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Economic Evaluation of

USE OF SOIL CONSERVATION AND IMPROVEMENT PRACTICES

. . . . IN WESTERN IOWA

UNITED STATES DEPARTMENT OF AGRICULTURE

Agricultural Research Service
Soil Conservation Service
and
Agricultural Conservation Program Service
in cooperation with the
Iowa Agricultural Experiment Station

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SUMMARY

The study reported here[1] was intended to analyze the relative soil conservation and soil improvement values of various practices and, when possible, to rate them on this basis. It was intended also to find the answers to certain questions, as follows:

How do practices differ in terms of conservation realized per dollar invested?

What are the implications of making payments for practices that are substitutes and those that are complements?

What are the costs of adopting various practices and how does their adoption affect net income from both the acreage on which the practices are applied and the farm as a whole?

What amounts of capital are required for conservation practices? What is the return on the capital investment over time and what is its relation to the use and availability of credit?

How important is it to plan the whole farm when establishing an efficient conservation program?

Experimental data from the Western Iowa Experimental Farm near Castana and the Page County Experimental Farm indicate that conservation practices differ in effects on yield, ability to control erosion, and costs of adoption. Wide-row spacing for corn with forage interplantings probably will reduce erosion, although sufficient data are not available to evaluate its effects. Rotations differ in their ability to control erosion. The larger the percentage of meadow in the rotation, the better can erosion be controlled. Soil losses, regardless of the rotation, are larger under a cash-grain system of farming than under a livestock farming system. The greatest gain in conservation on slopes that exceed 12 percent comes from the first year of meadow. If properly constructed, terraces will control soil loss to a level of 5 tons or less per acre per year, regardless of rotation, on slopes that do not exceed 12 percent. Terraces control erosion most effectively when used with a livestock system of farming and a rotation that contains meadow.

[1] Submitted for publication, May 15, 1956.

Although the data available do not permit accurate appraisal of the relative merits of various practices in terms of the soil they saved or the conservation obtained per dollar invested, they do point the way. Tentative ordering of individual practices on the basis of their ability to save soil is as follows: On slopes that exceed 12 percent, contour listing is most effective of the practices considered, followed, in order, by terracing, contouring (surface planting on the contour), and rotations. On lower slopes, the order suggested by the data presented is terracing followed by contour listing, rotations, and contouring.

Conservation practices differ as to the initial costs associated with their adoption. On rotations that do not include meadow, contouring and contour listing rank highest in terms of soil saved per dollar invested. On slopes of 2 to 20 percent, contour listing combined with a rotation that includes first-year meadow gives the greatest control of soil movement at least cost. When contour listing is not advisable for a specific soil or location, contouring should be used instead. As compared with contouring, contour listing, and rotations, terraces represent the most expensive method of controlling erosion.

If practices are complementary, they conserve soil only if used in combination. In these instances, payment should be made for one practice only if the other practice is used in combination with it. If practices compete in the sense that they represent alternative ways of accomplishing a specified level of erosion control, payments should be made for only one alternative.

Net incomes from crops are higher for any rotation or any system of farming on farms located on less steep slopes and more fertile soil. Terraces constructed with a moldboard plow cost less than those constructed with a whirlwind terracer or a bulldozer, or by custom hiring. The cost of constructing terraces increases with the slope, as the higher slopes involve more linear feet of terraces. Adoption of terraces causes net crop income to drop. The return on capital invested in terraces is low. When terraces are constructed by custom hiring, 4 or 5 years are needed to pay for them from increased yields under a cash-grain and 3 or 4 years under a livestock system of farming. A longer period is required to pay for the combined practices of terracing and contouring on rotations that contain meadow than on those that exclude meadow. Use of fertilizer with terracing and contouring holds crop incomes higher than they would be otherwise and decreases the time required to pay for the combined practice from the increased yields.

Using 3 case farms in western Iowa, the writers worked out a crop program and 8 livestock programs for each farm for the years from 1952 to 1967, inclusive. Assumptions are made of steady prices at the 1952 level and of declining prices from the 1952 level to a level of 225 percent of 1910–14 prices by 1958, with prices remaining steady thereafter. The minimum time required for a soil conservation plan to provide a higher annual net farm income than extension of the present plan is 4 years under assumption of steady prices and 5 years under assumption of declining prices. The minimum time required for accumulated net farm income under a conservation plan to exceed accumulated net farm income under the present plan is 7 years at 1952 prices. Ordinarily when future incomes are discounted, a longer period is needed.

The additional capital required for a conservation system of farming is greatest 5 to 8 years after the new plan is started. Variations in increased capital needs occur from year to year after a plan is started, chiefly because of greater investment in livestock. Indirect costs associated with a conservation plan, such as those for livestock, often exceed the direct costs of the conservation practices.

Heavy applications of fertilizer in the first few years of a conservation plan help to overcome the drop in net farm income that ordinarily occurs. Credit should be made available, not only for the conservation practices themselves but for related additional costs. Credit is required in varying amounts for a number of years after a conservation practice is started. Loans for fertilizer, tiling, and other practices that are profitable but nonconservational help to maintain farm incomes and increase adoption of conservation practices.

Overall farm planning for conservation is necessary if the practices that control erosion are to be accepted generally. Education must play an important role. Farmers must become convinced that conservation farming will not lessen their satisfaction. They must want to adopt the practices and to contend with them over a period of years. Conservationists should recognize the ramifications of proposed conservation plans on the farm business as a whole. The land, human, and capital resources are unique for each farm situation. They should be considered, as they function simultaneously in an individual farm business.

THE PROBLEM

One of the chief problems of agriculture in the United States today is the development of systems of farming that are in line with national needs and consumer demands for various products. These systems must also use capital, labor, and land efficiently, and they must maintain and improve soil productivity through application of recommended soil conservation and soil improvement practices. These objectives are interrelated in a major part of the Nation's farming. In regard to the part that conservation plays in the agricultural economy, two important problems arise: What part of total investment should be used to encourage conservation? How can the resources made available to achieve conservation be used most efficiently? The answer does not lie in conservation alone or in development alone. Together they determine what the agricultural production will be.

Farmers share in the national concern for a higher level of conservation than the present system of agriculture provides. But for farmers conservation has additional meaning. A farmer's crops depend upon the soil in his farm and his livestock depend upon the crops he grows. Soil is one of the chief determinants of farm income. Loss of soil means loss of fertility, which in turn is reflected in lower yields and reduced profits for the farmer—and a decrease in the supply of farm products for the country as a whole. Farmers are interested in how loss of soil, water, and fertility affect their incomes during their periods of tenure. Compared with the period in which the Nation is interested, these periods are very short.

In many agricultural areas, a sustained high level of farm output can be attained. This can be done if cropping systems, mechanical conservation practices, and adapted livestock programs are applied and integrated in the system of farming in a way that will retard soil erosion and raise the level of crop yields over a period of several years. But too frequently in the major regions, where prevention of soil erosion and improvement in soil productivity are basic to high-level, sustained production, these adjustments are not made. The proportion of farmers who follow even such simple practices as contouring and terracing is small. Only a slightly larger number follow crop rotations that include grasses and legumes—a practice known to be necessary for continued high-level production. Although use of lime and fertilizer is increasing, greater quantities of these materials should be used for efficient production of forage and feed crops. Furthermore, the livestock organization on many farms is neither of a kind nor at a level that would permit efficient utilization of feed crops, even if recommended conservation and soil improvement practices were followed.

The problem is critical. Without adjustments in farming systems of the kind suggested, a high-level sustained output of farm products might permanently impair the resources and productivity of a large part of the Nation's agriculture. The Nation, therefore, should decide what share of its total investment resources should be used to achieve conservation. It should then decide how to use the designated resources to realize the maximum amount of conservation.

This bulletin reports the findings obtained in a pilot study of data from western Iowa, which was designed to develop information on the latter part of the problem.

OBJECTIVES OF THE STUDY

Many practices are known to retard erosion. They differ, however, as to the extent of erosion control they provide and as to the costs associated with their adoption. Practices differ also in their effects on yields and profits to farmers. The results of practices applied singly differ from those obtained when two or more are applied in combination. In addition, the practices or combination of practices used on a specific farm must be examined on the basis of their effects on the farm as a whole. The net income of a farmer is not determined by one phase alone but by the simultaneous functioning of all parts of the farm business.

The overall purpose of the study reported here was to indicate how economic principles can be applied to the problem of conservation to obtain information for use in deciding policy, distributing payments, arranging credit, and accelerating adoption of conservation practices by farmers. Specific objectives were:

(1) To identify the soil conservation practices and adjustments in farming that are desirable on representative farms to conserve soil resources and facilitate efficient production.

(2) To learn the relative effectiveness of individual practices and groups of practices in controlling loss of soil.

(3) To determine costs and returns and their sequence over time to representative farmers of single practices and groups of practices, and to complete farm adjustments that achieve a greater degree of soil conservation.

(4) To determine the amount of capital required for various conservation practices, the conservation realized per dollar of investment, the return on capital investment over time, and the relation of each to the use and availability of credit.

(5) To learn the extent to which and the conditions under which conservation practices are profitable to the farmer.

(6) To indicate the implications of making payments for practices that are substitutes and those that are complements.

(7) To indicate the importance of farm planning in the establishment of an efficient and effective conservation program that will support farmers' incomes and assure the Nation sustained high-level production from agriculture.

THE STUDY AREA

The study area is located in the Ida-Monona and Marshall soil association areas of western Iowa. Ida-Monona soils are loessial soils of the Missouri River Valley. They were broken out of tall prairie grasses from 1870 to 1890. Since then, the loss of fertile topsoil through sheet erosion has been as much as 50 percent. Gully erosion is also serious, especially on the long, steep slopes adjacent to the bluffs. Because of the vertical structure of Ida and Monona soils, some of the gullies are now 100 feet deep. They cut back several hundred feet in a year. Frequently roads, bridges, fences, and farm buildings must be relocated because of them. Less spectacular, but more devastating so far as the soil is concerned, are the small gullies and depressions that are developing in most cultivated fields (*2, p. 2*).[2] Marshall silt loam, the dominant soil of the rolling uplands in much of western Iowa, is typically 14 to 16 inches in depth. It is dark grayish brown when dry, but when wet it is almost black. Drainage is good. The subsoil absorbs moisture readily, but excessive rainfall drains rapidly from the rolling surface. The relatively thin layer of topsoil is soon removed by the runoff of water. The exposed subsoil is lighter colored and less productive.

The erosion problem in these two soil association areas (Ida-Monona and Marshall) is perhaps the most critical of any in the Midwest. The soils have been damaged severely by sheet and gully erosion. The kind of farming usually practiced intensifies the damage. Corn is the chief crop. Crop rotations have not been universally accepted. When used, they may include two successive crops of corn, followed by a small grain and a seeding of timothy and legumes. Row crops are planted up and down hill on slopes that exceed 15 percent. Livestock enterprises are geared to a cash-grain type of farming.

Contour stripcropping, sodding of waterways, diversion terraces, improved rotations, and other soil conservation practices should be adopted on many farms. These practices would help to maintain or augment the low farm incomes, conserve soil resources, and reduce damage from floods.

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[2] Italic numbers in parentheses refer to Literature Cited, p. 82.

ANALYTICAL APPROACHES

The analysis and interpretation in this bulletin are divided into three parts. *First*, economic concepts with which to compare individual and combinations of conservation practices are applied. Physical data associated with various practices are used to compare the practices as to ability to curb erosion, cost, and acceptability in terms of their effects on farm organization and management. Estimates of the effects of these practices on yields and on income from crops for a typical farm are made for a farm of 120 rotation acres. This approach does two things: (1) It indicates the practices or combinations of practices that are alternative ways of obtaining a specified level of conservation, and it shows how the alternatives differ as to costs, returns, and acceptability; and (2) it yields information on the priority of practices in terms of erosion control and costs. *Second*, 9 conservation systems of farming are considered for 3 representative farms in western Iowa. This approach treats the element of time as it relates to costs and returns and the adjustments in net farm income and capital requirements that each conservation plan involves. *Third*, the concept of overall farm planning for conservation is advanced and discussed. The implications of the findings and the suggestions of preceding sections are used to illustrate the part society can play in the establishment of a conservation system of farming that will satisfy simultaneously the objectives of individual farmers and of the Nation as a whole.

CONSERVATION AND IMPROVEMENT PRACTICES

Analytical Procedures

In the study reported here the practices and combinations of practices regarded as conservational were those that reduce runoff and soil loss.[3] Data from physical research were used when they were available and appropriate. However, these data were found to be inadequate for the purpose, and many estimates were made. The accuracy of the physical data directly determines the validity of the results. The cost of adopting the different practices was estimated. Practices are compared on a per-acre and a per-farm basis. When totals for a farm are given, the farm is an assumed one of 120 rotation acres.[4]

Soil Losses

Soil losses are the tons of soil lost annually on each acre. In this study they were estimated by use of the Browning factors.[5] The formula used by Browning to determine annual losses from soil erosion is:

[3] It would have been desirable to regard as conservational only those practices necessary to maintain a specified production function over time, but data were insufficient to permit such a distinction in the applied situation (*5, p. 371*).

[4] The average size of farm in western Iowa is about 160 acres, but when deductions are made for farmstead, roads, gullies, permanent pasture, and other nonrotational acres, 120 acres in rotation should be fairly respresentative.

[5] BROWNING, G. M. BROWNING'S EROSION FACTORS. Iowa State Col., Dept. Agron. 1948. [Unpublished.]

(f_1) (f_2) (f_3) (f_4) (f_5) (f_6) (f_7) (10) = the annual soil loss in tons per acre.

The values of the factors for soil erosion losses were calculated for most field conditions. For example, in determining the annual erosion loss for an area of land, the factors are assigned values as follows:

Factor	Value
f_1—Ida soil type	1.5
f_2—10-percent slope	1.1
f_3—200-foot length of slope	1.8
f_4—corn-oats-meadow rotation	1.0
f_5—no manure, most crop residues removed	1.3
f_6—0 to 25 percent of surface soil removed	.8
f_7—contour cultivation, surface-planted	.5

Substituting these values into the formula: (1.5) (1.1) (1.8) (1.0) (1.3) (0.8) (0.5) (10) = 15.44, the annual soil loss in tons per acre.

Crop Yields for Specified Time Periods

Insufficient agronomic data made it necessary to use estimates of yields under various rotations, slopes, and systems of farming. One set of estimates is available for five major soil types in western Iowa with (1) no conservation practices, (2) a terrace-contour system, and (3) a terrace-contour-fertilizer system and specified applications of fertilizer.[6] The data in the estimates represent the average yields after major effects of conservation practices and the rotation have taken place. It is assumed that the estimated level of yields would be obtained about the end of the third cycle of rotations and that it would then remain constant.

An additional set of estimates comprises the annual yields for the same situations for the 10-year period immediately following adoption of the conservation practices.[7] The following assumptions were made:

(1) Yields are limited primarily by the available nitrogen supply; (2) most nitrogen is in the upper 7 inches of soil, and when 7 inches or when 1,000 tons of soil are lost, production is at a minimum; (3) the rate of decline of crop yields is a function of the loss of both topsoil and stable organic matter; (4) the loss of stable organic matter is 1 percent per year; (5) with cropping systems under which yields decline, they decline to a minimum of 5 bushels of corn or 5 bushels of oats plus the quantity of corn or oats produced by nitrogen added by the rotation or fertilizer, or both; (6) for Napier soils, loss of soil is less than 5 tons per acre per year (actually, there may be additions of colluvium for this type of soil).

Prices

The prices assumed for crops in this section for comparison of individual practices are: Corn, $1.42 per bushel; oats, $0.79 per bushel;

[6] AANDAHL, A. A., ALLAWAY, W. H., and RIECKEN, F. F. ESTIMATED AVERAGE YIELDS OF CORN, OATS AND ALFALFA-BROME HAY FOR THE FIVE PRINCIPAL SOIL TYPES AND PHASES IN THE MONONA-IDA-HAMBURG SOIL ASSOCIATION AREA OF IOWA. Iowa State Col., Dept. Agron. 1950. [Unpublished.]

[7] TOUSSAINT, W. D. FARM RENTAL OBSTACLES TO LAND IMPROVEMENTS AND SUGGESTED SOLUTIONS. (p. 68.) 1953. [Unpublished doctor's thesis. Copy on file, Iowa State College, Ames.]

W. D. Shrader of the Agronomy Department of Iowa State College worked out the procedure and made the estimates.

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hay, $18.30 per ton. These prices were the averages received by farmers in western Iowa from 1948 through 1952.

Costs

Costs of production of crops, excluding conservation practices, are computed on a per-acre basis for corn, oats, and alfalfa-brome hay. The method used is that developed by Jensen in a previous study of the area.[8] In general, the procedure was to estimate an average cost of production of crops for Ida and Monona Counties for each year from 1948 to 1952, inclusive, and then to average the estimates for the 2 counties by years. The figures for the 5-year period were averaged. Jensen's data ended with 1948, but the method and references he used were followed to provide the information needed for this study for 1948–52.[9]

The costs of different conservation practices for various soils, slopes, and methods of terrace installation on a farm of 120 rotation acres were computed separately. They were added to costs of production of crops, excluding conservation practices, to permit calculation of total costs of production when conservation practices were used.

Fertilizer was charged at the average rate for which it was obtainable locally—P_2O_5, 10 cents a pound; and nitrogen, 13 cents a pound. A charge of $1.50 per acre for applying fertilizer was allowed for the operator's labor when it was applicable.

Costs of contouring are those associated with removal of old fences and construction of enough new fences to permit controlled grazing. It was assumed that the old fencing would have no value and that it would be replaced by an electric fence. The charger was valued at $25, posts at 50 cents each, and 13-gage wire at 82 cents a rod. Operator's labor for removal of an old, and installation of a new fence was charged at the rate of $1 per acre. It was also assumed that fences for only 20 acres would be needed on 120 acres to facilitate pasturing. Total costs for 20 acres were $253.60. As contour farming requires less fuel than farming up and down hill, no additional charge was involved for operating on the contour.

The number of linear feet of terraces required on a farm varies with the slope. The vertical interval was determined by use of the formula $\frac{\text{slope}}{2} + 2$ on slopes of less than 12 percent. The distance between terraces was calculated by the formula $\frac{\text{vertical interval}}{\text{slope}}$. These are the formulas used by the Agricultural Conservation Program Service (ACPS). Computation of the total linear feet of terrace appropriate to a farm of 120 rotation acres assumed that the farm was 120 rods by 160 rods and that the slope was uniform. The cost of terraces constructed by custom hiring a motor patrol was estimated at 3 cents per

[8] JENSEN, H. R. ECONOMICS OF CROP ROTATIONS. 1950. [Unpublished doctor's thesis. Copy on file, Iowa State College, Ames.]

[9] See Appendix, for details of the method used by Jensen, including tables 37 to 39.

linear foot.[10] Costs of constructing terraces by use of the moldboard plow, whirlwind terracer, or bulldozer were estimated on an hourly basis (Appendix, table 39). The linear feet of terrace that can be constructed by these machines in an hour are averages of field data taken by agricultural engineers at Iowa State College.[11]

Net Income From Crops

Gross incomes from crops were computed for the 120 acres of the particular soil type, slope, and rotation specified, by using average yields after major effects of conservation practices and rotations have taken place, with the prices given on page 7. Costs of production per acre of corn, oats, and alfalfa-brome hay were computed with no costs of conservation assumed. The costs per acre of applying conservation practices were added to get the total cost of production with conservation. Net income from crops was computed by subtracting the total cost of production from the gross income from crops.

Individual Practices

Each conservation practice has its own erosion control characteristics and possibilities, which differ with location, soil, topography, and weather. Some practices may be duplicates in the sense that they are alternative methods of accomplishing the same degree of conservation. Others may be complementary in the sense that they depend upon each other to the extent that neither alone will result in conservation, but when they are used in combination results are obtained. The aggregate results in conservation when two practices are applied singly are not necessarily, or even likely, the same as those realized when the two are used in combination. Still other practices used singly might not conserve any additional soil but if combined with another practice that would save some soil when used alone, they would increase the quantity of soil conserved.

If a conservation practice is to be profitable, higher yields of crops must be obtained from its adoption, and the increased income from the sale of the larger production must exceed the cost of applying the practice. If increased yield were the only determinant of profits from conservation, almost every practice could be defended as profitable. However, the value of the additional yield may be small relative to the cost of the conservation plan or it may require a long period to become equivalent to it. There may be alternative practices or combinations of practices that will result in a specified level of conservation but with different costs of use. The possibilities of profit depend on the prices that can be obtained for the product in the future relative to present costs of adoption of conservation practices.

[10] A survey of the Ida-Monona area of western Iowa consistently revealed this as the charge.

[11] HERMSMEIER, L. F. TERRACES CONSTRUCTED WITH FIVE TYPES OF MACHINES IN WESTERN IOWA. 1950. [Unpublished master's thesis. Copy on file, Iowa State College, Ames.] Hermsmeier's findings indicate that custom hiring a whirlwind terracer costs about 2.50 cents; a bulldozer, 2.51 cents; and a motor patrol 2.39 cents per linear foot of terrace in 1950 [*p. 67*]. The estimated average rate at which the different machines could construct linear feet of terraces is given as: moldboard plow, 162 feet per hour; whirlwind terracer, 284 feet per hour; 70–hp. bulldozer, 302 feet per hour [*p. 55*]. The assumption was made that all terraces were constructed from corn-stubble covering.

Contouring

Contouring and up-and-down-hill methods of farming are compared in table 1 with respect to soil loss, runoff, and yield per acre of corn, oats, and hay. Both soil loss and runoff are greatly reduced by substituting contouring or contour listing of corn for up-and-down-hill farming. Erosion would be reduced by about 20 tons and runoff by 1.24 inches per acre per year by contouring. In the Ida-Monona soil area, 5 tons of soil loss per acre is considered permissible from an agronomic viewpoint of prevention of gullies and serious sheet erosion (*3*). Contouring alone on this relatively steep slope of 14 percent will not control erosion to this extent.

TABLE 1.—*Effect of rotation and planting method on soil loss, runoff, and yield per acre on Ida silt loam, 14-percent slope, 72.6 feet long, 1948–52*

Rotation [1] and planting method	Annual—		Average yield per acre [3]		Hay	
	Soil loss per acre [2]	Run-off per acre [2]	Corn	Oats	1st year	2d year
$C\text{–}O_s$:	*Tons*	*Inches*	*Bushels*	*Bushels*	*Tons*	*Tons*
Surface planted up and down hill	30.44	4.02	69.1	26.8	-----	-----
Surface planted on the contour (contouring)	10.84	2.78	77.8	30.0	-----	-----
Contour listed	3.37	1.65	76.7	[4] 30.7	-----	-----
C–O–M–M:						
Contour listed	1.79	.95	72.6	[4] 28.4	[4] 2.07	[4] 2.01

[1] C=corn, O=oats, O_s=oats followed by a sweetclover cover crop, and M=meadow.
[2] These data are the result of cooperative research carried on by the Soil and Water Conservation Branch, Agricultural Research Service, of the United States Department of Agriculture, and the Iowa Agricultural Experiment Station (*9, p. 8*).
[3] Shrader, William D., Ames, Iowa. Information on yields on runoff plots in western Iowa. 1953. [Private communication.] Fertilizer used was 125 pounds per acre of 0-20-0 on oats in corn-oats-meadow-meadow rotation and 200 pounds per acre on oats in the corn-oats (followed by a sweetclover cover crop) rotation. Yield of corn is expressed in terms of shelled corn at 15.5-percent moisture; yield of hay in tons at 12-percent moisture. These data are the result of cooperative research by the Soil and Water Conservation Branch, Agricultural Research Service, United States Department of Agriculture, and the Iowa Agricultural Experiment Station.
[4] Oats and hay seeded in the usual way.

Contouring (planting on the contour with a drill or planter) with a corn-oats (followed by a sweetclover cover crop) rotation gave an increase of 8.7 bushels of corn per acre and 3.2 bushels of oats per acre over yields when planting was done up and down hill. The cost of contouring under a rotation that includes meadow would be practically, if not actually, zero. In fact, under some circumstances the total cost of producing crops on the contour may be less than the cost with the up-and-down-hill method. The time and fuel required for operations may be less on the contour than with the up-and-down-hill method (*12, p. 324*). If contouring on all the land and no additional costs for contouring are assumed, annual net income per acre from corn would be increased by $12.35 and that from oats by $2.53. In an actual farm situation, however, a farmer would not be doing up-and-down-hill farming on all his land. Usually there are some flat areas on the tops of hills or between them. Because of the direction of slopes, boundary lines, and other obstacles, a farmer usually does some of his work on the contour.

It is probably realistic to assume that about half the increased revenue from contouring as compared with up-and-down-hill farming would be realized by farmers. Thus, a farmer with 60 acres in oats and 60 acres in corn could increase his annual net income from these crops by an average of $446.40 by altering the direction of plowing and planting. Contouring under this rotation represents possibility of a sizable profit, which should obviate the need for payments by government agencies for using the practice. Farmers who do not now practice contouring and who are foregoing the profits they might obtain from it may be doing so either because they are unaware of the possibility of profits or because they object to the practice for some other reason.

When meadow is included in the rotation, some costs are connected with the practice of contouring. If meadow is included, old fences must be removed and field boundaries relocated. The estimated additional costs of contouring are presented in table 2. It is assumed that the old fence has no value when removed and that a new electric fence and accessories will be bought to fence the meadow for controlled grazing.

On a farm with 120 acres in crops, 60 acres of which have a slope of 14 percent, the value of the increased yield from corn and oats would exceed the cost of contouring the first year under a corn-oats-meadow

TABLE 2.—*Costs of contouring, and estimated additional returns from this practice, on a farm of 120 rotation acres, Ida silt loam, 14-percent slope, 1948–52*

Rotation [1]	Meadow	Annual returns from sale of additional corn and oats [2]	Cost for the farm—		Cost per acre of meadow [3]—		Cost per acre of meadow depreciated over 20 years—	
			Without operator's labor	With operator's labor	Without operator's labor	With operator's labor	Without operator's labor	With operator's labor
	Acres	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
C–O–M	40	297.64	253.60	293.60	6.34	7.34	0.33	0.38
C–C–O–M–M	48	363.60	253.44	301.44	5.28	6.28	.28	.33
C–O–M–M	60	225.36	253.80	313.80	4.23	5.23	.22	.27
C–O–M–M–M	72	178.80	253.44	325.44	3.52	4.52	.18	.24

[1] C=corn, O=oats, and M=meadow.
[2] Calculated by assuming that when an entire farm is considered, increases in yield would be half those specified in table 1.
[3] Assuming that only 20 acres for pasture would need to be fenced at one time on a farm with 120 acres in rotation. Total cost of the fence was estimated to be $253.60. The cost per acre for fence was found by dividing the total cost by the number of acres in meadow. Operator's labor was charged at the rate of $1 per acre.

(C-O-M) or a corn-corn-oats-meadow-meadow (C-C-O-M-M) rotation.[12] This is true even when labor is included as a cost. As the proportion of total cropland in meadow is increased to half or more, a longer period is required to recover the costs of contouring from the sale of the additional grain produced. If the cost is depreciated over a period that exceeds 10 years, contouring is profitable under all 4 rotations.

Listing

A lister can be used to advantage on many soils in the Corn Belt. On the sloping soils of western Iowa, listing has shown these advantages: Increased response to fertilizers, increased yields, reduction in time and labor required, and retention of additional soil and water (*6, p. 20*). Listed furrows catch and hold water after rains, especially when done on the contour. The seedbed is prepared in one operation, thereby reducing the time and labor needed. Hard-ground and loose-ground listing both work well on the Marshall, Ida, and Monona soils of western Iowa, on heavy-textured soils of the Missouri River bottoms, and on Sac, Galva, and Moody soils in northwestern Iowa.

Under a rotation of corn and oats followed by a green-manure crop of sweetclover ($C-O_s$ rotation), soil loss with contour listing (lister planting on the contour) was only about one-ninth of that under contouring and up-and-down-hill planting, and a little more than a third of that under contouring alone (table 1). The greatest reduction in runoff also occurred under contour listing of corn. Under a corn-oats-meadow-meadow rotation, contour listing further reduced losses of soil and water. Regardless of the rotation, contour listing held soil loss well below what is generally regarded as a permissible level for this area (*3, p. 945*). Profits from the practice, on the basis of the data presented, equal or exceed those for contouring alone, because the reduction in time, fuel, and labor when the lister is used more than compensates for the decrease in yield of corn of 1.1 bushels per acre. Profits would be even greater if heavier applications of fertilizer were used, because the response from fertilizer with listing is greater than with plowing (*6, p. 20*).

Contour listing will increase profits by $446.40 on 120 rotation acres with a corn-oats (followed by sweetclover) rotation. The practice would remain profitable even if a yield somewhat less than that presented in table 1 were involved. Under a corn-oats-meadow-meadow rotation, additional returns from additional yield would average $93.51 annually, assuming that half the acreage in crops gave the yield responses to contour listing indicated (table 1).

Listers are not widely used in the area, because farmers say that their use means greater risk of crop failure. They say that heavy rains when the corn is quite small may cause the soil to level down in the deep furrow and cover the plant. Two other disadvantages less frequently mentioned are scalding or waterlogging, which results when an impervious soil holds water around the plant long enough to

[12] These results could be expected on the average. However, in some years the distribution and intensity of the rainfall might result in as high yields without contouring as with it.

cause injury, and increased damage to the stand from cultivation operations.

For perhaps 3 weeks after corn planted in the furrow made by a lister emerges, there is danger that the plants may be covered by soil. A heavy rain of short duration is likely to do greater damage than a long gentle rain. Soil washed around the leaves and stalk does little damage unless it covers the growing point of the plant. If the stand is materially reduced, replanting may be necessary. Not enough information is available to permit a reliable prediction of the frequency of damage or crop failure from this cause.

Risk of failure from flooding and scalding can be avoided if the corn is planted on top of the ridge made by the lister instead of in the furrow. In 1952 at the Western Iowa Experimental Farm near Castana, 18 different plots of ridge-planted corn yielded an average of 126.4 bushels per acre (*9, p. 12*). A similar number of plots of furrow-planted corn averaged 122.8 bushels per acre. The report states that the differences in yield are not significant in a year when damaging rains do not occur (considering differences in stand). Nevertheless, when heavy rains occur ridge planting is free insurance against damage from water. An additional observation indicated in the report is that ridge-planted corn emerges sooner than that planted in furrows.

Wide Rows of Corn Interplanted With Forage

Interplanting fall grain, legumes, or grasses between corn rows is currently receiving attention as a conservation practice. The rows of corn are spaced farther apart than the usual 40 inches. Interplanting the wide rows makes it possible to grow corn more frequently on a field, because erosion may be reduced and organic matter returned to the soil is increased at the same time. The oat crop, which is usually less profitable than corn, can be omitted from the rotation.

An experiment using this practice was conducted in 1952 on the Western Iowa Experimental Farm. The practice cannot be fully evaluated, however, because neither the yields from the forage crops nor the data on erosion and runoff are yet available. The corn was grown in rows with alternate spacings of 40 and 80 inches on land that was high in fertility and that had been in alfalfa-brome the 2 previous years (table 3). Corn was planted on May 17 and cultivated 3 times. On July 3 rye and vetch, alfalfa-bromegrass, sweetclover,

TABLE 3.—*Yields of corn from normal and widely spaced rows, Western Iowa Experimental Farm, 1952* [1]

Row spacing	Yield per acre	Stand per acre
	Bushels	*Plants*
40-inch rows	123.0	15,094
40- and 80-inch rows alternated	110.3	15,398

[1] These data are the results of cooperative research by the Soil and Water Conservation Branch, United States Department of Agriculture, and Iowa Agricultural Experiment Station (*9, pp. 10-11*).

and wheat were interplanted. Good stands of the interplantings were obtained, especially of rye, vetch, alfalfa, and sweetclover. Wheat was badly damaged by rust. The yield of corn from the more widely spaced rows was 12.7 bushels less than under the narrower spacing.

A corn-oats-meadow rotation could become a corn-corn-meadow rotation if two-thirds of the farm were in corn, or a corn-meadow rotation if half the crop acreage were planted to corn. On a farm of 120 rotation acres total returns from corn under a corn-oats-meadow rotation would be $6,986.40 at 1948–52 prices. Under the corn-corn-meadow and corn-meadow rotations returns would be $12,530.08 and $9,397.56 respectively.

A corn-oats-meadow-meadow rotation could become a 3-year rotation as corn-meadow-meadow, or it could remain a 4-year rotation as corn-corn-meadow-meadow. Either change would permit more acres in corn and meadow each year. It might, therefore, offer greater erosion control. The erosion control characteristics of interplanting cannot be appraised, however, until additional information becomes available. In time, the technique may prove useful in maintaining income and controlling erosion simultaneously.[13]

Rotations

Crop rotations maintain soil fertility, soil structure, and erosion control. Less erosion is found on fields planted to oats and other small grains than on those planted to row crops, but more erosion is found on the fields of cultivated crops than on those in meadow.

Table 4 compares the erosion, runoff, and yield per acre for continuous corn and for a corn-oats-meadow rotation on comparable land. Erosion on the acreage on which corn had been grown continuously for 21 years was more than 3¼ times that on land on which a corn-oats-meadow rotation had been used for the same length of time. Forty-six tons per acre of soil loss represents about a third of an inch of topsoil per year. The yield of corn after 21 consecutive years was only 9 bushels per acre—one-seventh of the yield of corn in a corn-oats-meadow rotation.

TABLE 4.—*Soil and water losses each year and yield of corn per acre, specified cropping systems, 1931–51* [1]

Cropping system	Soil losses per acre	Water runoff per acre	Corn yield per acre [2]	
			1951	1947–51 average
	Tons	*Inches*	*Bushels*	*Bushels*
Continuous corn for 21 years	46.0	7.35	9	18
Corn-oats-meadow rotation for 21 years	13.7	.77	63	84

[1] Iowa Agricultural Experiment Station FSR-55 (*7, pp. 2-3*).
[2] Plots were limed and received a uniform application of 20 percent superphosphate at the rate of 100 pounds per acre per year. The soil is gently sloping Marshall silt loam. The hay is a mixture of alfalfa, red clover, and bromegrass.

[13] Two other methods of managing crops offer as much, if not more, promise of erosion control than wide-row corn with forage interplantings. One of these is mulch tillage, which may help to control erosion and to reduce the cost of producing corn. The other is the planting of grasses in the fall, following an early crop such as sweet or silage corn. This method would offer the same possibility of eliminating the small-grain crop as would wide-row corn with forage interplantings, and probably it would increase profits. These practices are not appraised in this report, because data relating to them are not available.

The fertility, structure, and porosity of soils are better when a rotation of crops is used. Table 5 contains additional information on the effect of various rotations on yields and returns from crops. Returns are higher under a corn-corn-oats-meadow rotation than under any other. The corn-oats, corn-oats (followed by a sweetclover cover crop), and corn-corn-oats-meadow rotations on 120 acres each involve 60 acres in corn, but returns are considerably higher from the rotation that includes 30 acres of meadow. The rotation that has the greatest acreage of corn, corn-corn-oats (followed by a sweetclover cover crop) provides the second highest returns. When the rotation includes 48 acres of corn and 48 acres of meadow, income drops to $9,071. Within a range, returns from crops can be increased by substituting meadow for grain crops in the rotation. If the forage is fed to livestock, ordinarily a larger percentage of meadow crops may be included in the rotation.

TABLE 5.—*Average yields per acre of corn, oats, and hay, and gross returns per farm for 7 rotations, Marshall silt loam, 1948–52*

Rotation [1]	Average yields per acre [2]			Total annual farm returns from crops [3]
	Corn	Oats	Meadow	
	Bushels	*Bushels*	*Tons*	*Dollars*
C-O	61.6	32.7		6,798
C-C-O$_s$	80.0	34.7		10,185
C-O$_s$	82.6	32.6		8,583
C-C-O-M	97.3	37.4	3.01	10,687
C-O-M	104.3	35.7	2.56	8,928
C-C-O-M-M	103.7	36.8	2.97	9,071
C-O-M-M	103.6	37.4	3.00	8,584

[1] C=corn, O=oats, O$_s$=oats followed by a sweetclover cover crop, and M=meadow.
[2] Yields are from plots on Soil Conservation Farm, Page County, Iowa. See Iowa Agricultural Experiment Station FSR-75 (*8, p. 12*). These data resulted from cooperative research by the Soil and Water Conservation Branch, United States Department of Agriculture, Agricultural Research Service, and Iowa Agricultural Experiment Station.
[3] A farm of 120 rotation acres is assumed and the prices used were the average for each crop in 1948-52: Corn, $1.42 per bu.; oats, $0.79 per bu.; hay, $18.30 per ton.

Further indication of the effect of rotations in conserving soil is shown (table 6). Soil loss is given in tons per acre per year for various slopes of soils in the Ida-Monona-Napier soil association. It varies with the slope, soil, and farming system as well as with rotations. Introduction of a cover crop, even a sweetclover catch crop plowed down as green manure, reduces soil loss considerably. When meadow is introduced, soil loss becomes even smaller. The greater is the percentage of meadow, the smaller is the loss of soil. Soil losses are always higher under a cash-grain system of farming than under a livestock system that includes the same crop rotations and slopes.

TABLE 6.—*Annual soil loss per acre on Ida-Monona-Napier soils, by system of farming, rotation, and slope* [1]

Farming system and rotation [2]	Ida silt loam, 12- to 20-percent slope	Monona silt loam, 12- to 20-percent slope	Monona silt loam, 9- to 15-percent slope	Monona silt loam, 2- to 8-percent slope	Napier silt loam, 0- to 6-percent slope
	Tons	*Tons*	*Tons*	*Tons*	*Tons*
Cash-grain system:					
C-C-O	319.5	253.5	132.6	28.2	18.6
C-C-O$_s$	213.0	169.0	88.4	18.8	12.4
C-O$_s$-C-O-M-M	106.5	84.5	44.2	9.4	6.2
C-C-O-M-M	95.8	76.0	39.8	8.5	5.6
C-O-M-M	63.9	50.7	26.5	5.6	3.7
C-O-M-M-M	42.6	33.8	17.7	3.8	2.5
Livestock system:					
C-C-O	246.0	195.0	102.0	21.6	14.4
C-C-O$_s$	164.0	130.0	68.0	14.4	9.6
C-O$_s$-C-O-M-M	82.0	65.0	34.0	7.2	4.8
C-C-O-M-M	73.2	58.5	30.6	6.5	4.3
C-O-M-M	49.2	39.0	20.4	4.3	2.9
C-O-M-M-M	32.8	26.0	13.6	2.9	1.9

[1] Calculated by use of the Browning factors. Slopes 200 feet long are assumed. See footnote 5, p. 6.
[2] C=corn; O=oats; O$_s$=oats followed by a sweetclover cover crop; M=meadow.

Increasing the proportion of meadow in the rotation soon reduces soil losses on Napier silt loam with little slope to the permissible level or below. Rotations that keep half the land in meadow eliminate the erosion hazard on Monona silt loam with a 2- to 8-percent slope. On the steeper Ida and Monona soils, rotations that include 60-percent meadow do not reduce erosion to a 5-ton-per-acre level.

In terms of erosion control, the greatest benefit from meadow on steep slopes comes from the first year of meadow. It is more important to get rotations with 1 year of meadow established on all farms that have steep slopes than to get rotations with 2 years of meadow on 50 percent of the farms. This is illustrated for steep Monona silt loams of 9- to 15-percent slope (table 7). Soil loss per acre, when 50 percent of the farms on this soil and slope have a corn-oats-meadow-meadow rotation, is 260 tons. With 100 percent of the farms using a corn-oats-meadow rotation, soil loss is only 200 tons per acre. The gain is 60 tons per acre. On 120 acres of this soil and slope, soil loss is reduced from 31,200 to 24,000 tons.

The opposite relationship appears to hold for lower slopes of Monona silt loam. As indicated, soil loss per acre when 100 percent of the farms use rotations that include 1 year of meadow amounts to 36 tons (table 8). It amounts to only 28.8 tons per acre when rotations that include 2 years of meadow are used on half the farms.

TABLE 7.—*Annual soil loss with different percentages of farms using 4 kinds of rotations on Monona silt loam, 9- to 15-percent slope, length of slope 200 feet* [1]

Farms that have specified rotation (percent)	Soil loss per acre for rotation [2]				Soil loss per farm for rotation [2]			
	C-O-M	C-O-M-M	C-O-M-M-M	C-O-M-M-M-M	C-O-M	C-O-M-M	C-O-M-M-M	C-O-M-M-M-M
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
25	350	330	320	315	42,000	39,600	38,400	37,800
50	300	260	240	230	36,000	31,200	28,800	27,600
75	250	190	160	145	30,000	22,800	19,200	17,400
100	200	120	80	60	24,000	14,400	9,600	7,200

[1] Calculated by use of Browning factors assuming farms of 120 rotation acres, a soil loss of 50 tons per acre for C-O-M rotation, and Browning factors of 2.0, 1.0, 0.6, 0.4, and 0.3 for rotations C-O, C-O-M, C-O-M-M, C-O-M-M-M, and C-O-M-M-M-M, respectively. The other Browning factors assumed are: Management 1, fertilizer practice 1, and supplementary practice 1. See footnote 5, p. 6.
[2] C=corn; O=oats; M=meadow.

TABLE 8.—*Annual soil loss with different percentages of farms using 4 kinds of rotations on Monona silt loam, 2- to 8-percent slope, length of slope 200 feet* [1]

Farms that have specified rotation (percent)	Soil loss per acre for rotation [2]				Soil loss per farm for rotation [2]			
	C-O-M	C-O-M-M	C-O-M-M-M	C-O-M-M-M-M	C-O-M	C-O-M-M	C-O-M-M-M	C-O-M-M-M-M
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
25	63	32.4	19.8	13.5	7,560	3,888	2,376	1,620
50	54	28.8	18.0	12.6	6,480	3,456	2,160	1,512
75	45	25.2	16.2	11.7	5,400	3,024	1,944	1,404
100	36	21.6	14.4	10.8	4,320	2,592	1,728	1,296

[1] Calculated by use of Browning factors assuming farms of 120 rotation acres, a soil loss of 9 tons per acre for C-O-M rotation, and Browning factors of 2.0, 1.0, 0.6, 0.4, and 0.3 for rotations C-O, C-O-M, C-O-M-M, C-O-M-M-M, and C-O-M-M-M-M, respectively. The other Browning factors assumed are: Management 1, fertilizer practice 1, and supplementary practice 1. See footnote 5, p. 6.
[2] C=corn; O=oats; and M=meadow.

Terracing

Terraces are devices for shortening the slope, thereby reducing the velocity of movement of water and regulating the loss of soil. When spaced the distance apart recommended by agronomists and engineers, they are expected to hold soil loss within permissible limits for slopes up to 12 percent. This is illustrated by the data on soil loss with various soil types, slopes, rotations, and soil management practices (table 9). Terracing with contouring holds soil loss below 5 tons per acre with all rotations on Napier silt loam, 0- to 5-percent slope, and Monona silt loam, 2- to 8-percent slope. As slopes increase, more grass is needed in the rotation to hold soil loss below 5 tons. The effectiveness of terraces is greater under a livestock than under a cash-grain system of farming and with rotations that include meadow.

Soil loss with cash-grain farming on eroded Ida silt loam, 12- to 20-percent slope, for example, is 319.5 tons per acre when a corn-corn-oats rotation is used with no mechanical practices. It is reduced to 48 tons per acre when terraces and contouring are added. Terraces reduce soil loss from 132.6 to 19.8 tons per acre, when this rotation is used on Monona silt loam, 9- to 15-percent slope.

The costs of terracing and contouring are greater than those associated with the other practices discussed. Estimates of the cost of contouring and of custom hiring for construction of terraces and the additional net returns are shown in table 10. The costs of building terraces increase with the slope. The costs of contouring are added when meadow is included in the rotation, because of the need for fencing. The cost of terracing and contouring on a slope of 0 to 5 percent amounts to $7.69 under corn-corn-oats (with sweetclover cover crop) rotation, and to $8.86 under a corn-oats-meadow-meadow-meadow rotation. For the same rotations on a slope of 12 to 20 percent, the costs are $20.30 and $21.47, respectively. The value of additional yield in the year following adoption of terracing and contouring pays for the cost of these practices on the lower slopes only when rotations that involve little or no meadow are used.[14] Possibly, however, a farmer could recover the costs of terracing and contouring on steeper slopes, even with rotations that involve meadow, by appropriate applications of commercial fertilizer.

Fertilizer

Use of fertilizer does not greatly affect the quantity of soil lost by erosion. When used in combination with terracing and contouring, it contributes to the reduction of soil loss by facilitating rapid growth (table 9). Use of fertilizers contributes to a conservation system of farming chiefly by helping to maintain net incomes.

Priority of Practices

The foregoing information is useful in appraising the relative merits of different practices in conserving soil. Future studies should provide additional data on the problem. Detailed ramifications of

[14] When the ACP payments of 2 cents per linear foot of terrace are considered, the value of additional yields makes it profitable to terrace and contour with each of the rotations and slopes specified in table 10.

TABLE 9.—*Annual soil loss in tons per acre, by soil type, slope, rotation, and soil management practice* [1]

Rotation [2]	Annual soil loss per acre with— Cash-grain farming: No soil-management practices	Cash-grain farming: Terracing and contouring	Cash-grain farming: Terracing, contouring, and fertilizer	Livestock farming: No soil-management practices	Livestock farming: Terracing and contouring	Livestock farming: Terracing, contouring, and fertilizer
	Tons	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
NAPIER SILT LOAM, 0- TO 5-PERCENT SLOPE						
C-C-O	18.6	2.7	2.1	14.4	2.1	1.5
C-C-O_s	12.4	1.8	1.4	9.6	1.4	1.0
C-O_s-C-O-M-M	6.2	.9	.7	4.8	.7	.5
C-C-O-M-M	5.6	.8	.6	4.3	.6	.4
C-O-M-M	3.7	.5	.4	2.9	.4	.3
C-O-M-M-M	2.5	.4	.3	1.9	.3	.2
MONONA SILT LOAM, 2- TO 8-PERCENT SLOPE						
C-C-O	28.2	4.2	3.3	21.6	3.3	2.7
C-C-O_s	18.8	2.8	2.2	14.4	2.2	1.8
C-O_s-C-O-M-M	9.4	1.4	1.1	7.2	1.1	.9
C-C-O-M-M	8.5	1.3	1.0	6.5	1.0	.8
C-O-M-M	5.6	.8	.7	4.3	.7	.5
C-O-M-M-M	3.8	.6	.4	2.9	.4	.4
MONONA SILT LOAM, 9- TO 15-PERCENT SLOPE						
C-C-O	132.6	19.8	15.3	102.0	15.3	10.8
C-C-O_s	88.4	13.2	10.2	68.0	10.2	7.2
C-O_s-C-O-M-M	44.2	6.6	5.1	34.0	5.1	3.6
C-C-O-M-M	39.8	5.9	4.6	30.6	4.6	3.2
C-O-M-M	26.5	4.0	3.1	20.4	3.1	2.2
C-O-M-M-M	17.7	2.6	2.0	13.6	2.0	1.4
ERODED IDA SILT LOAM, 12- TO 20-PERCENT SLOPE						
C-C-O	319.5	48.0	36.9	246.0	36.9	25.8
C-C-O_s	213.0	32.0	24.6	164.0	24.6	17.2
C-O_s-C-O-M-M	106.5	16.0	12.3	82.0	12.3	8.6
C-C-O-M-M	95.8	14.4	11.1	73.8	11.1	7.7
C-O-M-M	63.9	9.6	7.4	49.2	7.4	5.2
C-O-M-M-M	42.6	6.4	4.9	32.8	4.9	3.4
ERODED MONONA SILT LOAM, 12- TO 20-PERCENT SLOPE						
C-C-O	253.5	43.8	33.6	195.0	33.6	23.7
C-C-O_s	169.0	29.2	22.4	130.0	22.4	15.8
C-O_s-C-O-M-M	84.5	14.6	11.2	65.0	11.2	7.9
C-C-O-M-M	76.0	13.1	10.1	58.5	10.1	7.1
C-O-M-M	50.7	8.8	6.7	39.0	6.7	4.7
C-O-M-M-M	33.8	5.8	4.5	26.0	4.5	3.2

[1] Calculated by using the Browning factors, assuming a length of slope of 200 feet. See footnote 5, p. 6.
[2] C=corn; O=oats; O_s=oats followed by a sweetclover cover crop; M=meadow.

TABLE 10.—*Average costs and additional net returns per acre for specified rotations from terracing and contouring, 1948–52* [1]

Soil type and slope	Average cost of terracing and contouring, with specified rotation [2]				Additional net returns with specified rotation [2]			
	C–C–O_s	C–C–O–M–M	C–O–M–M	C–O–M–M–M	C–C–O_s	C–C–O–M–M	C–O–M–M	C–O–M–M–M
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Napier silt loam, 0 to 5 percent	7.69	9.45	9.10	8.86	11.61	2.13	−0.73	−2.16
Monona silt loam, 2 to 8 percent	12.60	14.36	14.01	13.77	6.70	−2.78	−5.64	−7.07
Monona silt loam, 9 to 15 percent	19.61	21.37	21.02	20.78	1.19	1.95	−.02	.24
Monona silt loam, 12 to 20 percent	20.30	22.06	21.71	21.47	−11.84	−5.88	−2.75	−2.07

[1] Number of feet of terraces required was calculated with the formula, spacing $=\left(\frac{S}{2}+2\right)$, assuming a 20-acre square field. The results were divided by 20 to obtain the average estimate. *S* in the formula is slope in percentage. Two hundred and eighty linear feet of terrace are needed per acre with a slope of 2 percent, and 560 linear feet per acre are needed with a slope of 8 percent. The average of 280 and 560 was multiplied by 3 cents to give the costs shown under the C–C–O_s column. Other numbers in that column were found in a similar way. To these for rotations that involved meadow the appropriate cost of contouring were added.

[2] C=corn; O=oats; O_s=oats followed by a sweetclover cover crop; M=meadow.

using various practices can be learned only when these practices are applied to a specific farm and analyzed in terms of their effect on the entire farm organization as a business unit.

Control of soil (and water) movement.—A practice that holds erosion within the permissible 5-ton limit on lower slopes may be insufficient to do so on steeper slopes. Terracing plus contouring effectively controls erosion on slopes of from 2 to 12 percent (table 9). However, on slopes that exceed 12 percent this practice ranks second to contour listing when soils and climate permit its use. As indicated, on Ida silt loam with 14-percent slope, listing on the contour reduced soil loss to 1.79 tons per acre with a corn-oats-meadow-meadow rotation (table 1). Terraces and contouring on Ida silt loam, slope 12 to 20 percent, and with a corn-oats-meadow-meadow rotation reduced soil loss to 9.6 tons per acre (table 9).[15] Rotations probably rank third in ability to conserve soil on slopes of less than 12 percent and fourth on slopes of more than 12 percent. A corn-oats-meadow-meadow rotation on Ida silt loam, slope 12 to 20 percent, would hold soil loss to 63.9 tons per acre (table 6). Rotations such as corn-oats-meadow-meadow or corn-oats-meadow-meadow-meadow, which included meadow a fourth or more of the time, eliminated erosion as a hazard on slopes of less than 12 percent. On steep slopes it is more important to have rotations with 1 year of meadow on all the acreage than to have rotations with 2 years of meadow on half of it. Data presented indicate that contouring on Ida silt loam of 14-percent slope would hold soil loss down to 10.8 tons per acre with a corn-oats (followed by sweetclover cover crop) rotation (table 1).

Erosion control on the basis of cost.—Contouring and contour listing rank highest in terms of soil saved per dollar invested on gentle slopes if the rotations do not include meadow. These practices rank high even when meadow in the rotation involves new fence. On steeper slopes, contour listing and a rotation that includes 1 year of meadow would give the greatest control of soil at the smallest cost. When contour listing is not adapted to a specific soil or location, contouring and a rotation that includes 1 year of meadow would save the most soil at least cost on slopes of more than 12 percent.

These statements hold true of these practices on slopes of less than 12 percent. On such slopes, rotations are more effective in keeping soil losses down to a permissible level. The erosion that would occur without them is much less on the lower than on the higher slopes.

Terraces are effective in controlling erosion on slopes of less than 12 percent, but they are expensive.[16] Terracing plus contouring on

[15] In table 9, the slope length was given as 200 feet, and in table 1 as 72.6 feet. However, the agronomists who made the analysis of the data in table 1 state that these data are fairly applicable for slopes up to 200 feet. See Iowa Agricultural Experiment Station FSR–70 (*9, pp. 8–10*).

[16] Terraces involve the greatest total cost. They may be less expensive to the farmer than certain other practices if he can get 2 cents per linear foot of terrace in the form of ACP payments. Terraces have the added advantage of not having indirect costs associated with their adoption.

slopes of 2- to 8-percent costs as little as $12.60 per acre, and this practice would save up to 16 tons of soil per acre (tables 9 and 10). This is a cost of 0.787 cents per ton. It is not a high cost, but it is higher than the direct costs of using the other methods discussed.

Implications on payments and policy.—Although the foregoing ranking of practices on the basis of soil-saving possibilities and cost per ton of soil saved is tentative and a rough approximation, it merits further consideration from the viewpoint of both payment and policy.

If practices are complementary, it means that they give conservation results only when used in combination (*4, pp. 763–765*). In these instances, payment should be made only when the other practice is used in combination with it. The data available at this time are not adequate for classifying practices. In some degree, however, contouring and contour listing, as well as contouring and terracing, fall in that category. Unless listers are used on the contour, little or no conservation results.[17] This is true also of terraces. However, the very nature of terraces makes it almost impossible to do other than plant and cultivate on the contour.

If practices are competing in the sense that they represent alternative ways of accomplishing a specified result, payments should be made for only one alternative on a given acreage (*4, pp. 763–765*). Many practices or combinations of practices represent alternative methods of controlling erosion. The objective should be to get the desired amount of erosion control by using the alternative practice or combination of practices that is least costly. The choice of a practice may differ with location. Contour listing, for example, represents an alternative method of controlling erosion on the soils of western Iowa. But it is inappropriate on impermeable soils or where precipitation is such that frequent replantings are necessary. The practices that represent alternatives on higher slopes are contouring and terracing, contouring and rotations, contour listing, and contour listing and rotations. On lower slopes, the alternatives are rotations, contour listing, contouring, and terracing plus contouring.

A general statement to the effect that one practice or group of practices is the least costly alternative cannot be made. The degree of erosion control accomplished depends on the soil, the slope, the weather, the cropping system, and the livestock system. Final decision as to the degree of control that is needed must be made on the basis of a specific farm, with the whole farm considered as a business unit. This is also true with regard to alternative methods of erosion control and the decision as to which method is least costly.

The most efficient use of limited resources in conservation can be made only if overall farm planning is done. It must be made to dovetail into the organization already on the farm and to permit a gradual but continuous transition in terms of its effects on other sectors of the farm business, such as the livestock program, the situation as to capital, and net income.

[17] Some farmers are known to use the lister on slopes but they do not contour. The most likely result is an increase in erosion.

Combinations of Practices

The effects of applying (1) terraces and contouring and (2) terraces, contouring, and fertilizer on crop yields, costs, net crop income, and capital requirements were investigated. The estimates of yields on the various slopes and rotations and the applications of fertilizer used in this part of the analysis are the average yields after major effects of conservation practices and the rotation have taken place in a cash-grain system of farming and in a livestock system of farming.[18] The effects are measured on a farm of 120 rotation acres for each slope, each rotation, and each system of farming or conservation practice. Later in the analysis, the effects of various practices on net farm income are examined on the basis of yields that vary over a 10-year period after the practice is adopted.

Costs of Terracing, Contouring, and Fertilizer

The cost of terracing on a farm varies with the slope and method of construction. The slope determines the number of terraces and the number of linear feet of terrace needed. The steeper the slope, the more linear feet of terrace are required and the greater is the total cost of terracing. Machines used in building terraces differ as to original cost and cost of operation. If a farmer can operate them himself and still manage the rest of his business as before, an additional charge for his labor need not be included in the cost of terracing. Therefore, all costs were calculated with operator's labor both included and not included as a cost.

Costs and net crop incomes are computed for various methods of constructing terraces, as follows: (1) Terraces constructed by a moldboard plow and a 2-bottom tractor; (2) terraces constructed with a whirlwind terracer and a 3-bottom tractor; (3) terraces constructed by a 70-horsepower bulldozer; (4) terraces constructed by hiring the services of a motor patrol and its operator at a cost of 3 cents per linear foot of terrace built.

In the first three methods of construction, the cost was estimated on the basis of the number of hours required to do the job and an hourly rate as follows: (1) Moldboard plow and 2-bottom tractor without operator's labor, $0.57; with operator's labor, $1.57; (2) whirlwind terracer and 3-bottom tractor without operator's labor, $1.70; with operator's labor, $3.20; (3) bulldozer, 70-horsepower, without operator's labor, $4.76; with operator's labor, $6.26. These charges represent the fixed cost of ownership on the basis of an annual hourly use plus the cost of operating them.[19] They apply to a farmer who already owns the machine or who would buy it with the intention of keeping it for use on the farm or for custom work, or who could rent it at the rate indicated.

The average cost of terracing an acre in a 20-acre field of the various slopes indicated is shown (table 11). The total cost of terracing the field is divided by 20 to give the average cost per acre. Terraces constructed with a moldboard plow range from a cost of $2.04 an acre on

[18] See footnote 6, p. 7.
[19] See Appendix, table 39, p. 85.

the lowest slopes (up to 5 percent) to $5.39 on the steep slopes (from 12 to 20 percent) when operator's labor is included as a cost. Custom hiring a motor patrol at 3 cents per linear foot of terrace costs $7.69 on the lowest slopes and $20.30 on 12- to 20-percent slopes. The corresponding costs of terraces constructed by a whirlwind terracer are $3.15 and $8.32; $5.33 and $14.07 when done by a bulldozer. The costs for a moldboard plow, whirlwind terracer, or bulldozer are considerably lower when the operator's labor is not included as a cost.

TABLE 11.—*Average cost of terracing an acre in a 20-acre field by specified methods, operator's labor included and excluded as a cost, 1948–52*

Slope (percent)	Moldboard plow		Whirlwind terracer		Bulldozer		Custom hire of motor patrol
	With operator's labor included	Without operator's labor included	With operator's labor included	Without operator's labor included	With operator's labor included	Without operator's labor included	
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
0 to 5	2. 04	0. 74	3. 15	1. 66	5. 33	4. 08	7. 69
2 to 8	3. 65	1. 22	5. 16	2. 73	8. 73	6. 63	12. 60
9 to 15	5. 21	1. 88	8. 04	4. 25	13. 60	10. 32	19. 61
12 to 20	5. 39	1. 95	8. 32	4. 40	14. 07	10. 69	20. 30

Average costs of terracing and contouring by rotation, slope, and method of construction are shown (table 12). The costs of contouring vary with the number of acres of meadow in the rotation, as initially this practice would involve the removal of old fences, the laying out of new field boundaries, and the purchase of electric fencing to permit controlled grazing of meadows.

The cost is greatest when terraces are built on a custom basis. The cheapest method is with the moldboard plow and a 2-bottom tractor. Even when a charge is made for the farmer's time, the cost of building the terraces with a moldboard plow is only about a third the cost of hiring the work done by motor patrol at 3 cents per linear foot. The saving is more pronounced when the operator does not include his labor as a cost.

The costs of terracing and contouring are not recurring. They can be maintained by leaving the dead furrow next the terrace when plowing, except for occasional breaks caused by crossing the terraces with machines or by unusually heavy rains. The work involved in repairing them is not great if it is done soon after the break. The terraces and wire for fences should serve for about 20 years or longer if properly maintained.

The application of fertilizer is different. There is some carryover. However, maintaining yields at a specific level after a rotation has been in effect for a few years requires about the same application each time the crop is grown.

TABLE 12.—*Average cost of terracing and contouring an acre, by specified methods, operator's labor included and excluded as a cost, 1948–52* [1]

Slope and rotation [2]	Moldboard plow		Whirlwind terracer		Bulldozer		Custom hire of motor patrol	
	With operator's labor included	Without operator's labor included	With operator's labor included	Without operator's labor included	With operator's labor included	Without operator's labor included	With operator's labor included	Without operator's labor included
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Slope, 2 to 8 percent:								
C–C–O and C–C–O_s	4. 65	1. 22	6. 16	2. 73	9. 73	6. 63	13. 60	12. 60
C–O_s–C–O–M–M	6. 76	3. 33	8. 27	4. 84	11. 84	8. 74	15. 71	14. 71
C–C–O–M–M	6. 41	2. 98	7. 92	4. 49	11. 49	8. 39	15. 36	14. 36
C–O–M–M	6. 06	2. 63	7. 57	4. 14	11. 14	8. 04	15. 01	14. 01
C–O–M–M–M	5. 82	2. 39	7. 33	3. 90	10. 90	7. 80	14. 77	13. 77
Slope, 9 to 15 percent:								
C–C–O and C–C–O_s	6. 21	1. 88	9. 04	4. 25	14. 60	10. 32	20. 61	19. 61
C–O_s–C–O–M–M	8. 32	3. 99	11. 15	6. 36	16. 71	12. 43	22. 72	21. 72
C–C–O–M–M	7. 97	3. 64	10. 80	6. 01	16. 36	12. 08	22. 37	21. 37
C–O–M–M	7. 62	3. 29	10. 45	5. 66	16. 01	11. 73	22. 02	21. 02
C–O–M–M–M	7. 38	3. 05	10. 21	5. 42	15. 77	11. 49	21. 78	20. 78
Slope, 12 to 20 percent:								
C–C–O and C–C–O_s	6. 39	1. 95	9. 32	4. 40	15. 07	10. 69	21. 30	20. 30
C–O_s–C–O–M–M	8. 50	4. 06	11. 43	6. 51	17. 18	12. 80	23. 41	22. 41
C–C–O–M–M	8. 15	5. 82	11. 08	6. 16	16. 83	12. 45	23. 06	22. 06
C–O–M–M	7. 80	3. 36	10. 73	5. 81	16. 48	12. 10	22. 71	21. 71
C–O–M–M–M	7. 56	3. 12	10. 49	5. 57	16. 24	11. 86	22. 47	21. 47
Slope, 0 to 5 percent:								
C–C–O and C–C–O_s	3. 04	. 74	4. 15	1. 66	6. 33	4. 08	8. 69	7. 69
C–O_s–C–O–M–M	5. 15	2. 85	6. 26	3. 77	8. 44	6. 19	10. 80	9. 80
C–C–O–M–M	4. 80	2. 50	5. 91	3. 42	8. 09	5. 84	10. 45	9. 45
C–O–M–M	4. 45	2. 15	5. 56	3. 07	7. 74	5. 49	10. 10	9. 10
C–O–M–M–M	4. 21	1. 91	5. 32	2. 83	7. 50	5. 25	9. 86	8. 86

[1] One-twentieth the cost for contouring and terracing a 20-acre field of the various slopes.
[2] C=corn, O=oats, O_s=oats followed by a sweetclover cover crop, and M=meadow.

The annual cost of fertilizer per acre, at the rates indicated by the agronomists as needed for corn and oats to give the yields on which calculations of income are made, is given in table 13. These rates are less than those that would be most profitable under present price relationships.[20]

Costs of commercial fertilizer are less for a livestock than for a cash-grain system of farming. This difference in costs between systems is greatest for rotations that do not include meadow. With a cash-grain system of farming, the cost of fertilizer is greatest for a corn-corn-oats rotation and least for a corn-oats (followed by a sweetclover cover crop)-corn-oats-meadow-meadow (only corn and oats are fertilized). The per acre cost of fertilizer for oats exceeds that for corn for most rotations.

If fertilizer can be used profitably, a farmer receives the profit in the year he applies the fertilizer. It may take several years, however, even to recover the initial investment made when terraces are used. This is important to a farmer whose capital is limited. He

TABLE 13.—*Annual cost of fertilizer per acre for corn and oats, operator's labor included and excluded as a cost, 1948–52*

Rotation,[1] type of farming, and slope	Fertilizer cost per acre for—			
	Corn		Oats	
	Without operator's labor included	With operator's labor included	Without operator's labor included	With operator's labor included
	Dollars	*Dollars*	*Dollars*	*Dollars*
C-C-O—cash-grain:				
Eroded Ida, 12- to 20-percent slope	8. 50	10. 00	6. 90	8. 40
Eroded Monona, 12- to 20-percent slope	8. 00	9. 50	5. 90	7. 40
Monona, 9- to 15-percent slope	6. 20	7. 70	5. 90	7. 40
Monona, 2- to 8-percent slope	6. 20	7. 70	5. 25	6. 75
Napier, 0- to 5-percent slope	4. 90	6. 40	3. 60	5. 10
C-C-O—livestock:				
Eroded Ida, 12- to 20-percent slope	4. 60	6. 10	4. 60	6. 10
Eroded Monona, 12- to 20-percent slope	5. 40	6. 90	4. 60	6. 10
Monona, 9- to 15-percent slope	4. 90	6. 40	5. 90	7. 40
Monona, 2- to 8-percent slope	4. 90	6. 40	5. 25	6. 75
Napier, 0- to 5-percent slope	4. 90	6. 40	3. 60	5. 10
C-C-O_s—cash-grain:				
Eroded Ida, 12- to 20-percent slope	5. 90	7. 40	9. 90	11. 40
Eroded Monona, 12- to 20-percent slope	5. 40	6. 90	8. 90	10. 40
Monona, 9- to 15-percent slope	4. 25	5. 75	6. 90	8. 40
Monona, 2- to 8-percent slope	4. 25	5. 75	6. 25	7. 75
Napier, 0- to 5-percent slope	2. 95	4. 45	4. 60	6. 10
C-C-O_s—livestock:				
Eroded Ida, 12- to 20-percent slope	4. 28	5. 78	6. 60	8. 10
Eroded Monona, 12- to 20-percent slope	4. 10	5. 60	6. 60	8. 10
Monona, 9- to 15-percent slope	2. 95	4. 45	6. 90	8. 40
Monona, 2- to 8-percent slope	2. 95	4. 45	6. 25	7. 75
Napier, 0- to 5-percent slope	2. 95	4. 45	4. 60	6. 10

[20] A later section deals specifically with this point.

TABLE 13.—*Annual cost of fertilizer per acre for corn and oats, operator's labor included and excluded as a cost, 1948–52*—Continued

Rotation,[1] type of farming, and slope	Fertilizer cost per acre for—			
	Corn		Oats	
	Without operator's labor included	With operator's labor included	Without operator's labor included	With operator's labor included
	Dollars	*Dollars*	*Dollars*	*Dollars*
C-O_s-C-O-M-M—cash-grain:				
Eroded Ida, 12- to 20-percent slope	2. 65	4. 15	6. 45	7. 95
Eroded Monona, 12- to 20-percent slope	2. 15	3. 65	6. 45	7. 95
Monona, 9- to 15-percent slope	1. 65	3. 15	4. 30	5. 80
Monona, 2- to 8-percent slope	1. 65	3. 15	4. 30	5. 80
Napier, 0- to 5-percent slope	1. 65	3. 15	2. 30	3. 80
C-O_s-C-O-M-M—livestock:				
Eroded Ida, 12- to 20-percent slope	2. 00	3. 50	4. 65	6. 15
Eroded Monona, 12- to 20-percent slope	2. 15	3. 65	3. 80	5. 30
Monona, 9- to 15-percent slope	1. 65	3. 15	2. 80	4. 30
Monona, 2- to 8-percent slope	1. 33	2. 83	2. 80	4. 30
Napier, 0- to 5-percent slope	1. 65	3. 15	2. 30	3. 80
C-C-O-M-M—cash-grain:				
Eroded Ida, 12- to 20-percent slope	5. 25	6. 75	12. 90	14. 40
Eroded Monona, 12- to 20-percent slope	4. 43	5. 92	9. 90	11. 40
Monona, 9- to 15-percent slope	3. 60	5. 10	6. 60	8. 10
Monona, 2- to 8-percent slope	3. 60	5. 10	6. 60	8. 10
Napier, 0- to 5-percent slope	3. 60	5. 10	4. 60	6. 10
C-C-O-M-M—livestock:				
Eroded Ida, 12- to 20-percent slope	4. 28	5. 78	8. 60	10. 10
Eroded Monona, 12- to 20-percent slope	3. 45	4. 95	7. 60	9. 10
Monona, 9- to 15-percent slope	3. 60	5. 10	5. 60	7. 10
Monona, 2- to 8-percent slope	2. 30	3. 80	4. 30	5. 80
Napier 0- to 5-percent slope	3. 60	5. 10	4. 60	6. 10
C-O-M-M—cash-grain:				
Eroded Ida, 12- to 20-percent slope	4. 65	6. 15	10. 30	11. 80
Eroded Monona, 12- to 20-percent slope	3. 45	4. 95	7. 30	8. 80
Monona, 9- to 15-percent slope	2. 65	4. 15	4. 65	6. 15
Monona, 2- to 8-percent slope	2. 65	4. 15	4. 65	6. 15
Napier, 0- to 5-percent slope	2. 00	3. 50	2. 00	3. 50
C-O-M-M—livestock:				
Eroded Ida, 12- to 20-percent slope	4. 00	5. 50	6. 65	8. 15
Eroded Monona, 12- to 20-percent slope	3. 45	4. 95	5. 65	7. 15
Monona, 9- to 15-percent slope	2. 00	3. 50	3. 00	4. 50
Monona, 2- to 8-percent slope	2. 65	4. 15	3. 00	4. 50
Napier, 0- to 5-percent slope	2. 00	3. 50	2. 00	3. 50
C-O-M-M-M—cash-grain:				
Eroded Ida, 12- to 20-percent slope	5. 30	6. 80	10. 30	11. 80
Eroded Monona, 12- to 20-percent slope	3. 45	4. 95	9. 30	10. 80
Monona, 9- to 15-percent slope	3. 30	4. 80	4. 65	6. 15
Monona, 2- to 8-percent slope	2. 65	4. 15	4. 65	6. 15
Napier, 0- to 5-percent slope	2. 65	4. 15	2. 00	3. 50
C-O-M-M-M—livestock:				
Eroded Ida, 12- to 20-percent slope	4. 00	5. 50	8. 65	10. 15
Eroded Monona, 12- to 20-percent slope	3. 45	4. 95	6. 65	8. 15
Monona, 9- to 15-percent slope	2. 00	3. 50	3. 00	4. 50
Monona, 2- to 8-percent slope	2. 65	4. 15	3. 00	4. 50
Napier, 0- to 5-percent slope	2. 65	4. 15	2. 00	3. 50

[1] C=Corn; O=oats; O_s=oats followed by sweetclover cover crop; M=meadow.

must recover investments in a short time after making them to provide a continual and sufficient flow of operating capital.

Net Crop Income

Rotations.—The net crop incomes of farms of 120 rotation acres on 5 different soils of the Ida-Monona association, when various rotations are used in both a cash-grain and a livestock system of farming are shown (table 14). Net crop income was computed by deducting the total cost of the conservation practices from the total value of crops for the year following the adoption of the practices.

TABLE 14.—*Net crop incomes from farms of 120 rotation acres, by rotation and slope, cash-grain and livestock systems of farming, operator's labor included and excluded as a cost, 1948–52*

Type of farming and rotation [1]	Net crop income for 120 rotation acres on—				
	Eroded Ida silt loam, 12- to 20-percent slope	Eroded Monona silt loam, 12- to 20-percent slope	Monona silt loam, 9- to 15-percent slope	Monona silt loam, 2- to 8-percent slope	Napier silt loam, 0- to 5-percent slope
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Cash-grain, operator's labor included:					
C-C-O	−1,244	−904	1,228	1,831	3,158
C-C-O_s	−444	516	2,464	3,098	4,424
C-O_s-C-O-M-M	−492	565	2,184	2,859	4,036
C-C-O-M-M	−740	408	2,123	2,860	4,247
C-O-M-M	−1,007	103	1,740	2,458	3,652
C-O-M-M-M	−1,414	−272	1,409	2,152	3,366
Cash-grain, operator's labor not included:					
C-C-O	−640	−362	1,832	2,436	3,763
C-C-O_s	162	1,121	3,069	3,702	5,029
C-O_s-C-O-M-M	177	1,233	2,853	3,527	4,704
C-C-O-M-M	−34	1,114	2,829	3,567	4,953
C-O-M-M	−291	819	2,456	3,174	4,374
C-O-M-M-M	−669	472	2,154	2,897	4,111
Livestock, operator's labor included:					
C-C-O	82	122	2,000	2,554	3,158
C-C-O_s	824	1,536	3,098	3,761	4,424
C-O_s-C-O-M-M	−19	1,037	2,516	3,191	4,036
C-C-O-M-M	−191	1,022	2,651	3,323	4,247
C-O-M-M	—547	562	1,989	2,707	3,658
C-O-M-M-M	−961	180	1,608	2,351	3,366
Livestock, operator's labor not included:					
C-C-O	687	664	2,604	3,159	3,763
C-C-O_s	1,429	2,140	3,702	4,366	5,029
C-O_s-C-O-M-M	650	1,706	3,184	3,859	4,704
C-C-O-M-M	515	1,729	3,358	4,030	4,953
C-O-M-M	170	1,279	2,705	3,423	4,374
C-O-M-M-M	−216	927	2,352	3,096	4,111

[1] C=corn; O=oats; O_s=oats followed by a sweetclover cover crop; M=meadow.

On steep eroded Ida silt loam with slopes of 12 to 20 percent, net crop income is negative for all cash-grain farms, regardless of the rotation used when the operator's labor is included as a cost. Even when a livestock system of farming is used, farms on this slope have net crop incomes that are either negative or quite low. When the operator's labor is not included as a cost, the highest net crop income is only $1,429. This is with a corn-corn-oats (followed by a sweetclover cover crop) rotation in a livestock farming system, which is the most rewarding rotation for eroded Ida silt loam.

Incomes are higher for any rotation or any system of farming when farms are located on less steep soils or soils that have greater supplies of available plant nutrients. Eroded Monona silt loam has the same slope, but it is not so badly eroded as Ida silt loam and it has a greater productive potential. The other soils listed in table 14 are on lower slopes. The highest net crop income on eroded Monona silt loam that has from 12- to 20-percent slope is obtained from a corn-corn-oats (followed by a sweetclover cover crop) rotation with a livestock system of farming and from a corn-oats (followed by a sweetclover cover crop)-corn-oats-meadow-meadow rotation with a cash-grain system. On the other three soils of lower slopes, a corn-corn-oats (followed by a sweetclover cover crop) rotation consistently yields the highest net crop income.

It is clear that a rotation like corn-corn-oats (followed by a sweetclover cover crop), which includes chiefly corn with no meadow, must be used to maintain income on steep slopes on which mechanical conservation practices are not used. A farmer who has such a situation on his farm cannot be expected knowingly to adopt a conservation practice that will result in decreased income no matter how small the decrease may be. Income for the immediate future must be guaranteed before soil is saved for increased profits at some future date.

Terracing, contouring, and fertilizer.—The effects on net crop incomes of adding the combined practice of terracing and contouring or the combined practice of terracing, contouring, and application of fertilizer are shown in table 15. The net crop incomes shown are computed on the basis of deducting the total cost of the practice in the year following its adoption.

Even when terraces are constructed with moldboard plows, the least costly method (table 15), they usually cause net crop incomes to drop from the levels indicated (table 14) if operator's labor is included as a cost. Exceptions are the corn-corn-oats and corn-corn-oats (followed by a sweetclover cover crop) rotations on the lowest slope, 0- to 5-percent slope of Napier silt loam. Crop incomes are consistently higher under livestock systems of farming than under cash-grain systems on all slopes when terraces and contouring are not used and on all slopes that exceed 5 percent when terraces and contouring are used. This indicates that livestock become increasingly important in maintaining income on higher slopes when costly erosion controls are needed, even when the rotation does not include meadow.

Regardless of the method by which terraces are constructed, net crop incomes are very low or negative on slopes of 12 to 20 percent. When terraces are constructed by custom hiring a motor patrol, net incomes from crops are negative for all soils with slopes of 12 to 20

Livestock, operator's labor not included:										
C-C-O	839	1,632	1,442	2,370	2,873	4,037	3,399	4,727	4,060	5,376
C-C-O_s	1,581	1,854	2,322	2,642	3,971	4,430	4,496	5,121	5,326	5,908
C-O_s-C-O-M-M	580	1,154	1,629	1,940	3,070	3,202	3,628	3,803	4,585	4,626
C-C-O-M-M	494	1,201	1,679	2,085	3,280	3,475	3,796	4,168	4,843	4,976
C-O-M-M	101	728	1,262	1,556	2,605	2,794	3,149	3,341	4,199	4,228
C-C-O-M-M-M	−284	457	938	1,310	2,262	2,497	2,798	3,035	3,902	3,975

[1] Conservation costs not depreciated.
[2] C=corn; O=oats; O_s=oats followed by a sweetclover cover crop; M=meadow.
[3] T-C=terracing and contouring; T-C-F=terracing, contouring, and fertilizer.

Livestock, operator's labor not included:										
C–C–O	−1,363	−570	−760	168	746	1,910	2,033	3,361	3,226	4,542
C–C–O_s	−621	−348	120	440	1,843	2,303	3,131	3,755	4,492	5,074
C–O_s–C–O–M–M	−1,622	−1,048	−573	−262	942	1,074	2,262	2,438	3,751	3,792
C–C–O–M–M	−1,708	−1,001	−523	−117	1,152	1,348	2,431	3,803	4,009	4,142
C–O–M–M	−2,101	−1,474	−940	−646	477	666	1,784	1,975	3,365	3,394
C–O–M–M–M	−2,486	−1,745	−1,264	−892	134	369	1,432	1,669	3,068	3,141

[1] Conservation costs not depreciated.
[2] C=corn; O=oats; O_s=oats with a sweetclover green-manure crop; M=meadow.
[3] T-C=terracing and contouring; T-C-F=terracing, contouring, and fertilizer.

Livestock, operator's labor not included:										
C–C–O	1, 061	1, 854	1, 664	2, 595	3, 087	4, 573	2, 750	4, 866	4, 144	5, 460
C–C–O_s	1, 803	2, 076	2, 544	2, 864	4, 184	4, 644	4, 636	5, 260	5, 410	5, 992
C–O_s–C–O–M–M	1, 043	1, 576	2, 092	2, 403	3, 524	3, 656	4, 008	4, 183	4, 910	4, 951
C–C–O–M–M	956	1, 663	2, 141	2, 547	3, 733	3, 929	4, 176	4, 548	5, 167	5, 300
C–O–M–M	564	1, 191	1, 724	2, 018	2, 317	3, 248	3, 529	3, 721	4, 523	4, 553
C–O–M–M–M	179	919	1, 400	1, 774	2, 716	2, 951	3, 177	3, 415	4, 227	4, 300

[1] C=corn; O=oats; O_s=oats followed by a sweetclover cover crop; M=meadow.
[2] T–C=terracing and contouring; T–C–F=terracing, contouring, and fertilizer.

Livestock, operator's labor not included:										
C–C–O	945	1, 737	1, 548	2, 479	2, 975	4, 461	2, 678	4, 794	4, 101	5, 416
C–C–O$_s$	1, 686	1, 960	2, 428	2, 747	4, 073	4, 532	4, 564	5, 188	5, 367	5, 948
C–O$_s$–C–O–M–M	926	1, 460	1, 975	2, 286	3, 412	3, 544	3, 936	4, 111	4, 866	4, 908
C–C–O–M–M	839	1, 547	2, 025	2, 430	3, 622	3, 816	4, 104	4, 476	5, 124	5, 257
C–O–M–M	447	1, 075	1, 608	1, 902	2, 205	3, 136	3, 457	3, 649	4, 480	4, 510
C–O–M–M–M	62	803	1, 284	1, 658	2, 604	2, 839	3, 105	3, 343	4, 184	4, 257

[1] C=corn; O=oats; O$_s$=oats followed by a sweetclover cover crop; M=meadow.
[2] T-C=terracing and contouring; T-C-F=terracing, contouring, and fertilizer.

percent (table 16). Using fertilizer in combination with terracing and contouring increases net crop incomes considerably. Under a cash-grain system of farming, it gives the biggest boost to income on rotations that do not include meadow.

Net crop incomes with conservation costs depreciated over a 20-year period following adoption of the practices are shown (table 17). Original costs of the practices are depreciated over 20 years, assuming an interest rate of 5 percent and with one-twentieth of the original cost charged to the production of a single year. Under these assumptions, terracing and contouring increase net crop incomes when terraces are constructed with plows. When terraces are constructed by custom hiring a motor patrol, negative crop incomes still result under cash-grain farming for all rotations on eroded Ida silt loam, when the operator's labor is included as a cost (table 18). Even with a livestock system of farming, crop incomes are negative for corn-oats-meadow-meadow and corn-oats-meadow-meadow-meadow rotations.

Use of fertilizer increases net incomes. The rates of application of fertilizer on many of the slopes and rotations are not large enough to permit full advantage to be taken of the possibilities of profit. In many instances, use of more fertilizer following adoption of a larger acreage of meadow will prevent the drop in income that otherwise would occur.

Returns on Investment in Terracing and Contouring

When all the costs of terracing and contouring in cash-grain farming are charged against the income from crops in the year following adoption, the return per dollar invested in these practices is very low (table 19). This is true even when the terraces are constructed in the cheapest way, by using moldboard plows. When the operator's labor is included as a cost, the combined practice of terracing and contouring does not offer an attractive return on investment for the year ahead. When the operator's labor is not charged as a cost, less than a dollar is recovered for each dollar invested for all rotations that involve meadow, regardless of slope. A farmer who can invest his dollars elsewhere and recover his original investment plus 10 or 15 percent profit within a year is not likely to put it in terraces.

The situation is somewhat more attractive for a farmer who is willing to depreciate the cost of terracing and contouring over a 20-year period and who has no better use for his capital (table 20). Even when a value is put on the operator's labor, returns are still low. If a farmer discounts future returns, he may not find this opportunity attractive either. The highest return with corn-oats-meadow-meadow rotation, $8.10 per dollar invested, is on Monona silt loam when terraces are built with the moldboard plow. The returns would be much lower if the terraces were built by custom hiring a motor patrol. A farmer who is short on capital and who has alternative uses with reasonable assurance of quick profits for what he has may not find the returns mentioned attractive.

TABLE 19.—*Returns on investments per farm in terracing and contouring, by rotation and slope under a cash-grain system of farming, 1948–52* [1]

Rotation [2] and slope	Costs of terracing and contouring— Without operator's labor included	Costs of terracing and contouring— With operator's labor included	Additional returns from crops	Return per dollar invested— Without operator's labor included	Return per dollar invested— With operator's labor included
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*
C–C–O:					
Eroded Ida silt loam, 12- to 20-percent slope	234. 00	766. 80	169. 20	0. 72	0. 22
Eroded Monona silt loam, 12- to 20-percent slope	234. 00	766. 80	278. 00	1. 19	. 36
Monona silt loam, 9- to 15-percent slope	225. 60	745. 20	416. 00	1. 84	. 56
Monona silt loam, 2- to 8-percent slope	146. 40	558. 00	386. 00	2. 64	. 69
Napier silt loam, 0- to 5-percent slope	88. 80	364. 80	386. 00	4. 35	1. 06
C–C–O–M–M:					
Eroded Ida silt loam, 12- to 20-percent slope	487. 44	1, 020. 24	335. 76	. 69	. 33
Eroded Monona silt loam, 12- to 20-percent slope	487. 44	1, 020. 24	418. 56	. 86	. 41
Monona silt loam, 9- to 15-percent slope	479. 36	998. 64	466. 32	. 97	. 47
Monona silt loam, 2- to 8-percent slope	399. 84	811. 44	231. 60	. 58	. 29
Napier silt loam, 0- to 5-percent slope	342. 24	618. 24	231. 60	. 68	. 37
C–O–M–M:					
Eroded Ida silt loam, 12- to 20-percent slope	487. 80	1, 020. 60	379. 20	. 78	. 37
Eroded Monona silt loam, 12- to 20-percent slope	487. 80	1, 020. 60	401. 40	. 82	. 39
Monona silt loam, 9- to 15-percent slope	479. 40	999. 00	420. 00	. 88	. 42
Monona silt loam, 2- to 8-percent slope	400. 20	811. 80	167. 40	. 42	. 21
Napier silt loam, 0- to 5-percent slope	342. 60	618. 60	167. 40	. 49	. 27
C–O–M–M–M:					
Eroded Ida silt loam, 12- to 20-percent slope	487. 44	1, 020. 24	388. 08	. 80	. 38
Eroded Monona silt loam, 12- to 20-percent slope	487. 44	1, 020. 24	405. 60	. 83	. 40
Monona silt loam, 9- to 15-percent slope	479. 36	998. 64	420. 48	. 88	. 42
Monona silt loam, 2- to 8-percent slope	399. 84	811. 44	133. 92	. 33	. 17
Napier silt loam, 0- to 5-percent slope	342. 24	618. 24	133. 92	. 39	. 22

[1] Terraces constructed with 2-bottom tractor and moldboard plow; costs of conservation not depreciated.
[2] C=corn; O=oats; M=meadow.

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TABLE 20.—*Returns on investments per farm in terracing and contouring, by rotation and slope under a cash-grain system of farming when costs of conservation are depreciated over 20 years, 1948–52 prices* [1]

Rotation [2] and slope	Costs of terracing and contouring— Without operator's labor included	Costs of terracing and contouring— With operator's labor included	Additional returns from crops	Return per dollar invested— Without operator's labor included	Return per dollar invested— With operator's labor included
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*
C–C–O:					
Eroded Ida silt loam, 12- to 20-percent slope	12.00	38.40	169.20	14.10	4.41
Eroded Monona silt loam, 12- to 20-percent slope	12.00	39.60	278.00	23.17	7.83
Monona silt loam, 9- to 15-percent slope	12.00	38.40	416.00	34.67	10.83
Monona silt loam, 2- to 8-percent slope	7.20	28.80	386.00	53.61	13.40
Napier silt loam, 0- to 5-percent slope	4.80	19.20	386.00	80.42	20.10
C–C–O–M–M:					
Eroded Ida silt loam, 12- to 20-percent slope	25.20	52.80	335.76	13.32	6.36
Eroded Monona silt loam, 12- to 20-percent slope	25.20	52.80	418.56	16.61	7.93
Monona silt loam, 9- to 15-percent slope	25.20	51.60	446.32	17.71	8.65
Monona silt loam, 2- to 8-percent slope	20.40	42.00	231.60	11.35	5.51
Napier silt loam, 0- to 5-percent slope	18.00	32.40	231.60	12.87	7.15
C–O–M–M:					
Eroded Ida silt loam, 12- to 20-percent slope	25.44	53.04	379.20	14.91	7.15
Eroded Monona silt loam, 12- to 20-percent slope	25.44	53.04	501.40	15.78	7.57
Monona silt loam, 9- to 15-percent slope	25.44	51.84	420.00	16.51	8.10
Monona silt loam, 2- to 8-percent slope	20.64	42.24	167.40	8.11	3.96
Napier silt loam, 0- to 5-percent slope	18.24	32.64	167.40	9.18	5.13
C–O–M–M–M:					
Eroded Ida silt loam, 12- to 20-percent slope	24.96	52.56	388.10	15.55	7.38
Eroded Monona silt loam, 12- to 20-percent slope	24.96	52.56	405.60	16.25	7.72
Monona silt loam, 9- to 15-percent slope	24.96	51.36	420.48	16.85	8.19
Monona silt loam, 2- to 8-percent slope	20.16	41.76	133.92	6.64	3.21
Napier silt loam, 0- to 5-percent slope	17.76	32.16	133.92	7.54	4.16

[1] Terraces constructed with 2-bottom tractor and moldboard plow.
[2] C=corn; O=oats; M=meadow.

Additional Annual and Additional Accumulated Income Per Acre From Conservation Practices in 10 Years

Many farmers are short on capital and many depreciate returns in the future. Thus, timing of returns is important in deciding whether to adopt conservation practices. The additional income to be obtained each year from additional yields of crops and the accumulation of additional income for 10 years following adoption of terracing and contouring or of terracing, contouring, and fertilizer on eroded Ida silt loam are shown in table 21. Comparable data for other soils in the Ida-Monona soil association are presented in the Appendix, table 43. The values are based on the assumption that yields will vary from year to year following the installation of practices in 1951.[21] The estimates of yields assume fairly large increases immediately following adoption of the practice, with a gradual leveling off to a constant yield in the 10-year period.

The number of years needed to accumulate additional per-acre returns from additional per-acre yields that will be equal to the additional cost of the practice are shown for eroded Ida silt loam (table 22). These data indicate how soon the additional yield from an acre will pay for the cost of the practice. In a cash-grain system of farming on the most eroded soil—Ida silt loam, 12- to 20-percent slope—the combined practice of terracing and contouring, with terracing done with a moldboard plow, would be paid for by the additional yield in 2 to 3 years. When terraces are constructed by custom hiring, 5 to 6 years are needed to pay for the practice. When fertilizer is added, the practices are paid for 1 to 2 years sooner. If the practices are not paid for the first year, a shorter time is needed to pay for them with a livestock than with a cash-grain system of farming. Rotations that include meadow take longer to pay for terracing and contouring than those that include no meadow. Comparable data for other soils in the Ida-Monona group are shown (Appendix, table 44). On Monona silt loam with a slope of 2- to 8-percent, the cost of custom-built terraces would not be recovered on the corn-corn-oats-meadow-meadow and corn-oats-meadow-meadow rotations at the end of 10 years. When fertilizer is used, costs on the same soil and with the same rotations are recovered in 3 to 6 years.

CONSERVATION SYSTEMS OF FARMING FOR THREE FARMS [22]

Plans for conservation systems of farming should consider the farm as a unit, the farmer's capital and his managerial ability, and the sequence of returns, expenses, and capital requirements over time. A plan that involves a substantial drop in net income in the next few years may be unacceptable to a farmer, even though it may give greater returns in the future. If an operator has little capital and can earn a high return in a year from hogs or from some other investment, he discounts future income heavily; plans that require long-term investments in conservation practices are not attractive to

[21] See p. 7 for explanation of estimates of yield per acre.
[22] This section abstracted from—
STONEBERG, E. G. INCOME COMPARISON OF LAND USE PROGRAMS IN WESTERN IOWA. 1953. [Unpublished master's thesis. Copy on file, Iowa State College, Ames.]

TABLE 21.—*Additional returns from crops and accumulated additional returns per acre, 10-year period following adoption of conservation practices, eroded Ida silt loam with 12- to 20-percent slope, 1948–52 prices* [1]

Years after adoption of revised plan	Rotation [2]	Terracing and contouring: Cash-grain: Additional returns	Terracing and contouring: Cash-grain: Accumulated additional returns	Terracing and contouring: Livestock: Additional returns	Terracing and contouring: Livestock: Accumulated additional returns	Terracing, contouring, and fertilizer: Cash-grain: Additional returns	Terracing, contouring, and fertilizer: Cash-grain: Accumulated additional returns	Terracing, contouring, and fertilizer: Livestock: Additional returns	Terracing, contouring, and fertilizer: Livestock: Accumulated additional returns
		Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
	C–C–O:								
1	C	2.84	2.84	4.26	4.26	22.74	22.74	13.68	13.68
2	C	6.24	9.08	9.65	13.91	25.29	48.03	18.93	32.61
3	O	4.58	13.66	4.34	18.25	3.76	51.79	3.77	36.38
4	C	7.52	21.18	7.66	25.91	23.72	75.51	17.66	54.04
5	C	6.81	27.99	6.53	32.44	23.16	98.67	15.38	69.42
6	O	3.39	31.38	2.68	35.12	2.10	100.77	2.19	71.61
7	C	5.53	36.91	4.40	39.52	22.74	123.51	13.68	85.29
8	C	4.82	41.73	4.26	43.78	22.74	146.25	13.68	98.97
9	O	2.37	44.11	1.58	45.36	1.00	147.25	.93	99.90
10	C	3.69	47.79	4.26	49.62	22.74	169.99	13.68	113.58
	C–C–O_s:								
1	C	1.42	1.42	4.26	4.26	19.66	19.66	9.92	9.92
2	C	5.11	6.53	8.94	13.20	25.05	44.71	14.60	24.52
3	O_s	4.66	11.19	4.50	17.70	−.66	44.05	1.22	25.74
4	C	6.10	17.29	7.95	25.65	22.78	66.83	13.89	39.63
5	C	5.39	22.68	6.95	32.60	21.64	88.47	12.90	52.53
6	O_s	3.39	26.07	3.16	35.76	−2.00	86.47	−.45	52.07
7	C	3.97	30.04	4.82	40.58	19.66	106.13	10.91	62.98
8	C	3.26	33.30	4.26	44.84	19.66	125.19	9.92	72.90
9	O_s	2.29	35.59	1.58	46.42	−3.35	121.84	−1.23	71.67
10	C	2.13	37.72	4.26	50.68	19.66	141.50	9.92	81.59
	C–O_s–C–O–M–M:								
1	C	4.26	4.26	5.68	5.68	15.81	15.81	12.20	12.20
2	O_s	3.08	7.34	2.84	8.52	−.92	14.89	.56	12.76
3	C	9.65	16.99	10.65	19.17	21.06	35.95	17.31	30.07
4	O	4.34	21.33	4.50	23.67	.42	36.37	2.38	32.45
5	M	3.66	24.99	3.66	27.33	14.64	51.01	14.64	47.09
6	M	3.66	28.65	3.66	30.99	14.64	65.65	14.64	61.73
7	C	6.81	35.46	8.37	39.36	17.94	83.59	15.04	76.77
8	O_s	2.92	38.38	3.23	42.59	−.92	82.67	1.19	77.96
9	C	5.39	43.77	6.95	49.54	16.37	99.04	13.62	91.58
10	O	2.21	45.98	2.68	52.22	−1.54	98.50	.64	92.22
	C–C–O–M–M:								
1	C	2.84	2.84	5.68	5.68	13.21	13.21	11.76	11.76
2	C	5.39	8.23	7.81	13.49	15.62	28.83	14.89	26.65
3	O	3.79	12.02	3.55	17.04	−4.37	24.46	1.93	28.58
4	M	3.66	15.68	3.66	20.70	14.64	39.10	14.64	43.22
5	M	3.66	19.34	3.66	24.36	14.64	53.74	14.64	57.86
6	C	6.81	26.15	10.08	34.44	16.61	70.35	17.16	75.02
7	C	6.24	32.39	9.51	43.95	15.90	86.25	16.45	91.47
8	O	3.47	35.86	3.55	47.50	−4.85	82.40	1.93	93.40
9	M	3.66	39.52	3.66	51.16	14.64	97.04	14.64	108.04
10	M	3.66	43.18	3.66	54.82	14.64	111.68	14.64	122.68
	C–O–M–M:								
1	C	4.26	4.26	5.68	5.68	13.81	13.81	10.20	10.20
2	O	2.44	6.70	2.37	8.05	−5.44	8.37	−3.68	6.52
3	M	3.66	10.36	3.66	11.71	14.64	23.01	14.64	21.16
4	M	3.66	14.02	3.66	15.37	14.64	37.65	14.64	35.80
5	C	9.23	23.25	10.50	25.87	18.35	56.00	17.30	53.10
6	O	4.18	27.43	4.26	30.13	−3.70	52.30	−.75	52.35
7	M	3.66	31.09	3.66	33.79	14.64	66.94	14.64	66.99
8	M	3.66	34.75	3.66	37.45	14.64	81.58	14.64	81.63
9	C	7.10	41.85	8.37	45.82	15.94	97.52	17.30	98.93
10	O	3.16	45.01	3.31	49.13	4.63	102.15	−.75	98.18

[1] Based on changing yields after a practice is adopted.
[2] C=corn; O=oats; O_s=oats followed by a sweetclover cover crop; M=meadow.

TABLE 22.—*Number of years needed to accumulate additional returns from additional yield equal to the additional cost of conservation practices on eroded Ida silt loam with 12- to 20-percent slope*

Practice, system of farming, and rotation [1]	Basis of computing costs per acre for—							
	Moldboard plow		Whirlwind terracer		Bulldozer		Custom	
	With operator's labor included	With operator's labor excluded	With operator's labor included	With operator's labor excluded	With operator's labor included	With operator's labor excluded	With operator's labor included	With operator's labor excluded
	Years	*Years*	*Years*	*Years*	*Years*	*Years*	*Years*	*Years*
Terracing and contouring:								
Cash-grain:								
C-C-O	2	1	3	2	4	3	5	4
C-O$_s$-C-O	2	2	3	2	4	3	5	5
C-O$_s$-C-O-M-M	3	1	3	2	4	3	5	5
C-C-O-M-M	2	2	3	2	5	4	6	6
C-O-M-M	2	2	3	2	5	4	6	6
Livestock:								
C-C-O	2	1	2	2	3	2	4	4
C-O$_s$-C-O	2	1	2	2	3	2	4	4
C-O$_s$-C-O-M-M	2	1	3	2	3	3	4	4
C-C-O-M-M	2	2	2	2	3	2	5	5
C-O-M-M	2	1	3	2	5	4	5	5
Terracing, contouring, and fertilizer:								
Cash-grain:								
C-C-O	1	1	1	1	1	1	2	1
C-O$_s$-C-O	1	1	1	1	1	1	2	2
C-O$_s$-C-O-M-M	1	1	1	1	3	1	3	3
C-C-O-M-M	1	1	1	1	2	1	2	2
C-O-M-M	1	1	3	1	3	3	4	3
Livestock:								
C-C-O	1	1	1	1	2	1	2	2
C-O$_s$-C-O	1	1	2	1	2	2	2	2
C-O$_s$-C-O-M-M	1	1	3	1	3	3	3	3
C-C-O-M-M	1	1	2	1	2	2	2	2
C-O-M-M	3	1	3	1	3	3	4	4

[1] C=corn; O=oats; O$_s$=oats followed by a sweetclover cover crop; M=meadow.

him. The same conservation plan, however, may be preferred by a farmer who has access to more funds.

These considerations are important in farm planning and related programs. Plans that will cause only a small or a gradual decline in income for the first few years may need to be devised. Credit may be needed to offset high discount rates by farmers whose funds are limited. Schedules for Agricultural Conservation Program payments may need to be geared to the time required for the practice to begin to give returns.

Budgets for Three Representative Farms

The objectives of this part of the analysis are to show what happens on 3 representative 160-acre farms as conservation plans are put into effect. More specifically, it examines changes in (1) labor requirements, livestock numbers, crop acres, and crop production; (2) capital investment; (3) gross income, expenses, and net income; and (4) the discounted values of future net income. Budgets for the present (1944–51 average) and for 9 alternative systems of farming were constructed for each of the 3 representative farms. A conservation plan for each farm was made by Soil Conservation Service farm planners in the counties in which the farms are located. Each of 8 alternative livestock systems was combined with the revised cropping system for each farm in such a way that the animals would use all the feed crops grown on the farm in balanced rations. Annual budgets for each of the 8 alternative livestock systems and a cash-grain system of farming were computed for 1952–67, so that timing and changes in input and output can be examined.

Farm 1 is located in Lincoln Township, Harrison County, Iowa. The soils are predominantly Ida silt loam and Monona silt loam (fig. 1). Several ridges of moderately rolling Monona silt loam break off to steeper Ida silt loam on the southern and western slopes, and to a steep Monona silt loam on other slopes. Monona silt loam is found on slopes up to 14 percent; Ida silt loam on slopes as great as 20 percent. Below the slopes, 14 acres of Castana-Napier silt loam border 3 ditches. Thirty-three acres of permanent pasture, partly covered by timber, are located in the northeastern corner of the farm, chiefly on steep Monona silt loam. The farm is cut up by some fairly well stabilized ditches that in many places are too deep to cross. The farm buildings consist of a house, a 36- by 54-foot barn that has a 600-bushel grain bin, a 20- by 22-foot poultry house, a corncrib that will hold 3,000 bushels of ear corn, and a 12- by 20-foot tool shed. All except the poultry house are in good condition.

Farm 2 is located in LaGrange Township, Harrison County, Iowa. The soils on the farm are shown in figure 2. There are sharply pointed ridges, steep hillsides, and gently rolling to level bottom land. A gully 50 feet deep and 70 feet wide in places runs through the farm close to the buildings. Except for about 37 acres of steep Monona silt loam, the soils on the hills are tillable. Productive Hornick soil, 24 acres in extent, is east of the gully, and a little Napier silt loam is found on the banks of ditches and gullies. Little erosion occurs

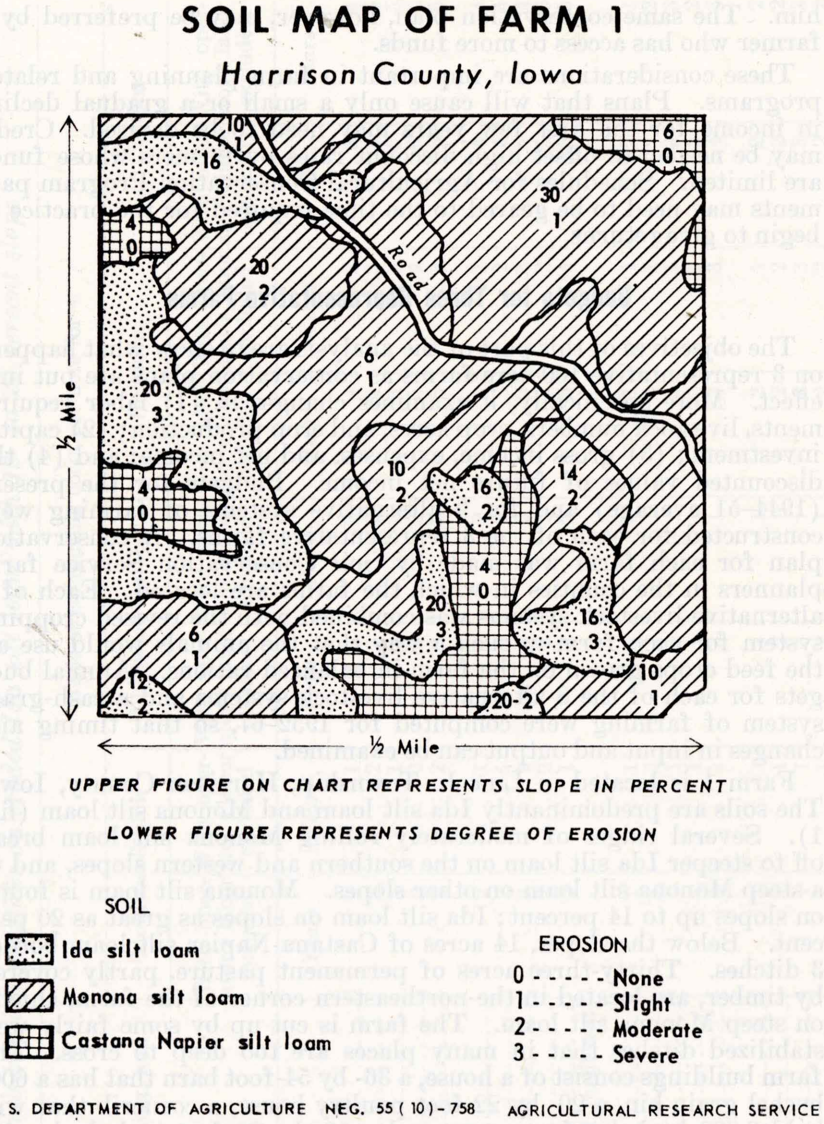

FIGURE 1.—Soil map of farm 1, Harrison County, Iowa.

on the Napier soil and none on the Hornick. The buildings consist of a house that was recently remodeled, a 32-foot-square barn, a combination corncrib and granary with a capacity of 1,100 bushels of ear corn and 800 bushels of small grain, and a 20- by 40-foot combination poultry-hog house. Except for the barn, the buildings are in good repair. Two 30- by 14-foot silos are unused and in poor condition.

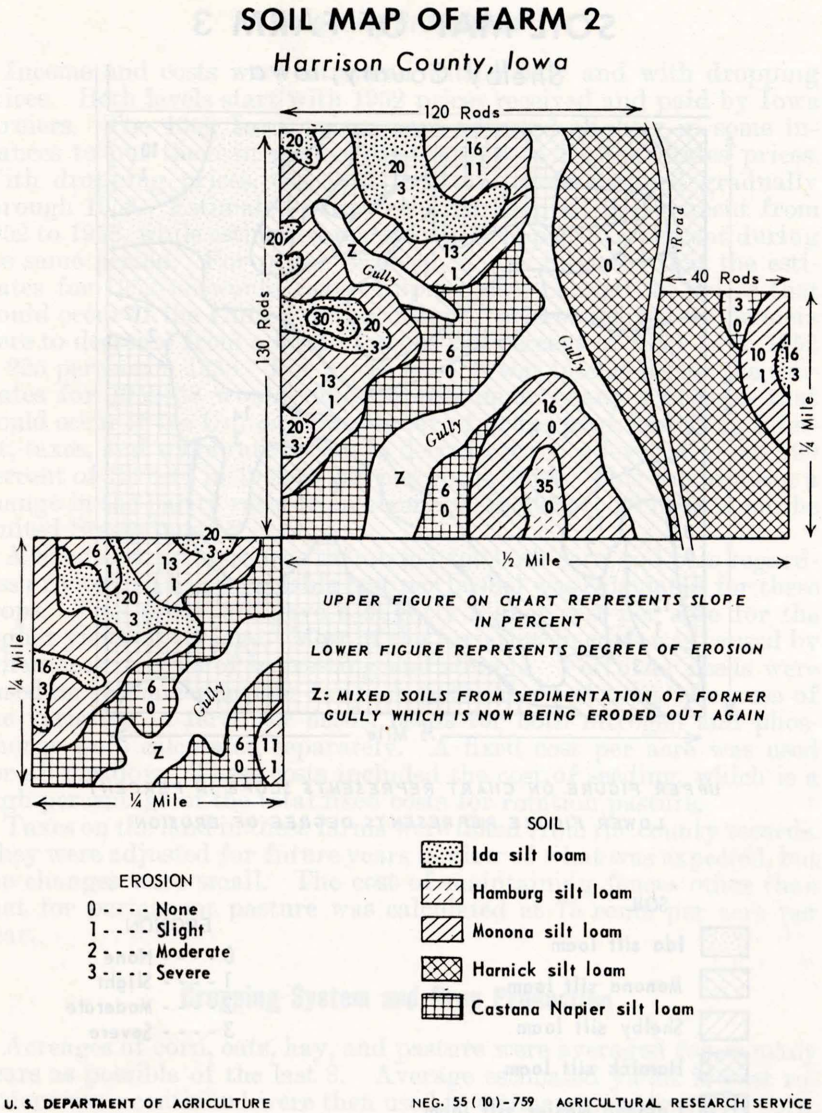

FIGURE 2.—Soil map of farm 2, Harrison County, Iowa.

Farm 3 is located in Washington Township, Shelby County, Iowa. This farm has more productive soils (fig. 3) than farms 1 and 2. Of the 152 acres of cropland, 7 are cut off by a gully and can be reached only from the road. A long ridge extends for four-fifths of the distance from the northeastern corner to the southwestern corner of the farm. The ridgetop includes about 31 acres of gently rolling Monona silt loam. The steep slopes of Ida, Monona, and Shelby silt loams in-

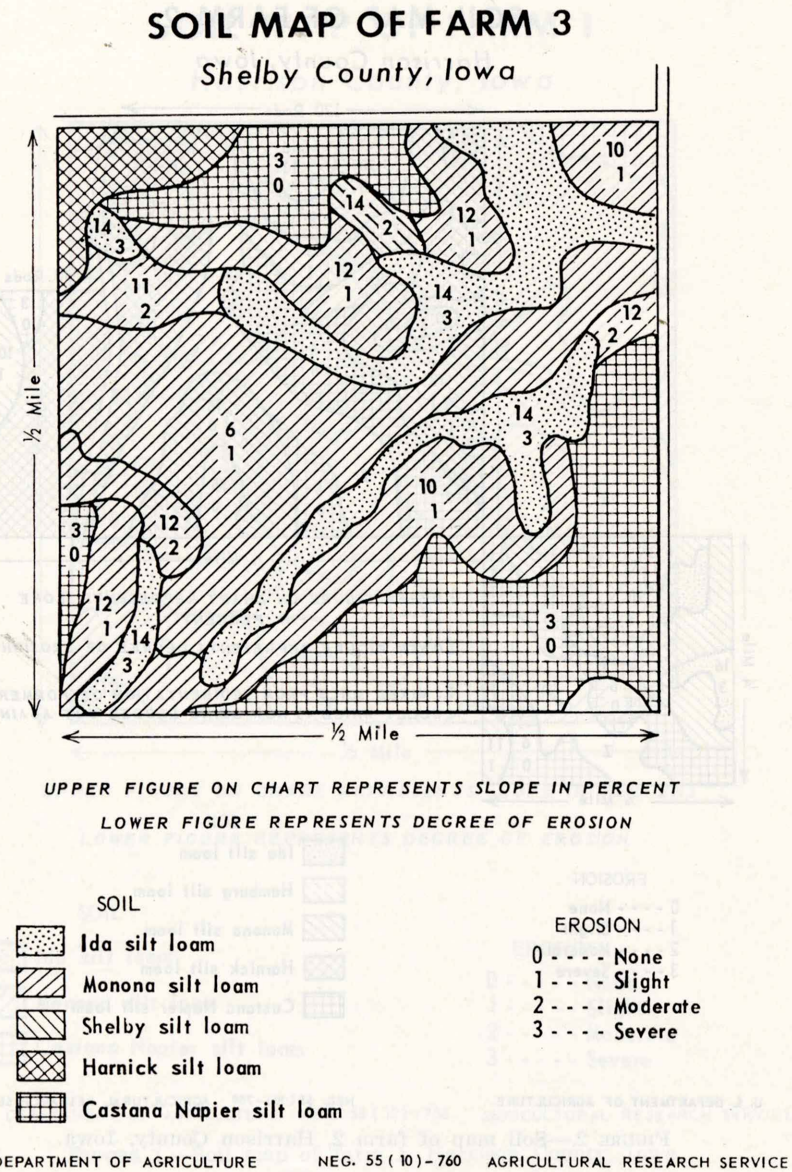

FIGURE 3.—Soil map of farm 3, Shelby County, Iowa.

clude about 50 acres. The other 40 acres of productive, level Napier and Hornick silt loams are located in the southeastern and northwestern corners of the farm. A 7-room house, a 60-foot-square barn, a 22- by 48-foot hog house, and a 24- by 60-foot machine shed are all in good condition. A 24- by 44-foot corncrib and a 12- by 14-foot brooder house are in fair condition. A poultry house, 20 by 40 feet, is in poor condition.

Budgeting Procedures [23]

Income and costs were estimated with steady and with dropping prices. Both levels start with 1952 prices received and paid by Iowa farmers. The 1952 Iowa prices were adjusted slightly in some instances to put them in proper relationship to United States prices. With dropping prices, the 1952 level of prices declined gradually through 1958. Estimated prices received dropped 22.4 percent from 1952 to 1958, while estimated prices paid dropped 13.8 percent during the same period. For prices received, it was intended that the estimates for 1952–58 would reflect approximate changes in prices that would occur if the United States index of prices received by farmers were to decrease from a level of about 290 percent of 1910–14 in 1952 to 225 percent in 1958. For prices paid, it was intended that the estimates for 1952–58 would reflect approximate changes in costs that would occur if the United States index of prices paid, including interest, taxes, and wage rates, were to decrease from a level of about 290 percent of 1910-14 in 1952 to 225 percent in 1958. This would mean a change in the parity ratio from about 100 in 1952 to 90 in 1958 on the United States index.[24]

A fixed cost per acre was calculated for both corn and oats regardless of yield. Then a variable cost per bushel was calculated for these crops. This procedure gave a slightly higher cost per acre for the higher yielding acreage. Most of the variation in costs was caused by differences in costs of harvesting and storage. Fertilizer needs were based on recommendations for each particular soil type. Because of the variation in fertilizer needs, needs for both nitrogen and phosphorus were calculated separately. A fixed cost per acre was used for all meadow. These costs included the cost of seeding, which is a high percentage of the total fixed costs for rotation pasture.

Taxes on the land in these farms were taken from the county records. They were adjusted for future years in view of what was expected, but the changes were small. The cost of maintaining fences other than that for permanent pasture was calculated at 75 cents per acre per year.

Cropping System and Crop Production

Acreages of corn, oats, hay, and pasture were averaged for as many years as possible of the last 8. Average estimated yields if past rotations were continued were then used to estimate production of corn, oats, and hay equivalents.[25] Yields with the revised rotations, terracing, contouring, and fertilizer were increased because of the use of fertilizer and good crop rotations. An initial increase of one-

[23] See Appendix for additional information on the budgeting procedure used (pp. 83 to 86).

[24] Parity ratio is the ratio of the index of prices received to the index of prices paid for commodities, interest, taxes, and wage rates.

[25] Production of hay and pasture was computed in terms of hay equivalent. Production of pasture was estimated in terms of the tons of hay the pasture would produce. Pasture requirements for livestock were also estimated in terms of tons of hay. Production costs for an acre of pasture were less than production costs for an acre of hay.

seventh of the average former yields of corn and oats on Ida and unterraced Monona silt loams was accredited to a fertilizer application of 40–40–0. For terraced Monona silt loam an increase in yield of one-fourteenth of the former average yield was credited to fertilizer. For 1952–67, increases in yield resulting from good crop rotations were expected to reach 90 percent of the difference between ultimate yields and former yield with fertilizer applied. This level would be reached at the end of the third complete round of the rotation. Yields of corn and oats would be increased by 30 percent of the expected difference each time the meadow appears in the rotation until the 90-percent increase attributable to good land use is reached. The transition from the past to the revised rotation was made to cause the farm operator as little inconvenience as possible. Consideration was given to having about the same production each year, particularly the production of forage. Distribution of the forage between hay and pasture would depend on the needs for hay and pasture.

Changes in acreage of crops depend on how rapidly soil conservation adjustments are made. Usually the acreage of corn is reduced immediately. The acreage of oats increases because a larger acreage is needed as a nurse crop for seedings of meadow. Since grass and legumes must be seeded the year before they are used, production of forage does not increase until the second year of a soil conservation plan. It may take 5 to 10 years before the increased yields and larger acreages combine to stabilize production of forage at a high level.

In time, production of corn may increase on an even smaller acreage because of the higher yields attributable to the conservation measures. Normally, 2 or 3 times through the new rotation are needed to reach a higher level of corn yields. The yield of oats also increases. If the change from exploitation to conservation results eventually in a larger total production of both grain and forages, the relationship between grain and forage is complementary. If the change brings about a smaller production of grain but a larger production of forage, the relationship is competitive; that is, increasing production of one means decreasing production of the other. When they operate in the competitive range, the relative productions of grain and forage may depend upon the marginal return expected from each in the farm business.[26]

Past average acreages (1944–51) on farm 1 were 66 acres of corn, 34 acres of oats, 11 acres of meadow, and 33 acres of permanent bluegrass and timber pasture. Acreages for 16 years under the new plan are given in table 23. The acreage of corn would drop to recommended levels the first year. The acreage of oats would be higher the first year but lower the second year. The acreage of hay would increase in both the first and second years, after which it would be at a recommended level of about 4 times the present acreage.

Not much change from past acreage would take place in the first year on farm 2. In the second year the acreage of corn would be reduced and the acreage of oats would be increased. In the third year the acreage of oats would decrease and the acreage of hay would increase. Changes in acreage would be small thereafter.

[26] As production of forage is increased the marginal returns from the additional forage may decrease. If production of grain decreases the marginal returns from grain may increase.

TABLE 23.—*Acreage of crops on 3 representative farms under average 1944–51 plans, and revised cropping plans, 1952–67*

Years after adoption of revised plan	Corn			Oats			Hay		
	Farm 1	Farm 2	Farm 3	Farm 1	Farm 2	Farm 3	Farm 1	Farm 2	Farm 3
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
1944–51 average	66	52	62	34	45	53	11	20	37
1	34	58	57	40	30	50	37	29	46
2	37	33	47	22	53	54	52	31	51
3	38	37	65	25	27	26	48	53	61
4	39	34	50	25	31	46	47	52	56
5	34	36	51	27	28	50	50	53	51
6	35	33	66	27	31	30	52	53	56
7	37	37	44	23	27	47	51	53	61
8	39	34	52	25	31	44	47	52	56
9	37	36	70	26	28	31	48	53	51
10	35	33	45	25	31	51	51	53	56
11	35	37	46	25	27	45	51	53	61
12	38	34	71	23	31	25	50	52	56
13	37	36	49	26	28	52	48	53	51
14	38	33	47	24	31	49	49	53	56
15	35	37	65	26	27	26	50	53	61
16	36	34	50	25	31	46	50	52	56

Farm 3 has the most productive land resources of the 3 farms studied. The owner has followed the best crop plan. As a result, smaller changes in acreage would be needed to put the recommended cropping plan into effect. Past acreages of crops on this farm were 62 acres of corn, 53 acres of oats, and 37 acres of meadow. Part of the change would be to crop the level land more intensively and the rolling land less intensively. The longtime change would reduce the acreages of corn and oats slightly and would increase the acreages of meadow. Most of the increase in the acreage of hay would be on the rolling land.

Soil losses under the past cropping program and under the proposed plan are indicated in table 24.

TABLE 24.—*Average annual soil loss on cropland* [1]

Farm	Soil loss from—			
	Past rotation		Revised rotation	
	Total	Per acre	Total	Per acre
	Tons	*Tons*	*Tons*	*Tons*
1	7, 631	73. 38	736. 00	6. 63
2	2, 830	24. 19	691. 50	5. 91
3	4, 107	27. 02	595. 77	5. 32

[1] Average annual loss for the years needed to complete the rotation.

Production of forage and production of grain are shown separately (fig. 4) to indicate the proportion of each in the total feed units under the past and the revised cropping programs.

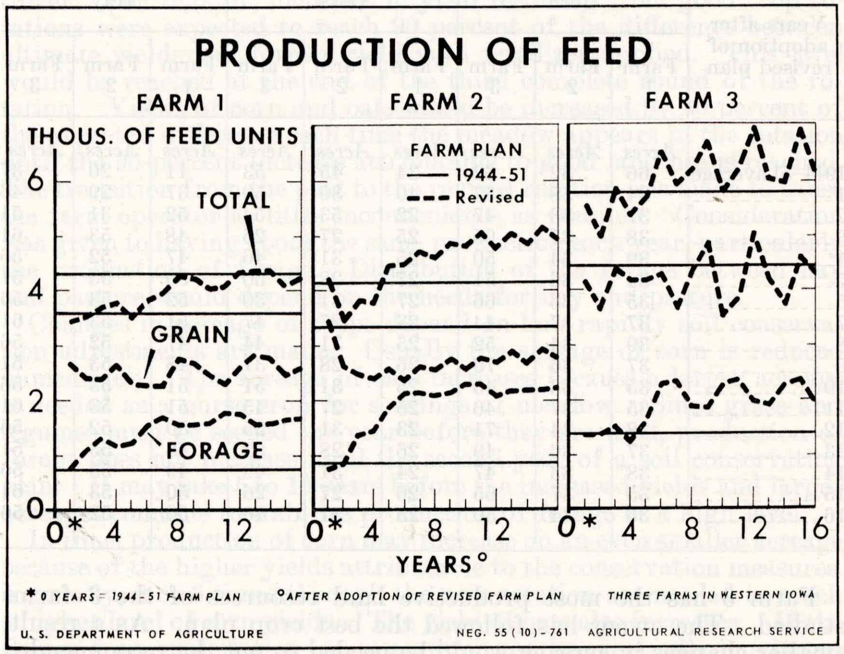

FIGURE 4.—Production of grain, forage, and total feed units on 3 farms in western Iowa.

Production of forage under the revised cropping plan for farm 1 would increase rapidly. At the end of the fifth year it would be double that of the present plan. Production of grain under the revised plan would not reach former levels. Even though the yield per acre of grain increases, the increase would not be large enough to overcome the heavy reduction in the acreage of grain. In the seventh year, total production of feed under both plans would be about equal; but forage would represent a much higher percentage of the total under the revised plan. Under the 2 cropping plans used, grain and forage are competitive. Increasing the production of forage would decrease the production of grain. For every additional ton of hay produced in the first 5 years (1952–56) under the revised plan, production of corn would decrease by 53 bushels. Production of corn would decrease by 18 bushels for each additional ton of hay produced from the 12th to the 16th year under the revised plan.

On farm 2 production of grain would drop after the first year. Later on it would gradually increase, but it would not reach the level of production obtained under the program used during 1944–51. After the second year, production of forage would increase rapidly under the revised plan, and in the fifth year, it would be more than double the production in 1951. Total production of feed would reach former levels in the fourth year and it would remain higher thereafter. Under the 2 plans studied for farm 2, forage and grain are competitive. Increasing production of one would result in a decrease in production of the other. Each additional ton of hay produced in the first 5 years under the revised plan would result in a 27-bushel drop in production of corn. Production of corn would drop 7 bushels for each additional ton of forage produced from the 12th to the 16th year. Under the revised pattern of production, soil conservation could become profitable after a few years if a farmer can use forage to advantage in his farming system and if future income is not discounted severely.

Production of grain under the revised program for farm 3 varies somewhat because of variations in acreage. During the first few years, production of grain would drop slightly and production of forage would stay about the same. Production of both grain and forage would begin to increase after the fifth year. Production of grain would be about equal to the 1951 level by the latter part of the period studied (1962–67), and production of forage would average 50 percent higher. Total production of feed would be 11 percent higher during the same period. During the first 5 years of the revised plan on this farm, production of corn would decrease 203 bushels for each additional ton of hay produced. Production of corn would decrease by only 2 bushels for each additional ton of hay in the last 5 years of the period studied.

If production of feed were the only consideration, most farmers would not be willing to lose these quantities of grain to gain the additional forage. It might be possible to maximize production of corn by adjusting acreage to a point somewhere between present and recommended levels. It is possible that neither of the two levels studied are at the peak of the longtime production curve.

Livestock Systems

Eight alternative livestock systems were considered for each farm, as follows:

(1) Yearling steers wintered, pastured, finished in dry lot—dairy cows (5)—hogs;
(2) Yearling steers wintered, fed on pasture, finished in dry lot—dairy cows (5)—hogs;
(3) Yearling steers wintered, pastured, finished in dry lot—hogs;
(4) Yearling steers wintered, fed on pasture, finished in dry lot—hogs;
(5) Feeder calves wintered, pastured, fed in dry lot—hogs;
(6) Feeder calves wintered, fed on pasture, finished in dry lot—hogs;
(7) Beef herd—hogs; and
(8) Dairy herd—hogs.

Hogs were used in all systems because they consume large quantities of grains. Beef-fattening cattle, beef cows, and dairy cows were used in various combinations with hogs to utilize the forage crops. When a combination of 3 types of livestock was used, the dairy herd was limited to 5 cows. Several different cattle-fattening systems were included to learn which would be the most profitable under a soil conservation system of farming. Yearlings and calves were used in two grain-and-forage feeding levels. Yearlings were also combined with a small dairy herd at both feeding levels.

The yearlings would be bought in October at an average weight of 604 pounds (Appendix, table 40). They would be wintered on hay and enough grain to gain about a pound a day. Those on the low grain ration would then be pastured in summer and finished on grain in dry lot to Choice grade, with a final average weight of 1,190 pounds for sale in December. Those on a higher grain ration would be fed on pasture and later finished in dry lot to Choice grade, with a final weight of 1,143 pounds for sale in November. Under these feeding programs, the yearlings fed on pasture would use about 11 more bushels of corn than those pastured before they were finished on grain (Appendix, table 41). But the former would go to market a month earlier.

The calves fed on a low grain ration would be bought in August at an average weight of 440 pounds. They would be pastured in fall and wintered on hay and enough grain to gain about a pound a day. In spring and early summer they would be on pasture. Late in summer they would be put in dry lot and fed to Choice grade for sale in December at a weight of 1,105 pounds. The calves fed on a high grain ration would be bought in September at an average weight of 440 pounds. They would be pastured in fall and wintered on hay to gain about a pound a day. In spring they would be put on pasture and fed on pasture throughout the summer. They would then be fed in dry lot to Choice grade for sale in December at a weight of 1,040 pounds. The calves fed on pasture would use 9.8 more bushels of corn to reach Choice grade than those pastured before starting on grain.

Poultry was not included in the livestock combinations. Poultry is usually a minor source of income and, as the number kept probably would be the same with any of these livestock combinations, the income would vary little.

The numbers of livestock in 8 alternative livestock systems that could be supported with the average cropping plan followed by each farm in 1944–51 are given for the 3 farms (table 25). The numbers of livestock that the revised cropping plans would support are indicated in tables 26 to 28. On farm 3 for the first several years, livestock numbers would be nearly the same with both the 1944–51 plan and the projected plans. After 4 years, cattle numbers would increase as production of forage increased under the revised plan and hog numbers would remain relatively steady. On farms 1 and 2, numbers of particular classes of livestock would vary more throughout the years because of greater variation in production of feed.

TABLE 25.—*Numbers of livestock in 8 alternative livestock systems that could be supported with cropping plans used on 3 representative farms, 1944–51*

Kind of livestock	Farm No.	Alternative livestock system [1]— 1	2	3	4	5	6	7	8
		Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Dairy cows	1	(2)	(2)	0	0	0	0	0	4
Do	2	(2)	(2)	0	0	0	0	0	5
Do	3	5	5	0	0	0	0	0	10
Beef cows	1	(2)	(2)	0	0	0	0	5	0
Do	2	(2)	(2)	0	0	0	0	7	0
Do	3	0	0	0	0	0	0	13	0
Yearling steers	1	(2)	(2)	5	6	0	0	0	0
Do	2	(2)	(2)	7	9	0	0	0	0
Do	3	7	8	14	17	0	0	0	0
Feeder calves	1	(2)	(2)	0	0	6	7	0	0
Do	2	(2)	(2)	0	0	8	9	0	0
Do	3	0	0	0	0	15	17	0	0
Hogs	1	(2)	(2)	186	180	180	174	192	186
Do	2	(2)	(2)	162	156	156	150	174	168
Do	3	210	204	204	192	204	186	234	216

[1] See p. 53 for a description of livestock systems.
[2] Livestock systems 1 and 2 not used on farms 1 and 2 as the feed available would not support these combinations of livestock.

TABLE 27.—*Numbers of livestock in alternative livestock systems that could be supported by revised cropping plans, farm 2, by years, 1952–67* [1]

Livestock system		Years after adoption of revised plan—										
		1 (1952)	2 (1953)	3 (1954)	4 (1955)	5 (1956)	6 (1957)	7 (1958)	8 (1959)	9 (1960)	10 (1961)	11 (1962)
		Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
1	Yearling steers	0	1	4	8	13	17	20	22	21	21	23
	Dairy cows	5	5	5	5	5	5	5	5	5	5	5
	Hogs	150	132	132	114	90	84	78	72	84	84	84
2	Yearling steers	0	2	5	10	14	21	25	25	27	27	28
	Dairy cows	5	5	5	5	5	5	5	5	5	5	5
	Hogs	150	132	126	90	84	60	54	54	54	54	60
3	Yearling steers	6	8	12	15	20	23	27	28	29	29	30
	Hogs	150	138	114	102	90	84	78	72	78	78	84
4	Yearling steers	7	9	13	17	25	29	33	36	36	36	37
	Hogs	150	126	108	84	60	54	42	36	36	36	48
5	Feeder calves	7	9	11	16	22	26	30	31	31	32	33
	Hogs	150	144	102	90	78	66	60	54	54	60	66
6	Feeder calves	8	10	13	18	26	30	34	36	36	37	38
	Hogs	144	132	96	78	54	42	36	24	24	30	36
7	Beef cows	5	6	10	12	14	18	22	28	26	26	27
	Hogs	150	150	150	132	126	126	126	126	126	126	144
8	Dairy cows	4	6	7	9	12	15	19	21	21	21	21
	Hogs	150	132	132	120	108	96	90	90	90	96	96

[1] Years 1963–67 are omitted from the table because the numbers of livestock would be the same as in 1962.

TABLE 28.—*Numbers of livestock in alternative livestock systems that could be supported by revised cropping plans, farm 3, by years, 1952–67* [1]

Livestock system	Years after adoption of revised plan— 1 (1952)	2 (1953)	3 (1954)	4 (1955)	5 (1956)	6 (1957)	7 (1958)	8 (1959)	9 (1960)	10 (1961)	11 (1962)	13 (1964)	15 (1966)
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
1 Yearling steers	7	7	10	7	8	12	18	18	18	17	20	18	20
Dairy cows	5	5	5	5	5	5	5	5	5	5	5	5	5
Hogs	186	186	186	192	192	192	174	174	174	180	162	180	162
2 Yearling steers	9	10	11	8	10	14	20	23	23	21	25	21	25
Dairy cows	5	5	5	5	5	5	5	5	5	5	5	5	5
Hogs	180	156	180	186	186	174	150	144	144	162	132	162	132
3 Yearling steers	14	14	16	14	15	19	24	24	24	25	25	25	25
Hogs	180	180	180	180	204	204	168	168	174	174	174	174	174
4 Yearling steers	18	18	19	17	18	24	31	31	30	30	33	30	33
Hogs	168	162	174	174	180	132	132	132	144	144	132	150	132
5 Feeder calves	16	16	17	15	17	22	26	26	26	26	30	27	29
Hogs	180	174	174	180	186	168	156	156	168	168	144	162	156
6 Feeder calves	18	18	20	18	19	25	32	32	30	30	33	31	33
Hogs	162	156	162	162	168	138	120	120	138	138	120	138	120
7 Beef cows	13	13	14	14	14	15	17	21	24	24	24	24	24
Hogs	216	210	216	216	216	216	216	216	222	222	216	222	216
8 Dairy cows	10	10	11	11	11	14	14	17	19	18	18	18	18
Hogs	180	180	186	192	186	186	216	204	186	186	186	186	186

[1] Some years between 1952 and 1967 are omitted from the table because the numbers of livestock are the same as in the preceding year.

Capital Requirements

More capital would be needed for conservation practices and additional livestock in a conservation system of farming than for the system now used on the farm. The additional amounts needed (compared with the 1944–51 system) by years are shown for each of the 3 case farms (table 29). Values are shown for 3 contrasting farming systems: Yearling steers and hogs (plan 3), beef cows and hogs (plan 7), and dairy cows and hogs (plan 8). The values are at 1952 prices.

A farmer who decides to shift to a conservation plan will need from several hundred to several thousand dollars immediately. The conservation plan and the livestock on the farm at the time a plan is instituted would affect the amount of additional capital needed. Plan 3 would require more capital to initiate on any of the farms than either plan 7 or plan 8. The amount of extra capital needed the year a plan is adopted would range from $446 to $3,446 (table 29). The greatest amount of additional capital is not needed in the initial year, however. That time would come on these farms between the sixth and ninth year after a revised plan was begun, as shown by the italic numbers in table 29. Even after 15 years, except for plan 8 on farm 3, from $1,124 to $5,312 more would be invested if the conservation plan were in effect. For plan 8 on farm 3, less capital would be invested after the 11th year.

The total non-real-estate investments after each of the 8 livestock plans and a cash-grain plan (plan 9) are completely in effect are shown in tables 30 and 31. Capital requirements for all livestock systems would be higher under the conservation plan than under the existing system. Some of the increase may be attributed to higher crop expenses when fertilizer and terraces are used and additional forage is grown. But the greatest increase is associated with livestock. Cattle must be bought to consume the larger quantities of forage produced under a conservation plan. The largest total investment would be for a system of farming that would include beef cows as the forage-consuming livestock. Despite the large investment, a beef cow and hog combination would return the lowest net income of any livestock system included in the study. The lowest capital requirements under a conservation plan would be for a cash-grain system of farming.

As the capital investment in livestock increases, risk may also increase because of changes in prices and the possibility of a loss from declining prices. A farmer who buys feeder steers to use forage should not only estimate what it will cost him to put the necessary pounds of gain on them but also what he will receive for them. If his estimates are wrong he may realize a loss rather than a profit. He has no reliable way of testing his estimates, and the prices he pays as well as those he receives may change considerably in the feeding period.

These values indicate the importance of credit in getting conservation plans established and keeping them functioning. The requirements are largest when the plan includes livestock. Capital is needed immediately and for a relatively long period of years. Maximum requirements usually occur a few years after a plan is originated. Not only is long-term credit needed, but additional credit should be available from year to year when needed.

TABLE 30.—*Capital requirements for 1944–51 plan and when specified farm plans are fully established, farm 3, 1952 prices*

Item	Plan—								
	1	2	3	4	5	6	7	8	9[1]
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
1944–51 cropping plan:									
Crop expenses[2]	3, 339	3, 340	3, 269	3, 288	3, 349	3, 350	3, 235	3, 407	3, 677
Land taxes	306	306	306	306	306	306	306	306	306
Livestock expenses[3]	2, 425	2, 355	2, 838	2, 181	2, 418	2, 595	2, 529	2, 550	------
Additional buildings[4]	35	39	36	40	31	28	65	34	------
Fences[4]	114	114	114	114	114	114	114	114	18
Value of breeding stock	2, 961	2, 911	1, 706	1, 605	1, 706	1, 555	5, 814	4, 216	------
Feeder cattle	1, 419	1, 622	2, 838	3, 446	2, 212	2, 595	------	------	------
Total capital, except machinery[5]	10, 293	10, 383	10, 801	10, 674	9, 860	10, 237	11, 807	10, 321	3, 991
Conservation cropping plan:									
Crop expenses[2]	3, 580	3, 580	3, 580	3, 580	3, 598	3, 598	3, 562	3, 769	4, 142
Land taxes	306	306	306	306	306	306	306	306	306
Livestock expenses[3]	2, 330	2, 056	2, 319	1, 974	2, 434	2, 023	2, 638	2, 685	------
Additional buildings[4]	50	74	70	86	25	31	103	73	------
Fences[4]	114	114	114	114	114	114	114	114	18
Value of breeding stock	2, 563	2, 309	1, 455	1, 104	1, 305	1, 003	8, 930	5, 893	------
Feeder cattle	4, 054	5, 067	5, 067	6, 689	4, 276	5, 037	------	------	------
Total capital, except machinery[5]	12, 704	13, 200	12, 605	13, 547	11, 752	11, 806	15, 347	12, 534	4, 180

[1] Cash-grain plan.
[2] Includes machinery upkeep and $11 yearly terrace cost.
[3] Includes protein feed, veterinary expense, equipment, and building upkeep.
[4] Yearly average cost.
[5] 1952 machinery investment was $4,325.

TABLE 31.—*Capital requirements for 1944–51 plan and when specified farm plans are fully established, farms 1 and 2, 1952 prices*

Item	Plan— 3	4	5	6	7	8	9 [1]
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Farm 1:							
1944–51 cropping plan:							
Crop and livestock expense [2]	4,653	4,607	4,702	4,639	4,727	4,798	2,735
Livestock investment	2,568	2,721	2,390	2,523	3,090	2,519	
Total capital, except machinery [3]	7,221	7,328	7,092	7,162	7,817	7,317	2,735
Conservation cropping plan:							
Crop and livestock expense [2]	4,340	4,028	4,288	4,123	4,713	4,890	3,276
Livestock investment	5,769	6,533	4,580	5,185	7,929	5,142	
Total capital, except machinery [4]	10,109	10,561	8,868	9,308	12,642	10,032	3,276
Farm 2:							
1944–51 cropping plan:							
Crop and livestock expense [2]	4,362	4,330	4,414	4,337	4,490	4,554	2,718
Livestock investment	2,773	3,128	2,484	2,628	3,532	2,610	
Total capital, except machinery [3]	7,135	7,458	6,898	6,965	8,022	7,164	2,718
Conservation cropping plan:							
Crop and livestock expense [2]	4,530	4,157	4,687	4,327	4,904	5,101	3,353
Livestock investment	6,783	7,913	5,418	6,101	9,066	5,864	
Total capital, except machinery [4]	11,313	12,070	10,105	10,428	13,370	10,965	3,353

[1] Cash-grain plan.
[2] Includes real estate taxes.
[3] 1952 machinery investment was $3,547.
[4] 1952 machinery investment was $4,750.

Technicians who plan conservation systems should recognize the effects of various plans on the additional capital involved at the time the plan is started and for many years later. They should also realize that the additional risk involved may be a strong determinant in getting a plan accepted by farmers. Those who are short on capital or who have what they consider more profitable alternatives will not accept a plan unless credit is available for it. The credit must be available for a period in keeping with the additional capital required and the additional revenue forthcoming over time.

Net Income

Even though income from a conservation system of farming may average more than that from the present system over a number of years, the sequence of net income and expenditures in the first several years is more important to a large number of farmers. Does net income immediately jump above the level of the present plan? Does it fall below and then gradually increase above the present level? How many years are required before income under a conservation plan is greater than income under the present system of farming? These questions, and the lack of information with which to answer them, are what is keeping many low-income and low-capital farmers from adopting soil conserving systems of farming. Such information is also needed for Soil Conservation Service planning, Agricultural Conservation Program payments, and loans of credit institutions. From the viewpoint of farm planning, a technician may need to consider alternative plans and select or recommend the one that minimizes sacrifices in income in the first few years. From the viewpoint of ACPS, payments for particular practices may need to be made continuously for a few years, rather than as a single lump-sum payment at the outset, to help bridge the income lag. Finally, a credit program provided for a farmer who is shifting to a conservation plan may need to be arranged over several years so that funds are available as investments in livestock, buildings, soil practices, and other items are needed. Repayment schedules should be arranged over a long period so that they would not affect living standards too greatly in the first few years when incomes decline.

In order to learn what changes occur in the first few years after adoption of a conservation program, year-by-year sequences of production, gross income, costs, and net incomes were computed for each of the three farms. These data were computed for each of the alternative conservation plans, except when sufficient feed was not available for the particular kind of livestock. Computations were made with prices extended into the future at the 1952 level, and with prices declining from the 1952 level to a level equal to 225 percent of 1910–14 by 1958 and then remaining at that level for the next several years. Most of the computations were made on the assumption of constant soil productivity with the present systems of farming. Some comparisons made, however, assume a continuous decline in productivity with extension of the plans now followed on the farms. Both procedures are realistic; some farmers who control erosion fairly well can maintain annual production by using fertilizer; other farms are cropped so heavily and erosion is so great that continuation of existing systems would result in a decline in productivity.

Constant Prices and Productivity

Under each of the plans considered for each farm, the immediate effect of shifting to a soil conservation plan is to reduce income in the first several years. This drop in income tends to parallel the drop in production that occurs when a soil conservation plan is first put into effect. As production of forage eventually increases, livestock numbers can be increased and income then increases. The

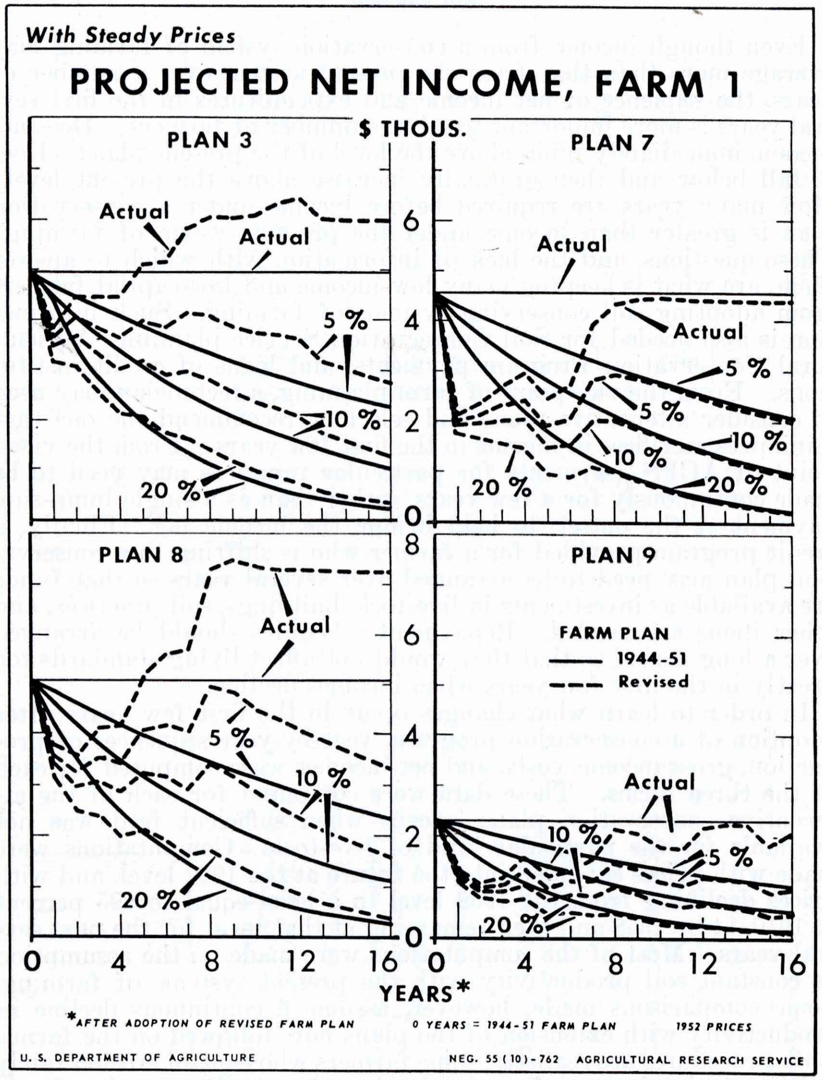

FIGURE 5.—Farm 1: Projected annual net income and discounted annual net income for plans 3, 7, 8, and 9 at 1952 prices.

length of time before income from a soil conservation plan would equal or exceed income from the plan in 1951 will vary among farms, the livestock combinations used, and the speeds with which the plan is put into effect.

Figures 5 to 7 show the sequence of both projected annual net incomes and discounted annual net incomes at 1952 prices from the 1944–51 system and 4 revised systems of farming on each of the 3 farms. The 4 revised systems for which income figures are charted are plan 3 (yearling steers wintered, pastured, and fed out in dry lot and hogs), plan 7 (beef cows and hogs), plan 8 (dairy cows and hogs), and plan 9 (cash-grain).

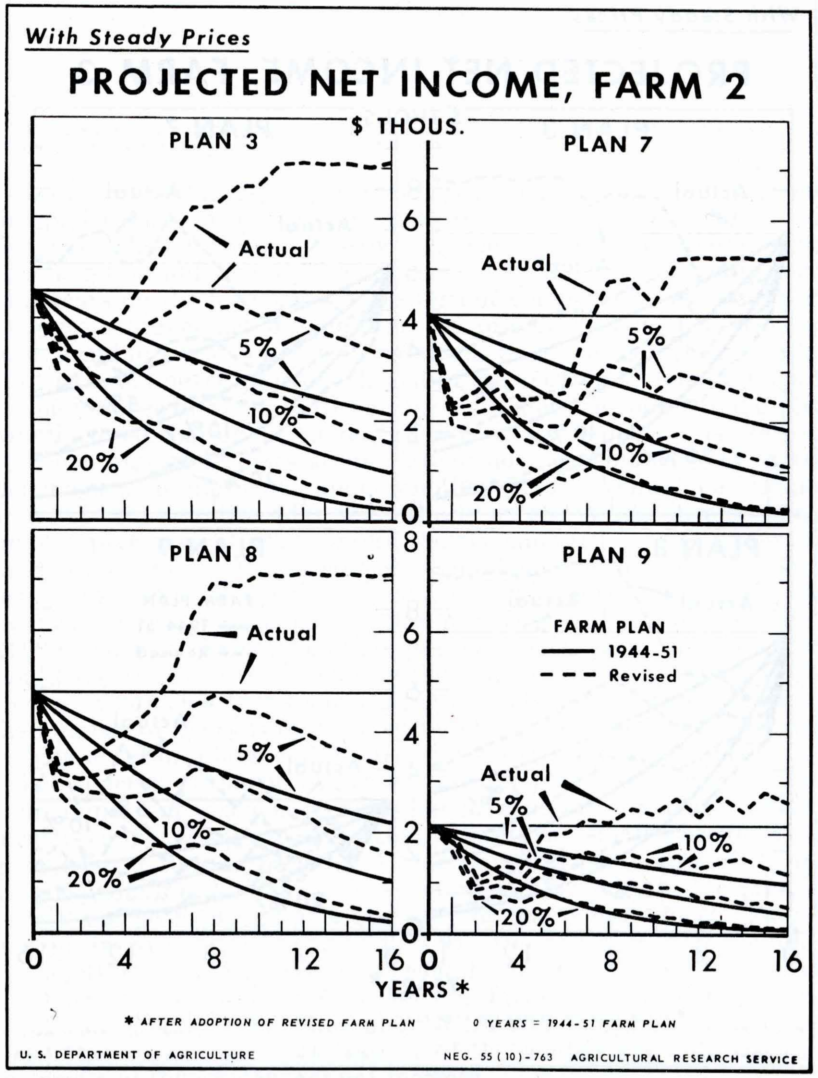

FIGURE 6.—Farm 2: Projected annual net income and discounted annual net income for plans 3, 7, 8, and 9 at 1952 prices.

Nondiscounted.—How long would it take after adoption of each of the 9 conservation plans for the nondiscounted net income from the farm to exceed that of the present plan? These data may be found in table 32. The shortest time would be 4 years for plan 5 on farm 1. In most other instances, it would take 5 to 7 years for the conservation plan to return a higher net income. When enough time has elapsed for a complete reorganization of the farm and for the yield-increasing effect of the improved rotations and soil management practices to be realized, a dairy and hog system of farming returns the highest net income of any plan considered in this study. Plan

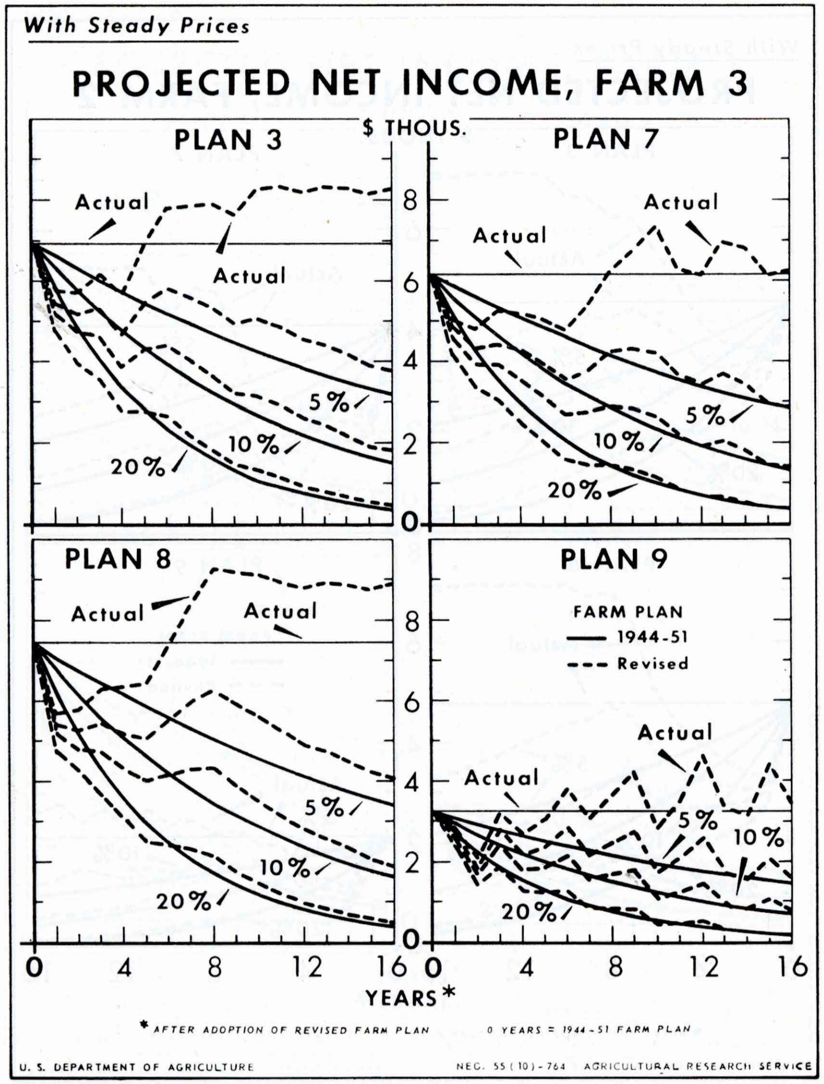

FIGURE 7.—Farm 3: Projected annual net income and discounted annual net income for plans 3, 7, 8, and 9 at 1952 prices.

TABLE 32.—*Number of years after adoption of soil conservation plans until net incomes exceed net incomes under 1944–51 plans, 1952 prices*

Plan	Farm 1	Farm 2	Farm 3
	Years	*Years*	*Years*
1	(1)	(1)	6
2	(1)	(1)	7
3	5	5	6
4	7	6	7
5	4	5	6
6	8	5	7
7	(2)	8	8
8	5	6	7
9	(2)	7	6

1 Plans are not used because insufficient feed was available with the present cropping plan.
2 Would not equal net income of present plan in 16 years

7 (beef cows and hogs) would require the longest time for net income to equal that from the present plan because turnover is slower for beef cows than for other livestock systems. Plan 3 (yearling steers and hogs) would give a lower income than the present plans for 5 to 6 years on the 3 farms. A cash-grain conservation system (plan 9) gives a higher net income than the present system in 6 years on farm 3 and in 7 years on farm 2. Returns under the conservation plan approach, but never quite equal, that of the existing system on farm 1.

The number of years until net income under the conservation plan would exceed that of the current plan is not so important as the year in which annual incomes accumulated under one plan would exceed the incomes accumulated under another plan. Annual net income under the conservation plan will usually exceed annual income of the current plan several years before the accumulated income under the conservation plan will exceed the accumulated income of the present farming system. For example, compared with an existing plan that returns $4,000 a year, a conservation plan that will return incomes of $2,000 a year for 5 years and then jump to $5,000 each year thereafter would return a greater income in the sixth year but the sums of the incomes would not be as much until the 15th year. Table 33 shows the number of years before the accumulated total net incomes under the conservation plans will equal those under the current plans.

The shortest period would be 5 years for plan 6 on farm 1. This is an important obstacle to adoption of conservation plans. Many farmers cannot change to a plan that will return a smaller accumulated income for a 10-year period. A beginning farmer is pressed to get income enough to live on and to strengthen his equity in the farm so he will not go bankrupt if a bad year or two comes along. Even a cash-grain conservation plan (plan 9)—the one that would require the smallest capital investment—would not give comparable cumulative net incomes until after 12 years on farm 3 and 15 years on farm 2. A cash-grain conservation plan would take longer to do this than plans that feature livestock because of the smaller annual volume of business and the smaller annual incomes.

TABLE 33.—*Number of years after adoption of soil conservation plans until accumulated incomes exceed accumulated incomes under 1944–51 plans, 1952 prices*

Plan	Farm 1	Farm 2	Farm 3
	Years	*Years*	*Years*
1	(1)	(1)	10
2	(1)	(1)	13
3	9	8	11
4	14	11	13
5	7	7	11
6	5	9	12
7	(2)	(2)	(2)
8	9	9	11
9	(2)	15	12

[1] Plans are not used because insufficient feed was available with present cropping plan.
[2] Would not equal net income of present plan in 16 years.

Discounted at Five Rates.—Farmers must base their decisions in regard to future costs and returns on present conditions. Decisions are made currently even though the income is forthcoming only in the future. Farmers use many "rough approximations" in discounting incomes of the future back to the present. Discounting permits comparison of an investment with incomes in the future with an investment that will return current income. For example, a farmer can invest an amount in hogs that will return $1,000, or 10 percent, in a year, and he can reinvest in hogs each year with an annual return. Or he can invest the same amount in a conservation plan which, at the end of 10 years, will return $1,500 a year. Which investment is better? To answer this question, he must compute the present value of the $1,500 that will be forthcoming in 10 years. It is the amount which if invested today at 10 percent will grow to $1,500 in 10 years, if it is reinvested at 10 percent for each of the 10 years.[27] Hence, $1,500 forthcoming in 10 years is worth no more than $578 from an investment that returns income in the present year. If the farmer can earn only 5 rather than 10 percent, the $1,500 forthcoming in 10 years is worth $920 today. Clearly, then, the value of future income from conservation investments depends on the amount of capital a farmer has and the return he can obtain from it if he invests in other parts of his farm business. If his capital is limited and he can invest in short-run enterprises such as fertilizer or hogs and earn 25 percent, future incomes from conservation have very little present value. But if he has a large amount of capital and he can earn only 5 percent on hogs or fertilizer, future incomes from conservation investments will be worth more today.

As the discount rates that farmers use may differ, those used in the study reported here were 5, 10, 15, 20, and 30 percent. A farmer's discount rate may change as his capital position changes, or as present returns from capital invested in his own business change. A farmer who has ample capital to invest in his farm business may use a 5-percent discount rate, because 5 percent is the best investment opportunity available to him within or outside his business. If the immediate effect of a soil conservation plan is to reduce income, a young farmer with limited capital may find it unprofitable to adopt such a plan. However, as he accumulates additional capital he may find that the last unit of added capital produces lower returns. As he receives lower returns on additional capital he discounts the future less severely, and it may then become profitable to adopt a soil conservation plan. This may explain why many low-income farmers are reluctant to adopt soil conservation plans.

If soil conservation farming systems produced more income from the beginning, more farmers would adopt them. If ways can be found to hold "income drops" to a minimum when a soil conservation plan is adopted, conservation will become attractive to more farmers. Discounting future income does not change the time it takes for a soil conservation system to produce a higher annual income than the present method of farming. But how heavily the future is discounted affects the length of time it will take before total accumulated income in terms of the present will be higher under a conservation plan. Lessening the drop in income the first few years under a conservation plan also helps to reduce the time required for total annual income under the conservation plan to equal total annual income under the present plan.

How long it will be before accumulated discounted net income under conservation systems of farming exceeds accumulated discounted net income under the present plans is shown (table 34). At a discount rate of 15 percent, 13 years would be needed for plans 3 and 8 on farm 1. The time would be 9 years for plan 3 and 13 years for plan 8 on farm 2. On farm 3 at a discount rate of 15 percent, it would be 16 years before accumulated discounted net income under conservation would exceed that under the present plan. This is also true of plan 7 on each farm for all discount rates and for plan 9 on each farm for all discount rates, except 5 percent on farm 3 which would require 13 years. With a discounting rate of 20 percent, returns from a cash-grain conservation system would never be so high as those from the present system. With intermediate discount rates, a cash-grain system has an advantage in that it allows greater returns over time and its capital requirements are not so great as those for the livestock conservation systems.

The time required for each plan will increase as the discount rate increases. In general, plans 3, 5, and 8 are the most favored when future returns from conservation are discounted.

[27] The formula for determining the present value (V) of a future income is $V=\frac{I}{(1+r)n}$, in which V is the present value, I is the income of the future, r is the interest or returns rate, and n is the number of years.

The present value of incomes over a series of years, 1 to i, is $V=\sum_{n=i}^{n=1}\frac{V_i}{(1+r)i}$, in which Σ refers to sum and i refers to the particular year.

TABLE 34.—*Number of years needed after adoption of conservation farming plans until accumulated discounted net incomes exceed accumulated discounted net incomes under 1944–51 plans, 1952 prices*

FARM 1

Discount rate (percent)	Plan—						
	3	4	5	6	7	8	9
	Years	*Years*	*Years*	*Years*	*Years*	*Years*	*Years*
None	9	14	7	15	(1)	9	(1)
5	10	(1)	7	(1)	(1)	10	(1)
10	11	(1)	8	(1)	(1)	11	(1)
15	13	(1)	9	(1)	(1)	13	(1)
20	(1)	(1)	10	(1)	(1)	(1)	(1)
30	(1)	(1)	(1)	(1)	(1)	(1)	(1)

FARM 2

Discount rate (percent)	3	4	5	6	7	8	9
None	8	11	7	9	(1)	9	15
5	8	12	8	9	(1)	10	(1)
10	9	14	8	10	(1)	11	(1)
15	9	(1)	9	12	(1)	13	(1)
20	11	(1)	10	14	(1)	(1)	(1)
30	(1)	(1)	14	(1)	(1)	(1)	(1)

FARM 3

Discount rate (percent)	3	4	5	6	7	8	9
None	11	13	11	12	(1)	11	12
5	12	15	12	13	(1)	13	13
10	14	(1)	14	(1)	(1)	(1)	(1)
15	(1)	(1)	(1)	(1)	(1)	(1)	(1)
20	(1)	(1)	(1)	(1)	(1)	(1)	(1)
30	(1)	(1)	(1)	(1)	(1)	(1)	(1)

[1] Would not equal net income of 1944–51 system in 16 years.

Constant Prices and Declining Productivity

A conservation cash-grain system would never give as great a nondiscounted net income as the present system on farm 1 under assumptions of constant productivity. But a decline of 1 percent a year in productivity under the existing system would cause returns under the conservation system to become greater in 7 years (fig. 8). With productivity declining at 2 percent, 6 years would be needed; and with productivity declining at 3 percent, 5 years would be required. When future incomes are discounted to give their 1944–51 values in terms of opportunity investment returns, income under the revised system would exceed that under the existing system for discount rates as high as 20 percent. Plan 7, which, assuming constant productivity, would never return as much as the existing plan, gives a higher return when declining productivity is assumed for the existing plan. It would take about 6 years for income to be greater under revised plan 7 and

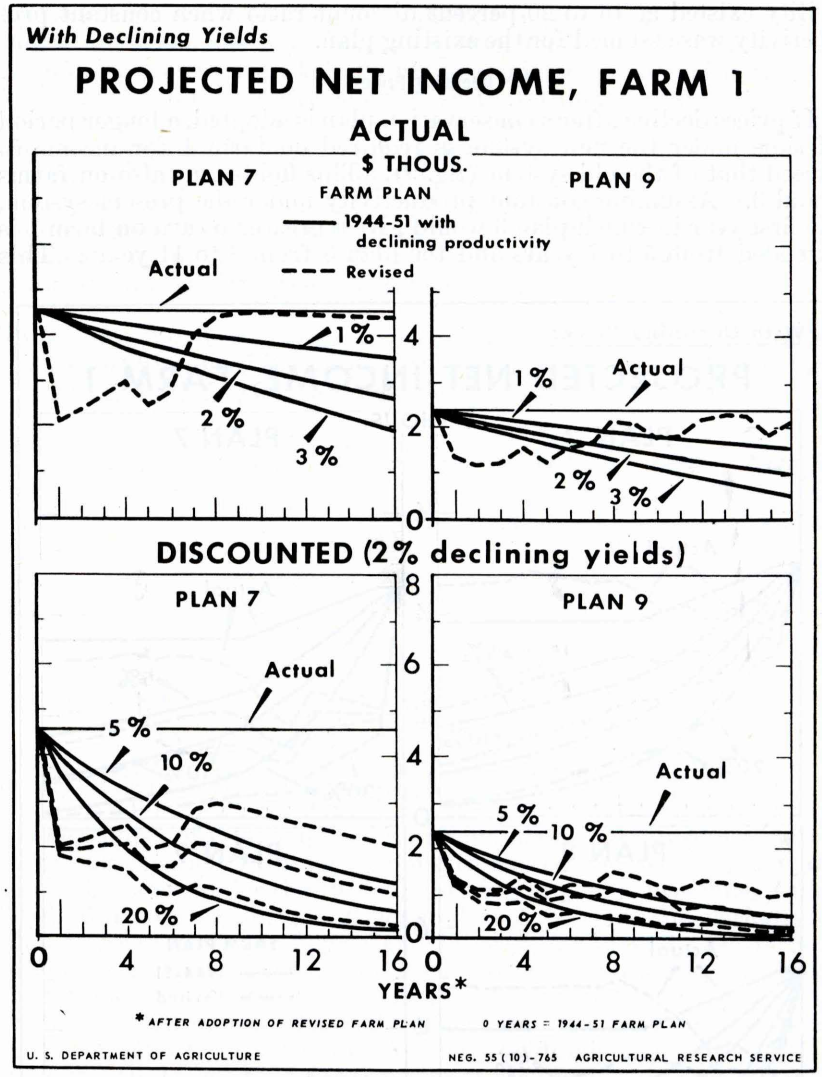

FIGURE 8.—Farm 1: *A*, Annual net income for 1944–51 farm plan with yields declining at 1, 2, and 3 percent and for revised plans 7 and 9; *B*, discounted annual net income for 1944–51 farm plan with yields declining 2 percent and for plans 7 and 9.

even with discount rates as high as 20 percent it would exceed that of the 1944–51 plan. Similar differences exist for farms 2 and 3.

Although, even without figuring a decline in productivity, income from conservation plans would eventually exceed that of the existing plan, the difference is accentuated with assumptions of falling yields under extension of the exploitive farming system. Under declining productivity, incomes from plans 7 and 9 would exceed those of the existing plan with discount rates up to 30 percent. Limits on profit-ability existed at 15 to 20 percent discount ratio when constant productivity was assumed for the existing plan.

Declining Prices

If prices decline after a conservation plan is adopted, a longer period of time under the new system is required on farm 1 for income to exceed that of the old system (fig. 9). This holds true also on farms 2 and 3. Assuming constant productivity under the present system, the first year in which plan 3 would give a greater return on farm 1 is extended from 5 to 7 years and for plan 6 from 8 to 11 years. This

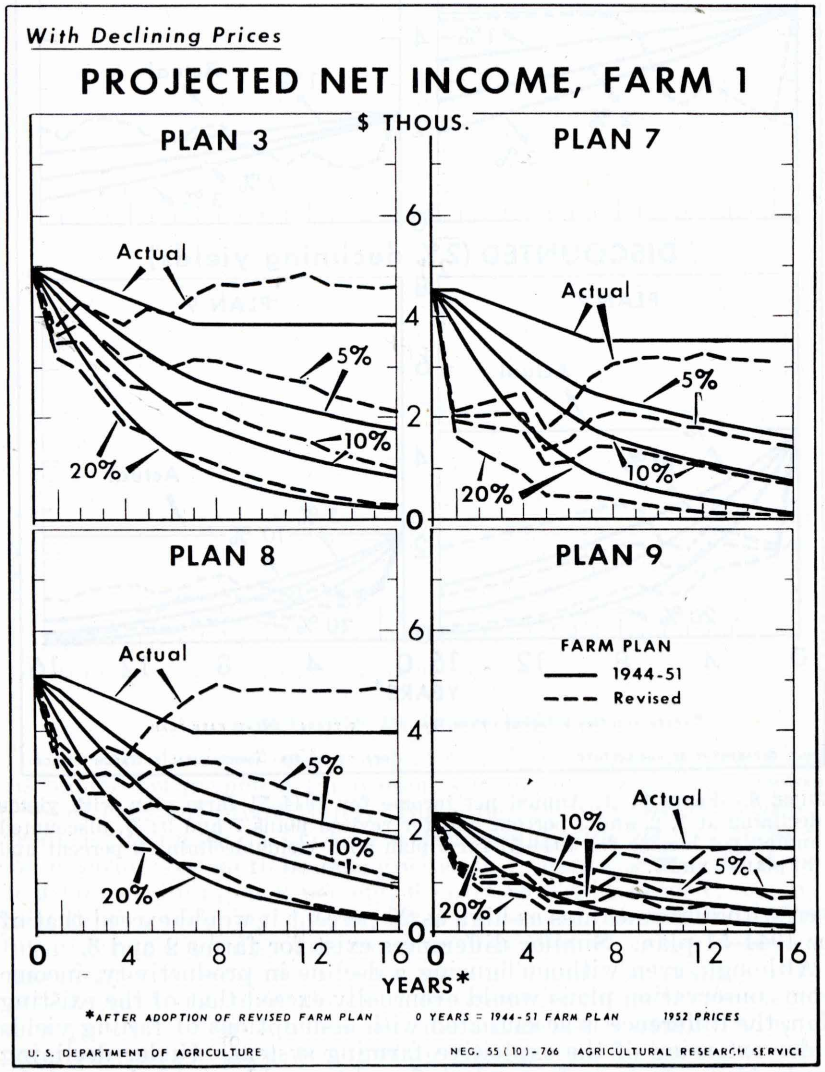

FIGURE 9.—Farm 1: Projected annual net income and discounted annual net income for 1944–51 farm plan and plans 3, 7, 8, and 9 at declining prices.

bothers farmers who cannot risk a decline in prices. It is particularly important when the new farming system requires large amounts of capital. Farmers are likely to resist a shift to a conservation plan with large capital requirements when they think that price declines are imminent. Under these circumstances, conservation planning should emphasize rotations and mechanical practices that give quick returns and require a minimum of funds.

The first year in which each of 9 conservation plans would give a higher annual net income than extension of the present plan under the declining prices used in this study is shown (table 35). A more severe drop would lengthen the time required.

TABLE 35.—*Number of years after adoption of conservation farming plans until annual net income with each of 9 plans is higher than with the 1944–51 plans with declining prices*

Plan	Farm 1	Farm 2	Farm 3
	Years	*Years*	*Years*
1	(1)	(1)	6
2	(1)	(1)	7
3	7	5	6
4	7	6	7
5	5	5	6
6	11	5	7
7	(2)	8	9
8	6	6	7
9	(2)	7	6

[1] Plans are not used because insufficient feed was available with the 1944–51 cropping plan.
[2] Would not equal net income of 1944–51 plan in 16 years.

The number of years required for accumulated discounted net income from conservation farming systems to exceed the accumulated discounted income under the 1944–51 farming system is presented (table 36). With future income discounted at 5 percent, the periods for plan 3 are 12 years for farm 1 and 14 years for farm 3. On farm 1, total accumulated income under conservation plan 3 would not exceed the total under the 1944–51 plan in 16 years with discounting at a rate of 15 percent or more. That is, the 1951 value of future incomes would become greater in 12 years for a farmer who discounts at 5 percent but it would still be less than for the current plan in 16 years for a farmer who has less capital and who discounts at 15 percent. On farm 2, conservation plan 3 would require only 15 years for accumulated income discounted at rates as high as 20 percent to exceed that of the 1944–51 farming system. At 30 percent, accumulated discounted income under plan 3 would never exceed that of the 1944–51 plan. On farm 3, accumulated discounted income is greater for conservation plan 3 in 14 years with discounting at 5 percent; under higher discount rates, the 1951 value of income under conservation would never exceed that of the current plan.

Plan 5 (feeder calves wintered, pastured, and fed in drylot and hogs) compares favorably with the 1944–51 plan. On farm 1, discounted income would be greater for the conservation plan in 12 years

TABLE 36.—*Number of years after adoption of conservation farming plans until accumulated discounted net incomes under conservation farming systems would exceed accumulated discounted net income under 1944–51 plans, declining prices*

Discount rate (percent)	Plan—						
	3	4	5	6	7	8	9
FARM 1							
	Years	*Years*	*Years*	*Years*	*Years*	*Years*	*Years*
None	11	([1])	8	([1])	([1])	13	([1])
5	12	([1])	9	([1])	([1])	16	([1])
10	14	([1])	10	([1])	([1])	([1])	([1])
15	([1])	([1])	12	([1])	([1])	([1])	([1])
20	([1])	([1])	([1])	([1])	([1])	([1])	([1])
30	([1])	([1])	([1])	([1])	([1])	([1])	([1])
FARM 2							
None	9	12	8	10	([1])	10	([1])
5	9	14	8	11	([1])	11	([1])
10	10	([1])	9	13	([1])	11	([1])
15	12	([1])	10	16	([1])	([1])	([1])
20	14	([1])	12	([1])	([1])	([1])	([1])
30	([1])	([1])	([1])	([1])	([1])	([1])	([1])
FARM 3							
None	11	14	12	14	([1])	12	15
5	14	([1])	14	([1])	([1])	16	([1])
10	([1])	([1])	([1])	([1])	([1])	([1])	([1])
15	([1])	([1])	([1])	([1])	([1])	([1])	([1])
20	([1])	([1])	([1])	([1])	([1])	([1])	([1])
30	([1])	([1])	([1])	([1])	([1])	([1])	([1])

[1] Would not equal net income of 1944–51 system in 16 years.

at a discount rate of 15 percent, although the 1944–51 plan gives a greater present value of future incomes at higher discount rates. On farm 2, plan 5 would give a greater discounted income in 12 years at a discount rate of 20 percent.

These data provide some important considerations for conservation programs. They show that the feasibility of a particular plan depends on the individual farm, the amount of capital the farmer has, and, therefore, on his discounting rate. For example, plan 6 on farm 1 would not give a 1951 value of future incomes greater than the current farming system, regardless of the farmer's capital position and discount rate. For farm 2, the same plan would give a 1951 value of future incomes greater than for the current system in 16 years under a 15-percent discount rate. For farm 3, no capital position with a discount rate greater than zero would give a 1951 income value under conservation that would equal that of the current plan in 16 years.

Ways of Reducing Loss of Income in Transition Years

The "income gap" in the first few years after a conservation plan is adopted may prevent many farmers from shifting to a conservation system of farming. Apparently, there are two possibilities for removing these gaps in planning farms for conservation. These are: (1) Use of nitrogen for fertilizer, or other farm practices to increase production and income immediately, when the practices themselves are profitable; (2) extending the time during which various practices and combinations of practices may be adopted and put into effect.

Heavy Application of Fertilizer

Ordinarily, there are additional practices that would be profitable on many farms independently of a soil conservation system. The added income from these additional practices should not be viewed as resulting from the conservation plan. Along with conservation adjustments, these practices are part of the overall management of the farm. One point should be emphasized. Overall farm-management planning of a farm to include both the practices that are and those that are not related to conservation may facilitate adoption of conservation-farming systems that would increase income for a longer period. This would be done by adopting practices that would increase income immediately to offset reductions caused by shifts from

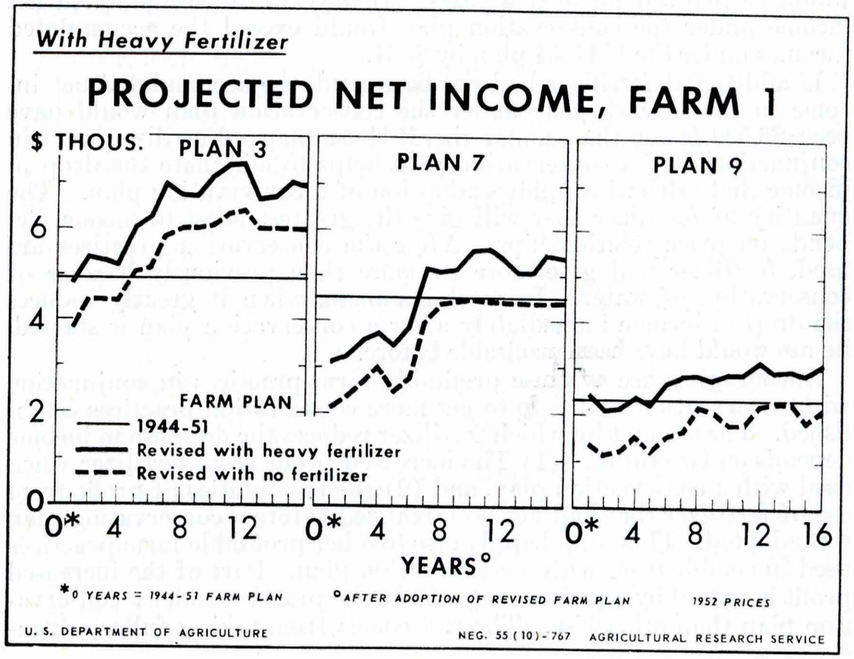

FIGURE 10.—Farm 1: Annual net income for 1944–51 farm plan and for plans 3, 7, and 9, with and without heavy applications of fertilizer at 1952 prices.

grain to forage. Figure 10 shows the influence of heavy applications of fertilizer on nondiscounted net income with 1952 prices on farm 1. Outcomes from applications of fertilizer are similar for all plans.

Additional fertilizer would be applied to corn on the Ida and Monona silt loams on farm 1 to increase the annual yield to 90 bushels per acre.[28] No fertilizer would be applied on Napier silt loam, although perhaps it could profitably use some. The increases in yields of oats and hay that would no doubt occur were omitted from the computations. Their value would more than counteract the cost of harvesting the additional yield of corn. Despite this conservative estimate, net income is increased considerably in the same year the fertilizer is applied. This is important to a farmer whose capital is limited.

As indicated (table 32), plan 3 applied to farm 1 resulted in a drop in annual net income for 5 years. Plans 7 and 9 would produce smaller annual net incomes than the 1944–51 plan for the entire projected period of 16 years. When a heavier application of fertilizer is used in combination with plan 3, net income is about equal to that under the 1944–51 plan the first year and consistently exceeds it in all subsequent years (fig. 10). Under plan 7, instead of remaining consistently lower than under the 1944–51 plan, annual net income would be lower for only the first 6 years after a conservation plan is adopted. Under plan 9, the net income would not always be less under conservation than under the present plan. A reduced income would be realized for only 4 years. In 7 years the accumulated net income under the conservation plan would exceed the accumulated incomes under the 1944–51 plan by $334.

If additional fertilizer had not been used, the accumulated net income in the seventh year under the conservation plan would have been $6,590 lower than under the 1944–51 plan. Fertilizer used in conjunction with a conservation plan helps to eliminate the drop in income that otherwise follows adoption of a conservation plan. The quantity of fertilizer that will give the greatest boost to income depends on price relationships. After the conservation practices are used, fertilizer will give more response than previously because of conservation of water. In most instances, when it greatly reduces the drop in income immediately after a conservation plan is started, its use would have been profitable before.

Encouraging use of these profitable farm practices in conjunction with conservation will help to get more conservation practices established. The amount by which fertilizer reduces the decrease in income depends on two things: (1) The increased profit from fertilizer when used with a conservation plan, and (2) the possibilities of profit from use of fertilizer that had not been realized before a conservation plan was adopted. This would apply also to other profitable farm practices used in combination with a conservation plan. Part of the increased profit is caused by a greater response to the practice under a conservation plan than otherwise. The rest comes from taking fuller advantage of profits from the practice than had been done before. It may also be expressed as an increase in physical response, farm-management efficiency, and profits from a farm practice (not necessarily conservational) when used in combination with a conservation plan.

[28] The amounts needed were based on experimental data on Ida silt loam (*9, pp. 14–15*).

More Gradual Adoption of Conservation Practices

If the conservation plan involves drastic changes in the system of farming, gradual adoption over a period of years will result in a smaller annual reduction in income but for a greater number of years. This may be more attractive to some farmers than a larger drop in income for fewer years. In many instances, a combination of gradual adoption of conservation practices and greater use of fertilizer may provide larger annual net incomes than when either is carried out singly.

FARM PLANNING

It is a reasonable assumption that conservation will always be a part of American agriculture. The longtime prospect, therefore, is that many billions of dollars will be spent to control the movement of soil and water. If maintenance of the productivity potential of the soil justifies a sacrifice of this size by society, conservation deserves the concentrated attention of scientists and legislators alike. Some of the cost of conservation will be borne by farmers and some by society. Regardless of their source or extent, however, resources expended for conservation should be allocated to result in maximum conservation. The basic objective is to acquire the greatest conservation return per dollar invested. This requires that resources be allocated among soils and areas in a way that will equate marginal returns in terms of conservation. Such an allocation requires the use of economic principles.

Unless a clear distinction is made between what is and what is not conservation, the principles of economics cannot be applied properly. An acceptable definition of conservation must, therefore, be used. Heady and Scoville have said that conservation involves maintenance of a production function over time, assuming that inputs will remain unchanged at each point in time (*5, pp. 374–376*). This definition permits the use of economic principles in making decisions as to conservation. Although many of the physical data needed to apply economic concepts to actual farm situations are not yet available, an effort should be made to accumulate them in the years to come.

Governmental participation in conservation will not be limited to farmland. Wildlife, upkeep of roads, bridges and railways, construction of dams, irrigation, and flood control will also receive attention. However, the greatest part of the annual cost of erosion damage to the Nation is from erosion to farmland. Soil conservation, therefore, will absorb all the conservation resources provided by farmers and most of those provided by the Government. Future production of agriculture, farm incomes, and consumption at both the individual and the national level are all involved in conservation farming. Use of limited resources to achieve the highest possible level of conservation on farms, therefore, merits consideration.

Conservation on farms will continue to require cooperative action by farmers and government. Education must play an important role. Each proposal to establish more conservation on a farm involves a change. Farmers, like others, resist change. In general, they believe that they are managing their farms in the most appropriate way to maximize satisfaction, considering the things that they regard as limitations. This does not mean that a farmer will not make a change later if he becomes convinced that the change would better his situation, or at least not worsen it. His values and appraisal of the situation may differ from those of other individuals, but he operates on the basis of his own values.

A farmer cannot be expected to put terraces on his farm, for instance, simply because someone advises him to do so. Before he builds them he must be informed of their possibilities, must be convinced that they will enhance his position, and must want to maintain them for a period of years. Sharing or provision of installation costs by society does not circumvent the requirements mentioned. Lacking sufficient knowledge, some farmers would reject an offer of free terraces. Others might allow the terraces to be constructed on their farms, but they would soon let them fall into disrepair and abandon them because of the inconvenience they would cause relative to the benefits actually, or believed to be, received.

Failure of conservationists to recognize the ramifications of proposed conservation plans on the farm business as a whole is an obstacle to general acceptance of plans by farmers. Conservation involves more than the land resource alone. Decisions on conservation must also recognize the human and capital resources. Although the land resource has gained recognition on the basis of its own specific characteristics on a given farm at a specific point in time, human and capital resources have not received similar consideration. Physical aspects of the conservation problem are now generally regarded to differ sufficiently among farms to require plans that are unique to each farm. The soil varies in slope, in fertility, in its tendency to erode, and in its response to a specific control. Today, recommendations of an agronomic or engineering nature are made on an individual farm basis. Individual differences among farm situations in human and capital resources make it imperative to regard these resources as unique to each farm business.

In drawing up a conservation plan for a farm, it is not a matter of deciding the relative importance of the land, labor, or capital resources. Rather, it is realizing that any one or any combination of them constitutes limitations. To be most effective and acceptable, plans for conservation farming must be in terms of the land, labor, management, and capital situation on the individual farm as they function simultaneously, not singly. In other words, overall farm planning is needed when conservation programs are adopted so that the conservation practices become a part of the farm management.[29]

[29] Overall farm planning does not mean that each farm would be planned or that any would necessarily be planned completely. It does mean that suggested plans for conservation, whether partial or complete, would recognize the entire farm organization.

A conservation plan that is designed according to agronomic and engineering considerations to control erosion within specified limits is inadequate. Such a plan may be the most costly alternative. It may also be the least attractive to the farmer in terms of both farm operation and its effects on capital requirements and net income. The effects of applying a practice or group of practices are not confined to the physical changes in soil loss, runoff, or even in yields. They permeate the entire farm business. As indicated by data in preceding sections, the adoption of a simple practice, such as contouring with a corn-oats-meadow rotation, involves more than physical changes. A farmer must remove old fences, realine field boundaries, and put up a new fence to confine his livestock. This requires a change in labor, capital, and cropping methods. His net income, on which he depends for a living, is affected. If a farmer's values are disregarded, his satisfaction may be lessened.

Adoption of some practices causes even more drastic changes in the farm organization and the problems with which a farmer must contend. A shift from a cash-grain system using a corn-oats seeded with sweetclover rotation to a livestock system using a corn-oats-meadow-meadow rotation causes him to contend with problems that differ from those with which he has dealt previously. He must now decide how to utilize forages through livestock and must depend less on the income from cash crops. He must familiarize himself with the physical and economic relationships—a knowledge of which is needed to permit profitable decisions relating to livestock production. His yields differ and his crops now include meadow. The new organization may necessitate new machinery and building facilities. The capital needed for the changes in the farm business may be impossible for him to manage, even though few, if any, additional costs are involved in adopting the conservation practice. When the combined practice of terracing and contouring is required in addition, the demand for capital is increased. The returns on the investment in the practices may be lower than those from other investment opportunities open to him for the funds he has available.

Many farmers discount future income severely and prefer to invest their capital in shorter run ventures even at a lower rate of interest. The capital position of some farmers forces them to recover their investments after short periods to provide money for consumption or to reinvest in a new opportunity that will be open to them. They prefer, therefore, to invest in something like fertilizer and to recover their initial investment plus a profit 6 months later, so that they can pay a bill or reinvest the money in something like hogs, which also give a quick turnover of capital.

If these and other ramifications of conservation plans are disregarded, the overall program cannot be fully effective. Offering payments to farmers for adoption of conservation practices is not enough. Many practices such as contouring, contour listing, and rotations, considered without regard to the "side" effects they cause, appear to be very profitable. All farmers who have failed to adopt them are not unaware of their profit possibilities. But some reject the practices because they recognize the additional capital requirements that would arise in other sectors of the farm business. They realize also that the decisions they would be required to make in the future would concern alternatives with which they are unfamiliar.

The advice of experts in suggesting physical methods of controlling erosion on individual farms is a necessary step in overall farm planning. It is only the beginning, however. To appraise correctly the overall effects of conservation farming, a farm-management specialist is needed to consult with the conservation specialist on physical practices. The two should consider not only one combination, but all the various practices and combinations that might constitute alternative ways of accomplishing the physical result. In consultation with the farmer, the farm-management specialist would then estimate the effects of each alternative on the entire farm business. The plan adopted would be one that would recognize the farmer's interest as well as that of the Nation. That is, it would be the most efficient plan of conserving soil and water consistent with the maintenance of the farmer's income, his capital position, and his competence and willingness to contend with different decisions in the future.

In some instances the only way of getting conservation adopted may be to recommend the plan that minimizes income sacrifices for the farmer in the years ahead. In other instances it may be desirable to suggest partial adoption of the plan or to plan certain practices at the beginning and then plan additional steps as a more reliable estimate can be made of the effects on the farm business. The latter suggestion would involve a continuous type of planning for a farm. When farmers expect declines in prices, resistance to costly conservation plans increases. It is then, particularly, that planners should emphasize practices which require a minimum of funds and which give quick returns. These might include contouring and improved rotations. Practices that do not have indirect costs to the farm business have a distinct advantage for farmers who are low in capital or managerial ability.

Overall farm planning would include and consider both practices that conserve soil and water by controlling erosion and runoff and those that do not do so. Many of these practices may be profitable whether used with or without a conservation plan. The use of lime, commercial fertilizer, and tile drains are examples. Encouragement of the use of these in combination with erosion and water control practices, especially those that promise low, uncertain, and slow returns, should help to get conservation-farming systems adopted. Profitable practices of this kind help to provide immediate additional income and greater total income over time, thereby counteracting to some extent the reductions in income that result from a shift to more forage and less grain. However, the added income that results from practices that would yield an early return should not be attributed to an effort to control erosion. It is the result of a more profitable managerial use of the resources a farmer controls.

Plans must be geared to the amount of capital a farmer has and to his discounting rate for capital invested in conservation—not in general, but in the practices suggested in the proposed plan. Credit must be made available. The quantity needed to initiate a program depends on the practices involved and the adjustments in the farm organization which their adoption requires. Even after a plan is started credit is needed from year to year. The amounts needed over time also differ among plans. Failure to provide the additional credit needed to keep a plan going results in stagnation or abandonment in many instances. Loans available as needed over time are more desirable than lump sums granted at the time the plan is adopted.

The period for which a loan is made should be governed by the additional revenue likely to result (from the revised organization), its sequence, regularity, evenness of flow, and dependability. A farmer who would not otherwise accept a plan is not likely to be interested simply because a loan is available. He must also be convinced that the prospects are good that he can repay the loan in the specified period from increased income resulting from use of the borrowed capital.

The conservation program could be assisted further by extending credit for specific practices used in or with a conservation plan. Credit would be advanced for use in specified practices only. For instance, capital made available for buying fertilizer would eliminate or shorten the "income drop" which ordinarily accompanies a conservation program that involves large initial costs. Similarly, if credit were advanced only on the condition that a practice such as terracing were adopted (to cover the share of the cost the farmer must assume), and provided then only for payment of that specific bill, it would mean that farmers who are now bypassing the practice because they have more profitable places to invest available funds would adopt it. The period for which the loan should be made should differ with the practice on the basis of how long it would be before the accumulated revenue from additional yield would repay it with interest. That period would vary somewhat with cost-price relationships. Practices that would not result in accumulation of enough additional revenue over a reasonable portion of a farmer's active life (for instance, 15 to 20 years) to pay for the costs of installation should, if believed necessary for conservation of soil and water, be paid for entirely from public funds.

To determine those practices for which farmers should receive payments, enough information should be collected to learn which practices are substitutes and which are complementary. For exact answers to this, more information is needed on the physical side.[30] When practices are substitutes, payment should be made for one but not for both. When practices are complementary, payment would be made only if both were adopted in combination. When forage is complementary with other crops, it should be produced in quantities that will reach the end of the complementary range even if no value is attached to the forage. Erosion would be reduced thereby and the economic product increased with given resources.

[30] The information would take the form of advice of specialists in agronomy and engineering, based on research, on alternative ways of controlling erosion, and on the interactional effects of practices used in combination.

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APPENDIX

Cost of Production of Crops on Farm of 120 Rotation Acres

Costs of production exclusive of conservation costs were computed on a per-acre basis for corn, oats, and alfalfa-brome hay. The method of computation followed a procedure outlined by Jensen.[31] In general, the procedure was to compute an average cost of production of each crop for Ida County and for Monona County for each year from 1948 through 1952, inclusive, to average the estimates for the 2 counties by years, then to average the figures for the 5-year period. Ida and Monona Counties are in the Ida-Monona soil association area in western Iowa where the area studied is located.

In computing costs of crop production, items of costs are divided into two classes—those that vary and those that do not vary with output.

Constant costs are overhead and operating tractor costs, fixed machinery costs, seed costs, building costs, real estate taxes, and operator labor costs. The method of computing overhead and operating tractor costs and fixed machinery costs for 100 acres of corn is shown in tables 37–38.[32]

Annual building costs included depreciation, repair, interest on investment, and insurance. They were based on the capital needed for a 2,050-bushel corncrib and a 2,000-bushel grain bin. The capital needed to construct these buildings was estimated from building plans and building materials requirements lists and the use of current prices for lumber as quoted by local lumber dealers. Labor costs of constructing buildings were estimated at 40 percent of the cost of materials. Building-construction costs (materials and labor) were taken from the Iowa Service Buildings Materials index. Annual costs of depreciation and repair were taken as 3 percent of the construction costs, and annual interest costs were computed with the use of Iowa interest rates on farm-mortgage debts, which were supplied by the Division of Agricultural Statistics, Iowa Department of Agriculture, Des Moines. Insurance costs were computed by multiplying total capital investment by insurance costs per $1,000, taken from statistical tables of Iowa County Mutuals.

The annual tax per acre for each county involved was computed by the Iowa State Tax Commission (*10*). The tax per acre (including land and buildings) for each year is estimated by adjusting the 1947 tax per acre by the index of Iowa farm real estate taxes per acre.

The cost of the operator's labor was estimated by multiplying the hours of labor required per acre by the wage rate per hour. Seven hours per acre were

TABLE 37.—*Annual hours of use and overhead and operating costs for a Farmall H tractor used on 100 acres of corn, 1948–52*

Operation	Speed per hour [1]	Average time lost [1]	Average speed per hour	Width of machine	Work per 10-hour day	Time per acre	Total acres	Total hours
	Miles	*Percent*	*Miles*	*Feet*	*Acres*	*Hours*	*Number*	*Number*
Disking	4.0	16	3.4	11.5	47.4	0.211	200	42.2
Harrowing	4.5	27	3.3	20.4	81.6	.122	200	24.4
Plowing	3.75	18	3.1	2.33	8.7	1.150	100	115.0
Planting	3.5	41	2.1	7.0	17.8	.562	100	56.2
Cultivating	4.0	20	3.2	7.0	27.1	.369	300	110.7
Picking corn	3.25	35	2.1	7.0	17.8	.562	100	56.2
Hauling grain from field to crib [2]								100.0
Total for all operations								504.7

	Dollars
Overhead costs (depreciation, interest, housing, taxes, insurance) with annual use of 505 hours at $0.469 per hour [3]	237.00
Operating costs (fuel, oil, grease, repairs, service) with annual use of 505 hours at $0.536 per hour [3]	271.00

[1] Barger, E. L. Information on Average Tractor Speeds for Farm Operations. (Private communication.) Dept. Agr. Engin. Iowa State College. Ames, Iowa. 1950.

[2] Based on one drawbar horsepower-hour per acre as calculated by E. L. Barger and E. V. Collins (*1, p. 304*).

[3] HUSAIN, S. M. A. COST RELATIONSHIPS IN FARM MACHINERY USE. 1949. (See *p. 68.*) [Unpublished master's thesis. Copy on file, Iowa State College, Ames.] Data reported here were adjusted to 1948–52 prices.

[31] See footnote 8, p. 8.

[32] Jensen's data ended with 1948. His method was used to obtain data for 1948–52, inclusive.

TABLE 38.—*Machine costs (depreciation, interest, insurance, housing, taxes) for 100 acres of corn, 1948–52*

Operation	Times over	Total acres	Cost of use per acre per year	Total costs
	Number	*Number*	*Dollars*	*Dollars*
Disking, 11½-foot, single	2	200	0.160	32.00
Harrowing, 4-section, 20-foot, 5-inch	2	200	.064	12.80
Plowing, 2-bottom, 14-inch	1	100	.467	46.70
Planting, 2-row	1	100	.380	38.00
Cultivating, 2-row	3	300	.150	45.00
Corn picking, 2-row, mounted	1	100	2.600	260.00
Total				435.00
Elevator, electric motor, 2 wagons and gear				140.00
Total				575.00

used for corn. The wage rate per hour was calculated by dividing the wage rate per day without board by 10 hours per day (*11, v. 25*).

Costs that vary with yield and output included shelling costs, hired labor for hauling corn from field to crib, elevating corn into crib, and hauling corn to town. Costs of shelling included man with power and machine at 2 cents a bushel and 0.01 man-hours (based on 10 man-hours per 800 bushels) hired labor per bushel times 63 cents per hour, or 0.63 cents. The cost of labor hired to haul corn from field to crib was estimated on the basis of 0.5 man-hours per acre, or 40 bushels, which would be 0.0125 man-hours per bushel. Multiplying this by 63 cents per hour gave 79 cents. The cost of elevating corn into the crib was the cost of the electricity used estimated at 1 cent per 100 bushels. The cost of hauling corn to town by hired truck was estimated at 2.5 cents per bushel. Total estimated costs per bushel were 5.9 cents.

The price used for seed corn was that paid by Iowa farmers for hybrid seed corn in 1948–52. Total annual per acre costs of seed were calculated by dividing the price per bushel by 6, as 6 acres were planted with each bushel of seed.

The cost of oat seed was based on seeding at a rate of 3 bushels per acre multiplied by the prices paid by farmers for seed oats as obtained from the Division of Agricultural Statistics, Iowa Department of Agriculture, Des Moines. The only building costs included were the annual costs on a 5,000-bushel grain bin. The cost of the operator's labor was based on 5 hours per acre multiplied by the wage rate without board. The variable costs were the labor costs of hauling oats from field to bin, the cost of electrically elevating oats into the bin, and the cost of hauling oats to town by hired truck.

Alfalfa is seeded at a rate of 10 pounds per acre. The seed prices used were those paid by Iowa farmers for alfalfa seed, as reported by the Division of Statistics, Iowa Department of Agriculture, Des Moines. Building costs included only the annual costs for a hay shed. The operator's labor costs were based on 9 hours per acre multiplied by the wage rate per hour without board. The variable costs consisted of hired labor costs for loading, hauling, and unloading hay. This was estimated as 84 man-hours per ton times the wages per hour without board. The total man-hours per ton were estimated at 1.40. Sixty percent of this total was assumed to be hired on the basis of a boy to drive the tractor and the value of the operator's labor off the farm to help his neighbor.

Method of Calculating Terracing Costs [33]

Annual depreciation, interest on investment, housing, taxes, insurance, and cost of lubrication were included in the fixed costs for building terraces. Annual fixed costs as a percentage of original costs were determined and the total was used to find the fixed cost per hour (table 39). The fixed cost per hour was the total percentage that the fixed cost was of the original cost multiplied by the original cost and divided by the annual use in hours. Variable costs included costs of repairs, labor, fuel, oil, and grease. Labor charges for the operator of the tractor and plow were $1 per hour and for the operator of all other equipment $1.50 per hour. Gasoline was charged at 20 cents a gallon and diesel oil at 16 cents a gallon. Oil and grease for the bulldozer was charged at the rate of 20 cents an hour.

[33] See footnote 11, p. 9 (pp. 68 to 70 of report).

TABLE 39.—*Terracing costs per hour with specified kinds of equipment, 1948–52 prices*

Equipment	Cost price	Annual use	Fixed costs per per hour	Variable costs per hour—		Total costs per hour—	
				With labor included	With labor excluded	With labor included	With labor excluded
	Dollars	*Hours*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
2-bottom tractor	1,345	720	(1)	} 1.57	0.57	1.57	0.57
2-bottom moldboard plow	204	350	(1)				
Whirlwind terracer	680	600	0.18	} 3.02	1.52	3.20	1.70
3-bottom tractor	2,800	1,800	(1)				
Bulldozer, 70-horsepower	12,000	1,800	1.40	4.86	3.36	6.26	4.76

[1] No fixed costs on the assumption that the farmer already owns the equipment.

Calculating Gross and Net Income

In the budgets livestock returns were calculated as follows: For yearling steers and calves, the selling value was computed at the Chicago price, minus a 3-percent death loss of the final weight. The buying price for steers and calves was the price at Kansas City for the months in which they were purchased. A return from hogs following the cattle was credited to the beef cattle feeding enterprise. All expenses other than farm feed were deducted from gross returns.

Income from dairy cattle came from sales of butterfat, veal calves, and cull animals (table 40). A credit was given for skim milk used on the farm, which reduced the requirements for other feeds. Cull animals were figured as 20 percent of the herd minus a 3-percent death loss. This left 17 percent of the herd to be sold as culls each year. All expenses other than farm feed were subtracted from dairy income. The feed requirements for livestock are shown in table 41.

Income from beef cows came from the sale of calves and cull beef cows. The calves were sold in the fall rather than fed out on the farm. However, enough calves were held back to furnish herd replacements. The cull cows were figured as one-seventh of the herd each year, minus a 3-percent death loss. This left 11.3 percent of the herd for sale as culls each year. All expenses other than farm feed were subtracted from the beef cattle income.

Income from hogs was calculated by subtracting expenses other than farm feed from the market value of hogs. The market price was figured on a yearly basis, using an average sale weight of 225 pounds. Six pigs were weaned per

TABLE 40.—*Livestock production levels used on 3 representative farms*

Type of livestock	Production		
Dairy cow	327.4 butterfat and a 400-lb. calf at 7 months.		
Beef cow	500-lb. calf at 7 months.		
	Beginning weight	Ending weight	Gain
	Pounds	*Pounds*	*Pounds*
Yearling steer:			
Wintered, pastured, finished in dry lot	604	1,190	586
Wintered, fed on pasture, finished in dry lot	604	1,143	539
Choice steer calf:			
Wintered, pastured, finished in dry lot	440	1,105	665
Wintered, fed on pasture, finished in dry lot	440	1,040	600
Market hog		225	

litter. Feed requirements for sows over and above what was necessary to take them to a market weight of 225 pounds were budgeted.

Table 42 indicates the form that was used in calculating income on farm 2 for a dairy-hog system of farming. This procedure was followed for each livestock combination for each of the three farms.

Income on a cash-grain basis was determined for each of the three farms. All the crops, including hay, were considered as sold off the farm. The value of permanent pasture was considered on a cash rental basis. Because these products were sold off the farm, a lower yield of crops was used than is customary when crops are retained and fed to livestock on the farm.

TABLE 41.—*Livestock feed requirements on 3 representative farms*

Type of livestock	Grain [1]	Hay	Pasture [2]	Total hay and pasture
	Bushels	*Tons*	*Tons*	*Tons*
Milk cow and replacement [3]	43.6	3.5	1.71	5.2
Dairy heifer	5.0	.58	.85	1.43
Beef cow and replacement [4]	4.2	1.58	2.35	3.93
Beef heifer	4.5	.58	.75	1.33
Choice yearling steer:				
Wintered, pastured, finished in dry lot	40.18	1.4	2.4	3.8
Wintered, fed on pasture, finished in dry lot	51.07	1.3	1.9	3.2
Choice steer calf:				
Wintered, pastured, finished in dry lot	46.1	1.9	1.63	3.53
Wintered, fed on pasture, finished in dry lot	55.9	1.72	1.43	3.15
Hog:				
Market hog	13.5	.029	.05	.079
Sow	30.0	----------	.2	.2

[1] Corn equivalent.
[2] Pasture requirements are calculated in terms of tons of hay equivalent. Production of pastureland was figured in tons of hay to make it easier to handle differences in production per acre.
[3] Dairy cattle replacement is calculated to be 20 percent annually.
[4] Beef cow replacement is calculated to be 14.3 percent annually.

TABLE 42.—*Income from dairy-hog system (No. 8), farm 2, 1944–51 cropping plan, declining prices* [1]

Item	Years after adoption of the revised plan—						
	1 (1952)	2 (1953)	3 (1954)	4 (1955)	5 (1956)	6 (1957)	7–16 (1958–67)
Income:	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Skim milk	209.30	204.10	195.85	193.80	188.40	183.25	178.05
Butterfat	1,214.50	1,178.85	1,140.85	1,103.40	1,065.55	1,029.55	991.90
Veal	397.60	375.20	357.00	338.94	320.60	302.54	284.20
Beef (cull)	210.20	200.26	190.23	180.20	170.26	160.31	150.28
Total dairy income	2,031.60	1,958.41	1,883.93	1,816.34	1,744.81	1,675.65	1,604.43
Dairy expenses	260.10	252.55	244.95	237.40	230.70	223.15	215.60
Dairy net income	1,771.50	1,705.86	1,638.98	1,578.94	1,514.11	1,452.50	1,388.83
Hogs:							
Income	7,586.88	7,356.72	7,124.88	6,894.72	6,667.92	6,437.76	6,207.60
Expense	1,579.20	1,533.84	1,488.48	1,443.12	1,402.80	1,357.44	1,312.08
Net income	6,007.68	5,822.88	5,636.40	5,451.60	5,265.12	5,080.32	4,895.52
Livestock net income	7,779.18	7,528.74	7,475.38	7,030.54	6,779.23	6,532.82	6,284.35
Costs:							
Corn and oats	2,167.00	2,103.00	2,038.00	1,976.00	1,920.00	1,857.00	1,795.00
Hay	293.05	284.48	275.94	267.44	259.88	251.37	243.06
Rotation pasture	90.13	87.53	84.90	82.29	79.96	77.34	74.73
Taxes	316.08	321.35	326.62	331.88	330.00	328.00	326.00
Fences	117.00	117.00	117.00	117.00	117.00	117.00	117.00
Total costs	2,983.26	2,913.36	2,842.46	2,774.61	2,706.84	2,630.71	2,555.79
Net farm income	4,795.92	4,615.38	4,432 92	4,255.93	4,072.39	3,902.11	3,728.56

[1] 5 dairy cows and 168 hogs.

Data on Additional Annual and Additional Accumulated Income

Tables 43 and 44 supply additional data to those given in tables 21 and 22 (pp. 42 to 44) for other soils in the Ida-Monona group.

TABLE 43.—*Additional returns from crops and accumulated additional returns per acre, 10-year period following adoption of conservation practices on Monona silt loams, 1948–52 prices* [1]

ERODED MONONA SILT LOAM, 12- TO 20-PERCENT SLOPE

Years after adoption of revised plan	Rotation	Terracing and contouring				Terracing, contouring, and fertilizer			
		Cash grain		Livestock		Cash grain		Livestock	
		Additional returns	Accumulated additional returns	Additional returns	Accumulated additional returns	Additional returns	Accumulated additional returns	Additional returns	Accumulated additional returns
	C–C–O:	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
1	C	2.84	2.84	4.26	4.26	24.66	24.66	15.90	15.90
2	C	6.95	9.79	9.66	13.92	28.06	52.72	20.58	36.48
3	O	4.58	14.37	3.95	17.87	4.76	57.48	7.56	44.04
4	C	12.07	26.44	14.77	32.64	31.76	89.24	26.12	70.16
5	C	13.34	39.78	13.60	46.24	32.32	121.56	24.86	95.02
6	O	3.39	43.17	4.50	50.74	3.10	124.66	6.14	101.16
7	C	11.64	54.81	11.40	62.14	29.34	154.00	22.43	123.59
8	C	10.93	65.74	10.40	72.54	27.78	181.78	21.29	144.88
9	O	2.37	68.11	3.95	76.49	2.00	183.78	4.64	149.50
10	C	9.51	77.62	8.40	84.89	25.08	208.86	18.88	168.40
	C–C–O_s:								
1	C	2.84	2.84	4.26	4.26	17.32	17.32	10.10	10.10
2	C	7.24	10.08	10.37	14.63	21.58	38.90	14.78	24.88
3	O_s	4.66	14.74	5.76	20.39	.34	39.24	3.19	28.07
4	C	13.77	28.51	15.19	35.58	27.54	66.78	21.17	49.24
5	C	12.92	41.43	14.05	49.63	26.40	93.18	20.18	69.42
6	O_s	3.39	44.82	5.60	55.23	−1.00	92.18	3.11	72.53
7	C	11.07	55.89	11.92	67.15	24.13	116.31	18.05	90.58
8	C	10.22	66.11	11.07	78.22	23.00	139.31	17.20	107.78
9	O_s	2.29	68.40	4.42	82.64	−2.35	136.96	1.93	109.71
10	C	8.37	76.77	9.08	91.72	20.72	157.68	15.35	125.06
	C–O_s–C–O–M–M:								
1	C	4.26	4.26	2.84	2.84	10.63	10.63	6.37	6.37
2	O_s	3.08	7.34	2.47	6.31	−.92	9.51	2.83	9.20
3	C	10.36	17.70	8.37	14.68	16.87	26.38	12.19	21.39
4	O	4.34	22.04	5.45	20.13	.42	26.80	4.89	26.28
5	M	3.66	25.70	5.49	25.62	10.98	37.78	10.98	37.26
6	M	3.66	29.36	5.49	31.11	10.98	48.76	10.98	48.24
7	C	13.20	42.56	12.21	43.32	19.71	68.47	16.45	64.69
8	O_s	2.92	45.48	5.60	48.92	−.92	67.55	5.20	69.89
9	C	11.50	56.98	10.65	59.57	18.15	85.70	15.03	84.92
10	O	2.21	59.19	4.97	64.54	−1.54	84.16	4.65	89.57
	C–C–O–M–M:								
1	C	4.26	4.26	2.84	2.84	12.61	12.61	7.91	7.91
2	C	6.81	11.07	5.39	8.23	15.16	27.77	10.46	18.37
3	O	3.79	14.86	4.10	12.33	−1.37	26.40	1.24	19.61
4	M	3.66	18.52	5.49	17.82	10.98	37.38	10.98	30.59
5	M	3.66	22.18	5.49	23.31	10.98	48.36	10.98	41.57
6	C	14.62	36.80	13.49	36.80	22.83	71.19	18.56	60.13
7	C	13.91	50.71	12.78	49.58	22.12	93.31	17.99	78.12
8	O	3.47	54.18	5.92	55.50	−1.85	91.46	2.98	81.10
9	M	3.66	57.84	5.49	60.99	10.98	102.44	10.98	92.08
10	M	3.66	61.50	5.49	66.48	10.98	113.42	10.98	103.06
	C–O–M–M:								
1	C	4.26	4.26	2.84	2.84	9.33	9.33	5.07	5.07
2	O	2.44	6.70	3.23	6.07	−2.41	6.92	.74	5.81
3	M	3.66	10.36	5.49	11.56	10.98	17.90	10.98	16.79
4	M	3.66	14.02	5.49	17.05	10.98	28.88	10.98	27.77
5	C	11.21	25.23	11.64	28.69	18.84	47.72	12.87	40.64
6	O	4.18	29.41	6.55	35.24	−.67	47.05	4.06	44.70
7	M	3.66	33.07	5.49	40.73	10.98	58.03	10.98	55.68
8	M	3.66	36.73	5.49	46.22	10.98	69.01	10.98	66.66
9	C	13.49	50.22	17.04	63.26	23.53	92.54	19.27	85.93
10	O	3.16	53.38	7.90	71.16	−1.70	90.84	5.41	91.34

See footnote at end of table.

TABLE 44.—*Number of years needed to accumulate additional returns from additional yield equal to the additional cost of conservation practices, specified soils and slopes*

ERODED MONONA SILT LOAM, 12- TO 20-PERCENT SLOPE

Conservation practice, type of farming, and rotation	Basis of computing costs per acre							
	Moldboard plow		Whirlwind terracer		Bulldozer		Custom	
	With operator's labor included	With operator's labor excluded	With operator's labor included	With operator's labor excluded	With operator's labor included	With operator's labor excluded	With operator's labor included	With operator's labor excluded
TERRACING AND CONTOURING								
Cash-grain:	*Years*	*Years*	*Years*	*Years*	*Years*	*Years*	*Years*	*Years*
C-C-O	2	1	2	2	4	3	4	4
C-C-O$_s$	2	1	2	2	4	3	4	4
C-O$_s$-C-O-M-M	3	1	3	2	3	3	5	5
C-C-O-M-M	2	2	3	2	5	4	6	6
C-O-M-M	3	1	4	2	5	4	5	5
Livestock:								
C-C-O	2	1	2	2	3	2	4	4
C-C-O$_s$	2	1	2	2	3	2	4	4
C-O$_s$C-O-M-M	2	1	3	2	3	3	4	4
C-C-O-M-M	2	2	2	2	3	2	5	5
C-O-M-M	2	1	3	2	5	4	5	5
TERRACING, CONTOURING, AND FERTILIZER								
Cash-grain:								
C-C-O	1	1	1	1	1	1	1	1
C-C-O$_s$	1	1	1	1	1	1	2	2
C-O$_s$-C-O-M-M	1	1	3	1	3	3	3	3
C-C-O-M-M	1	1	2	1	2	1	2	2
C-O-M-M	3	1	3	1	4	3	4	4
Livestock:								
C-C-O	1	1	1	1	2	1	2	2
C-C-O$_s$	1	1	2	1	2	2	2	2
C-O$_s$-C-O-M-M	3	1	3	2	3	3	4	4
C-C-O-M-M	2	1	2	1	3	2	4	4
C-O-M-M	3	1	3	2	4	3	4	4

MONONA SILT LOAM, 9- TO 15-PERCENT SLOPE

Conservation practice, type of farming, and rotation	Moldboard plow: With operator's labor included	Moldboard plow: With operator's labor excluded	Whirlwind terracer: With operator's labor included	Whirlwind terracer: With operator's labor excluded	Bulldozer: With operator's labor included	Bulldozer: With operator's labor excluded	Custom: With operator's labor included	Custom: With operator's labor excluded
TERRACING AND CONTOURING								
Cash-grain:								
C-C-O	2	1	2	2	4	3	4	4
C-C-O$_s$	2	1	2	1	3	2	4	4
C-O$_s$-C-O-M-M	3	1	3	2	3	3	5	4
C-C-O-M-M	2	1	2	2	4	2	6	6
C-O-M-M	2	1	3	1	5	3	5	5
Livestock:								
C-C-O	2	1	2	1	2	2	4	4
C-C-O$_s$	2	1	2	1	2	2	4	4
C-O$_s$-C-O-M-M	2	1	2	2	3	2	4	4
C-C-O-M-M	2	1	2	2	3	2	4	4
C-O-M-M	2	1	2	1	3	2	4	4
TERRACING, CONTOURING, AND FERTILIZER								
Cash-grain:								
C-C-O	1	1	1	1	1	1	1	1
C-C-O$_s$	1	1	1	1	2	1	2	2
C-O$_s$-C-O-M-M	1	1	3	1	3	3	3	3
C-C-O-M-M	1	1	1	1	2	1	2	2
C-O-M-M	1	1	3	1	4	3	4	4
Livestock:								
C-C-O	1	1	1	1	1	1	2	2
C-C-O$_s$	1	1	1	1	2	1	2	2
C-O$_s$-C-O-M-M	3	1	3	2	5	3	5	5
C-C-O-M-M	2	1	2	1	4	2	5	4
C-O-M-M	3	1	1	2	4	3	5	5

TABLE 44.—*Number of years needed to accumulate additional returns from additional yield equal to the additional cost of conservation practices, specified soil and slopes*—Continued

MONONA SILT LOAM, 2- TO 8-PERCENT SLOPE

Conservation practice, type of farming, and rotation	Basis of computing costs per acre							
	Moldboard plow		Whirlwind terracer		Bulldozer		Custom	
	With operator's labor included	With operator's labor excluded	With operator's labor included	With operator's labor excluded	With operator's labor included	With operator's labor excluded	With operator's labor included	With operator's labor excluded
TERRACING AND CONTOURING								
Cash-grain:	*Years*	*Years*	*Years*	*Years*	*Years*	*Years*	*Years*	*Years*
C-C-O	2	1	2	1	3	2	4	4
C-C-O$_s$	2	1	2	1	3	2	4	4
C-O$_s$-C-O-M-M	3	1	3	2	4	3	7	7
C-C-O-M-M	2	1	2	2	6	2	6	6
C-O-M-M	5	1	5	1	6	5	9	9
Livestock:								
C-C-O	2	1	2	1	3	2	4	4
C-C-O$_s$	2	1	2	1	4	3	5	5
C-O$_s$-C-O-M-M	3	2	4	3	7	4	9	9
C-C-O-M-M	3	2	6	2	7	6	(1)	8
C-O-M-M	5	1	6	2	9	6	(1)	(1)
TERRACING, CONTOURING, AND FERTILIZER								
Cash-grain:								
C-C-O	1	1	1	1	1	1	1	1
C-C-O$_s$	1	1	1	1	1	1	2	1
C-O$_s$-C-O-M-M	1	1	3	1	3	1	3	3
C-C-O-M-M	1	1	1	1	2	1	2	2
C-O-M-M	3	1	3	1	4	3	5	5
Livestock:								
C-C-O	1	1	1	1	1	1	1	1
C-C-O$_s$	1	1	1	1	2	1	2	2
C-O$_s$-C-O-M-M	3	1	4	2	5	3	6	5
C-C-O-M-M	2	1	2	1	2	2	4	2
C-O-M-M	4	1	4	3	5	4	7	5

[1] Practice will not be paid for at the end of 10 years.

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