54.58	100.0	54.58	100.0	54.58	99.8	54.35	503.	2818.	3453.
P	SR	0.040	37.31	100.0	37.31	99.8	37.16	99.1	36.61	344.	1926.	2356.
CP	SR	0.020	53.26	100.0	53.26	100.0	53.26	99.8	53.05	491.	2750.	3370.
NP	SR	0.081	33.26	100.0	33.26	99.1	32.92	97.8	32.47	307.	1714.	2095.
C/C/S	SR	1.067	74.80	98.6	72.49	50.0	-9.18	50.0	-9.18	681.	2954.	2847.
	C	0.533	70.12	99.5	69.36	90.7	54.44	50.0	-13.86	645.	3373.	3749.
	T	0.339	67.29	99.9	62.97	95.4	59.36	83.8	40.10	582.	3322.	3960.
C/S/S	SR	0.906	76.10	98.9	74.29	63.8	17.43	50.0	-5.03	695.	3327.	3294.
	C	0.453	72.35	99.7	71.86	93.1	61.12	63.8	13.68	666.	3542.	4104.
	T	0.288	69.21	100.0	65.01	96.1	62.79	89.0	51.38	600.	3450.	4151.
C/W/W	SR	0.604	50.44	99.4	49.71	87.8	35.32	50.0	-11.57	463.	2387.	2549.
	C	0.302	47.02	100.0	47.02	96.0	42.00	87.8	31.90	434.	2335.	2790.
	T	0.192	43.77	100.0	39.57	97.4	40.40	94.6	37.06	365.	2198.	2664.
S/W/W	SR	0.463	51.54	99.7	51.16	92.8	43.05	61.4	5.85	475.	2516.	2900.
	C	0.231	49.02	100.0	49.02	96.9	45.36	92.8	40.53	452.	2466.	2976.
	T	0.147	45.47	100.0	41.27	98.0	42.96	96.1	40.80	381.	2304.	2804.
C/S	SR	0.986	81.05	98.7	78.92	53.2	1.15	50.0	-4.30	740.	3414.	3365.
	C	0.493	76.83	99.6	76.19	92.0	63.13	53.2	-3.06	707.	3740.	4269.
	T	0.314	73.85	100.0	69.62	95.8	66.48	86.7	51.07	642.	3671.	4403.
C/S/W	SR	0.705	67.26	99.2	66.13	82.2	41.18	50.0	-5.95	617.	3143.	3278.
	C	0.352	63.70	99.9	63.56	95.2	56.63	82.2	37.63	587.	3159.	3756.
	T	0.224	60.50	100.0	56.30	97.0	55.94	93.2	50.53	519.	3038.	3678.

TABLE 33. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES HB24.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
S	SR	1.366	24.53	98.2	22.63	50.0	-27.41	50.0	-27.41	218.	412.	92.
	C	0.683	21.67	99.3	20.91	83.6	4.59	50.0	-30.26	198.	897.	710.
	T	0.566	17.14	99.5	11.35	89.4	5.96	50.0	-34.80	108.	709.	606.
W	SR	0.683	25.57	99.3	24.94	83.6	11.40	50.0	-17.50	234.	1136.	1069.
	C	0.342	23.22	99.9	23.16	95.3	19.21	83.6	9.05	214.	1125.	1315.
	T	0.283	19.31	100.0	14.83	96.2	15.88	89.4	10.22	137.	928.	1104.
H	SR	0.034	21.38	100.0	21.38	99.9	21.32	99.3	20.78	197.	1104.	1350.
P	SR	0.068	16.69	100.0	16.69	99.3	16.30	98.2	15.72	154.	858.	1045.
CP	SR	0.034	23.80	100.0	23.80	99.9	23.74	99.3	23.26	219.	1229.	1503.
NP	SR	0.137	22.95	100.0	22.95	98.2	22.47	96.4	21.99	212.	1178.	1438.
S/W/W	SR	0.786	23.78	99.1	22.96	76.1	2.11	50.0	-21.49	217.	979.	797.
	C	0.393	21.27	99.8	21.11	94.4	16.22	76.1	-0.40	196.	1007.	1143.
	T	0.325	16.62	100.0	11.33	95.6	12.43	85.4	3.42	105.	774.	901.

TABLE 34. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES TCFF.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
H	SR	0.012	71.18	100.0	71.18	100.0	71.18	100.0	71.18	656.	3675.	4504.
P	SR	0.024	49.09	100.0	49.09	100.0	49.09	99.6	48.78	453.	2535.	3105.
CP	SR	0.012	67.99	100.0	67.99	100.0	67.99	100.0	67.99	627.	3510.	4302.
NP	SR	0.049	39.16	100.0	39.16	99.6	39.00	98.8	38.63	361.	2021.	2473.

TABLE 35. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES TCOF.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
C	SR	0.837	62.67	99.0	61.04	71.4	16.13	50.0	-18.65	572.	2727.	2584.
S	SR	0.558	76.47	99.5	75.68	89.8	60.52	50.0	-1.44	703.	3704.	4141.
W	SR	0.279	47.11	100.0	47.11	96.3	43.10	89.8	36.09	434.	2358.	2836.
H	SR	0.014	87.78	100.0	87.78	100.0	87.78	100.0	87.78	810.	4532.	5554.
P	SR	0.028	49.09	100.0	49.09	100.0	49.09	99.5	48.67	453.	2535.	3105.
CP	SR	0.014	75.36	100.0	75.36	100.0	75.36	100.0	75.36	695.	3890.	4768.
NP	SR	0.056	39.16	100.0	39.16	99.5	38.94	98.5	38.54	361.	2020.	2472.
C/C/S	SR	0.739	79.05	99.2	77.62	79.8	44.23	50.0	-7.06	725.	3659.	3767.
C/S/S	SR	0.627	83.92	99.4	82.84	86.7	61.24	50.0	-1.12	771.	4016.	4368.
C/W/W	SR	0.418	50.44	99.8	50.15	93.9	42.87	71.4	14.96	465.	2470.	2880.
S/W/W	SR	0.321	54.99	100.0	54.95	95.7	49.72	85.9	37.88	507.	2741.	3281.
C/S	SR	0.683	87.49	99.3	86.19	83.6	58.35	50.0	-1.09	803.	4139.	4408.
C/S/W	SR	0.488	71.51	99.6	70.96	92.1	59.65	54.7	3.24	658.	3495.	4013.

TABLE 36. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES WC01.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
C	SR	1.101	54.54	95.1	46.95	0.0	0.0	0.0	0.0	468.		
S	SR	0.734	17.55	96.8	14.43	56.2	-24.88	0.0	0.0	149.	279.	
W	SR	0.367	11.21	98.7	10.27	85.5	0.81	56.2	-20.22	100.	363.	302.
H	SR	0.018	4.79	100.0	4.79	99.7	4.60	98.7	3.91	44.	246.	297.
P	SR	0.037	15.22	100.0	15.22	98.7	14.53	96.8	13.56	140.	779.	943.
CP	SR	0.018	9.07	100.0	9.07	99.7	8.91	98.7	8.29	84.	468.	569.
NP	SR	0.073	22.22	100.0	22.22	96.8	21.39	93.6	20.56	205.	1135.	1380.
C/C/S	SR	0.973	49.69	95.7	43.49	8.9	-80.46	0.0	0.0	430.	1079.	
C/S/S	SR	0.826	37.22	96.3	32.71	41.6	-34.87	0.0	0.0	324.	965.	
C/W/W	SR	0.551	24.31	97.7	22.06	75.4	0.18	0.0	0.0	215.	813.	
S/W/W	SR	0.422	12.10	98.4	10.82	83.1	-1.24	38.1	-36.69	107.	354.	224.
C/S	SR	0.899	47.19	96.0	41.71	26.8	-53.01	0.0	0.0	411.	1208.	
C/S/W	SR	0.642	33.66	97.2	30.54	67.2	-3.29	0.0	0.0	298.	1127.	

TABLE 37. YIELD LOSS AND PER ACRE RETURN TO LAND AND MANAGEMENT FOR SOIL SERIES WC13.

ROT	CP	% SOIL LOST/YR	REMAINING YIELD (AS A % OF YEAR 1) AND PROFITS AT YR 1	YEAR 10		YEAR 100		YEAR 200		P.V. OF PRT STREAM TO YR 10	100	200
C	SR	2.748	37.16	89.0	23.00	0.0	0.0	0.0	0.0	274.		
	C	1.649	32.46	92.9	22.84	0.0	0.0	0.0	0.0	253.		
	T	1.049	30.15	95.3	19.49	0.0	0.0	0.0	0.0	210.		
S	SR	1.832	17.28	92.2	9.98	0.0	0.0	0.0	0.0	124.		
	C	1.099	14.70	95.1	9.95	0.0	0.0	0.0	0.0	114.		
	T	0.699	11.24	96.9	4.10	60.8	-26.93	0.C	0.0	53.		
W	SR	0.916	11.21	95.9	8.28	23.0	-44.08	0.0	0.0	90.		
	C	0.550	8.87	97.7	7.22	75.4	-8.78	0.0	0.0	75.		
	T	0.350	5.97	98.8	1.61	86.2	-4.05	60.8	-22.20	20.	96.	2.
H	SR	0.046	4.79	100.0	4.79	98.2	3.58	95.9	2.08	44.	233.	268.
P	SR	0.092	15.22	100.0	15.22	95.9	13.11	92.2	11.19	140.	751.	895.
CP	SR	0.046	9.07	100.0	9.07	98.2	8.00	95.9	6.67	84.	456.	543.
NP	SR	0.183	22.22	99.7	22.15	92.2	20.20	85.5	18.49	205.	1108.	1336.
C/C/S	SR	2.427	37.97	90.1	25.69	0.0	0.0	0.0	0.0	291.		
	C	1.456	34.04	93.6	25.69	0.0	0.0	0.0	0.0	274.		
	T	0.927	31.26	95.9	21.63	20.4	-73.88	0.0	0.0	226.	354.	
C/S/S	SR	2.061	31.37	91.4	21.66	0.0	0.0	0.0	0.0	242.		
	C	1.237	28.10	94.5	21.63	0.0	0.0	0.0	0.0	229.		
	T	0.787	24.94	96.5	16.66	48.3	-36.26	0.0	0.0	174.	433.	
C/W/W	SR	1.374	18.94	93.9	13.34	0.0	0.0	0.C	0.0	148.		
	C	0.824	15.53	96.3	12.15	41.8	-38.30	0.0	0.0	129.	86.	
	T	0.525	12.26	97.8	6.07	77.2	-8.98	0.0	0.0	67.	229.	
S/W/W	SR	1.053	12.10	95.3	8.40	0.0	0.0	0.0	0.0	95.		
	C	0.632	9.59	97.3	7.45	68.3	-15.42	0.C	0.0	80.	77.	
	T	0.402	6.02	98.5	0.64	84.0	-6.75	45.3	-37.10	13.	44.	-115.
C/S	SR	2.244	38.39	90.7	27.10	0.0	0.0	0.0	0.0	299.		
	C	1.346	34.84	94.1	27.19	0.0	0.0	0.0	0.0	285.		
	T	0.857	31.84	96.2	22.76	35.7	-51.12	0.C	0.0	234.	574.	
C/S/W	SR	1.603	28.14	93.0	20.82	0.0	0.0	0.0	0.0	224.		
	C	0.962	24.74	95.7	20.13	11.7	-70.12	0.C	0.0	207.	183.	
	T	0.612	21.51	97.4	14.52	70.2	-10.65	0.0	0.0	149.	555.	

APPENDIX B

Impacts of various regulatory erosion-sedimentation controls.

Table 38. Major economic consequences of NPS control options in Lavon watershed assuming farmers have a 10 year planning horizon.

Control Option	Change in Annualized Farm Income ($1000)	Gov't Cost(-) or Revenue (+) ($1000)	Change in Gross Soil Loss (1000 T)	Offsite Sediment Damages Abated ($1000)	Net Social Benefits Excluding Administrative Costs ($1000)
SL < T	-4349.44	0.0	3295.07	913.77	-3435.67
SL < 2	-4483.13	0.0	3473.50	942.27	-3540.86
SL < 5	-3894.08	0.0	3147.58	887.85	-3006.23
SL < 10	-600.30	0.0	1476.11	476.19	-124.11
TR 50	0.0	0.0	0.0	0.0	0.0
TR 100	9.01	-42.18	72.48	24.72	- 8.45
C 50	2.06	-7.80	31.39	10.72	4.98
C 100	136.77	-811.47	1578.60	506.34	-168.36
IT 50	0.0	0.0	0.0	0.0	0.0
IT 100	0.0	0.0	0.0	0.0	0.0
SL < T, TR 50	-3207.84	-1201.70	3295.07	913.77	-3495.77
SL < T, C 50	-4331.63	-28.87	3255.96	907.10	-3453.40
SL < T, IT 50	-3835.34	-4990.22	3308.54	916.04	-7909.53
SL < 5, TR 50	-2880.90	-1066.51	3147.58	887.85	-3059.56
SL < 5, C 50	-3839.89	-65.26	3089.17	877.01	-3028.14
SL < 5, IT 50	-3440.26	-4405.10	3147.58	887.85	-6957.50
TX 8	-302.77	302.75	0.0	0.0	-0.02
TX 10	-378.46	378.44	0.0	0.0	-0.03
TX 12	-454.13	454.12	0.0	0.0	0.00
TX 14	-529.81	529.81	0.0	0.0	0.00
TX 16	-605.50	605.50	0.0	0.0	0.00
TX 18	-681.20	681.19	0.0	0.0	-0.01
TX 20	-756.37	750.60	31.39	10.72	4.95
TX 8, 50 T&C	-296.93	216.45	350.34	118.54	38.07
TX 10, 50 T&C	-365.63	285.13	350.34	118.54	38.04
TX 12, 50 T&C	-434.29	353.81	350.34	118.54	38.07
TX 14, 50 T&C	-502.96	422.49	350.34	118.54	38.08
TX 16, 50 T&C	-571.65	491.17	350.34	118.54	38.07
TX 18, 50 T&C	-639.49	76.49	1431.40	462.89	-100.11
TX 20, 50 T&C	-686.56	123.55	1431.40	462.89	-100.12

Table 39. Percent of acreage in each crop by control option for Lavon watershed assuming farmers have a 10 year planning horizon.

Control Option	Cotton	Grain Sorghum	Wheat	Hay and Pasture
Benchmark	20.62	20.48	22.00	36.90
SL < T	15.69	18.34	23.14	42.82
SL < 2	15.69	15.69	16.51	52.10
SL < 5	15.69	18.34	23.14	42.82
SL < 10	20.53	20.53	22.04	36.90
TR 50	20.62	20.48	22.00	36.90
TR 100	20.62	20.48	22.00	36.90
C 50	20.62	20.48	22.00	36.90
C 100	20.62	20.48	22.00	36.90
IT 50	20.62	20.48	22.00	36.90
IT 100	20.62	20.48	22.00	36.90
SL < T, TR 50	15.69	18.34	23.14	42.82
SL < T, C 50	15.69	18.34	27.38	38.58
SL < T, IT 50	15.69	18.34	23.14	42.82
SL < 5, TR 50	15.69	18.34	23.14	42.82
SL < 5, C 50	15.69	18.34	27.38	38.58
SL < 5, IT 50	15.69	18.34	23.14	42.82
TX 8	20.62	20.48	22.00	36.90
TX 10	20.62	20.48	22.00	36.90
TX 12	20.62	20.48	22.00	36.90
TX 14	20.62	20.48	22.00	36.90
TX 16	20.62	20.48	22.00	36.90
TX 18	20.62	20.48	22.00	36.90
TX 20	20.62	20.48	22.00	36.90
TX 8, 50 T&C	20.62	20.48	22.00	36.90
TX 10, 50 T&C	20.62	20.48	22.00	36.90
TX 12, 50 T&C	20.62	20.48	22.00	36.90
TX 14, 50 T&C	20.62	20.48	22.00	36.90
TX 16, 50 T&C	20.62	20.48	22.00	36.90
TX 18, 50 T&C	20.62	20.48	22.00	36.90
TX 20, 50 T&C	20.62	20.48	22.00	36.90

Table 40. Extent and cost of terracing and contouring by control option for Lavon watershed assuming farmers have a 10 year planning horizon.

Control Option	Terracing Acres (1000)	Terracing Cost ($1000)	Contouring Acres (1000)	Contouring Cost ($1000)
Benchmark	0.0	0.0	0.0	0.0
SL < T	214.70	2403.40	5.60	13.15
SL < 2	214.70	2403.40	0.0	0.0
SL < 5	183.70	2133.03	36.60	85.92
SL < 10	3.70	42.18	180.00	678.50
TR 50	0.0	0.0	0.0	0.0
TR 100	3.70	42.18	0.0	0.0
C 50	0.0	0.0	3.70	15.60
C 100	0.0	0.0	233.70	811.47
IT 50	0.0	0.0	0.0	0.0
IT 100	0.0	0.0	0.0	0.0
SL < T, TR 50	214.70	2403.40	5.60	13.15
SL < T, C 50	214.70	2403.40	24.60	57.75
SL < T, IT 50	214.70	2403.40	5.60	13.15
SL < 5, TR 50	183.70	2133.03	36.60	85.92
SL < 5, C 50	183.70	2133.03	55.60	130.52
SL < 5, IT 50	183.70	2133.03	36.60	85.92
TX 8	0.0	0.0	0.0	0.0
TX 10	0.0	0.0	0.0	0.0
TX 12	0.0	0.0	0.0	0.0
TX 14	0.0	0.0	0.0	0.0
TX 16	0.0	0.0	0.0	0.0
TX 18	0.0	0.0	0.0	0.0
TX 20	0.0	0.0	3.70	15.60
TX 8, 50 T&C	0.0	0.0	46.70	116.54
TX 10, 50 T&C	0.0	0.0	46.70	116.54
TX 12, 50 T&C	0.0	0.0	46.70	116.54
TX 14, 50 T&C	0.0	0.0	46.70	116.54
TX 16, 50 T&C	0.0	0.0	46.70	116.54
TX 18, 50 T&C	0.0	0.0	183.70	694.09
TX 20, 50 T&C	0.0	0.0	183.70	694.09

Table 41. Major economic consequences of NPS control options in Lavon watershed assuming farmers have a 100 year planning horizon.

Control Option	Change in Annualized Farm Income ($1000)	Gov't Cost (-) or Revenue (+) ($1000)	Change in Gross Soil Loss (1000 T)	Offsite Sediment Damages Abated ($1000)	Net Social Benefits Excluding Administrative Costs ($1000)
SL < T	-2343.33	0.0	1842.55	425.40	-1917.93
SL < 2	-2449.60	0.0	1875.04	430.35	-2019.25
SL < 5	-2013.31	0.0	1681.59	399.28	-1614.03
SL < 10	-0.93	0.0	6.52	1.90	.97
TR 50	0.0	0.0	0.0	0.0	0.0
TR 100	376.88	-1321.04	1231.37	313.23	-630.93
C 50	339.25	-339.25	0.0	0.0	0.0
C 100	724.16	-809.02	37.44	10.85	-74.0
IT 50	0.0	0.0	0.0	0.0	0.0
IT 100	0.0	0.0	0.0	0.0	0.0
SL < T, TR 50	-1636.91	-743.59	1842.55	425.40	-1955.11
SL < T, C 50	-2336.75	-6.57	1842.55	425.40	-1917.93
SL < T, IT 50	-2253.04	-4906.40	1842.55	425.40	-6734.04
SL < 5, TR 50	-1385.82	-660.52	1681.59	399.28	-1647.07
SL < 5, C 50	-1970.35	-42.96	1681.59	399.28	-1614.03
SL < 5, IT 50	-1933.79	-4321.28	1681.59	399.28	-5855.79
TX 8	-175.01	174.99	0.0	0.0	-0.02
TX 10	-218.75	218.74	0.0	0.0	-0.01
TX 12	-262.48	262.49	0.0	0.0	0.01
TX 14	-306.24	306.23	0.0	0.0	-0.01
TX 16	-349.86	348.94	6.52	1.90	.98
TX 18	-393.49	392.55	6.52	1.90	.96
TX 20	-437.10	436.17	6.52	1.90	.97
TX 8, 50 T&C	169.90	-207.23	82.30	23.77	-13.55
TX 10, 50 T&C	127.81	-165.13	82.30	23.77	-13.55
TX 12, 50 T&C	85.71	123.02	82.30	23.77	-13.54
TX 14, 50 T&C	43.60	-80.92	82.30	23.77	-13.55
TX 16, 50 T&C	1.63	-39.86	88.82	25.64	-12.59
TX 18, 50 T&C	-40.35	2.11	88.82	25.64	-12.60
TX 20, 50 T&C	-82.32	44.08	88.82	25.64	-12.60

Table 42. Percent of acreage in each crop by control option for Lavon watershed assuming farmers have a 100 year planning horizon.

Control Option	Cotton	Grain Sorghum	Wheat	Hay and Pasture
Benchmark	20.14	20.14	17.76	41.96
SL < T	15.28	15.28	17.76	51.68
SL < 2	15.28	15.28	17.76	51.68
SL < 5	15.28	15.28	17.76	51.68
SL < 10	20.07	20.07	17.76	42.11
TR 50	20.14	20.14	17.76	41.96
TR 100	20.14	20.14	17.76	41.96
C 50	20.14	20.14	17.76	41.96
C 100	20.14	20.14	22.00	37.72
IT 50	20.14	20.14	17.76	41.96
IT 100	20.14	20.14	17.76	41.96
SL < T, TR 50	15.28	15.28	17.76	51.68
SL < T, C 50	15.28	15.28	17.76	51.68
SL < T, IT 50	15.28	15.28	17.76	51.68
SL < 5, TR 50	15.28	15.28	17.76	51.68
SL < 5, C 50	15.28	15.28	17.76	51.68
SL < 5, IT 50	15.28	15.28	17.76	51.68
TX 8	20.14	20.14	17.76	41.96
Tx 10	20.14	20.14	17.76	41.96
TX 12	20.14	20.14	17.76	41.96
TX 14	20.14	20.14	17.76	41.96
TX 16	20.07	20.07	17.76	42.11
TX 18	20.07	20.07	17.76	42.11
TX 20	20.07	20.07	17.76	42.11
TX 8, 50 T&C	20.14	20.14	17.76	41.96
TX 10, 50 T&C	20.14	20.14	17.76	41.96
TX 12, 50 T&C	20.14	20.14	17.76	41.96
TX 14, 50 T&C	20.14	20.14	17.76	41.96
TX 16, 50 T&C	20.07	20.07	17.76	42.11
TX 18, 50 T&C	20.07	20.07	17.76	42.11
TX 20, 50 T&C	20.07	20.07	17.76	42.11

Table 43. Extent and cost of terracing and contouring by control option for Lavon watershed assuming farmers have a 100 year planning horizon.

Control Option	Terracing		Contouring	
	Acres (1000)	Cost ($1000)	Acres (1000)	Cost ($1000)
Benchmark	0.0	0.0	180.00	678.50
SL < T	211.00	1487.18	5.60	13.15
SL < 2	216.60	1517.20	0.0	0.0
SL < 5	180.00	1321.04	36.60	85.92
SL < 10	0.0	0.0	180.00	678.50
TR 50	0.0	0.0	180.00	678.50
TR 100	180.00	1321.04	0.0	0.0
C 50	0.0	0.0	180.00	678.50
C 100	0.0	0.0	235.60	809.02
IT 50	0.0	0.0	180.00	678.50
IT 100	0.0	0.0	180.00	678.50
SL < T, TR 50	211.00	1487.18	5.60	13.15
SL < T, C 50	211.00	1487.18	5.60	13.15
SL < T, IT 50	211.00	1487.18	5.60	13.15
SL < 5, TR 50	180.00	1321.04	36.60	85.92
SL < 5, C 50	180.00	1321.04	36.60	85.92
SL < 5, IT 50	180.00	1321.04	36.60	85.92
TX 8	0.0	0.0	180.00	678.50
TX 10	0.0	0.0	180.00	678.50
TX 12	0.0	0.0	180.00	678.50
TX 14	0.0	0.0	180.00	678.50
TX 16	0.0	0.0	180.00	678.50
TX 18	0.0	0.0	180.00	678.50
TX 20	0.0	0.0	180.00	678.50
TX 8, 50 T&C	0.0	0.0	211.00	751.27
TX 10, 50 T&C	0.0	0.0	211.00	751.27
TX 12, 50 T&C	0.0	0.0	211.00	751.27
TX 14, 50 T&C	0.0	0.0	211.00	751.27
TX 16, 50 T&C	0.0	0.0	211.00	751.27
TX 18, 50 T&C	0.0	0.0	211.00	751.27
TX 20, 50 T&C	0.0	0.0	211.00	751.27

Table 44. Major economic consequences of NPS control options in Lavon watershed assuming farmers have a 200 year planning horizon.

Control Option	Change in Annualized Farm Income ($1000)	Gov't Cost (-) or Revenue (+) ($1000)	Change in Gross Soil Loss (1000 T)	Offsite Sediment Damages Abated ($1000)	Net Social Benefits Excluding Administrative Costs ($1000)
SL < T	-1461.47	0.0	1465.83	319.50	-1141.98
SL < 2	-1564.80	0.0	1498.32	324.45	-1240.35
SL < 5	-1148.93	0.0	1304.87	293.38	-855.55
SL < 10	0.0	0.0	0.0	0.0	0.0
TR 50	427.07	-645.11	943.47	225.73	7.59
TR 100	1061.92	-1452.18	1051.66	247.22	-143.04
C 50	368.54	-375.63	-287.90	-80.26	-87.35
C 100	750.45	-764.41	-274.35	-76.39	-90.35
IT 50	18.29	-1217.54	0.0	0.0	-1199.26
IT 100	36.58	-2435.09	0.0	0.0	-2398.51
SL < T, TR 50	-771.68	-726.09	1465.83	319.50	-1178.28
SL < T, C 50	-1454.90	-6.57	1465.83	319.50	-1141.97
SL < T, IT 50	-1387.81	-4906.40	1465.83	319.50	-5974.71
SL < 5, TR 50	-536.08	-645.11	1304.87	293.38	-887.81
SL < 5, C 50	-1105.97	-42.96	1304.87	293.38	-855.55
SL < 5, IT 50	-1084.05	-4321.28	1304.87	293.38	-5111.95
TX 8	-143.44	141.56	41.23	11.11	9.23
TX 10	-178.80	176.94	41.23	11.11	9.26
TX 12	-214.16	212.33	41.23	11.11	9.29
TX 14	-249.52	247.72	41.23	11.11	9.31
TX 16	-284.86	283.11	41.23	11.11	9.36
TX 18	-320.22	318.50	41.23	11.11	9.39
TX 20	-351.31	165.19	984.69	234.04	47.92
TX 8, 50 T&C	396.83	-623.07	998.25	236.74	10.50
TX 10, 50 T&C	380.75	-606.82	998.25	236.74	10.57
TX 12, 50 T&C	364.67	-590.57	998.25	236.74	10.84
TX 14, 50 T&C	348.58	-574.33	998.25	236.74	10.99
TX 16, 50 T&C	332.53	-558.08	998.25	236.74	11.19
TX 18, 50 T&C	316.43	-541.83	998.25	236.74	11.34
TX 20, 50 T&C	300.34	-525.58	998.25	236.74	11.49

Table 45. Percent of acreage in each crop by control option for Lavon watershed assuming farmers have a 200 year planning horizon.

Control Option	Cotton	Grain Sorghum	Wheat	Hay and Pasture
Benchmark	20.07	20.07	17.76	42.11
SL < T	15.28	15.28	17.76	51.68
SL < 2	15.28	15.28	17.76	51.68
SL < 5	15.28	15.28	17.76	51.68
SL < 10	20.07	20.07	17.76	42.11
TR 50	20.07	20.07	17.76	42.11
TR 100	20.07	20.07	17.76	42.11
C 50	20.07	20.07	17.76	42.11
C 100	20.07	20.07	17.76	42.11
IT 50	20.07	20.07	17.76	42.11
IT 100	20.07	20.07	17.76	42.11
SL < T, TR 50	15.28	15.28	17.76	51.68
SL < T, C 50	15.28	15.28	17.76	51.68
SL < T, IT 50	15.28	15.28	17.76	51.68
SL < 5, TR 50	15.28	15.28	17.76	51.68
SL < 5, C 50	15.28	15.28	17.76	51.68
SL < 5, IT 50	15.28	15.28	17.76	51.68
TX 8	19.58	19.58	17.76	43.09
TX 10	19.58	19.58	17.76	43.09
TX 12	19.58	19.58	17.76	43.09
TX 14	19.58	19.58	17.76	43.09
TX 16	19.58	19.58	17.76	43.09
TX 18	19.58	19.58	17.76	43.09
TX 20	19.58	19.58	17.76	43.09
TX 8, 50 T&C	19.58	19.58	17.76	43.09
TX 10, 50 T&C	19.58	19.58	17.76	43.09
TX 12, 50 T&C	19.58	19.58	17.76	43.09
TX 14, 50 T&C	19.58	19.58	17.76	43.09
TX 16, 50 T&C	19.58	19.58	17.76	43.09
TX 18, 50 T&C	19.58	19.58	17.76	43.09
TX 20, 50 T&C	19.58	19.58	17.76	43.09

Table 46. Extent and cost of terracing and contouring by control option for Lavon watershed assuming farmers have a 200 year planning horizon.

Control Option	Terracing		Contouring	
	Acres (1000)	Cost ($1000)	Acres (1000)	Cost ($1000)
Benchmark	43.00	303.37	168.00	650.33
SL < T	211.00	1452.18	5.60	13.15
SL < 2	216.60	1481.44	0.0	0.0
SL < 5	180.00	1290.21	36.60	85.92
SL < 10	43.00	303.37	168.00	650.33
TR 50	180.00	1290.21	31.00	72.77
TR 100	211.00	1452.18	0.0	0.0
C 50	0.0	0.0	211.00	751.27
C 100	0.0	0.0	216.60	764.41
IT 50	43.00	303.37	168.00	650.33
IT 100	43.00	303.37	168.00	650.33
SL < T, TR 50	211.00	1452.18	5.60	13.15
SL < T, C 50	211.00	1452.18	5.60	13.15
SL < T, IT 50	211.00	1452.18	5.60	13.15
SL < 5, TR 50	180.00	1290.21	36.60	85.92
SL < 5, C 50	180.00	1290.21	36.60	85.92
SL < 5, IT 50	180.00	1290.21	36.60	85.92
TX 8	43.00	303.37	168.00	650.33
TX 10	43.00	303.37	168.00	650.33
TX 12	43.00	303.37	168.00	650.33
TX 14	43.00	303.37	168.00	650.33
TX 16	43.00	303.37	168.00	650.33
TX 18	43.00	303.37	168.00	650.33
TX 20	180.00	1290.21	31.00	72.77
TX 8, 50 T&C	180.00	1290.21	36.60	85.92
TX 10, 50 T&C	180.00	1290.21	36.60	85.92
TX 12, 50 T&C	180.00	1290.21	36.60	85.92
TX 14, 50 T&C	180.00	1290.21	36.60	85.92
TX 16, 50 T&C	180.00	1290.21	36.60	85.92
TX 18, 50 T&C	180.00	1290.21	36.60	85.92
TX 20. 50 t&C	180.00	1290.21	36.60	85.92

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