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Economic Appraisal of Conservation Farming in the Grenada-Loring-Memphis Soil Area of West Tennessee

S. W. Atkins

University of Tennessee Agricultural Experiment Station

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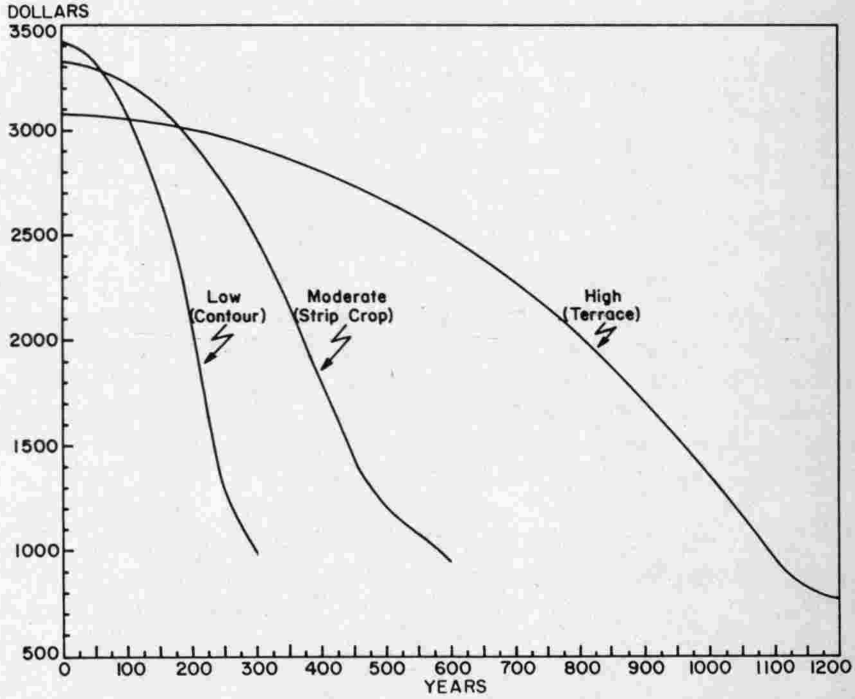


Agricultural Experiment Station
The University of Tennessee
in Cooperation with
Farm Production Economics Division
Economic Research Service
United States Department of Agriculture

Summary

THIS STUDY was made primarily to appraise the effects of different levels of soil conservation on crop yields, farm costs, and net farm income over time. The results are applicable to upland farms in the Grenada-Loring-Memphis Soil Area of West Tennessee.

- **Three levels of conservation were analyzed in this study: 1) low level, consisting of continuous row cropping with contour cultivation but no winter cover crops; 2) moderate level, consisting of continuous row cropping with parallel strip cropping and no winter cover; and 3) high level, consisting of continuous row cropping, parallel terracing and winter cover crops on cotton land. A fourth level, consisting of continuous sod, was not included in the economic appraisal because of negligible soil losses and relatively constant rates of production over time.**

- Annual soil losses and crop yields over time were estimated for the different levels of conservation on the various soils occurring on the farm selected for the study. Using these yield estimates and other input-output data, net labor incomes were computed for a grade C dairy-hog-cotton system by 25-year periods over the productive life of the soil.

- **These income estimates were based on the assumption that type of farming, production technology, and prices of farm products and items used in production would not change over the period of the study. Thus, the changes in net income would be the result of changes in rates of crop production resulting from soil change.**

- Soil losses, according to these estimates, would be significantly larger on soils managed under the low conservation system than under high conservation. The most productive or most desirable part of Loring soil, for example, would be lost in 200 years under low conservation and in 940 years under high conservation. Consequently, crop yields under high conservation were estimated to decline at a relatively slow rate.

- **In the early years, however, net incomes under high conservation would be reduced below incomes obtained under**

low conservation. Net labor returns under high conservation on the case-study dairy-hog-cotton farm, for example, would be 10% less than net returns under low conservation in the bench mark period.

If all costs (cash and noncash) are charged and future incomes are discounted at 6% per year, high conservation would not be profitable during the lifetime of present farmers under the assumptions of constant technology and constant prices. The sum of all present values of future incomes from high conservation would be 10% below similar incomes from low conservation for the first 50 years. For moderate conservation, the comparative income would be only 3% below that for the low conservation level of management. Omission of noncash costs, however, would improve the relative income position of the higher conservation systems.

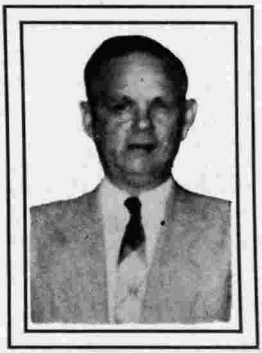
About the Author

SAMUEL Wesley Atkins, who devoted most of his career to work in Agricultural Economics, died on May 25, 1963 after a brief illness.

Shortly before his death, Mr. Atkins received approval for this publication, entitled "Economic Appraisal of Conservation Farming in the Grenada-Loring-Memphis Soil Area of West Tennessee." This publication reflected his ability to work with and draw upon the experiences of scientists in other subject matter areas, in projecting the influence of different levels of conservation on soil losses, crop yields, and income on a case study farm in the decades ahead. The author recognized the limitations of this study; however, his use of scientific information plus a vivid imagination made this a valuable addition to our body of knowledge in Agricultural Economics.

Mr. Atkins was a native of Tennessee and received both his B.S. and M.S. Degrees from the University of Tennessee. He later completed two additional years of graduate studies (1930 and 1942) at Cornell University and completed all the requirements for the Ph.D. Degree except for the dissertation. He was the second graduate student and the second full-time staff member in the Department of Agricultural Economics and Rural Sociology at the University of Tennessee.

After teaching at George Peabody College, Martin Branch Junior College, and the University of Tennessee, he was appointed Agricultural Economist, Soil Conservation Service, U. S. Department of Agriculture, in 1937, and was located at North Carolina State College, Raleigh, North Carolina for about 5 years. In 1943, he transferred to the Bureau of Agricultural Economics, USDA, and was sent to the University of Tennessee to conduct a study of Tennessee's agricultural production capacity for the War effort. He remained here for life.



Samuel Wesley Atkins

Mr. Atkins was author or co-author of over 30 research publications during his career. Most of these publications were about problems in farm management.

Mr. Atkins' keen sense of fairness and justice in human relations was widely known and admired by his many friends. The esteem with which he was held in this regard was evidenced by his appointment and service during the last year of his life as Chief Hearing Officer of the Southern Region for the United States Civil Service Commission. In this service to his co-workers, he reflected the depth of human understanding, compassion, and kindness which was a peculiar endowment that distinguished him among men.

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Introduction

THE LOSS of productivity through soil erosion has long been recognized as a national as well as an individual farm problem. The individual farmer must be concerned with the current cost and return aspects of conservation practices as well as the longer term situation. When immediate costs of conservation practices exceed immediate returns, the adoption of such practices often must be postponed.

Society as a whole, faced with a rapidly growing population and a relatively fixed supply of land, has an interest in conserving soil for future use. Thus, there is a great need for consideration of both the short-run and long-term aspects of conservation farming to bring more clearly into focus the current problems of the individual farmer and the interests of future generations.

This study applies, generally, to the Grenada-Loring-Memphis Soil Area that occupies much of the Plateau Slope of West Tennessee. This Soil Area covers most of Tennessee type-of-farming Area 3 (Fig. 1). The upland soil parent materials consist of loess underlain by

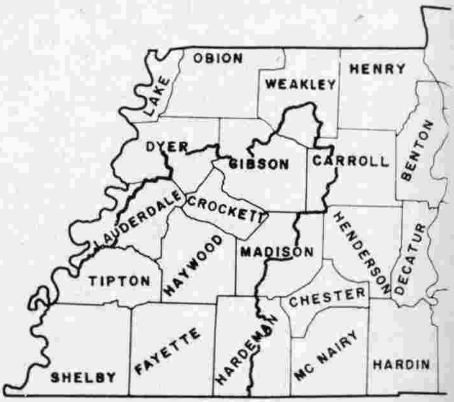


Figure 1. Type-of-farming Area 3, Tennessee.

*Agricultural Economist, Farm Production Economics Division, Economic Research Service, U. S. Department of Agriculture. The author is especially indebted to Professors Max E. Springer and Frank F. Bell, Department of Agronomy, College of Agriculture, University of Tennessee, for their assistance in providing estimates of soil losses and crop yields over time essential to the completion of this study. He also gratefully acknowledges the assistance in planning and conducting this study provided by E. Lee Langsford, and Charles P. Butler, Farm Production Economics Division, Economic Research Service, U. S. Department of Agriculture.

Coastal Plain sands and clays. In the study area, most slopes are moderate but range from gently to strongly rolling. In general, the upland soils are easily tilled but are quite susceptible to erosion. Bottomland soils vary in productivity according to the adequacy of drainage.

On most farms cotton and corn are important crops and are grown on the more productive soils. Hay crops and pasture generally are grown on the steeper slopes and on the less well-drained bottomland soils. The area traditionally has low livestock production. Beef cattle, hogs, and dairying are the principal livestock enterprises.

Generally the farms are small. According to the 1959 census, the average farm contained about 95 acres.

Purpose of the Study

The overall objective of this study was to appraise the effect of different levels of soil conservation on crop yields, costs, and net farm income over time. These analyses should provide useful guides to: 1) farmers in determining the conditions under which it would be profitable for them to operate under alternative levels of conservation practices; and 2) agricultural policymakers in determining the conditions under which society might bear some of the costs of soil conservation.

Procedure

The procedure used in this analysis involved several steps. Briefly they were:

1) Selecting a typical farm and soil resource situation;

2) Determining the levels of conservation to be evaluated;

3) Estimating annual soil loss of the major soils under different levels of conservation;

4) Developing estimates of costs and returns for crop and livestock enterprises on the case study farm for a base period;

5) Developing estimates of costs of conservation practices associated with the different levels of conservation;

6) Relating soil losses to crop yields over time; and

7) Evaluating the effects of the level of conservation on crop yields and net farm income over time.

The case study farm. The farm selected for study contained 125 acres of cleared land. It was typical of the medium-sized, gently sloping to rolling upland farm in the Grenada-Loring-Memphis Soil Area. The silty upland soils were developed in loess, but are underlain by Coastal Plain sands and clays. They are easy to till, but erode when left bare. Grenada is a moderately well-drained soil with a brown surface soil and a yellowish brown subsoil over a gray and brown mottled, brittle fragipan layer at about 2 feet. The pan layer restricts movement of water, air, and roots. Loring has better drainage and a weaker pan. Memphis, a well-drained soil, is brown throughout. The gray soil with distinct fragipan and poor drainage is Henry. The poorly-drained bottom soil, where deposit rather than erosion occurs, is Waverly.

All of the soils are moderate in fertility. Use suitability and productivity increase from the poorly- to the well-drained soils. The Mem-

phis and Loring soils, for example, are suitable for producing alfalfa. In contrast, soils with poor drainage, such as Waverly and Henry, are poorly suited.

The acreage, slope, and distribution of soils on the case study farm are shown in Figure 2.

Levels of conservation. Four levels of conservation were defined as follows:

1) Low consisting of continuous row cropping with contour cultivation but no winter cover crops. Soil losses are heavy.

2) Moderate consisting of continuous row cropping with parallel strip cropping but no winter cover crops. Soil losses are moderate.

3) High consisting of continuous row cropping, parallel terracing, and winter cover crops on land in cotton. Soil losses are low.

4) Very High consisting of continuous sod crops. Soil losses are very low.

Estimating soil losses. Until recently an empirical basis for estimating the rate of soil losses on Tennessee farms was not available. Now, by using the soil loss estimating equation developed by the Soil Conservation Service and Agricultural Research Service, U. S. Department of Agriculture, and the University of Tennessee, it is possible to estimate annual soil losses in tons per acre on different types of soil with different slopes and with varying rainfall patterns, crop management practices, and conservation practices.[1]

This equation was used to estimate the annual soil losses on all of the soil situations (type and slope) on the farm for each of the levels of conservation referred to above (see Appendix Exhibit A for method of using the soil loss estimating equations).

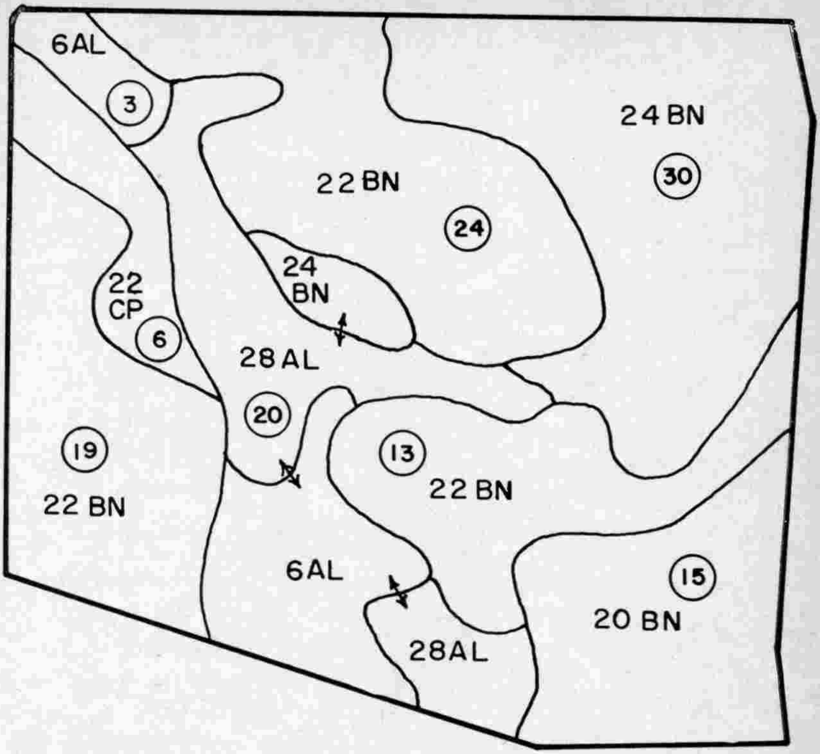
The time to remove the most productive layers of each soil under different levels of conservation was estimated. In preparing these estimates, the depth of the most productive soil layers in inches was estimated as follows: Memphis, 4% slope, 36 inches; Loring, 4% slope, 30 inches; Loring, 7% slope, 20 inches; Grenada, 4% slope, 24 inches; and Waverly, 2% slope, 18 inches. Using 150 tons as the soil weight per acre-inch, soil depth in inches and the calculated annual soil loss per acre, an estimate was made of the number of years required, on the average, to erode the soils to the depths indicated above.

In this study a constant annual rate of soil loss was assumed.

Estimating yields per acre over time. Starting with current yields per acre and practices of moderately high levels, estimates were made of yields likely to be obtained over the time period necessary to erode away the more desirable layers of the soils.[2] As-

[1] "Soil Loss Estimation in Tennessee," unnumbered mimeographed report prepared by members of the Agronomy Department, University of Tennessee and the Soil Conservation Service, USDA, Program Section, p. 4, based on an equation for predicting rainfall erosion losses by W. H. Wischmeier of ARS, USDA.

[2] Productive life of each soil is defined as the time period necessary for the soil to erode under different levels of conservation to the point where the yield of crops would decrease to the "stable" yield levels indicated in Table 1.



Soil Legend

20 Memphis silt loam
22 Loring " "
24 Grenada " "
28 Henry " "
6 Waverly " "

Slope and Erosion Legend

BN 2-5% slope, moderate erosion
CP 5-8% slope, severely eroded
AL under 2% slope, little erosion
○ Number of acres

Figure 2. Soil and erosion map of a medium-sized upland farm, Grenada-Loring-Memphis Soil Area, West Tennessee.

sumptions with regard to the relationship of soil losses and yields per acre were as follows:

1) That production practices would be constant at a moderately high level over the productive life of the soil.

2) Yields per acre on row crop-

land in this study would be stabilized at a yield level above zero. The level of the yield would depend largely on the characteristics of the subsoil. Yields on Memphis soil that had a friable subsoil, for example, would stabilize at a higher level than those on a fragipan soil such as Grenada.

3) Yields per acre would decline slowly in the early stages of erosion with the rate of decline increasing at a constant rate per acre.

Estimates of yields per acre were computed for each 25-year time period under the assumptions outlined in the preceding sections. The formula used for estimating the constant factor in yield decreases is shown in Appendix Exhibit D.

Estimated Soil Loss on Case Study Farm

The annual soil losses on the case study farm differed widely under the selected levels of conservation (Table 1). On Memphis soil with 4% slope, for example, the annual soil loss was estimated to be 22.5 tons per acre when cotton was grown continuously under low conservation. In contrast, the soil loss would be reduced to 4.8 tons annually when cotton was grown under the high level of conservation.

The time required to remove the most productive layers of Loring soil, with the same annual soil loss as Memphis soil, was estimated to be shorter because Loring has a thinner layer of productive soil.

The average yields per acre were estimated to decline to a lower level on Loring soil than on Memphis soil. The stable yield for cotton on Loring would be 250 pounds of lint per acre compared with 300 pounds on Memphis soil.

The annual soil losses were less for corn than for cotton when both were grown under high levels of production practices and the same soil situations (Table 1). The relatively heavy residue from stalks and roots of corn reduced annual soil losses.

On the case study farm, annual soil losses over time were estimated to be negligible on soils kept in sod crops, ranging from 0.5 to 1.7 tons per acre.

Estimated Current Income

This section is devoted to the estimation of current costs and returns from a grade C dairy-hog-cotton system of farming on the case study farm operated under each of the three levels of conservation. These estimates provide bench marks from which income changes resulting from differences in levels of conservation may be measured over time.

The farm budgeting technique was used to estimate the costs and returns. This procedure involved:

1) The setting up of combinations of enterprises or farm organizations for each level of conservation;

Table 1. Estimated soil loss of representative soils, under specified levels of conservation for selected crops, Grenada-Loring-Memphis Soil Area, West Tennessee

Soil type and level of conservation[1]	I. Row crops					
	Cotton			Corn		
	Annual soil loss per acre[2]	Years of life[2]	Stable yield of lint per acre[3]	Annual soil loss per acre[2]	Years of life[2]	Stable yield per acre[3]
	Tons	No.	Lb.	Tons	No.	Bu.
A. Memphis soil, 4% slope						
1. Low level of conservation	22.5	240	300	15.0	360	32
2. Moderate level of conservation	11.2	480	300	7.5	720	32
3. High level of conservation	4.8	1125	300	3.6	1500	32
B. Loring soil, 4% slope						
1. Low level of conservation	22.5	200	250	15.0	300	24
2. Moderate level of conservation	11.2	400	250	7.5	600	24
3. High level of conservation	4.8	938	250	3.6	1250	24

Table I. (Continued). Estimated soil loss of representative soils, under specified levels of conservation for selected crops, Grenada-Loring-Memphis Soil Area, West Tennessee

Soil type and level of conservation[1]	II. Sod crops					
	Alfalfa		Permanent pasture		Lespedeza-rye pasture	
	Annual soil loss per acre[2]	Years of life[2]	Annual soil loss per acre[2]	Years of life[2]	Annual soil loss per acre[2]	Years of life[2]
	Tons	No.	Tons	No.	Tons	No.
C. Memphis soil, 4% slope						
4. Very high level of conservation	0.8	6750	[4]	—	[4]	—
D. Loring soil, 4% slope						
4. Very high level of conservation	0.8	5625	[4]	—	[4]	—
E. Loring soil, 7% slope						
4. Very high level of conservation (continuous end)	[4]	—	1.7	1764	[4]	—
F. Grenada soil, 4% slope						
4. Very high level of conservation	[4]	—	1.0	3600	2.0	1800
G. Waverly soil, 2% slope						
4. Very high level of conservation (continuous end)	[4]	—	.54	5000	[4]	—

[1]The levels of conservation are described on page 8.

[2]The basic data used in computing annual soil losses and years to remove the most productive soil layers are shown in Appendix Exhibits A, B, and C.

[3]Assumed yields after productive soil layers have been removed. High level of cultural practices are assumed.

[4]Not grown on the specified soils on this farm.

2) The development of input-output data for the farm enterprises to be included in the specified farm organizations;

3) Selection of prices to be used in preparing the estimates of costs and returns for these enterprises (Appendix Table 1).

A high level of management practices was assumed in preparing the crop and livestock cost and returns estimates. This level of practice was assumed to remain constant over time.

Farm Organizations

In this section, only the immediate or current effects of differences of conservation on net farm income are evaluated. The long-time consequences are analyzed in a later section of this report.

The current or low conservation farm organization consisted of cotton as the major cash crop, a 20-cow grade C dairy, a supplementary hog enterprise, and feed crops—corn, alfalfa hay, and pasture (Table 2).

Table 2. Assumed land use and livestock on the selected grade C dairy-hog-cotton farm, by levels of conservation, Grenada-Loring-Memphis Soil Area, West Tennessee[1]

Item	Levels of conservation[2]		
	Low	Moderate	High
	Acres	Acres	Acres
Land use:			
Corn for grain	30	27.8	27.2
Cotton	15	15.0	14.5
Alfalfa hay	15	17.2	16.7
Oats for hay	3	3.0	3.0
Hay from pasture	(12)	(12.0)	(12.0)
Annual lespedeza-oat pasture	12	12.0	12.0
Permanent pasture:			
Orchardgrass-Ladino clover	34	34.0	34.0
Fescue-Ladino clover	16	16.0	16.0
Winter cover:			
Rye after cotton	0	0	(14.5)
Grassed waterway	0	0	1.6
Total crops and pasture	125	125.0	125.0
Livestock:			
Dairy cows	20	20	20
Dairy heifer	10	10	10
Brood sows	6	6	6
Gilts	2	2	2
Market hogs	94	94	94

[1]Each conservation level is operated under the same level of production practices, differing only in the level of conservation practices.

[2]Low—contour only; moderate—parallel strip cropping; high—parallel terraces, winter cover crop after cotton.

The harvested crops were grown on the Memphis and Loring soils —the most productive soils which make up half the farm area. The permanent pasture and the annual lespedeza-rye supplementary pasture were grown on the less productive Grenada, Henry, and Waverly soils. See Figures 2 and 2a for soil and land use patterns, respectively.

Except for protein supplements, all feeds were produced on this farm. The alfalfa hay was supplemented by some hay cut from permanent pastures and a small acreage of oats grown in the alfalfa rotation.

No basic changes in farm organization would result from the adoption of either the moderate or high level of conservation. The adjustments would be chiefly in land use. For example, to establish the parallel strip crop system for the moderate level of conservation, land would be needed to provide "correction" areas that are required to maintain a series of parallel strips, thus eliminating short rows within the strip intervals. These correction areas, located at the ends of

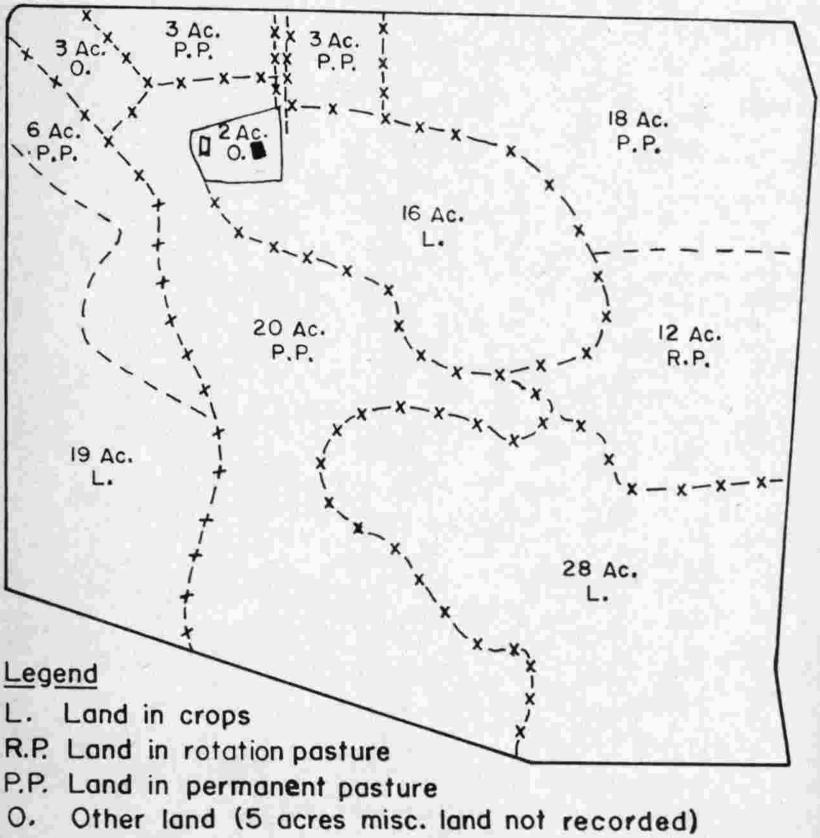


Figure 2a. Major land uses and field arrangements, medium-sized upland farm, Grenada-Loring-Memphis Soil Area, West Tennessee.

the strips, generally are seeded to sod crops, preferably the same as the sod crops in the strip system—alfalfa on the case study farm. This adjustment would be made in the corn and alfalfa acreage, leaving the cotton acreage unchanged from the low conservation alternative. Consequently, part of the cotton acreage would be shifted from Memphis soil to lower yielding Loring soil.

For high conservation, the land use adjustments consisted of a 3-acre "correction" area necessary to establish the parallel terracing system and 1.6 acres of grassed waterways, or terrace outlets. The net changes in land use from the low conservation alternative were reductions of 3.3 acres of row crops (corn 2.8 acres and cotton 0.5 acres), and increases of 1.7 acres of alfalfa for hay and 1.6 acres of grassed waterways to serve as terrace outlets (Table 2).

The land in cotton would be seeded to late winter cover, possibly rye. Cover crops would not be sown after corn because the residue from the corn crop left on the land and leaving the land undisturbed gives more protection from erosion than either early- or late-seeded winter cover.[3]

Estimated Costs of Conservation Practices

The direct costs of establishing and maintaining the conservation practices characterizing the different levels of conservation on the farm are presented in this section. These conservation practices are strip cropping, terracing, providing grassed waterways, and planting winter cover crops. The costs are directly related to the conservation practices such as the construction of terraces, labor and equipment required for maintaining terraces, and seed and fertilizer used on grassed waterways and winter cover crops.

Strip cropping. The estimated direct cost of operating the strip cropping system was relatively small, averaging approximately $50 annually (Table 3 and Appendix Table 4). About half of this cost was the estimated value of the operator's labor used in harvesting small patches of hay on the "correction" areas and extra labor used in performing field operations on crops in the strip-crop area.[4] The cost of extra tractor work made up the remainder of the estimated total costs.

It was assumed that none of the extra labor would be hired. Only the extra cost of operating the tractor would be a cash outlay. Thus, the decision regarding the adoption of strip cropping would likely not depend very greatly on these extra costs.

Parallel terraces. Terraces constructed on the contour often result in numerous short rows, which reduce operational efficiency—an increasing problem as tractor farming expands. By using parallel terraces this problem is minimized, but, as in strip cropping, this method leaves small areas—often referred to as "correction" areas.

[3]"Soil Loss Estimation in Tennessee," op. cit., Table 6A, page 2 of 2, 1959.

[4]It is recognized that on some farms a rearrangement of fields with strip cropping might actually reduce the labor requirements.

These occur at the terrace outlet end of the field and should be kept in sod crops. It was estimated that "correction areas" use about 5% of the land terraced on the average farm in this area.

The estimated annual cost of constructing and maintaining parallel terraces on the selected farm was $184, or $2.92 per acre terraced. It was assumed that terraces would be constructed by custom work but that maintenance would be done by the farm labor force. Included in the annual cost were extra operational labor and power on crops, prorated costs of terrace construction, and interest on the average investment in the terrace system. These costs are summarized in Table 3.

On 63 acres of cropland terraced on the case study farm, the largest annual cost ($66) was for maintenance, followed by the cost ($51) of extra operational labor and power.[5] Of these amounts, however, $60 represented unpaid farm labor; and the $25 interest charge on the average investment in terrace construction might not be a cash outlay on some farms. (For details of costs, see Appendix Table 2.)

Grassed waterways. The grassed outlets for terraces would be seeded to tall fescue and Ladino clover. They would be fertilized and limed to produce a dense sod. The annual cost of $20 included maintenance, depreciation charge, and interest on the average investment in establishing 1.6 acres of outlets (Table 3 and Appendix Table 3).

This annual total cost, however, might be reduced by a credit for forage produced. If an average of 1.6 tons of hay were produced annually, a net credit of $14 above variable costs of harvesting and storing the hay could be made. Thus, the estimated net cost of grassed waterways would amount to only $6 annually. If no charge was made for harvest labor ($6), net value of hay would equal the annual cost of the grassed waterway.

Winter cover crops. To seed 1 acre of rye was estimated to cost $5.38 when only variable costs were considered. It was assumed that drilling seed would be custom-hired (Table 3 and Appendix Table 5).

Farm Incomes Under Three Levels of Conservation

In this section the costs and returns from low, medium, and high levels of conservation on the selected farm are compared for the current or bench mark period. Estimates of the costs and income were developed for each crop and livestock enterprise included in the farm organization. These dollar estimates were based on estimates of the physical inputs and outputs for each of these farm enterprises, and a set of assumed prices. Overhead costs, including an estimated land charge, were included in the total farm cost. Only the labor of the operator and his family were excluded from total costs.

The adoption of either the mod-

[5]The use of parallel terraces minimized the time required to operate tractor equipment on terraced land, but extra time was required to harvest the hay from the "correction" areas.

Table 3. Summary of estimated annual cost of specified conservation practices on the selected grade C dairy-hog-cotton farm, Grenada-Loring-Memphis Soil Area, West Tennessee

Practice	Amount	Unit	Price	Value: Cash	Value: Noncash	Value: Total
			Dollar	Dollar	Dollar	Dollar
I. *Parallel strip cropping:*						
Extra labor on crops	43.2	hr.	.60	—	25.92	25.92
Extra tractor operation (variable costs)	43.2	hr.	.59	25.49	—	25.49
Total strip crop				25.49	25.92	51.41
II. Terraces with winter cover[1]						
1. *Terraces:*						
Prorata annual cost of construction[2]				41.60		41.60
Extra labor for maintenance and for crop production	100.2	hr.	.60	—	60.12	60.12
Extra tractor operation	87.2	hr.	.59	51.45	—	51.45
Equipment repair	44.0	hr.	.14	6.16	—	6.16
Interest on average investment in terraces	416	dol.	.06	—	24.96	24.96
Total terraces				99.21	85.08	184.29
2. *Winter cover (rye)*	14.5	ac.	5.38	78.01	—	78.01
3. *Grassed waterway:*						
Annual prorated cost of establishing				—	6.60	6.60
Other annual costs				8.74	4.86	13.60
Total				8.74	11.46	20.20
4. *Grand total terraces with winter cover*				185.96	96.54	282.50
5. *Grand total less net returns from hay on grassed waterway ($14)*						268.50

[1]Winter cover only on land in cotton.

[2]Custom construction @ $132 per mile and 5% depreciation (on 63 acres of cropland).

erate conservation level or the high conservation level would require adjustments in land use and development of specific conservation practices. Thus, each of these alternative levels of conservation would have a different income-cost structure from that of the low conservation level. The resulting net incomes provided bench marks, or points of departure, from which to measure the economic effects of soil losses on this farm operated under each of the three levels of conservation over time.

For this bench mark period, production practices and rates of production were assumed to be the same for each conservation alternative. Thus, changes in income and costs were the result of changes in conservation practices and not of changes in production practices.

When the costs and benefits of these adjustments were balanced in monetary terms, it was estimated that they would result in a net reduction of returns to labor of $95 for moderate conservation and $344 for high conservation on the case farm (Table 4).

Shifting acreage from corn to alfalfa hay had practically no effect on net income for the moderate conservation system. However, shifting part of the cotton acreage from Memphis to Loring soil caused reductions of $30 to $40 in

Table 4. Summary of estimated bench mark costs and returns on the selected grade C dairy-hog-cotton farm, by levels of conservation, Grenada-Loring-Memphis Soil Area, West Tennessee

Item	Levels of conservation		
	Low	Moderate	High
	Dollars	Dollars	Dollars
Income:			
Cotton, lint and seed	3,135	3,079	3,031
Corn, shelled	132	0	0
Alfalfa	0	168	130
Hay from grassed waterway	0	0	14
Hogs	2,967	2,967	2,967
Dairy (milk, calves, cull cows)	5,475	5,475	5,475
Total income	11,709	11,689	11,617
Costs:			
Total cash expenses	6,132	6,181	6,301
Total noncash expenses (other than labor)	2,158	2,184	2,241
Total costs	8,290	8,365	8,542
Net returns to operator and family labor and management	3,419	3,324	3,075
Change from low conservation	—	−95	−344
Index of net returns[1]	100	97	90

[1]Low conservation=100%.

net labor returns. The largest income-reducing item was the estimated $52 cost of extra labor and equipment use resulting from field operations over the strip crop area. Half of this cost was labor, which would be a noncash item on most medium-sized farms.

The larger reduction in income for the high conservation in comparison with the moderate conservation system was chiefly the result of larger annual costs of the terrace system and winter cover crops compared to the estimated annual cost of the strip crop system. Annual costs of these conservation practices under high conservation, for example, amounted to $282 or about 80% of the net loss of income. This compared with an annual cost of $52 for strip cropping (Table 5).

The decision for or against the adoption of a given conservation practice may depend less on the total cost than on the cash or out-of-pocket costs in relation to added income from conservation. The annual costs of strip cropping and terracing on the selected farm were about equally divided between cash and noncash costs. On the other hand, the total costs were cash items for the winter rye crop, as all materials were assumed to be bought and the labor to be custom hired. Other farms with home-produced seed and operator labor would have a smaller ratio of cash to total costs.

Effects of Different Levels of Conservation on Yields and Income Over Time

Long-Time Effects on Crop Yields

Changes in crop yields over time are the result of many forces, including soil erosion. Improvements in production technology, such as better seed, more effective insect and disease controls, and higher rates of fertilization, have been major factors in the rapid rise in crop yields in recent years. Consequently, it is difficult to separate the effects of soil losses on yields from the effects of changing technology.

For this study, however, it is assumed that agricultural technology will not change over time. The estimated changes in yields per acre presented in this section would be the result of soil losses associated with different levels of conservation. The general procedure used in estimating the long-run effect of erosion on crop yields per acre is described on pages 7-8. For the detailed method of computing yield changes over time, see Appendix Exhibit D, "Method of Estimating Yields Per Acre Over Time."

The yields presented in this study are not predicted yields that may be expected as a result of *all* forces that affect rates of production. Actually, the upward trend of yields will probably continue because agricultural technology is also likely to improve, possibly at a faster rate than in the past. However, the hypothetical yields, which are estimated to decline over time, indicate that expected yields would

Table 5. Estimated effects on bench mark costs and returns of adopting moderate and high conservation on the selected grade C dairy-hog-cotton farm, Grenada-Loring-Memphis Soil Area, West Tennessee

Item	Changes in costs and returns[1]	
	Increase	Decrease
	Dollars	Dollars
A. Moderate conservation		
Income:		
Corn sales, 120 bu. @ $1.10	—	132
Cotton (acreage shift),[2] 3.75 ac. @ $14.92	—	56
Alfalfa, 6.6 T (2.2 ac.) @ $25.50	168	—
Total income changes	168	188
1. Net decrease in income	—	20
Costs:		
Corn, 2.2 ac. @ $38.91	—	86
Cotton (acreage shift), 3.75 ac. @ $4.85	—	18
Corn bought, 6 bu. @ $1.25	7	—
Alfalfa, 6.6 T @ $18.23	120	—
Conservation, annual (Table 3)	52	—
Total income changes	179	104
2. Net increase in costs	75	—
3. Net decrease in returns to labor ($75 + $20)		95
4. Net farm labor returns—low conservation (Table 4)		3,419
5. Net returns to labor—moderate conservation (4 minus 3)		3,324
B. High conservation		
Income:		
Corn sales, 120 bu. @ $1.10	—	132
Cotton, 0.5 ac. @ $209.00	—	104
Alfalfa hay, 5.1 T (1.7 ac.) $25.50	130	—
Hay from grassed waterway	14	—
Total income changes	144	236
1. Net decrease in income	—	92
Costs:		
Corn produced, 2.8 ac. @ $38.91	—	109
Cotton, 0.5 ac. @ $120.00	—	60
Corn bought, 37 bu. @ $1.25	46	—
Alfalfa hay, 1.7 ac. @ $54.70	93	—
Conservation, annual (Table 3)	282	—
Total cost changes	421	169

Table 5 (Continued). Estimated Effects on bench mark costs and returns of adopting moderate and high conservation on the selected grade C dairy-hog-cotton farm, Grenada-Loring-Memphis Soil Area, West Tennessee

Item	Changes in costs and returns[1]	
	Increase	Decrease
	Dollars	Dollars
2. Net increase in costs	252	—
3. Net decrease in return to labor ($252 + $92)		344
4. Net farm labor returns—low conservation (Table 4)		3,419
5. Net farm labor returns—high conservation (4 minus 3)		3,075

[1]Changes were measured from the low conservation level base. Figures were rounded to the nearest $1.

[2]Shift in acreage from Memphis to lower producing Loring soil caused by the adoption of strip cropping over the entire crop area.

rise less under certain levels of conservation than under others.

In the absence of experimental data adapted to local situations, the long-run yield estimates were based on theoretical relationships of soil loss rates and yields per acre. The magnitude of changes in yields are yet to be verified and may be subject to considerable error. However, these estimates provide dependable guides to relative changes between various situations as, for example, different soil types and levels of conservation practices.

Only per acre yields of row crops —corn and cotton—are assumed to change significantly as a result of soil losses. Pasture and hay production is assumed to remain constant over time because estimated annual soil losses would not affect production rates materially. Soil losses on forage cropland would be very low because of relatively favorable topography for maintaining a protective sod through the use of recommended rates of fertilizations and other improved production practices. Annual soil loss rates are shown in Table 1.

Effects of soil characteristics on yields. As a result of erosion, annual yields of corn and cotton were estimated to decline at a relatively slow rate in the early years, with the decline increasing at a constant rate per acre over time as erosion reduces the depth of the most productive soil layers. Thus, yields per acre decline more rapidly on a given soil as the most productive soil layers get thinner. Also, yield decreases are greater on shallow and moderately shallow soils than on the deeper soils. With low conservation, for example, it was estimated that cotton on Loring soil, with 30 inches of most productive soil, would have decreased 5.1% in yield per acre in 50 years, compared with 3.1% on the deeper Memphis soil. Similar differences in yields also exist between these soils when operated under moderate and high levels of conservation (Table 6).

Long-time crop production on Memphis and Loring soils would

not decline to zero when the most productive soil has been lost. The subsoils are tillable and have considerable productive capacity. When they are reached through progressive erosion, crop yields would stabilize at low levels. The annual average yield of cotton, for example, on Memphis soil, 4% slope, was estimated to decline to a minimum of 300 pounds lint per acre per year. On Loring soil the estimated minimum yield was 250 pounds per acre. Estimated minimum yields of corn were 32 and 24 bushels per acre for Memphis and Loring soils, respectively.

Effects of conservation on yields. The reduction in yields of corn and cotton caused by erosion would be at a substantially higher rate if farmers kept the low level of conservation rather than adopting either the moderate or high level. Yields of 350 pounds of lint cotton on Memphis soil, for example, would be reached in about 250 years under low conservation and 475 years under moderate conservation. But if high conservation practices were adopted, this yield level would not be reached for about 1,100 years. Similar trends are predicted for cotton on Loring soil and for corn on both Memphis and Loring soils (Tables 6 and 7).

The yield of cotton grown under low conservation on Memphis soil, for example, was estimated to decrease 1 percent during the first 25-year period; but during the next 25 years yields would drop an estimated 2.1%, and then the rate of decrease would increase over time as the most productive soil layers became thinner.

However, at some time, the rate of decrease would lessen and yields would finally reach a stable level. In quantitative terms, the downward trend in yields was estimated to increase 7.3 pounds of lint per acre for each 25-year period. The long-time yield trends are represented graphically in Figures 3, 4, 5, and 6, showing trends in gross income from corn and cotton grown on Memphis and Loring soils. (Gross income and yield trends are identical for a given crop because a constant price was used in computing gross income.) It is recognized that the yields would not continue to decrease at this rate until they reached zero; however, it is assumed that crop yields would stabilize at the levels indicated in Table 1. Yields and cost-return relationships below this "stable" yield point are not included in this analysis. Estimated yields per acre of corn and cotton for selected periods over time are shown in Appendix Tables 6 and 7.

During the first 25 to 50 years, estimated reductions of cotton yields under high conservation on Memphis soil were exceedingly small, 0.1% yearly by the 25th year and 0.2% by the 50th year. Reductions under low conservation for comparable periods were 1.0% and 3.1%, respectively.

In the long run, corn yields would decrease less rapidly than cotton yields when both were grown under the relatively high level of practices assumed for this study (Tables 6 and 7). High fertilization rates combined with relatively dense plant population per acre of corn should produce dense root systems and heavy forage residue. When turned under, adding

Table 6. Cotton lint: Index of change in estimated yields and labor returns per acre for selected years, by levels of conservation and soil types, Grenada-Loring-Memphis Soil Area, West Tennessee[1]
(Year 1 = 100 percent)

End of year	Low conservation		Moderate conservation		High conservation	
	Yield	Labor returns[2]	Yield	Labor returns[2]	Yield	Labor returns[2]
	Percent	Percent	Percent	Percent	Percent	Percent
1. Memphis soil (4 percent slope)						
1	100.0	100.0	100.0	100.0	100.0	100.0
25	99.0	98.2	99.7	99.5	99.9	99.9
50	96.9	94.5	99.1	98.4	99.8	99.7
75	93.7	88.9	98.2	96.8	99.7	99.4
100	89.6	81.6	97.0	94.6	99.4	98.9
Minimum[3]	42.9	–15.6	42.9	–16.7	42.9	–22.6
Year	(250)	xx	(475)	xx	(1125)	xx
2. Loring soil (4 percent slope)						
1	100.0	100.0	100.0	100.0	100.0	100.0
25	98.3	96.9	99.6	96.9	99.9	99.8
50	94.9	90.6	98.6	95.1	99.7	99.5
75	89.8	81.2	97.3	92.6	99.5	99.0
100	83.1	68.6	95.5	89.3	99.1	98.2
Minimum[3]	38.5	–34.8	38.5	–36.3	38.5	–44.1
Year	(200)	xx	(400)	xx	(950)	xx

[1]Future incomes unadjusted to present values.

[2]Gross income less all cash and noncash costs except labor used in growing and harvesting crops.

[3]Points in time (years are enclosed in parentheses) when yields per acre are assumed to stabilize. Range in yield: 700 to 300 pounds, Memphis soil; 650 to 250 pounds, Loring soil.

Table 7. Corn: Index of change in estimated yields and labor returns per acre for selected years, by levels of conservation and soil types, Grenada-Loring-Memphis Soil Area, West Tennessee[1]
(Year 1 = 100 percent)

End of year	Low conservation Yield	Low conservation Labor returns[2]	Moderate conservation Yield	Moderate conservation Labor returns[2]	High conservation Yield	High conservation Labor returns[2]
	Percent	Percent	Percent	Percent	Percent	Percent
1. Memphis soil (4 percent slope)						
1	100.0	100.0	100.0	100.0	100.0	100.0
25	99.5	98.7	99.9	99.6	99.9	99.9
50	98.6	96.3	99.6	99.0	99.8	99.7
75	97.2	92.5	99.2	97.9	99.7	99.3
100	95.3	87.5	98.8	96.5	99.6	98.9
Minimum[3]	50.0	–33.2	50.0	–38.0	50.0	–67.9
Year	(350)	xx	(700)	xx	(1400)	xx
2. Loring soil (4 percent slope)						
1	100.0	100.0	100.0	100.0	100.0	100.0
25	99.3	97.6	99.8	99.4	99.9	99.8
50	97.8	92.9	99.4	98.0	99.8	99.3
75	95.6	85.7	98.8	96.0	99.7	98.7
100	92.7	76.3	98.0	93.3	99.5	97.8
Minimum[3]	42.9	–85.4	42.9	–94.7	42.9	–158.0
Year	(300)	xx	(600)	xx	(1200)	xx

[1]Future incomes unadjusted to present values.

[2]Gross income less all cash and noncash costs except labor used in growing and harvesting crops.

[3]Point in time (year enclosed in parentheses) when yields per acre are assumed to stabilize. Range in yield: 64 to 32 bushels, Memphis soil; 56 to 24 bushels, Loring soil.

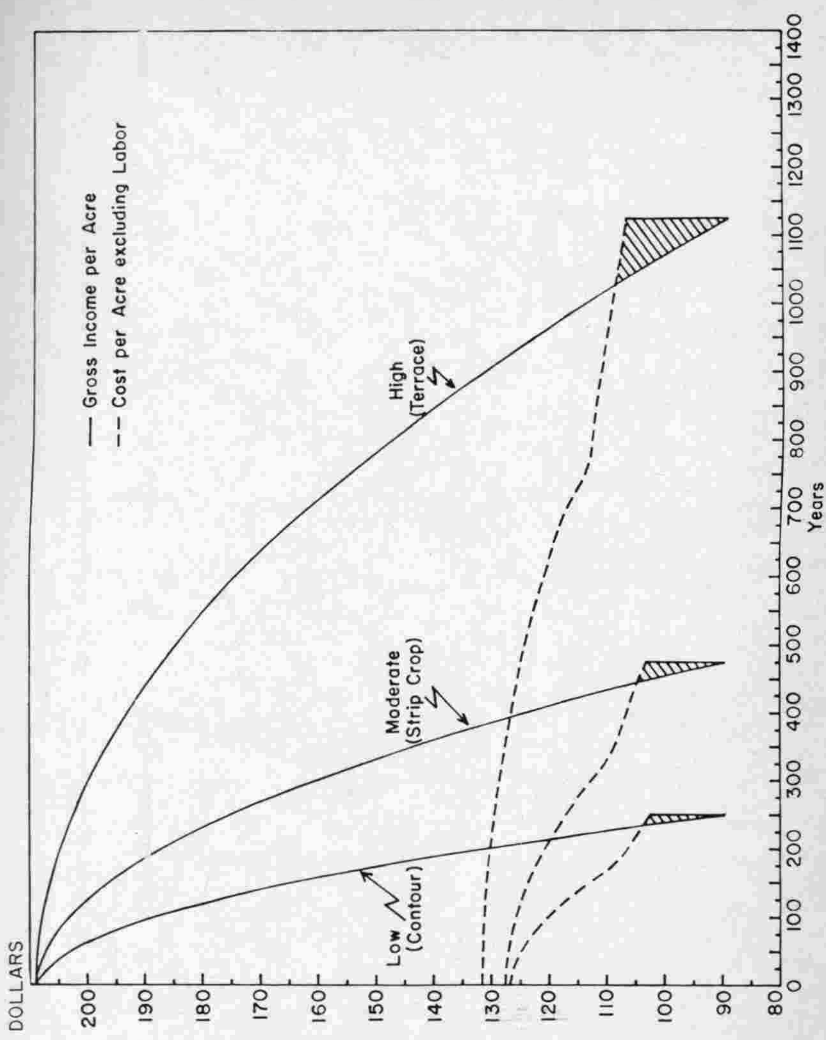


Figure 3. Cotton on Memphis soil (4% slope): estimated gross income and cost per acre for three levels of conservation over time, Grenada-Loring-Memphis Soil Area, West Tennessee.

organic matter to the soil, annual soil losses would be smaller on a given soil producing corn than the same soil producing cotton under a comparable level of management (Table 1, page 11).

Long-Time Effects on Income

The long-time effects on income of using three alternative levels of conservation would stem chiefly from reductions in cotton production and in part from reductions in the sale of surplus corn above farm needs, as corn yields decline with progressive erosion. Gross incomes from alfalfa, livestock, and livestock products are estimated to

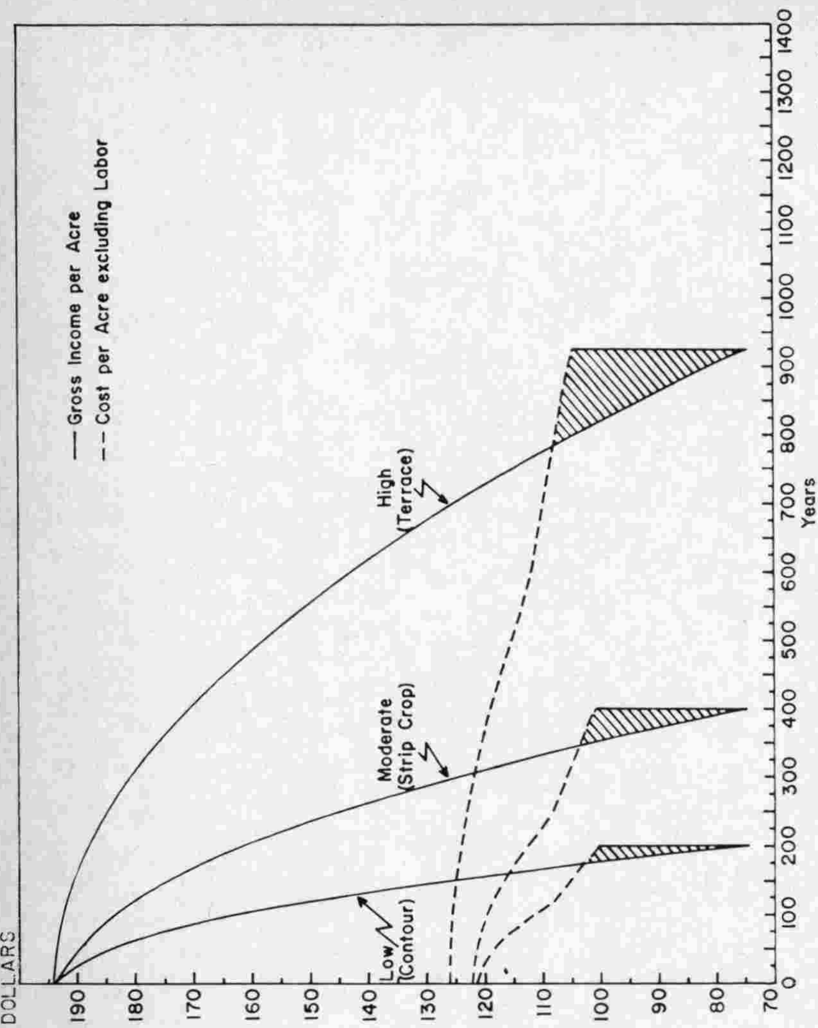


Figure 4. Cotton on Loring soil (4% slope): estimated gross income and cost per acre for three levels of conservation over time, Grenada-Loring-Memphis Soil Area, West Tennessee.

remain constant at the bench mark levels.

Items of cost that change in magnitude over time may be classified into two groups:

1) Items associated with reductions in yield per acre of cotton and corn, such as harvesting, hauling to gins and baling cotton, and hauling to storage and storing corn. With the exception of mechanical harvesting, the cost of

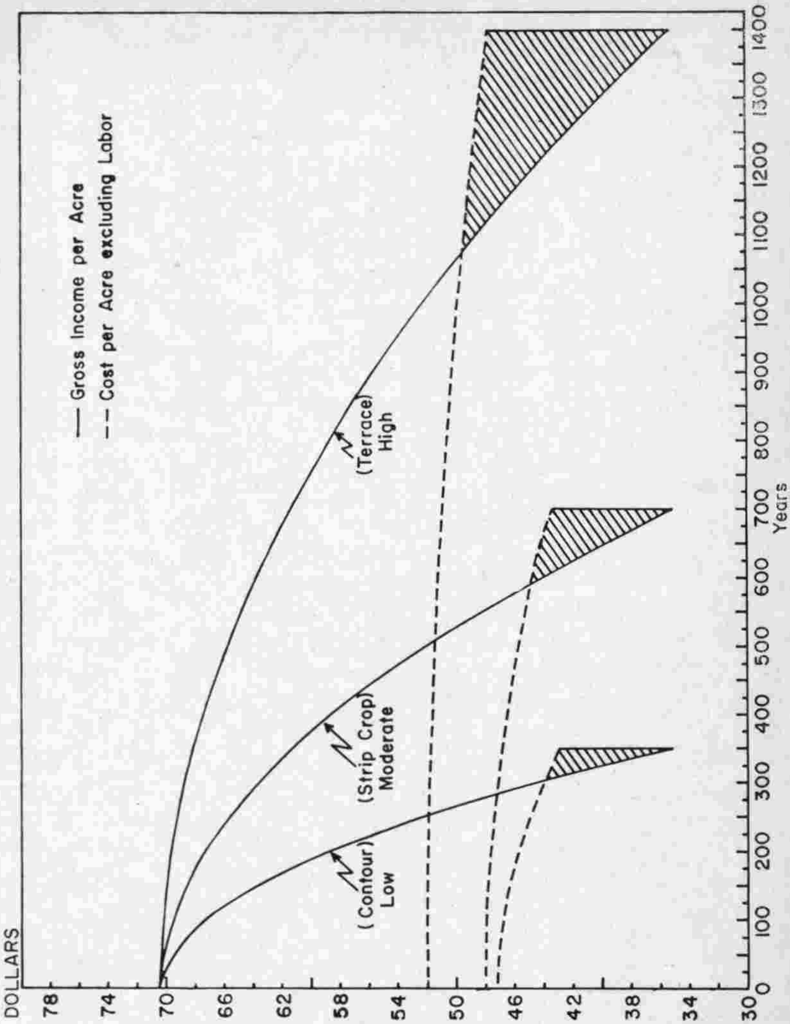


Figure 5. Corn on Memphis soil (4% slope): estimated gross income and cost per acre for three levels of conservation over time, Grenada-Loring-Memphis Soil Area, West Tennessee.

these items decline as per acre yields are reduced.[6]

2) Items associated with the cost of corn fed to livestock on the farm as: a) home-grown corn which rises in cost per bushel as yields decline, and b) purchased corn, needed to maintain constant livestock pro-

[6]Cost rates for mechanical harvesting are based on minimum charges per acre plus constant cost rates per unit of production. Costs of hauling and ginning of cotton, and hauling and storing of corn are based on constant rates per unit of production. It is recognized that certain storage costs, however, are constant over the life of the storage facility.

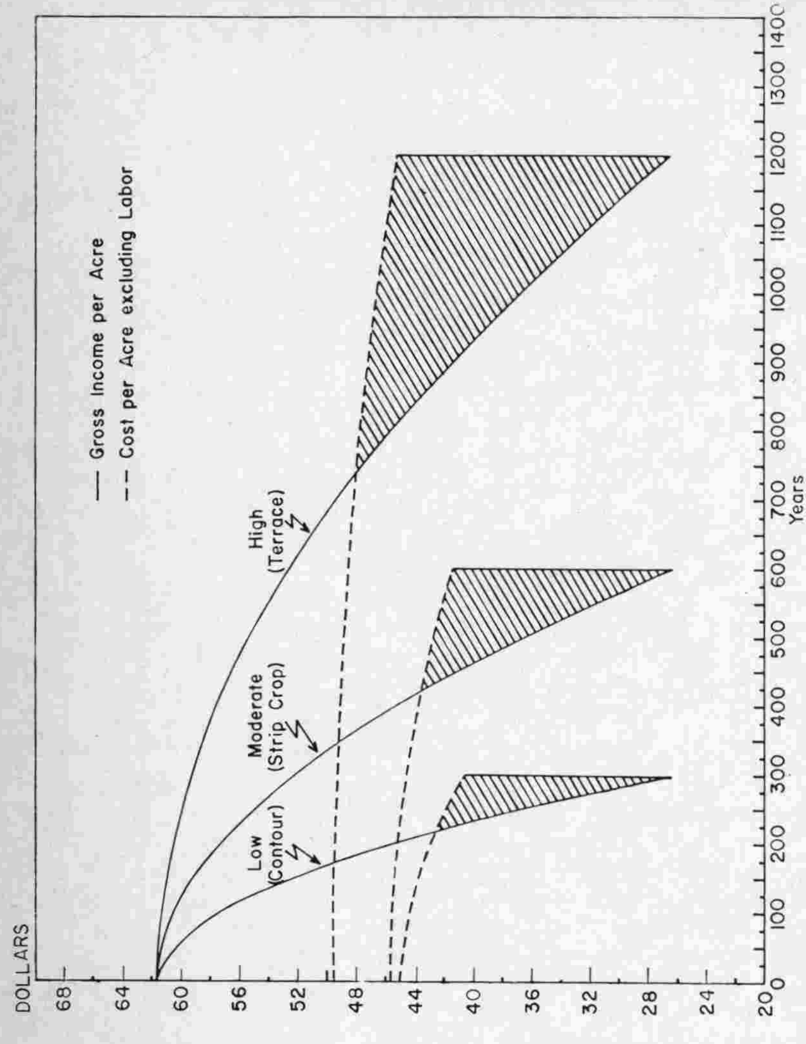


Figure 6. Corn on Loring soil (4% slope): estimated gross income and cost per acre for three levels of conservation over time, Grenada-Loring-Memphis Soil Area, West Tennessee.

duction, made necessary by reductions in home-grown corn.[7]

All other items of cost were assumed to remain constant over time, such as conservation practices, land, and direct costs of producing crops and livestock not referred to above.

In the short run, net returns from conservation farming often were reduced below current income levels of soil depleting systems be-

[7]Purchased at a constant price of $1.25 per bushel, assuming that the market price would not change over time.

cause of 1) the additional expenditures required to establish and maintain conservation systems, and 2) the lag in benefits received from their adoption. This situation was illustrated by comparative labor returns on the selected farm operated under the three alternative conservation systems in the bench mark period (Table 4).

With farm technology, farm size and prices held constant over time, the variable factor affecting net incomes for the different systems of conservation was yield per acre. Thus with declining yields over time, estimated for each of the levels of conservation, net incomes also would decline. But under the low conservation level, net returns would fall fastest. In 50 years, for example, net labor returns from cotton on Memphis soil would decrease 5.5% for low conservation, 1.6% for moderate conservation, but less than 1% for high conservation (Table 6).

This is illustrated further by comparative net labor returns from the dairy-hog-cotton farming system on the case farm shown in Table 8. In 300 years using low conservation, net returns would decline from a high of $3,419 in the bench mark period (year 1) to a low of $988. During this time span, however, net returns would decline to about $2,500 for moderate conservation and around $2,900 for high conservation.[8]

In the early years, net incomes from the higher conservation alternatives gain slowly on the low conservation system because of the relatively small difference in crop yields per acre. The widening spread in yields over time in favor of the higher conservation alternatives is reflected in improved incomes relative to that from the low conservation system. These comparative trends are shown in Figure 7.

In the bench mark period, net labor returns from moderate and high conservation systems lagged behind low conservation by $95 and $344, respectively. About 50 and 100 years later, however, net returns from moderate and high conservation, respectively, would be equalized with returns from low conservation. Then, in succeeding years net incomes from the higher systems of conservation would be larger than those from low conservation and in increasing amounts (Table 9).

These differences in net income between levels of conservation are based on gross income less cash and noncash costs, whereas some farmers may consider only the cash costs in relation to income when choosing between conservation alternatives. On the dairy-hog-cotton farm, for evample, 51%, or $144, of the annual direct costs of establishing and maintaining the high level of conservation were noncash (Table 3, page 17). Omitting these items from total cost would add $144 to net labor returns in each period. Consequently, in the bench mark period (year 1), the net income from the high conservation alternative would be only $200 below that of the low conservation,

[8]For purposes of comparisons over the long run, returns are shown in dollars unadjusted for the present value of future incomes.

Table 8. Estimated net Labor returns on the selected farm, by levels of conservation over time, Grenada-Loring-Memphis Soil Area, West Tennessee[1]

End of year	Low conservation (contour only)	Moderate conservation (strip crop)	End of year[2]	High conservation (terrace-winter cover)
	Dollars	Dollars		Dollars
1	3419	3324	1	3075
25	3396	3310	50	3068
50	3319	3296	100	3060
75	3222	3269	150	3042
100	3081	3219	200	3004
125	2907	3177	250	2973
150	2682	3107	300	2924
175	2429	3037	350	2868
200	2074	2948	400	2805
225	1661	2855	450	2736
250	1288	2751	500	2664
275	1140	2623	550	2585
300	988[3]	2487	600	2485
325		2344	650	2389
350		2177	700	2285
375		1987	750	2159
400		1791	800	2029
425		1634	850	1868
450		1464	900	1703
475		1280	950	1541
500		1214	1000	1358
525		1156	1050	1168
550		1088	1100	966
575		1017	1150	839
600		949[3]	1200	772

[1]Unadjusted for present value of future income.

[2]Note change to 50-year periods for the high conservation level.

[3]Net returns stabilize at the periods indicated.

instead of $344, as shown in Table 9.

Present Value of Future Income. The present value that farmers place on future income is a major factor influencing their choice of a conservation system. A dollar "today" is worth more than a dollar "tomorrow" because individuals discount the future. If the discount rate of 6% compounded annually is used, for example, the present value of $1.00 in 1 year in the future is 94.3 cents, but only 5.4 cents in 50 years. A lower discount rate increases the present value or vice versa. In this report, time preference was measured by discounting future incomes at the rate of 6% compounded annually, and the discount period is limited to 50 years, as the present value of future income is close to zero at that time.

A measure of the income potentials of conservation alternatives is the sum of the present values of future incomes over time. Under the assumptions of this study and with all costs charged, the high conservation level would not pay

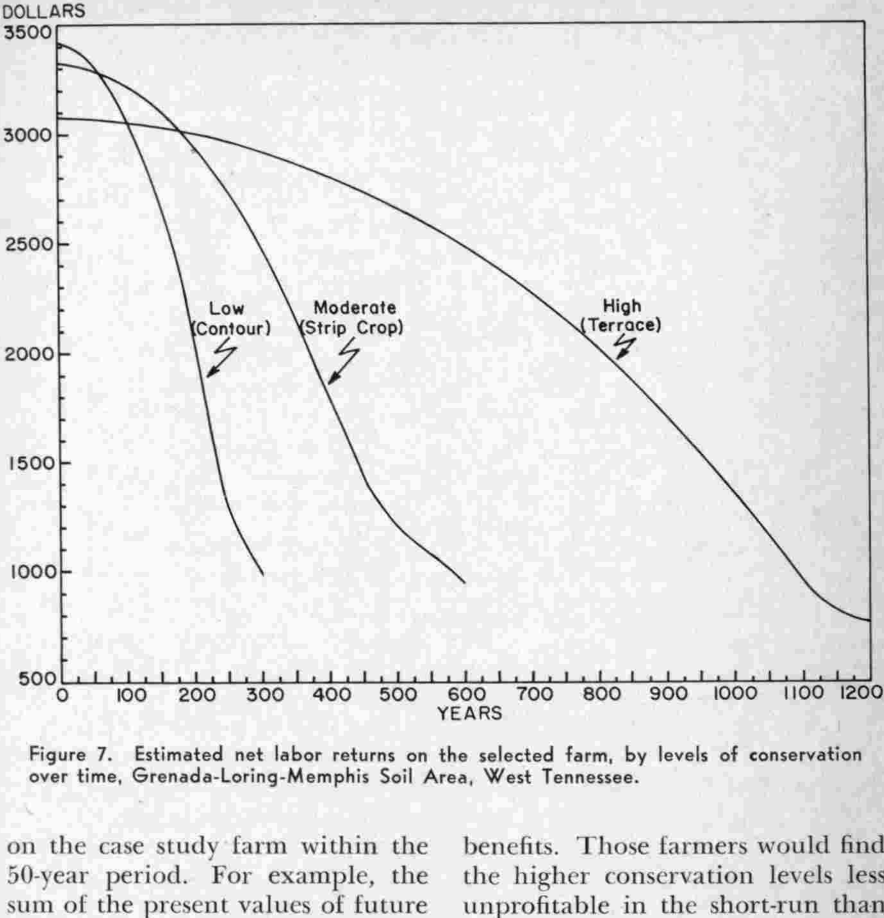


Figure 7. Estimated net labor returns on the selected farm, by levels of conservation over time, Grenada-Loring-Memphis Soil Area, West Tennessee.

on the case study farm within the 50-year period. For example, the sum of the present values of future income over this period would amount to $48,453 for high conservation and $53,630 for low conservation. During the period, added benefits would not cover additional direct costs of terracing, waterways, and winter cover crops. Income from the moderate conservation level, however, is only slightly below that of low conservation (Table 10).

But, as indicated elsewhere in this report, some farmers may choose to adopt conservation practices on the basis of the cash-cost benefits. Those farmers would find the higher conservation levels less unprofitable in the short-run than would farmers who made their choices on the basis of total costs.

The other side of the picture is the better protection of soil productivity provided by the higher conservation systems. Terracing with grassed waterways and winter cover crops after cotton would provide protection over a longer time than either strip cropping or contour farming (Table 1, page 11). Important also would be the greater protection of land values that would stem from the adoption of these conservation practices.

Table 9. Estimated changes in net labor returns resulting from adjusting from low conservation to moderate or high conservation, and crop index for selected years, on the selected farm, Grenada-Loring-Memphis Soil Area, West Tennessee

End of year	Changes in labor returns by levels of conservation[1]		Crop yield index by levels of conservation[2]		
	Low to moderate	Low to high	Low	Moderate	High
	Dollar	Dollar	Pct.	Pct.	Pct.
1	–95	–344	100.0	100.0	100.0
25	–85	—	99.2	99.5	—
50	–25	–251	97.6	99.0	99.8
75	47	—	95.3	98.5	—
100	138	—21	92.0	97.5	99.5
125	270	—	87.5	96.4	—
150	425	360	82.7	95.0	98.9
175	608	—	76.9	92.8	—
200	874	930	69.0	91.0	98.2
225	1194	—	62.4	88.7	—
250	1463	1685	54.3	86.4	97.0
275	1483	—	48.9	83.7	—
300[3]	1499	1936	42.9	81.1	96.0

[1]Future incomes not adjusted to present values.

[2]Year 1=100%.

[3]Yield index for the farm stabilizes at this time period for the low conservation level. Yields of cotton and corn were weighted by number of acres.

Table 10. Estimated present value of future labor returns on a case study farm, by levels of conservation, Grenada-Loring-Memphis Soil Area, West Tennessee, year 1 to 50 by 5-year periods (discounted 6% per year)

End of year	Levels of conservation		
	Low	Moderate	High
	Dollars	Dollars	Dollars
1	3,225	3,136	2,901
5	2,553	2,483	2,298
10	1,905	1,854	1,717
15	1,421	1,384	1,283
20	1,060	1,034	958
25	791	771	716
Total 25 years[1]	43,597	42,441	39,305
30	589	576	535
35	438	430	400
40	326	321	298
45	243	240	223
50	180	179	167
Totals 50 years[1]	53,630	52,284	48,453

[1]Accumulated annual totals for entire period. The annual data are shown only by 5-year periods.

Appendix

Exhibit A. Method of estimating annual soil losses per acre[1]

The rate of soil loss depends upon several factors, such as the rainfall pattern, characteristics, length and degree of slope, and soil management and soil conservation practices. The soil loss estimating equation is a means of combining the effects of these factors into quantitative estimates of the annual soil loss per acre. The illustration of the method of estimating soil loss shown below relates to Memphis silt loam soil on 4% slope averaging 300 feet in length. The specific location is Fayette County in the Grenada-Loring-Memphis Soil Area.

1. The soil loss estimating equation:

   A = RKLSCP, when
   A = Soil loss per acre per year
   R = Rainfall-erosion index
   LS = Soil loss factor adjustment to length and degree of slope
   K = Soil erodibility factor
   C = Crop-management factor
   P = Conservation practice

2. Substituting the appropriate data in the above formula for low conservation (contour only),

   R = 320
   K = 0.38
   LS = 0.73
   C = .508 (cotton continuous without winter cover)[2]
   P = .50 (contour cultivation on 2.1 to 7.0 percent slope)
   A = 320 x .38 x .73 x .508 x .50
   A = 22.5 tons soil loss per acre per year

3. For moderate conservation (strip cropping) P = 0.25
   Substituting P = 0.25 in the above formula,

   A = 11.25 tons soil loss per acre per year

4. For high conservation (terrace with winter cover):

   a) The length of the slope on terraced land is the width of the terrace interval instead of the length of the slope as shown in the illustration above. The terrace interval for this area is 75 feet for which the LS value = 0.25.

   b) The C value is based on a crop-management pattern of continuous cotton with late-seeded winter cover, for example, C = 0.451.

   c) The conservation practice is contour terracing (P = 0.25 on 2.1% to 7.0% slope).
   Substituting these values in the soil loss estimating equation,

   A = 320 x .38 x .35 x .451 x .25
   A = 4.8 tons soil loss per acre per year.

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[1]For details of this procedure see "Soil Loss Estimation in Tennessee," unnumbered mimeographed report prepared by members of the Agronomy Department, University of Tennessee, and the Soil Conservation Service, USDA, based on an equation for predicting rainfall erosion losses by W. A. Wischmeier, of ARS, USDA.

[2]Cotton grown under this crop-management level is used for illustrative purposes. C values are available or may be computed for other crops and crop-management practices.

Exhibit B. Crop-management factors (average annual C values) used in the soil loss estimating equation, Grenada-Loring-Memphis Soil Area, West Tennessee[1]

Land use	Annual C values	Crop-management practice (high level of fertilization)
Corn (60 bu. per acre)	0.337	Continuous corn without winter cover, residue left.
Cotton	.508	Continuous cotton without winter cover.
Cotton	.451	Continuous cotton with late-seeded winter cover.
Alfalfa	.009	Meadow, renovated 1 in 5 years, turn-plow and fallow, Aug. 1-30.
Permanent pasture	.004	Meadow, well established grass-legume mixture; excellent cover.
Permanent pasture	.010	Meadow, well established grass-legume mixture; fair cover.
Lespedeza-rye pasture	.020	Rye sod-seeded annually.

[1]Adapted from "Soil Loss Estimation in Tennessee."

Exhibit C. Estimating years to remove the most productive layers of soils

The basic data used in computing the estimated number of years required to erode all of the most productive soil layers away were: 1) number of inches of top soil for specified types of soils, 2) weight of an acre-inch of soil (150 tons), and 3) annual soil loss per acre.

The total weights per acre of the top soil of specific soils are as follows:

Memphis, 4% slope (36" depth)	5,400 (tons)
Loring, 4% slope (30" depth)	4,500 (tons)
Loring, 7% slope (20" depth)	3,000 (tons)
Grenada, 4% slope (24" depth)	3,600 (tons)
Dyer-Waverly, 2% slope (18" depth)	2,700 (tons)

Exhibit D. Method of estimating yields per acre over time

1. Situation:

   Cotton on 4% Memphis soil grown under low conservation (contour only) range in yields per acre from 700 pounds lint in year 1 to a minimum of 300 pounds in year 250.

2. Formula for estimating the constant factor used in computing the yield decreases by periods:

$$X = \frac{YL}{(T\text{-}1)\ (M)}$$

When,

X = Constant rate of decline
YL = Total loss of yield over time
T-1 = Total number of time periods minus 1
M = Median number of time periods represented by T-1

Substituting in the formula:

$$X = \frac{400}{(11\text{-}1)(5.5)}$$

$$= \frac{400}{(10)\ (5.5)}$$

$$= 7.2727 \text{ pounds}$$

3. Estimated yields per acre of cotton over time, Memphis soil, 4% slope, low conservation, Grenada-Loring-Memphis Soil Area, West Tennessee:

End of year	Reduction from preceding period[1]	Yield per acre[1]
	Pound	Pound
1	0	700
25	–7	693
50	–15	678
75	–22	656
100	–29	627
125	–36	591
150	–44	547
175	–51	496
200	–58	438
225	–65	373
250	–73	300

[1]Rounded to the nearest pound.

Appendix Table 1. Assumed prices received by farmers for products sold and prices paid for items of production, Grenada-Loring-Memphis Soil Area, West Tennessee

Item	Unit	Price	Item	Unit	Price
		Dollar			Dollar
		A. Prices received			
1. Crops:			2. Livestock:		
Cotton, lint	lb.	0.26	Swine		
Cotton seed	ton	50.00	Hogs, slaughter 215 lb.	cwt.	14.50
Corn, shelled	bu.	1.10	Cull sows	cwt.	11.00
Oats	bu.	.70	Milk for processing	cwt.	3.30
Alfalfa hay, baled	ton	25.50	Cattle		
Oat hay, baled	ton	20.70	Slaughter cows, dairy	cwt.	13.50
			Dairy calves	head	8.00
		B. Prices paid			
1. Seed:			5. Custom work:		
Cotton	cwt.	8.40	Bale hay	ton	5.00
Corn, hybrid	bu.	10.00	Drill grain	acre	1.50
Alfalfa	lb.	0.45	Drill rental	acre	.75
Ladino clover	lb.	.65	Haul seed cotton to gin	cwt.	.30
Orchardgrass	lb.	.32	Gin, bag and ties	bale	14.00
Fescue 31	lb.	.20	Apply insecticides, 1 time	acre	.75
Lespedeza, Kobe	lb.	.20	Insecticide	lb.	.09
Rye	bu.	1.35	Defoliate cotton	acre	1.40
Oats	bu.	1.00	Harvest lint cotton, mech.	lb.	.06
			Pick and shell corn	bu.	.15
			Haul milk	cwt.	.40
			Grind feed	cwt.	.25

Appendix Table I (Continued). Assumed prices received by farmers for products sold and prices paid for items of production, Grenada-Loring-Memphis Soil Area, West Tennessee

Item	Unit	Price
		Dollar
2. Feed:		
Corn, shelled	bu.	1.25
Oats	cwt.	2.50
Cottonseed meal	cwt.	3.70
Calf starter	cwt.	5.75
Hog supplement		
A.	cwt.	4.00
C.	cwt.	3.90
Salt, loose	cwt.	1.50
3. Fertilizer:		
Nitrogen (N)	lb.	.12
Phosphate (P_2O_5)	lb.	.06
Potash (K_2O)	lb.	.05
Blending	cwt.	.25
6-12-12	cwt.	2.40
Ground limestone	ton	5.00
4. Labor:		
Day labor	hr.	.60
Hoe cotton	hr.	.50
Specialized labor	hr.	1.00
6. Machinery:		
Tractor, 2-row		2060.00
Plow, 2-disk		260.00
Disk harrow, 8-disk		300.00
Harrow, 2-section		80.00
Planter-distributor, 2-row		245.00
Cultivator, 2-row		280.00
Mower, 7-ft.		310.00
Rake, side delivery		350.00
Fertilizer spreader		190.00
Manure spreader, 80 bu.		450.00
Trailer wagon		180.00
7. Livestock:		
Cows		200.00
Heifers, 1 year +		175.00
Heifers, under 1 year		75.00
Sow, gilt		60.00
Boar		75.00

Appendix Table 2. Estimated cost of constructing and maintaining 6 miles of parallel terraces on 63 acres of Memphis-Loring soil, selected medium-sized farm, Grenada-Loring-Memphis soil Area, West Tennessee

Item	Amount	Unit	Price	Value
			Dollar	Dollar
A. Constructing terraces	63	acre	13.20[1]	831.60
B. Annual cost:				
1. Maintenance				
Labor[2]	57	hr.	.60	34.20
Tractor, operation & repair	44	hr.	.59	25.96
Equipment, repair	44	hr.	.14	6.16
Total				66.32
2. Extra labor and power, operational[3]				
Labor	43.2	hr.	.60	25.92
Tractor, operation & repair	43.2	hr.	.59	25.49
Total				51.41
3. Depreciation of terraces	832	dol.	.053[4]	44.09
4. Interest on average investment	416	dol.	.06	24.96
Total				186.78
Average per acre				2.96

[1]Estimated 1 mile of terraces per 10 acres of B slope land @ $2.50 per 100 linear feet.

[2]Adapted from Coutu, Arthur J. and McPherson, W. W., *Methods for an Economic Evaluation of Soil Conservation Practices,* Tech. Bul. 137, North Carolina Agricultural Experiment Station, January, 1959.

[3]Extra labor and power growing crops resulting from establishment of the "correction" area, 19.2 hours; growing crops in the regular cropping system, 24.0 hours.

[4]Estimated 20-year life if properly maintained.

Appendix Table 3. Estimated cost of grassed waterways (1.6 acres) for 6 miles of terraces on 63 acres of cropland on Memphis-Loring soils, selected medium-sized farm, Grenada-Loring-Memphis Soil Area, West Tennessee[1]

Item	Amount	Unit	Price	Value
			Dollar	Dollar
Establish:				
Fescue seed	30	lb.	0.20	6.00
Fertilizer, 3-12-12	16	cwt.	2.00	32.00
Lime	3	ton	5.00	15.00
Tractor, operation & repair	48	hr.	.59	28.32
Equipment, repair	48	hr.	.15	7.20
Labor	72	hr.	.60	43.20
Total cost of establishing				131.72
Annual costs:				
Maintain				
Fertilizer, 3-12-12	3.2	cwt.	2.00	6.40
Lime	4.0	cwt.	.25	1.00
Labor	1.5	hr.	.60	.90
Tractor	1.5	hr.	.59	.89
Equipment	1.5	hr.	.30	.45
Total				9.64
Depreciation (20-yr. life)	132	dol.	.05	6.60
Interest on avg. investment	66	dol.	.06	3.96
Grand total annual cost[2]				20.20

[1]Estimates of the area occupied by grassed waterways, and labor and power requirements were adapted from N. C. Tech. Bul. 137.

[2]Annual cost may be reduced by the harvesting of hay from the grassed waterway as indicated by the following estimate:

Production:	1.6 tons grass hay @ $15	24.00
Variable costs:		
Labor	10 hrs. @ 60c (mow, rake, haul loose from windrow)	6.00
Power and equipment	Operation and repair	3.70
Total variable cost		9.70
Net returns above variable costs		14.30
Net cost ($20.20 – $14.30)		5.90

Appendix Table 4. Estimated cost of parallel strip cropping on 63 acres of Memphis-Loring soils, selected medium-sized farm, Grenada-Loring-Memphis Soil Area, West Tennessee

Item	Amount	Unit	Price	Value
			Dollar	Dollar
Extra labor:				
a. Harvesting small patches of alfalfa (3 acres)[1]	19.2	hr.	0.60	11.52
b. Operational on 60 acres	24.0	hr.	.60	14.40
Extra tractor power[2]	43.2	hr.	.59	25.49
Total labor and power				51.41

[1]Correction area resulting from parallel strip cropping.
[2]Operation and repair.

Appendix Table 5. Estimated variable costs per acre of seeding of rye for Winter cover, Grenada-Loring-Memphis Soil Area, West Tennessee

Item	Description	Amount	Unit	Price	Value
				Dollar	Dollar
Seed		1.5	bu.	1.50	2.25
Tractor[1]	Operation & repair	1.6	hr.	0.59	0.95
Equipment	Disk repair	1.0	ac.	.23	.23
	Drill hire	1.0	ac.	.75	.75
Labor	Hired	1.6	hr.	.75	1.20
Total specifed expenses					5.38

[1]Disk once over, 0.7 hours; drill once over, 0.9 hours.

Appendix Table 6. Estimated yield per acre of cotton lint on 4 percent slope, Memphis and Loring soils, by levels of conservation over time, Grenada-Loring-Memphis Soil Area, West Tennessee

Year	Low conservation		Moderate conservation		Year[1]	High conservation	
	Memphis	Loring	Memphis	Loring		Memphis	Loring
	Pound	Pound	Pound	Pound		Pound	Pound
1	700	650	700	650	1	700	650
25	693	639	698	647	50	699	648
50	678	617	694	641	100	696	644
75	656	584	687	632	150	692	638
100	627	540	679	621	200	686	629
125	591	484	668	606	250	679	619
150	547	417	656	588	300	670	606
175	496	339	641	568	350	659	590
200	438	[2]250	624	544	400	647	572
225	372		606	518	450	633	552
250	[2]300		584	488	500	618	530
275			561	455	550	601	506
300			536	421	600	582	479
325			509	382	650	563	450
350			480	341	700	542	418
375			448	297	750	519	385
400			414	[2]250	800	494	349
425			378		850	468	311
450			340		900	440	271
475			[2]300		950	412	[2]250
					1,000	381	
					1,050	350	
					1,100	317	
					1,125	[2]300	

[1]Note the change to 50-year periods for the High Conservation Level.

[2]Yields are assumed to stabilize at the levels indicated. The year ending the period of decline was rounded to the nearest 25 years.

Appendix Table 7. Estimated yield per acre of corn on 4 percent slope, Memphis and Loring soils, by levels of conseration over time, Grenada-Loring-Memphis Soil Area, West Tennessee

Year	Low conservation		Moderate conservation		Year[1]	High conservation	
	Memphis	Loring	Memphis	Loring		Memphis	Loring
	Bushels	Bushels	Bushels	Bushels		Bushels	Bushels
1	64.0	56.0	64.0	56.0	1	64.0	56.0
25	63.7	55.6	63.9	55.9	50	63.9	55.9
50	63.1	54.8	63.8	55.7	100	63.8	55.7
75	62.2	53.4	63.5	55.3	150	63.6	55.4
100	61.0	51.9	63.2	54.9	200	63.3	55.0
125	59.5	49.9	62.8	54.4	250	62.9	54.5
150	57.7	47.4	62.3	53.7	300	62.4	53.9
175	55.6	44.5	61.8	52.9	350	61.9	53.1
200	53.2	41.2	61.1	52.0	400	61.3	52.3
225	50.5	37.6	60.4	51.0	450	60.6	51.4
250	47.5	33.5	59.6	49.9	500	59.8	50.3
275	44.1	28.9	58.7	48.7	550	58.9	49.1
300	40.4	[2]24.0	57.8	47.4	600	58.0	47.9
325	36.4		56.7	46.0	650	57.0	46.5
350	[2]32.0		55.6	44.5	700	55.9	45.0
375			54.4	42.9	750	54.7	43.3
400			53.1	41.2	800	53.4	41.6
425			51.8	39.4	850	52.1	39.8
450			50.3	37.5	900	50.7	37.7
475			48.8	35.5	950	49.2	35.7
500			47.2	33.4	1,000	47.6	33.6
525			45.6	31.2	1,050	45.9	31.3

Appendix Table 7 (Continued). Estimated yield per acre of corn on 4 percent slope, Memphis and Loring soils, by levels of conservation over time, Grenada-Loring-Memphis Soil Area, West Tennessee

Year	Low conservation		Moderate conservation		Year[1]	High conservation	
	Memphis	Loring	Memphis	Loring		Memphis	Loring
	Bushels	Bushels	Bushels	Bushels		Bushels	Bushels
550			43.8	28.9	1,100	44.2	29.0
575			42.0	26.5	1,150	42.4	26.5
600			40.0	[2]24.0	1,200	40.5	[2]24.0
625			38.2		1,250	38.5	
650			36.2		1,300	36.4	
675			34.1		1,350	34.3	
700			[2]32.0		1,400	[2]32.0	

[1]Note the change to 50-year periods for the High Conservation Level.
[2]Yields are assumed to stabilize at the levels indicated.

Appendix Table 8. Summary of income, cost and labor returns on a medium-sized dairy-hog-cotton farm, by levels of conservation over time, Grenada-Loring-Memphis Soil Area, West Tennessee[1]

Year	Low level (contour only)			Moderate level (strip crop)			Year[2]	High level (terrace-winter cover)		
	Income	Costs	Labor returns	Income	Costs	Labor returns		Income	Costs	Labor returns
	Dollar	Dollar	Dollar	Dollar	Dollar	Dollar		Dollar	Dollar	Dollar
1	11,709	8,290	3,419	11,689	8,365	3,324	1	11,603	8,528	3,075
25	11,675	8,279	3,396	11,672	8,362	3,310	50	11,598	8,530	3,068
50	11,570	8,251	3,319	11,652	8,356	3,296	100	11,586	8,526	3,060
75	11,432	8,210	3,222	11,621	8,352	3,269	150	11,567	8,525	3,042
100	11,250	8,169	3,081	11,580	8,361	3,219	200	11,542	8,538	3,004
125	11,087	8,180	2,907	11,529	8,352	3,177	250	11,510	8,537	2,973
150	10,892	8,210	2,682	11,466	8,359	3,107	300	11,472	8,548	2,924
175	10,663	8,234	2,429	11,394	8,357	3,037	350	11,426	8,558	2,868
200	10,380	8,306	2,074	11,312	8,364	2,948	400	11,373	8,568	2,805
225	10,110	8,449	1,661	11,219	8,364	2,855	450	11,314	8,578	2,736
250	9,786	8,498	1,288	11,115	8,364	2,751	500	11,248	8,584	2,664
275	9,786	8,646	1,140	11,001	8,378	2,623	550	11,175	8,590	2,585
300	[3]9,786	8,798	988	10,878	8,391	2,487	600	11,093	8,608	2,485
325				10,744	8,400	2,344	650	11,010	8,621	2,389
350				10,600	8,423	2,177	700	10.917	8,635	2,282
375				10,445	8,458	1,987	750	10,817	8,658	2,159
400				10,282	8,491	1,791	800	10,711	8,682	2,029
425				10,161	8,527	1,634	850	10,597	8,729	1,868
450				10,033	8,569	1,464	900	10,478	8,775	1,703
475				9,898	8,618	1,280	950	10,354	8,813	1,541

Appendix Table 8 (Continued). Summary of income, costs and labor returns on a medium-sized dairy-hog-cotton farm, by levels of conservation over time, Grenada-Loring-Memphis Soil Area, West Tennessee[1]

Year	Low level (contour only)			Moderate level (strip crop)			Year[2]	High level (terrace-winter cover)		
	Income	Costs	Labor returns	Income	Costs	Labor returns		Income	Costs	Labor returns
	Dollar	Dollar	Dollar	Dollar	Dollar	Dollar		Dollar	Dollar	Dollar
500				9,898	8,684	1,214	1,000	10,223	8,865	1,358
525				9,898	8,742	1,156	1,050	10,086	8,918	1,168
550				9,898	8,810	1,088	1,100	9,943	8,977	966
575				9,898	8,881	1,017	1,150	9,871	9,032	839
600				[3]9,898	8,949	949	1,200	[3]9,871	9,099	772

[1]Unadjusted for present value of future income.

[2]Note the change of 50-year time periods.

[3]Costs and returns stabilize at periods indicated.

Appendix Table 9. Index of crop yields per acre and net labor returns on a medium-sized dairy-hog-cotton farm, by levels of conservation over time, Grenada-Loring-Memphis Soil Area, West Tennessee[1]

Year	Low conservation		Moderate conservation		Year[2]	High conservation	
	Yield per acre	Labor returns	Yield per acre	Labor returns		Yield per acre	Labor returns
	Percent	Percent	Percent	Percent		Percent	Percent
			Year 1 = 100 percent				
1	100.0	100.0	100.0	100.0	1	100.0	100.0
25	99.2	99.3	99.5	99.6	50	99.8	99.8
50	97.6	97.1	99.0	99.2	100	99.5	99.5
75	95.3	94.2	98.5	98.3	150	98.9	98.9
100	92.0	90.1	97.5	96.8	200	98.2	97.7
125	87.5	85.0	96.4	95.6	250	97.0	96.7
150	82.7	78.4	95.0	93.5	300	96.0	95.1
175	76.9	71.0	92.8	91.4	350	94.6	93.3
200	69.0	60.7	91.0	88.7	400	92.7	91.2
225	62.4	48.6	88.7	85.9	450	91.3	89.0
250	54.3	37.7	86.4	82.8	500	89.3	86.6
275	48.9	33.3	83.7	78.9	550	87.3	84.1
300	[3]42.9	28.9	81.1	74.8	600	84.3	80.8
325			77.6	70.5	650	82.0	77.7
350			73.8	65.5	700	78.9	74.2
375			70.9	59.8	750	75.9	70.2
400			66.9	53.9	800	73.0	66.0
425			63.0	49.2	850	70.2	60.7

Appendix Table 9 (Continued). Index of crop yields per acre and net labor returns on a medium-sized dairy-hog-cotton farm, by levels of conservation over time, Grenada-Loring-Memphis Soil Area, West Tennessee[1]

Year	Low conservation: Yield per acre	Low conservation: Labor returns	Moderate conservation: Yield per acre	Moderate conservation: Labor returns	Year[2]	High conservation: Yield per acre	High conservation: Labor returns
	Percent	Percent	Percent	Percent		Percent	Percent
			Year 1 = 100 percent				
450			59.7	44.0	900	65.6	55.4
475			55.5	38.5	950	62.3	50.1
500			53.6	36.5	1,000	57.9	44.2
525			51.0	34.8	1,050	54.7	38.0
550			48.4	32.7	1,100	50.3	31.4
575			45.2	30.6	1,150	46.3	27.3
600			[3]42.5	28.5	1,200	[3]43.0	25.1

[1]Weighted average yield per acre of corn and cotton by soil types. Yields of hay and pasture were held constant.

[2]Time period changed to 50 years.

[3]Yields are assumed to stabilize at the levels indicated.

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