Costs and Returns for Soil-Conserving Systems of Farming on Ida-Monona Soils in Iowa

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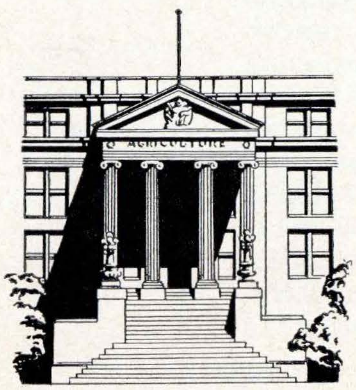

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SUMMARY

Conservation and improvement of the soil is one of the foremost problems facing farmers on the hilly Ida-Monona and associated soils that border the Missouri River bottomlands in western Iowa. Some changes in the present systems of farming, which center around grain crops and drylot fattening of cattle and hogs, are necessary to control serious gully and sheet erosion.

Several alternative ways are suggested by which old gullies can be controlled, new gullies prevented and the productivity of the soil maintained or improved. These are: use of crop rotations which include more acres of grass and legumes; a combination of better rotations and such practices as terracing and contouring; and a combination of better rotations, mechanical erosion-control practices and fertilizer. On 160-acre farms use of rotations alone to control erosion would limit the acreage of grain to about 35 acres of corn and 25 acres of oats. Although about 95 acres of hay and pasture in the crop rotation would increase the yields per acre of grain crops, the percentage decreases in acreage of grain would be much greater and total production of grain would be lowered. Total production of forage would be increased because of the larger acreage, but the increase in forage production would not be enough to offset the decrease in grain production.

A soil-management system built around improved rotations, terraces and contouring would include about 50 acres of corn, 34 acres of oats, and 70 acres of hay and pasture on 160-acre farms. This system of conservation farming would produce more feed than is normally produced with present systems, except on those farms on which 50 percent or more of the cropland is used for corn.

A combination of improved rotations, terraces, contouring and fertilizer would produce more feed on all farms when the conservation systems had been used long enough to reflect the yield-increasing potentialities of the improved practices. On 160-acre farms, about 56 acres would be in corn, 34 acres in oats and 62 acres in hay and pasture.

The greater production of hay and pasture would favor a livestock system of farming, which would require increased investments in livestock, buildings and fences. These greater investments would be in addition to the added investments in terracing and fertilizer. The amount of the investment in livestock and buildings would depend on the soil-management practices and the kind of livestock in the system of farming used to control erosion. Many farmers have already partly achieved conservation through improved rotations, and they have the cattle to use the additional forage. If farmers who were producing 30 acres of forage in 1948, for example, are to achieve a conservation goal of reducing annual soil loss to 7 tons an acre through a system of farming that includes more hay and pasture, terraces, contouring and fertilizer and uses a beef-cow herd to market the additional forage, they must make an additional capital investment of about $5,200 at 1940-44 prices. Of this total about $650 would be for terraces, $90 for fertilizer, $1,900 for building and fencing alterations, and $2,560 for livestock (cattle and hogs). But those who were producing 70 acres of forage in 1948 would need to invest only about $500 more in livestock and a corresponding small amount in building alterations.

Compared with a hog-beef raising system of farming, a hog-dairy system would involve a slightly smaller investment in livestock and buildings, and hogs and yearling steers (wintered, pastured and fed grain in the drylot) would require about 14 percent less.

The change from present to alternative systems of farming would be profitable. Compared with a net farm income of about $1,318 at 1940-44 prices from an exploitive cash-grain system of farming, a soil-conserving cash-grain system would return $1,918; a hog-beef raising system, about $3,158; a system including hogs and yearling steers wintered, pastured and fed grain in drylot, about $3,219; and a hog-dairy system, about $3,271. Comparison of the net farm incomes at a higher price level (approximately 1953 prices) for the same systems of farming shows about $2,301 for the exploitive cash-grain system, $2,588 for the soil-conserving cash-grain system, $5,948 for the hog-beef raising system, $5,459 for the hog-yearling system and $5,518 for the hog-dairy system.

These larger net farm incomes for the soil-conserving systems would not be forthcoming immediately. For a year or two in the transition period, incomes would be lower than with present systems of farming. But as additional capital and labor are employed and become productive through yield-increasing rotations and other soil-management practices and through more livestock, net farm incomes would increase. And within a few years the accumulated net income from the conservation system would exceed the accumulated net income from present systems. The period in which this would occur would be even shorter if allowance were made for the slow but continuous decline in yields of crops that will result if the soil-depleting system of grain farming now practiced is continued.

Costs and Returns for Soil-Conserving Systems of Farming on Ida-Monona Soils in Iowa[1]

BY ROSS V. BAUMANN, EARL O. HEADY AND ANDREW R. AANDAHL[2]

Shifting to systems of farming that include better soil-management practices is a major farm management problem in west-central Iowa. The originally rich, but strongly rolling, loess soils have been progressively damaged by erosion and depletion under systems of intensive grain farming which have persisted since the first settlers broke the prairie sod three to four generations ago.

[1] Project 1085, Iowa Agricultural Experiment Station. This is the second study in a series dealing with farm management and production economics aspects of farming on soils with an erosion hazard. For a report on an earlier study dealing with Marshall soils in western Iowa, see: Heady, Earl O. and Allen, Carl W. Returns from and capital required for soil conservation farming systems. Iowa Agr. Exp. Sta. Res. Bul. 381. For a discussion of fundamental economic principles as they apply to resource conservation generally and soil conservation specifically, see: Heady, Earl O. and Scoville, O. J. Principles of conservation economics and policy. Iowa Agr. Exp. Sta. Res. Bul. 382.

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In the wide strip just back of the Missouri River bluffs which soil scientists identify as the area of Ida-Monona and associated soils (fig. 1), slopes are steep and long. These are the more coarsely textured of the loessial soils, and the subsoils are highly permeable. Water runoff from even moderate rainfall erodes these soils rapidly when they are farmed intensively with intertilled crops. Many farmers plant grain crops on fields in which the slope exceeds 15 percent. Both gully and sheet erosion are serious. Deep straight-walled gullies like those pictured in fig. 3 form quickly. They now divide many farms into several parts, each of which must be cultivated separately. These gullies are rapidly growing larger and more numerous. Annual loss of soil in the area averages about 20 tons an acre. On some farms, it is as much as 60 tons.[3] Sixty tons of soil removed evenly from an acre would be a little less than ½ inch of the topsoil.

Present systems of farming in the area are built around production of corn and oats for feeding to hogs and fattening cattle or for sale, mainly to neighboring farmers for feeding purposes. Although the area generally is spoken of as the Western Livestock Area, it includes many strictly cash-grain farms. Livestock enterprises tend to

[3] Frey, John C. Some obstacles to soil erosion control in western Iowa. Iowa Agr. Exp. Sta. Res. Bul. 391.

Fig. 1. The steep slopes often found in Ida and Monona soils are frequently badly eroded. If caught in time, the gullies may be bulldozed, and the land returned to crop use.

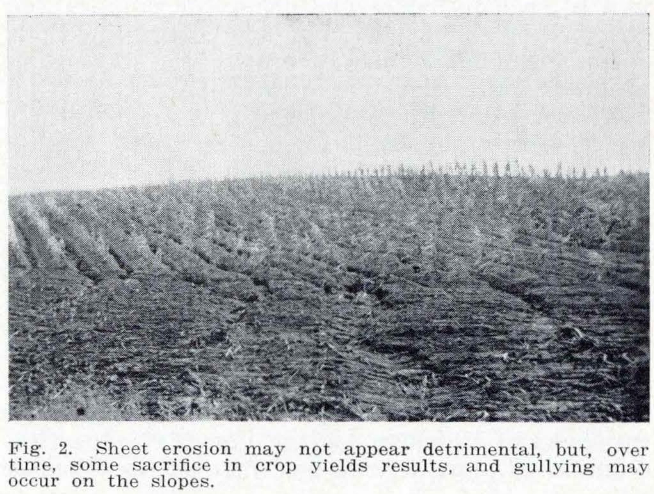

Fig. 2. Sheet erosion may not appear detrimental, but, over time, some sacrifice in crop yields results, and gullying may occur on the slopes.

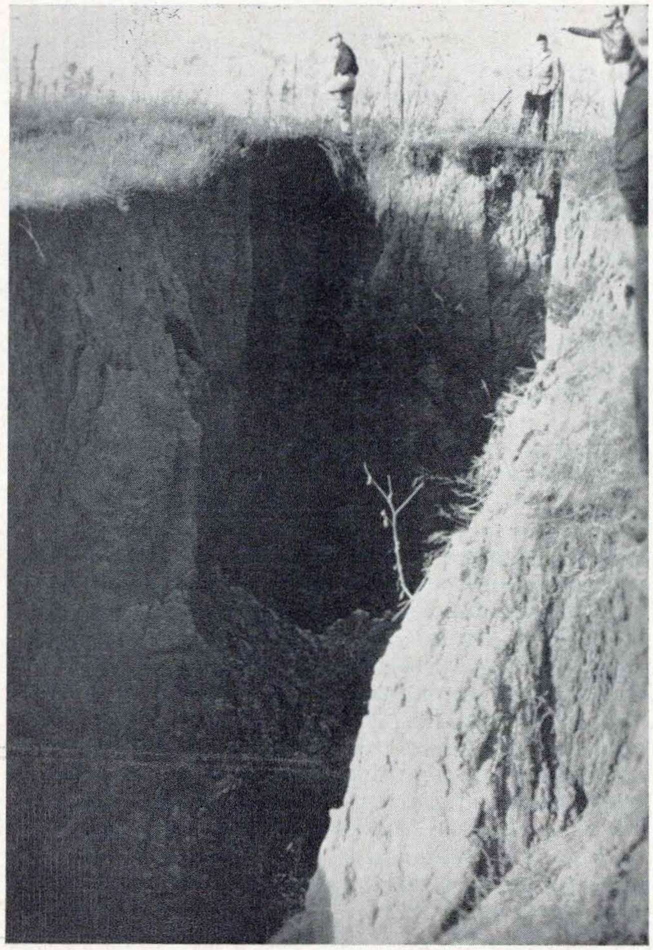

Fig. 3. Deep straight-walled gullies form quickly on the slopes in Ida and Monona soils. Gullies which reach this size are difficult to control.

be located on farms on which a fourth or more of the cropland is used for hay and pasture.

The unusual original depth of the mantle of loess, which ranges from a few to more than 100 feet in thickness, has kept crop yields from declining rapidly as the unprotected top layers have washed from the steep slopes. Consequently, farmers have tended to overlook sheet erosion and to be more concerned about the number and the size of the gullies that are cutting up their farms. But both kinds of erosion are proceeding at an accelerated rate. In Woodbury County in 1947, for example, half of the farms had serious to excessive gullying and severe sheet erosion (table 1). Another 30 percent had serious to severe sheet erosion with occasional to excessive gullying. As the difficulty of farming around deep gullies increases, more farmers recognize that erosion may soon ruin their farms unless they do something about it. But relatively few have made progress in shifting to soil-conserving systems of farming.

Both soil scientists and farm management specialists who have studied the soil conservation problems of this area believe there is a practical solution. Old gullies can be controlled, new gullies can be prevented and the productivity of the soil can be maintained or improved by the use of improved soil-management practices. The job can be done by several alternative ways; for example, by better crop rotations, by a combination of better rotations, mechanical practices and fertilizer. Further, if a farmer applies these recommended conservation practices efficiently and effectively uses the additional forage that would be produced in feeding livestock, he would soon find his new system of farming to be at least as profitable as his present system. Among the available alternative combinations of soil-improvement practices and livestock-feeding systems, some would meet the individual situations of operators who are in favorable capital and tenure positions. Others would be suitable for those who have only limited capital or whose tenure on their present farms is uncertain.

But many farmers are still undecided as to whether conservation systems of farming would pay. Progress has been made in providing farmers with adequate information as to the additional benefits and costs of conservation practices, but many still lack this information or have too little confidence in it to act. Apparently many farmers have made little progress toward greater conservation because they question the profitableness of improved soil management and associated practices. These farmers are particularly concerned about the practicability and additional costs and returns of soil-conservation systems of farming for their own farms.

Study Objectives

The study reported here provides some research evidence, through economic analysis, of the application of suggested adjustments to a sample of farms on Ida-Monona and associated soils. Farms in the sample differ as to the degree of soil conservation already attained. Analysis is concerned chiefly with estimates of long-run costs and re-

TABLE 1. CLASSIFICATION OF SOIL BY DEGREE OF SLOPE AND EROSION, WOODBURY COUNTY, 1947.*

Item and degree	Percentage of land in county
	percent
Percentage slope:	
0 to 1	17.8
1 to 5	13.0
5 to 9	22.4
9 to 14	22.9
14 to 18	12.3
18 to 24	3.9
24 and more	0.6
Degree of erosion:	
None or little	22
Moderate sheet erosion with occasional to moderate gullying	3
Serious sheet erosion with occasional to excessive gullying	19
Severe sheet erosion with occasional to moderate gullying	8
Severe sheet erosion with serious to excessive gullying	48

*Estimates provided by the Iowa Soil Conservation Service.

turns of alternative soil-conservation practices as an integral part of the over-all management of a farm. Thus, it covers all associated practices, especially the important management problem of effectively utilizing the additional forage produced from better crop rotations. But no attempt is made here to maximize returns from the farm through changes in other practices that are not closely related to erosion control.

Specific objectives are to estimate (1) changes in the organizational structure that would be involved in shifting from usual farming systems, which represent various degrees of conservation attainment, to alternative recommended systems that would reduce annual erosion loss to 7 tons of soil per acre, (2) additional capital requirements and (3) additional costs and returns.

Only farms that are homogeneous with respect to size and soils are included in this study. The purposes of this were (1) to eliminate the possibility that differences in production and returns resulting from variations in these factors might be imputed to the use or omission of conservation practices, (2) to provide adequate sampling and (3) to keep the study manageable with limited funds and research personnel.

Methods of Study

The first part of the analysis compares the organization, livestock investment, labor used and returns in 1948 on a stratified random sample of 140, 160-acre farms on the Ida-Monona group of soils.[4] Acreage used for hay and pasture—an index of current conservation status—was the basis of stratification of the farms. Acreage of forage was used for stratification because: (1) It was the only measure of conservation that could be derived from secondary data for sampling. (2) It is the most important conservation practice now used in the area. (3) It is the foundation of recommended practices. Regression coefficients were computed from farm organization data for individual farms to measure the relationship between the variables mentioned above and the degree of conservation. The results are presented graphically. Data for the analysis were obtained from records in the county offices of the Agricultural Stabilization and Production Committees and the Soil Conservation Service and by personal interview of the operators of the 140 farms. Average prices during 1940-44 were used in computing livestock investment and gross income for individual farms.

In the second part of the analysis, budgets for 1948 and for 30 alternative systems of farming were constructed for each of 40 farms which make up a stratified subsample selected from the larger original sample. The 30 alternative systems of farming included a cash-grain system and nine alternative livestock systems for each of three alternative systems of soil management. Each alternative soil-management system would reduce erosion loss to an average of 7 tons per acre per year. The subsample also was stratified according to acreage in hay and pasture. Therefore, comparisons of the budgets for the current and alternative systems of farming for each of the 40 farms show the additional production, resource inputs and returns for each alternative system for a group of farms that differed in level of conservation attainment at the time of the survey. Additional budgets would not need to be constructed if regression analyses were used. The relationship between these additional quantities and the degree of conservation (acres of forage) for the 40 observations provides a basis for estimating inputs or returns for an infinite number of points. Use of a stratified sample and regression analysis recognizes that attainment of conservation on farms is a matter of degree growing out of varying combinations of practices and that the relationship may be treated as a continuous functional relationship between economic returns and input of capital, labor or other resources invested in conservation and related practices. To have presented all of the data only in terms of averages for the entire sample or a limited number of subgroups would have provided less useful information to the many farmers who are not represented by the means.

Budgets for the current systems of farming are based upon the data obtained in the survey plus supplementary data from a second and more comprehensive survey of the 40 farms in the subsample. Yields of crops were adjusted to the average level for 1939-47. Budgets for the alternative systems of farming reflect the recommendations of production specialists as derived from experimental research and observations of the experience of progressive farmers. They represent the organization and expected returns (with prices and costs at the 1940-44 level) after the farming systems have been used long enough to express any increments in physical production and returns resulting from yield-increasing elements of the new plan. Budgets for five of the alternative systems also were computed with a higher level of prices than prevailed in 1940-44. All farms were put on a common income source and debtor basis by excluding minor farm and off-farm receipts, and interest payments in computing net farm income.

Estimates of changes in production, investment, resource inputs (costs) and returns that would accompany shifts from usual to improved systems of farming are presented in the form of means of budget items for each of three conservation groups (low, median and high) and in the form of regressions. Tabular procedure is followed when estimates are made for discrete or minor practices. But inferences based upon these means have the limitations mentioned previously, and they may not reflect differences in adjustment between farms not at the means. Estimated

[4] The sampling procedures and tests for homogeneity are explained in detail in Appendix A.

values for the more important items are presented in the form of regressions to indicate more exactly the differences in adjustment on farms which, at the time of the survey, already had attained particular degrees of conservation. Regressions are presented in linear or curvilinear form, depending upon whether departure from linearity was suggested by conventional probability analysis. The range of the fiducial limits for the relevant probability statements for each relationship is given.

The analysis and presentation emphasizes comparisons between alternative systems of conservation farming from the viewpoint of their relative economic feasibility to individual farmers who differ in capital position, tenure position, farm labor force, managerial ability and ability to withstand risks. Although conservation systems of farming must be tailored to fit soil conditions on the particular farm, land is only one of several resource inputs, all of which must be considered together.

COMPARISON OF FARMS IN THE SAMPLE

Comparison of farms that differ in degree of conservation already attained is one method of analysis for prediction of changes in structural organization and in costs and returns that occur with a shift toward a conservation system of farming. This procedure uses data that reflect the experience of farmers who are in various stages of the process of making adjustments in farming practices. It reveals the characteristics of different farms and groups of farms as they were organized and operated in 1948 and the influence of variations in farming practices upon costs and returns. But generally, as is true here, the sample does not include the full range of potential variations in practices or combinations of practices on farms that are homogeneous with respect to production resources. Furthermore, the experience is response to a past rather than a forward price situation.

General Organization of Farms

About 62 percent of the farms in the sample were operated by tenants. About three-fourths of the operators used a cash-grain system of farming, and one-fourth had a livestock system in which fattening of steers and hogs were the dominant enterprises. Investment in livestock ranged from about $400 to $12,000 in 1947-48 (table 2). These were essentially one-man farms, although the labor force ranged as high as 22 man-months. Land used for grain averaged 97.6 acres, or 60 percent of the land in the farm; 36 percent was in corn. The range of the acreage in corn was from 28.3 to 86.8 acres. Acreage in hay and pasture averaged 57.9 acres, and the range was from 17.0 to 118.6. Acreage in pasture was about three times as large as acreage in hay.

TABLE 2. ORGANIZATION OF 160-ACRE FARMS, AVERAGE FOR 140 FARMS IN 1947 AND 1948.

Item	Unit	Mean	Range	
			Lower	Upper
Labor available	months	14	12	22
Investment in livestock	dollars	2,219	390	11,709
Corn	Acres	57.2	28.3	86.8
Small grains	"	40.4	10.7	51.6
Hay	"	15.5	0.5	80.7
Pasture	"	42.4	13.5	108.2
Grain sold	bushels	1,145	0.0	3,971
Grain bought	"	303	0.0	7,071
Mixed feed (grain equivalent)	"	149	0.0	286
Milk cows	number	3.7	0.0	10.0
Beef cows	"	2.3	0.0	20.0
Litters of pigs	"	11.9	0.0	35.0
Cattle fattened	"	14.7	0.0	128.0
Ewes	"	4.7	0.0	106.0
Hens	"	113.8	0.0	358.0

Acres in Grain and Forage

Figure 4 relates acreage of grain to acreage of forage. Although it may seem obvious that an acre not in forage must be used for grain or some other purpose, the graph has other interesting interpretations for the 140 farms. Forage was less important than grain, as indicated by the position of the line on the chart. The average acreage of forage on the 160-acre farms was in the low forties while the average acreage of grain is in the high nineties. The distributions are skewed to the left —to the lower acreages of forages and to the higher acreages of grain.

Feed Units Produced

Farms in the sample which differed in proportion of acreage in grain and forage crops did not produce significantly different total quantities

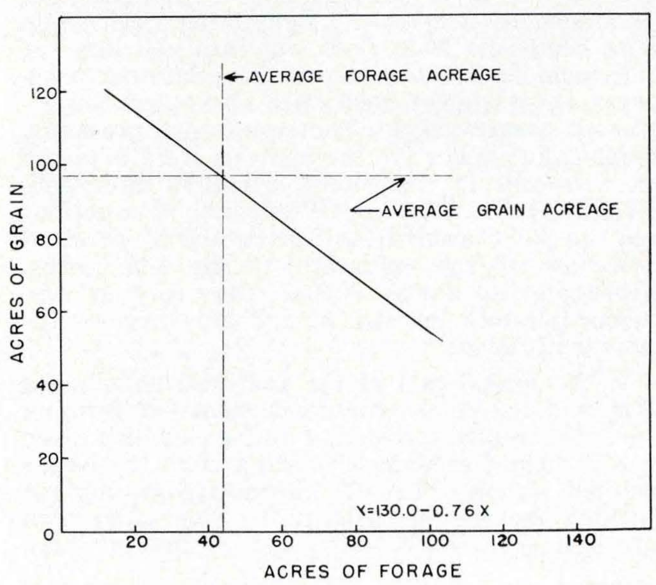

Fig. 4. Relationship between acreage of forage and acreage of grain, 1947-48.

of feed.[5] But a definite relationship existed in the make-up of the feed supply. The relationship is shown in fig. 5. The regression line shows that the percentage of feed units in forage increased and that the percentage in grain declined as acreage of forage increased. The fact that only linear terms were significant in the regression analysis suggests that the complementary effects of forage production on grain production either was the same, regardless of the quantity of forage grown, or did not exist in the range covered (fig.6).

Livestock Investment

The relationship of total livestock investment to acreage of forage is indicated in fig. 7. The average value of livestock investment for all farms in the sample was $2,219 (including breeding stock and animals bought for growing, fattening and replacement purposes). It is evident from the regression relationship that farms on which the acreage of forage was small are largely of the cash-grain type. The bulk of the crops produced on such farms is sold, often to other farmers in the area who carry on extensive feeding operations. Farmers who have small acreages of forage and low investments in livestock are chiefly beginning operators with little capital and low equities in owned land or are tenant operators. It is apparent that alternative soil-conserving systems of farming, such as are discussed in later sections, are needed to fit the circumstances peculiar to each individual farm.

Months of Labor

The amount of labor employed on the farms of the sample did not vary significantly with the acreage of forage.[6] Most farmers in the area reported 12 months of operator labor and several months of family labor regardless of the degree of intensiveness or continuity of farm work throughout the year. Farmers in the sample reported an average of 14 months of labor employed throughout the year. Had it been possible to measure the labor continuously and as actually used in farm work (rather than simply the amount available on the farm), a significant relationship between months of labor and acres of forage might have been obtained. As is brought out later in this report, the budgeted farming systems which include more livestock are relatively more profitable when the additional work can be handled without added hired help.

[5] Using an aggregate measure of feed units based on total digestible nutrients in hay and grain, a regression of feed production on total forage acres was computed. Regression coefficients for neither linear nor squared measures of forage acreage were significant at the 10-percent level of probability.

[6] The computed regression coefficient was not significant at the 20-percent level of probability.

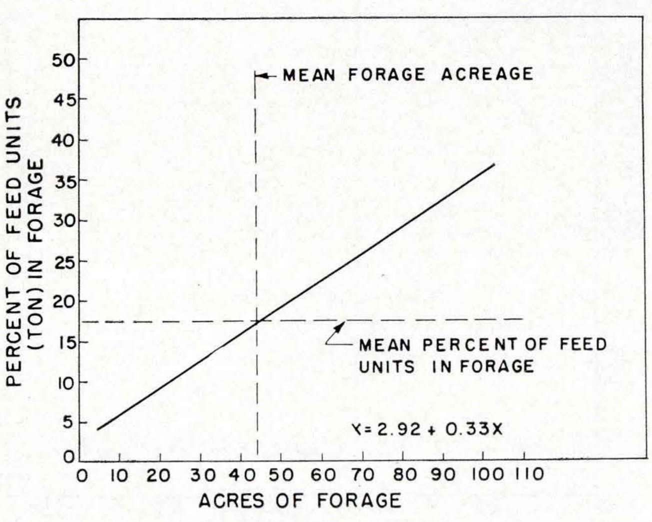

Fig. 5. Relationship between acreage of forage and percentage of feed units in forage, 1947-48.

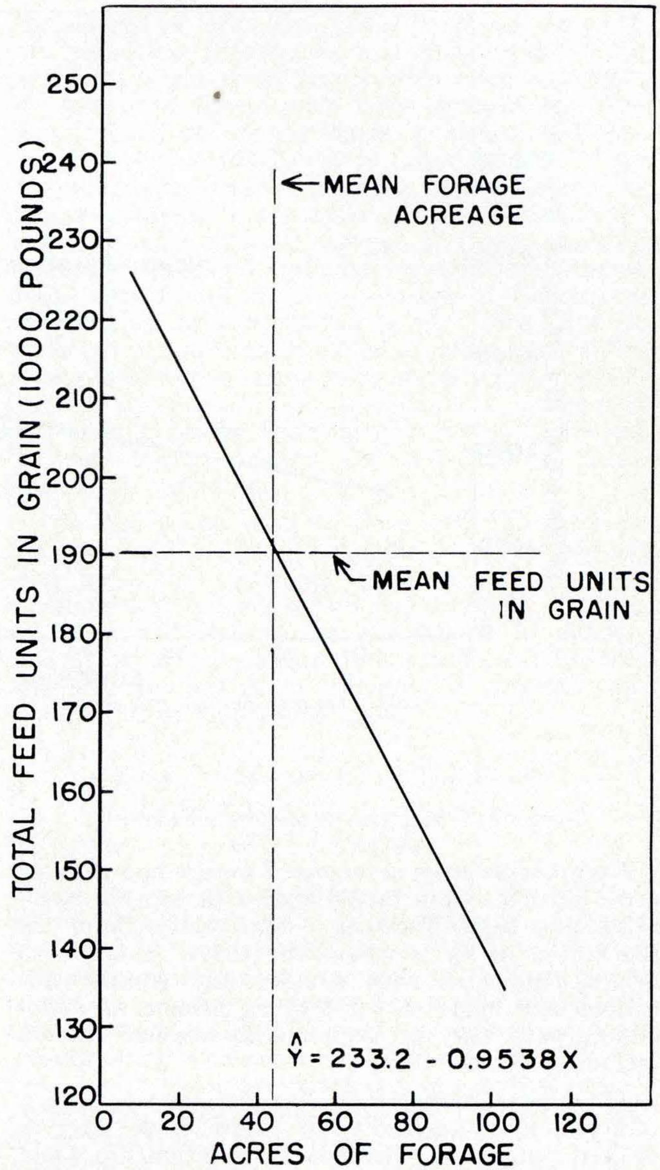

Fig. 6. Relationship between acreage of forage and total feed units in grain, 1947-48.

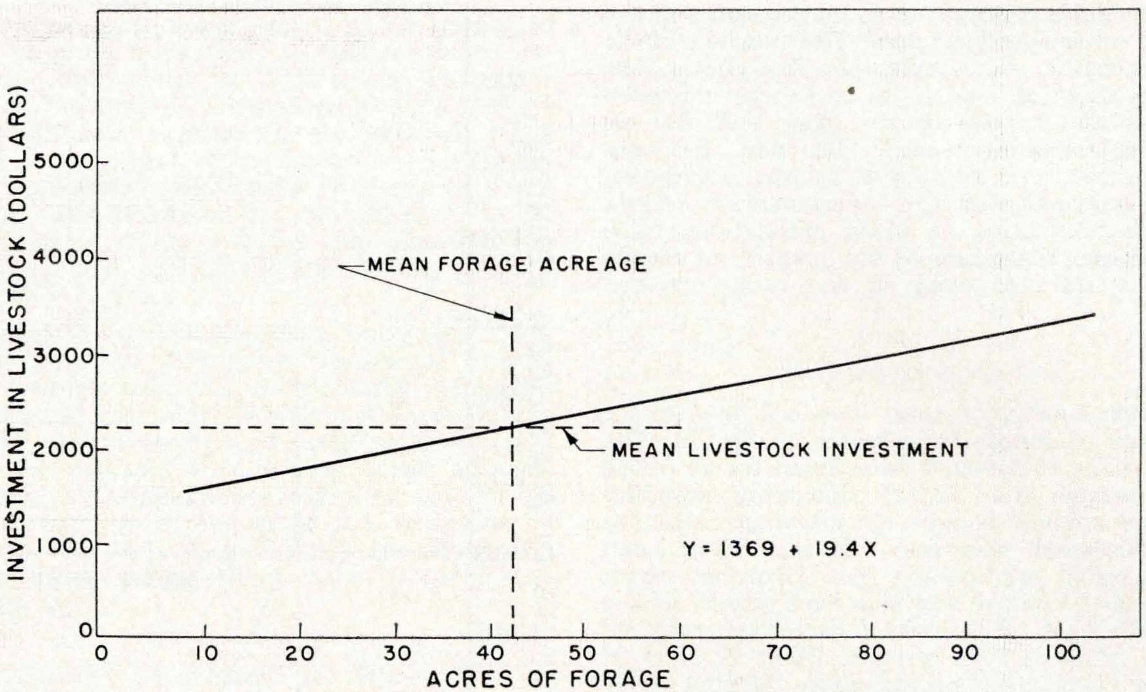

Fig. 7. Relationship between acreage of forage and investment in livestock, 1947-48.

Gross Income and Marginal Returns

Farms with large acreages of forage had greater gross incomes than farms with a cash-grain operation and little livestock. The relationship,[7] as illustrated in fig. 8 where the curve (concave to origin) indicates that smaller and smaller additions are made to total gross income at a declining rate, may be explained by several factors including the following:

(1) Small acreages of forages may serve in a complementary capacity to grain crops over a limited range, and, through this relationship, yield per acre and total production of grain from a given acreage of land are both increased.[8] This complementary effect comes through nitrogen, erosion control and organic matter contributed by forages. Effects of this relationship appear to be rather small or at least not apparent in the data obtained for this study (see fig. 6). Additional acreages of forage did not contribute sufficiently to per-acre yields of grain to cause total grain production from a given acreage of land to continue increasing. Grain yields per acre tend to increase at a decreasing rate as forages add nitrogen and organic matter.

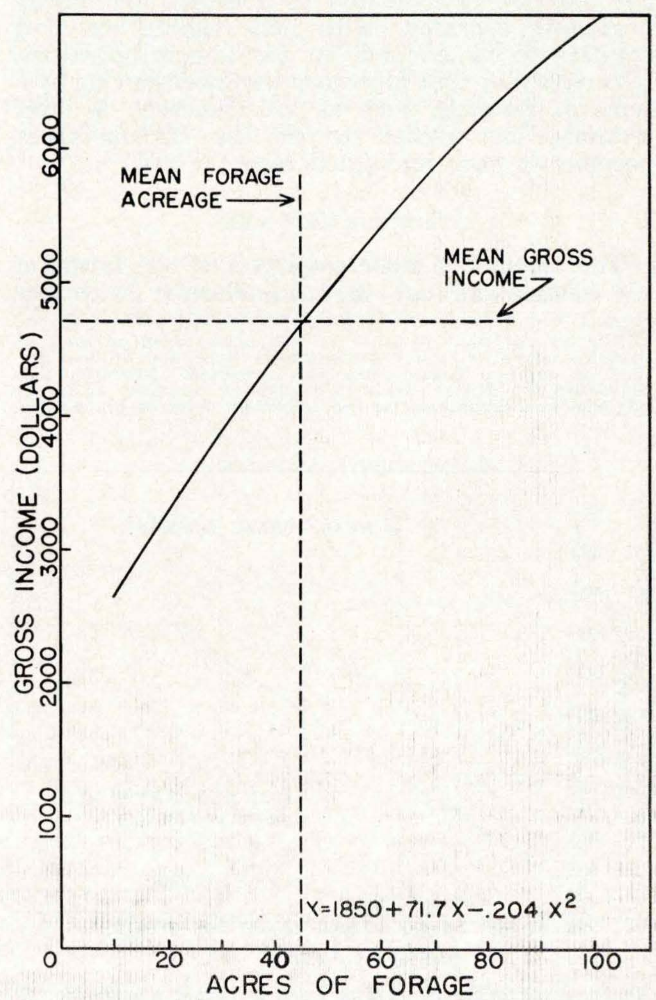

Fig. 8. Relationship of acres of forage to gross income, 1948.

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[7] The regression equation upon which fig. 8 is based is $Y = 1,850 + 71.7X - 0.204X^2$. Using the derivative of this total income equation as related to forage acreage, we obtain $dY/dX = 71.7 - 0.408X$ which indicates the change (marginal quantity) of total gross income for each 1 acre increase in forage.

[8] For a detailed discussion of complementary relationships in the crop rotation see: Heady, Earl O. and Jensen, Harald R. The economics of crop rotations and land use. Iowa Agr. Exp. Sta. Res. Bul. 383; and Heady, Earl O. Economics of rotation with farm and production policy applications. Jour. Farm Econ. 30:645-664. 1948.

(2) The livestock systems followed tended to parallel the line of greatest profitability. Farms with the smallest acreage of forage carried very little livestock. Those with a medium acreage of forage carried livestock which promised the greatest returns from a small investment. Those with a large acreage of forage and greater investment in livestock doubtless selected the most profitable kinds of livestock first and then pushed investment into succeedingly less profitable kinds as capital and acreages of forage were extended.

(3) It is quite likely that management was greater or more efficient on farms with greater acreages of forage, and this may have prevented an even greater rate of decline in the curve.

Gross income tells little about net income and profits. But from the relationship shown in fig. 8 and other derived data, it is possible to estimate which farms had the greatest net farm income in terms of acreage of forage. The specific point of maximum profits has no particular reference to a specific soil-conservation system of farming, but it is of interest in terms of the profitability of various types of farming in the area. Using the data for fig. 8 plus derived cost information,[9] it is estimated that net incomes were greatest for those farms in the sample which had about 71.4 acres of forage.[10] Net income is at a maximum when the addition to gross annual revenue is equal to the addition to total annual costs. For smaller acreages of forage, the addition to revenue is greater than the addition to costs, and net income can be increased by extending both gross income and costs. For larger acreages of forage, the marginal or additional cost is greater than the marginal or additional gross income. At 71.4 acres of forage, marginal or additional cost is equal to marginal or additional gross income, and net income is at a maximum.

These estimates are not highly refined because they include the aggregation of cropping systems, livestock systems and cost structures found on the sample of 160-acre farms.[11] They describe the transition (quantities and structure) of returns and costs from farms with small acreages of forages to farms with large acreages of forage. Farms at the extremes in acreage of forage differed considerably in organization. The estimates serve as a descriptive step in characterizing the farms in the area. However, some individual farms with an acreage of forage greater or smaller than 71.4 acres had greater net incomes than those farms with an acreage of forage approximating this calculated point. This type of variation is due both to sampling error and to the diverse techniques, management and capital structure on the farms. The homogeneity introduced into the sample by limiting the size of farm and the soil types included did not remove these sources of variation.

The foregoing analysis does little to indicate the costs and returns of specific conservation and feed utilization farming systems. The budget analysis that follows serves this purpose. It also indicates the amount of investment in conservation and livestock that is adapted to individual farmers who differ in amounts of capital controlled and in managerial skill.

ANALYSIS OF ALTERNATIVE CONSERVATION SYSTEMS OF FARMING

The purpose of this phase of the study is to examine several alternatives available to farmers in the area in conserving the soil and in utilizing the additional forage produced in different conservation cropping systems. Kinds of adjustments necessary, capital and labor requirements for these adjustments, and costs and incomes of the different systems are estimated through the budget process as outlined in the explanation of methods of analysis.

The best use of forages has become an increasingly pressing problem in western Iowa. Acreages and yields of hay and pasture have increased and the acreage of row crops has shown a relative downward trend in this area in the last 35 years. This is in contrast to a slight increase in row crops in Iowa as a whole.[12] It now appears likely that more forage will aid in reducing erosion to manageable proportions, and the additional forage will require more cattle to process it economically. More forage could be used as a green manure crop, but the returns are likely to be greater if

[9] The equation defining added costs in relation to forage acres has been synthesized or derived from basic figures used in this study and in the studies reported in Iowa Agr. Exp. Sta. Buls. 381 and 389. The equation of total annual costs (outlays) in relation to acreage of forage and livestock systems where C represents total annual costs and X represents forage acreage is $C = 695 + 42.56X$. Using the derivative of this total cost function, we obtain $dC/dX = 42.56$ indicating that the increase in total costs associated with each 1-acre change in forage is constant, $42.56. This includes labor, fuel and seed, repairs and depreciation, taxes, supplies, annual outlays for feeder stock, depreciation on breeding stock, and other items. Its magnitude is great not because forage costs so much per acre but largely because the annual outlay for feeding stock is great for most of the farms producing more forage.

[10] Given the gross income function of equation (1) below and the total cost function of equation (2) below (both in respect to forage acreage) the derivatives become those indicated in equations (3) and (4), respectively:

(1) $Y = 1{,}850 - 71.7X - 0.204X^2$
(2) $C = 695 - 42.56X$
(3) $dY/dX = 71.7 - 0.408X$
(4) $dC/dX = 42.56$.

As we wish to equate additional (marginal) returns to additional (marginal) costs, we can set the derivatives equal in the manner $dY/dX = dC/dX$ and thus obtain equation (5). Solving for X we obtain equation (6) which states that the addition to costs is equal to the addition to revenue and, therefore, that net profit is at a maximum with 71.4 acres of forage.

(5) $71.7 - 0.408X = 42.56$ or $X = (71.7 - 42.56)/(0.408)$
(6) $X = 71.4$.

[11] The gross income and total costs functions of previous paragraphs are not related to farm output, the conventional procedure, but to forage acreage as the latter is more nearly the point of interest in the study here. The total functions presented are "hybrids" of changes in output and changes in products and factor combinations as forage acreage varies from zero upward. The writers are fully aware of this "aggregation." They use the marginal analysis as a simple and appropriate way of presenting the results as compared to alternative methods.

[12] See: Toward a long-range land use and soil conservation policy for Iowa with special reference to a western Iowa problem area. Summary for Soil Conservation Seminar, June 30, 1948. Iowa State College, Ames, Iowa. p. 29.

the forage is fed to livestock and the manure is returned to the land.

Forages are used in various ways in feeding livestock on farms in the area. On many farms, yearling steers or calves are bought in the fall, wintered, pastured in spring and summer, and finished on grain for the fall market. Other cattle-feeding systems are used on individual farms. Small numbers of dairy cows use some hay and pasture on most farms. Beef cows and calves represent one method of utilizing the forage in the area, although small numbers of cows, in combination with other cattle systems, are more characteristic than are large specialized beef cow herds. Each system requires certain additional investments, some in buildings and some in animals. Each type of livestock can be fed many different rations including different proportions of grain and forage. These different rations call for different numbers of animals, different investments in livestock, different periods of production and different amounts of risk and uncertainty.

Conservation Goal and Alternative Ways of Attainment

Agronomists tentatively estimate that if average annual soil losses are held at about 5 tons per acre, permanent soil deterioration is not likely to occur. A loss of 7 tons per acre is taken in this study as a goal or objective to which changes in systems in farming may be directed.[13] This level of soil loss may be attained by using (1) mainly mechanical erosion control practices (terracing and contouring), (2) mainly crop rotation containing more forages or (3) many combinations of the two methods. Conservation is not a discrete phenomenon which must be attained in one degree, or by one method, or not at all. Many possible levels are attainable, and each can be reached by different methods. The economic or farm management problem is one of deciding "which level" and "which method" is most profitable for various farming situations.

Three, somewhat distinct, soil-management systems are studied as a basis for analysis of combined crop-livestock systems. They include (1) rotations alone, (2) rotations, terracing and contouring in combination and (3) rotations, terracing, contouring and fertilizer in combination. A cash-grain system of farming that would reduce erosion to satisfactory levels also is outlined later in this bulletin. Each conservation system is estimated to be capable of reducing erosion to an acceptable level of soil loss per acre. The steeper land is put in grass to decrease erosion to economic levels. The adequacy of a rotation or practice on a particular soil type was arrived at by using the calculations from Browning.[14]

[13] See Appendix B for a statement of the reasons for choosing a goal of 7 tons per acre.

Cropping Patterns

The three soil-management systems that involve changes in crop rotations were applied to each of the 40 sample farms. The particular rotation used on each soil- and slope-group area in the farm, as indicated in detailed soil survey maps for the individual farms, was the one with the smallest acreage of forage that would control erosion at the goal level of 7 tons of soil loss per acre (see Appendix B, tables B-1 and B-2).

The cropping patterns in 1947-48 for the farms were grouped into three categories for comparisons with the recommended pattern (table 3). Although large differences existed among farms in 1947-48, the acreage pattern projected for the alternative systems would be quite similar for the three groups of farms. These similarities suggest that the physical characteristics of the farms are much alike and, in the long-run, that they can carry similar cropping programs.

Use of rotations alone to control erosion would limit the acreage of grain to about 35 acres of corn and 25 acres of oats on these 160-acre farms. Although about 95 acres of hay and pasture in the crop rotation would increase the yields per acre of grain crops, the percentage decrease in acreage of grain would be much greater, and total production of grain would be lowered (table 4). Total production of forage would be increased because of the larger acreage, but meadows in long rotations yield less per acre after the first 2 or 3 years as the stand becomes thinner.

[14] Browning, G. M., Parish, C. L. and Glass, John A. A method for determining the use and limitations of rotations and conservation practices in the control of soil erosion in Iowa. Jour. Amer. Soc. Agron. 39:65; and other materials furnished by the senior author.

TABLE 3. AVERAGE ACREAGE PER FARM OF CORN, OATS AND MEADOW WITH THREE ALTERNATIVE SYSTEMS OF SOIL MANAGEMENT THAT WOULD HOLD SOIL LOSSES TO 7 TONS PER ACRE, COMPARED WITH ACTUAL ACREAGES IN 1947-48.

Group of farms in 1947-48	1947-48 average			Alternative systems of soil management: Rotations only			Rotations, terracing and contouring			Rotations, terracing, contouring and fertilizer		
	Corn	Oats	Meadow	Corn	Oats	Meadow	Corn	Oats	Meadow	Corn	Oats	Meadow
High acreage of forage	44	28	80	31	22	99	49	33	70	55	34	63
Medium acreage of forage	60	39	53	37	26	89	51	35	66	58	35	59
Low acreage of forage	69	50	36	35	24	96	49	34	72	56	34	65

TABLE 4. PRODUCTION OF FEED PER FARM WITH THREE ALTERNATIVE SYSTEMS OF SOIL MANAGEMENT, COMPARED WITH AVERAGE AND ESTIMATED NORMAL PRODUCTION IN 1947-48.

Group of farms in 1947-48	Normal on 1947-48 acreage *			Alternative systems of soil management† Rotations only			Rotations, terracing and contouring			Rotations, terracing, contouring and fertilizer		
	Corn	Oats	Hay	Corn	Oats	Hay	Corn	Oats	Hay	Corn	Oats	Hay
	(bu.)	(bu.)	(tons)	(bu.)	(bu.)	(tons)	(bu.)	(bu.)	(tons)	(bu.)	(bu.)	(tons)
High acreage of forage......	2,275	1,052	64	1,645	793	106	2,563	1,136	95	3,184	1,296	116
Medium acreage of forage	2,907	1,451	55	1,938	931	107	2,703	1,236	101	3,45[illegible]	1,382	115
Low acreage of forage........	3,542	1,555	38	1,808	871	102	2,494	1,210	99	3,174	1,391	119

*Yields obtained in 1947-48 were adjusted to weather conditions equal to the 1939-47 average, which was somewhat more favorable than in 1947 but less favorable than in 1948.
†Yields for alternative systems of soil management are shown in Appendix A, table A-1.

A soil-management system built around improved rotations, terraces and contouring would include about 50 acres of corn, 34 acres of oats and 70 acres of hay and pasture on 160-acre farms. This system of conservation farming would produce more feed than is normally produced with present systems, except on those farms where corn is grown on 50 percent or more of the cropland.

A combination of improved rotations, terraces, contouring and fertilizer would produce more feed on all farms after the conservation systems were used long enough to reflect the yield-increasing potentialities of the improved practices. On 160-acre farms, about 56 acres would be in corn, 34 acres in oats and 62 acres in hay and pasture.

Amount of Terracing Required

Terraces shorten the slopes from which runoff is carried on the land. The terraces decrease both the rate and, to some extent, the total amount of water runoff. Where terraces are used to reduce erosion, a greater proportion of the land may be in grains, and conservation depends to a lesser extent on a large acreage of forage crops. The retention of some extra moisture by terraces is beneficial to crop yields during dry periods in western Iowa. This benefit is in addition to the more effective control of erosion by terracing. In the analysis that follows, other recommended mechanical practices, such as contour listing and contour planting, are used in conjunction with terracing.

The three groups of farms do not differ greatly in estimated amount of terracing required (table 5). Estimates assume that terraces would be put on all land with slopes of more than 4 percent or less than 12 percent (except on the hilltop area before or at the break of the hill such as are found on Monona soils). "It is difficult to build and maintain terraces which have adequate capacity and can be farmed with modern machinery on slopes above 12 percent."[15] Much of the land on many farms is too steep to terrace. Investment in terraces would average $600 to $700 per farm if construction work is hired (table 5). But out-of-pocket costs could be reduced considerably if a farmer does the work himself, when he has no urgent tasks to do, with his own tractor, moldboard plow or a large disk blade. Terracing can be done with these implements at the rate of 1,600 to 2,400 feet of terrace per day.[16] "Out-of-pocket" costs for a farmer doing his own work would amount to only about half the amount shown in table 5. The average for all farms, excluding labor costs, would be $403.

Upkeep on properly constructed terraces is very low; if handled carefully, terraces require very little care other than that encountered in ordinary field work. Ordinarily, terraces are constructed to take care of most unusual conditions but occasional hard rains can cause severe damage. However, to meet all eventualities would be more costly than to repair terraces occasionally. Most recommendations for terracing provide for eventualities that would occur at least once in 10 years.[17]

Response to Fertilizer and Costs

Addition of fertilizer to a cropping program, along with terraces and accompanying mechanical

[15]Hamilton, C. L. Terracing for soil and water conservation. U. S. Dept. Agr. Farmers' Bulletin 1,789. Washington, D. C.

[16]Ibid., p. 49.

[17]Agricultural engineers refer to the overflowing of terraces occurring on the average of once in 10 years as economic construction of terraces. The possibility exists, in this case, that overflowing the terraces might occur in 2 or more consecutive years, but the probability exists that it would not occur again for 18 or more years. The average probability would still be once in 10 years.

TABLE 5. ESTIMATED TERRACE CONSTRUCTION REQUIRED AND COST PER FARM ON FARMS IN IDA-MONONA SOILS AREA OF WESTERN IOWA.

Group of farms in 1947-48	Terrace construction per farm *	Cost per farm at $3.50 per 100 ft.
	(100 ft.)	(dollars)
High acreage of forage	181	634
Medium acreage of forage	200	700
Low acreage of forage	172	602

*Estimated by applying table of requirements for feet of terrace required per acre, as shown in USDA Farmers' Bulletin No. 1789, p. 34, to areas of soil and average percent of slope from soil maps and adjusted for experience with the slopes in the area. That the terraces might not fit field by field is recognized. However, it is believed that the amount of terracing required per farm will be approximately as estimated.

practices, increases the production of both grain and hay. Fertilization is a way of increasing the size of the farm business through the addition of inputs on a given area; more feed can be produced from a limited farm acreage. Output of both grain and hay increases. The proportion of grain to forage does not change much. Both types of crops respond well to fertilizer applications in the area.

Use of fertilizer may facilitate the use of rotations with a slightly higher proportion of grain on some farms. Fertilizer causes a heavier growth of the forage crops and contributes more to erosion control than the same acreage of forage without fertilizers.

Rates of fertilization used in the study are shown in Appendix B, tables B-1 and B-2. No attempt has been made to maximize returns from the fertilizer application itself, and, although other rates of application might be more profitable, the average return per unit of fertilizer used in this study is high. Production under the projected soil-management system, including use of fertilizer with terraces, rotations and contouring, was shown in table 4.

Investment in fertilizer differs from investment in terraces. Terraces normally last for many years. The results from fertilizer are of short duration. Most of the returns from fertilizer are obtained within a crop season or the term of a rotation. Only a small proportion of the benefits extend over a longer period.

Increases in yields (as compared to current yields) because of fertilizer are estimated to be 14 percent for corn on farms with a median to low acreage of forage in 1947-48 and 8 percent on farms that had a relatively high amount of forage in those years. Oat yields per acre would be increased 16 to 25 percent and hay yields about 15 to 20 percent by the use of fertilizer.

The quantity of fertilizer required for the soil-management program indicated in table 4 for the three groups of farms would vary from 420 pounds of nitrogen on the high-forage farms to about 450 pounds per farm per year on farms which the acreage of forage crops was smaller in 1947-48. The quantity of phosphate (P_2O_5) would average from 300 to 350 pounds per farm (table 6).

The average added cost of the nitrogen on all farms would be about $37 at 1940-44 prices for 4-16-8 analysis. Phosphate would cost about $22. The added return at 1940-44 prices would amount to a little more than $700. Even when costs for the fuel and labor used in fertilizer applications are added, use of fertilizer with terracing and contouring would be profitable for all three groups of farms. Response to fertilizer on terraced land may be relatively greater in the Ida-Monona soil area than in other areas because of some additional moisture conserved by terraces.

TABLE 6. ANNUAL FERTILIZER REQUIREMENTS PER FARM FOR INCREASE IN PRODUCTION INDICATED IN TABLE 4.

Group of farms in 1947-48 with:	Nitrogen (N)	Phosphate (P_2O_5)
	(pounds)	(pounds)
High acreage of forage	420	349
Medium acreage of forage	458	300
Low acreage of forage	452	345

Livestock Systems

After the soil-management systems and their costs were computed, nine alternative livestock feeding systems were considered for each farm. These systems included milk cows; beef cows to raise calves; 2-year-old steers fed in drylot; calves or yearling steers, wintered and fed in drylot; calves or yearlings wintered, pastured and finished in drylot; and calves or yearlings, wintered, fed on pasture and finished out in drylot. These cattle systems, which are described in detail in Appendix C, were studied as practical alternatives in using the forage produced under the different soil-management systems.

Each soil-management system has a different proportion of forage and grain feeds, as shown in table 4. In fitting the different livestock systems to the soil-management systems on an individual farm, this procedure was followed: Enough of the particular kind of cattle, based on known feed requirements and combinations, was used to utilize the forage produced; enough grain was withdrawn from production of corn and oats for the grain requirements of the cattle. Feed also was provided for the horses, poultry and a small dairy enterprise on each farm. The rest of the grain was used for a hog enterprise. The hog enterprise thus becomes a residual in terms of feed supplies, and the farms are self-sufficient in feeds in the sense that the entire production would be fed on the farm.

A total of 27 complete organizations that include livestock were considered for each farm—nine livestock systems for each of the three soil-management systems. Numbers of cattle and hogs for each alternative system are shown in table 7. Hog numbers would be smaller than in 1948 on all farms if rotations alone were relied upon for erosion control. The level of dairy production used was 323 pounds of butterfat production per year. This is higher than the average production in Iowa on all farms but it is less than the better dairy herds produce.

Investment in Livestock

The various alternative systems of conservation farming, which differ in soil-management practices and method of utilizing forage, require different amounts of capital invested in livestock. Thus a farmer has numerous alternatives, and he may select a system that fits his own capital position and his ability to withstand risks.

TABLE 7. NUMBERS OF LIVESTOCK FOR SPECIFIED SOIL-MANAGEMENT AND LIVESTOCK SYSTEMS.

Livestock system (including hogs)	Soil-management system					
	Rotations		Rotations, contouring, and terracing		Rotations, contouring, terracing and fertilizer	
	Cattle	Hogs	Cattle	Hogs	Cattle	Hogs
Dairy cows	18	65	17	122	20	155
Beef cow herd	24	102	22	156	26	192
Yearlings wintered, fed in drylot	53	26	50	46	58	68
Yearlings wintered, pastured, fed grain in drylot	26	60	24	109	28	144
Yearlings wintered, fed on pasture, finished in drylot	27	41	26	90	30	120
Calves wintered, fed in drylot	53	6	50	37	58	44
Calves wintered, pastured, fed grain in drylot	26	48	24	104	28	131
Calves wintered, fed on pasture, finished in drylot	29	31	27	82	32	105
Two-year-olds fed in drylot	168	74	157	70	185	82

TABLE 8. TOTAL INVESTMENT IN SPECIFIED KINDS OF CATTLE AND HOGS UNDER EACH OF THE THREE SYSTEMS OF SOIL MANAGEMENT FOR A 160-ACRE FARM, 1940-44 PRICES.

Livestock system (including hogs)	Soil-management system		
	Rotations	Rotations, contouring and terracing	Rotations, contouring, terracing, and fertilizer
Dairy cows	$3,206	$3,303	$3,942
Beef cow herd	3,351	3,431	4,074
Yearlings wintered, pastured and fed grain in drylot	2,128	2,256	2,750
Yearlings wintered, fed on pasture, finished in drylot	2,121	2,254	2,728
Yearlings wintered, fed in drylot	3,900	3,752	4,531
Calves wintered, pastured, and fed grain in drylot	1,704	1,828	2,240
Calves wintered, fed on pasture, finished in drylot	1,616	1,794	2,186
Calves wintered, fed in drylot	2,994	2,867	3,427
Two-year-old steers fed in drylot	16,668	15,563	18,285

DAIRY CATTLE

A dairy cattle herd consumes a large quantity of forage with a minimum of investment and risk. A dairy herd also provides an opportunity for marketing a large amount of labor—though usually at a low rate per hour of labor performed. But for those farmers who want to do the work, there is an opportunity to obtain a high total income; higher than could be obtained by investing a like amount of capital in any other type of cattle.

As the investment in dairy cows is for cattle which remain on the farm for several years of milking, the risk of fluctuation in prices for dairy animals is less important than for fattening cattle, which depend upon a margin between the purchase and sale prices for a profit. One advantage of an investment in dairy cows is that losses in value of the animals need not be taken at the time the change in price occurs; usually it can be postponed for several years. In fact, the loss may be canceled out by future rises in value. Salvage value of a cull cow may not fluctuate widely or be large in comparison with the value of her production.

When rotations alone are used to control erosion, the amount of investment required for livestock with dairy cattle used to consume the forage is about $3,200 at 1940-44 price levels (table 8). This includes a few hogs as well as dairy cows. When terracing and contouring are used with the proper rotations, the investment is $3,300. More hogs and fewer cattle are included in this figure. When fertilizer is added to the soil-management system that includes terracing, contouring and appropriate rotations, more cattle and hogs are included in the investment figure of about $3,950. When terracing and contouring are used to control erosion, less forage is produced relative to grain than when only rotations are used. But both forage and grain are produced in greater quantities when fertilizer is added.

A BEEF COW HERD

Investment in livestock to use the forage is slightly higher for a beef cow herd than for a dairy cow herd. Fewer replacement heifers are needed with a beef cow herd than with a dairy cow herd. Accordingly, more of the forage consumption is by mature beef cows.

A beef cow herd ordinarily utilizes very little grain. Therefore, the grain produced by the three soil-management systems would be fed to hogs. The combination of beef cows and hogs is more specialized than any other cattle-hog system; that is, the cattle get only forage and all of the grain is consumed by hogs.

The beef herd offers the same sort of price risk as dairy cows. Absorption of a drop in price of cows may be postponed for several years. Turnover of investment is shorter in beef cows and hogs than in dairy cows and hogs because less is invested in cattle and more in hogs (compare tables 8 and 9).

The total investment per farm in beef cattle and hogs for each of the three systems of soil management would be: rotations alone, $3,350; rotations, terracing and contouring, $3,430; and the latter system combined with fertilizer applications, $4,075. Total investment in livestock (cattle and hogs) is slightly more for a beef herd than for a dairy herd with each soil-management system.

YEARLINGS WINTERED, PASTURED AND FED GRAIN IN DRYLOT

This system of cattle fattening utilizes more forage per head than most systems common in Iowa. The cattle use a relatively small quantity of grain and a considerable part of the farm supply of grain can be used to produce hogs. Good gains are obtained on grass with a minimum of labor and investment in livestock. Investment in livestock to utilize feed when rotations alone are used to control erosion would be about $2,130; using rotations, terracing and contouring, $2,260; and adding fertilizer to these practices, $2,750.

Fattening cattle in any kind or system of cattle feeding involves considerable price risk compared to a dairy or beef cow herd. The cattle must be sold when fat and within a relatively short period of time. If kept beyond a certain degree of fatness, gains are expensive and mere maintenance would not pay a return on feed or care. Thus, if prices fall, the loss must be assumed at the time or within a few weeks. There is little opportunity to postpone marketing, as can be done with dairy or beef cows which are ordinarily sold only as culls. Once a steer is started on grain it is usually not economical to return to a ration consisting largely of forage. Generally, a part of the returns must be obtained through a margin between the purchasing price and the selling price. This type of cattle is not efficient enough in converting feed to meat to make a profit without a margin.

CALVES WINTERED, PASTURED AND FED GRAIN IN DRYLOT

Calves put on more weight than yearlings and they are kept on the farm longer. Calves would gain 600 pounds and yearlings 557 pounds before being finished to choice grade. More total grain would be required for calves, and so a few less hogs could be raised on the farm. Also, fewer hogs can be supported in the feed lot after the calves. As calves would take longer to finish, the market may be a bit more favorable for them when sold.

YEARLINGS WINTERED, FED GRAIN ON PASTURE AND FINISHED IN DRYLOT

This system of cattle production utilizes slightly less forage than when steers are pastured in summer and then placed in a feed lot. A smaller part of the fattening or growth is made on pasture. Also, if the pasture feed becomes unpalatable, steers will turn more and more to the grain available. Furthermore, a steer may start the fattening process early. Forcing him to consume pasture will be uneconomical, especially if the pasture becomes dry. Hence, full utilization of pasture may be difficult to accomplish. The system has the advantage of providing an alternative feed when the pasture fails to produce. But farmers generally may obtain the same advantage by pasturing steers until the pasture becomes short and then placing the animals in a drylot.

This system of feeding steers on pasture usually obtains high gains per day and often gets the cattle to market before the large movements of grass fat or range cattle arrive.

A disadvantage of this system is the extra labor involved in hauling feed to the pasture and in providing water. This is important because it comes at a time when farm work with crops is also at a peak.

Total investment in livestock is not high; it is about the same as in the system with steers pastured. Investment required in livestock is about $2,120 with rotations; $2,250 with rotations, terracing and contouring; and $2,730 with fertilizer. A little more corn is needed per head for cattle handled this way than where no grain is fed while on pasture. The cattle are in the drylot a shorter time so fewer hogs can be produced behind the steers.

CALVES WINTERED, FED GRAIN ON PASTURE AND FINISHED IN DRYLOT

The difference between calves and steers under this system of feeding and the system with no grain while on pastures is about the same as explained above for the system of pasturing before starting grain feeding. Relative response is about the same, although calves might tend to fall on a less favorable market as they would be marketed a little later than steers.

The required investment in livestock with calves wintered, fed on pasture and finished in drylot would be about $1,600 for the soil-management system using rotations alone to control erosion; $1,800 for the system using rotations, terracing and contouring; and $2,200 for the system using fertilizer in addition to these practices.

YEARLING STEERS WINTERED AND FED IN DRYLOT

Feeding yearling steers in drylot is commonly done in western Iowa. The steers are wintered chiefly on roughage before they are fed grain and hay in drylot in summer. Drylot systems of cattle feeding are discussed here to show some differences between the usual system of cattle feeding and the systems that use more pasture. Fattening cattle on pasture part of the year is generally thought of as a cattle-feeding system that uses forage.

A relatively large number of yearling steers will be required to utilize the forage if the steers are wintered and fed in drylot. Few hogs could be fed, especially when rotations alone are depended upon to control erosion. The quantity of grain produced would be small compared to production of forage.

Total investment in all livestock would amount to about $3,900 for the soil-management system of rotations alone and $3,750 for rotations, terracing and contouring. When terracing and contouring are used, less forage is produced, fewer steers would be needed to utilize it and more grain would be available for hogs. With fertilizer added to rotations, terracing and contouring, more of both grain and forage would be produced, and more steers and hogs could be fed. Investment in livestock would amount to about $4,530.

CALVES WINTERED AND FED IN DRYLOT

Much of the discussion of yearling steers above also applies to calves handled similarly, except that a margin is not so important with calves because more efficient gains are obtained with calves than with steers. Calves bought at 440 pounds make considerable growth before reaching maturity. Growth and fattening of calves can be accomplished with less feed per pound of gain than the mere adding of fat to an older animal. Calves are generally kept on the farm longer than steers. The total amount of weight added is greater with calves (560 pounds) than with yearlings (465 pounds) fed in a similar way. Calves would take more grain but about the same quantity of hay. Accordingly, fewer hogs can be produced with the grain left after feeding the calves from the supply produced on the farm. Also, fewer hogs can be supported after the calves in the feed lot.

Investment in livestock with calves to utilize the forage would be about $3,000 for rotations alone; $2,870 for rotations, terracing and contouring; and $3,425 for the latter practices plus fertilizer.

Ordinarily, somewhat more care is necessary for calves than for yearlings. Feeder calves are not as likely to stand shipping as well as older cattle. Better shelter from wet weather and cold is important for calves.

TWO-YEAR-OLD STEERS FED IN DRYLOT

The greatest investment in livestock would be needed for 2-year-old steers fed in drylot. Usually, each animal consumes only about ½ ton of hay since the cattle are kept on the farm but a short time. Accordingly, a relatively large number of animals would be needed with this system to consume the hay under any one of the soil-management systems.

Amount of investment in livestock required under the soil-management system having rotations alone to control erosion would be large—about $16,670 at 1940-44 price levels. A large quantity of forage would be produced, all of which would be harvested as hay for this particular system. Using such cattle to pasture a part of the forage usually is not done because the large investment per animal makes the risk of loss from price changes relatively high. Consequently, the 2-year-old steers in drylot system is not ordinarily used as a method of consuming forage. The latter is incidental in the minds of those feeding this type of cattle.

Less investment ($15,560) is necessary for this livestock system used to consume the forage from a rotations, terracing and contouring system of soil management as less forage is produced. When fertilizer is added to the system with rotations, terracing and contouring, still fewer acres of forage are grown, but yield per acre is greater, and more steers are needed to consume the larger total production of forage. Investment required in livestock would be about $18,285.

No hogs could be fed on the farm with these systems other than those used to follow the cattle in the feed lot. In fact, grain would have to be bought to finish all the cattle required to utilize the forage.

Investment in Cattle Only

Investment in livestock would be least when forage is used in fattening calves or yearlings, followed by beef and dairy cows and finally by cattle fattened in drylot (table 9). This assumes that only enough cattle would be kept to utilize the forage produced, and all of the grain aside from that necessary to complete the ration of the roughage-consuming livestock was sold. Additional grain would have to be bought for the system with 2-year-old steers because of their relatively low forage requirements and the heavy grain requirements. Thus, for a farmer who is short on capital and who wishes to have only enough livestock to utilize the forage produced, fattening cattle with a combination of pasture and grain would require the smallest outlay.

But utilization is a particular problem only when forage is competitive with grain. So long as forage is complementary, in the sense that additional acreage and production of hay increases total production of grain although corn acreage is smaller, profits can be increased even if the forage is not utilized. The greater production of grain will increase gross profits while costs can be reduced by growing but not harvesting hay. (The

TABLE 9. INVESTMENT IN SPECIFIED KINDS OF CATTLE UNDER EACH OF THREE SYSTEMS OF SOIL MANAGEMENT FOR A 160-ACRE FARM, 1940-44 PRICES.

Kind of livestock	Soil-management system		
	Rotations	Rotations, contouring and terracing	Rotations, contouring, terracing and fertilizer
Dairy cows	$2,912	$2,711	$3,319
Beef cow herd	2,847	2,674	3,147
Yearlings wintered, pastured and fed grain in drylot	1,829	1,703	2,009
Yearlings wintered, fed on pasture, finished in drylot	1,930	1,822	2,133
Yearlings wintered, fed in drylot	3,775	3,525	4,158
Calves wintered, pastured and fed in drylot	1,392	1,297	1,529
Calves wintered, fed on pasture, finished in drylot	1,565	1,457	1,724
Calves wintered, fed in drylot	2,887	2,693	3,173
Two-year-old steers fed in drylot	16,037	15,221	17,700

TABLE 10. INVESTMENT IN CATTLE TO UTILIZE 100 TONS OF FORAGE, BY KINDS OF LIVESTOCK AND BY FEEDING SYSTEM.

Livestock and feeding system	Head required *	Investment 1940-44 prices
Dairy cows	17	$2,781
Beef cow herd raising feeder calves	19	2,302
Feeder cattle: †		
Calves:		
Wintered, feed in drylot	119	6,309
Wintered, fed on pasture, finished in drylot	65	3,450
Wintered, pastured, fed grain in drylot	48	2,544
Yearling steers:		
Wintered, fed in drylot	57	4,151
Wintered, fed on pasture, finished in drylot	31	2,258
Wintered, pastured, fed grain in drylot	23	1,675
Two-year-old steers:		
Fed in drylot only	182	17,661

*Heady, Earl O. and Olson, Russel O. Substitution relationships, resource requirements and income variability in the utilization of forage crops. Iowa Agr. Exp. Sta. Res. Bul. 390. Requirements for calves are estimated from unpublished data.

†Includes wintering and finishing period in drylot.

per-acre cost of growing hay is less than the per-acre cost of growing and harvesting grain.)[18]

Investment in cattle to utilize a given production of forage by kind of livestock and by feeding system is shown in table 10. The table shows the cost of utilizing 100 tons of hay, or its equivalent in combination with pasture, when investment is in various types of livestock at prices equal to the average of 1940-44.

ADDITIONAL INVESTMENT IN LIVESTOCK

Added investment in livestock would differ among farms, depending on the quantity of forage they produced and the investment in livestock in 1948. Generally, farmers who had large acreages of forage in 1948 already had greater investments in livestock to consume the forage; farmers who had few acres of hay or pasture generally were those who sold most of their grain for cash and kept only a few hogs and chickens. Farmers who were already producing large acreages of forage probably would require only small additional investments in livestock. These relationships are shown in figs. 9, 10 and 11 for beef cows, milk cows and yearling steers in drylot.

The line relating investment to current acreage of forage is curved downward in each figure. This indicates that farms with small acreages of forage would require relatively greater livestock investments per added acre of hay or pasture than those with large acreages.[19] The reason is found in the fact that forage would be complementary to grain on farms now using an intensive grain rotation; the shift of land from grain to forage would increase total output of both on many farms.[20]

R = rotations; R-T-C = rotations-terracing-contouring; R-T-C-F = rotations-terracing-contouring-fertilizer.

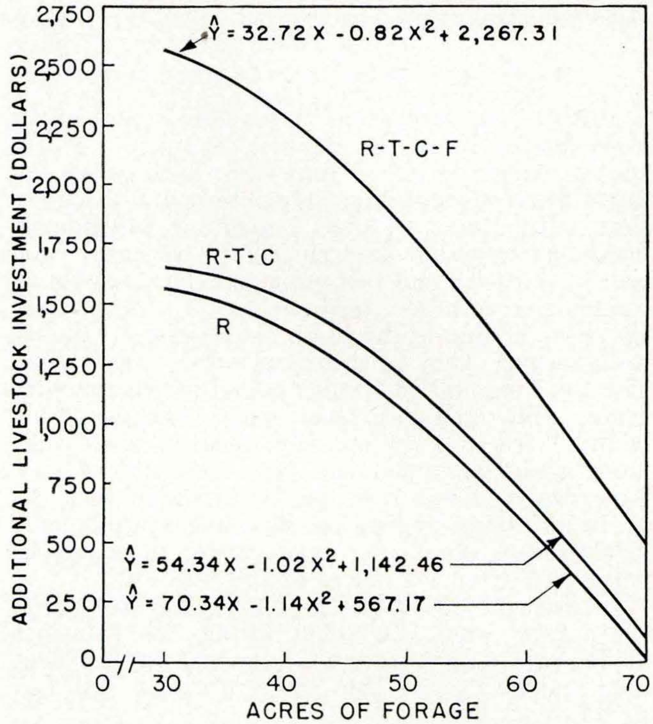

Fig. 9. Relationship between acreage of forage and additional investment in livestock with budgeted conservation farming systems that include beef cows, 1947-48.

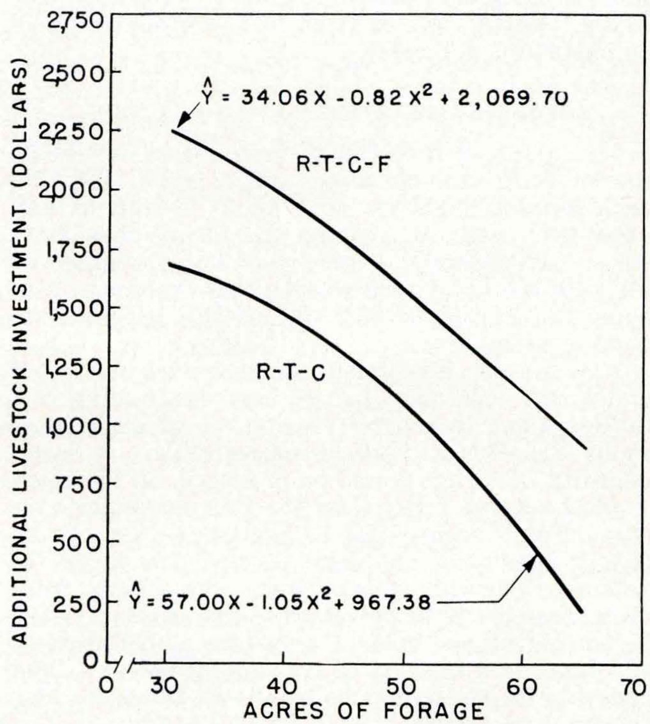

Fig. 10. Relationship between acreage of forage and additional investment in livestock with budgeted conservation farming systems that include dairy cows, 1947-48.

[18]See Heady and Jensen. The economics of crop rotations and land use. op. cit.

[19]In the regressions presented in figs. 9, 10 and 11 the coefficients for the squared term were significant at a probability level of between 1 and 10 percent.

[20]Heady and Jensen. The economics of crop rotation and land use. op. cit.

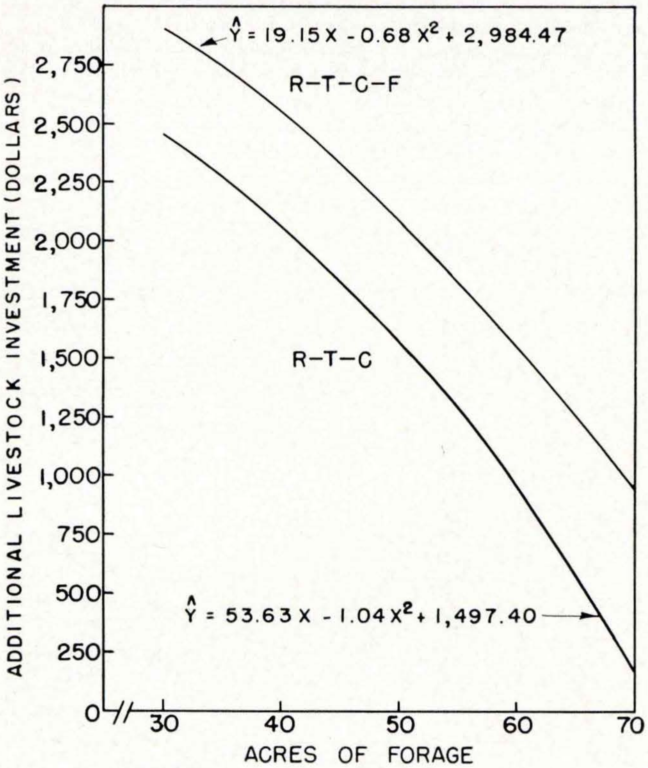

Fig. 11. Relationship between acreage of forage and additional investment in livestock with budgeted conservation farming systems that include yearlings grain-fed in drylot, 1947-48.

The graphs also illustrate some points already indicated in table 8. Added investment for a particular livestock system would be greatest for the soil-management system which included fertilizer because of the greater total production of feed (and because livestock systems have been worked out to use all feed produced). Also, the added investment is much greater for 2-year-old steers than for the other systems of livestock.

These points are important in farm planning. An operator who has been following a cash-grain cropping system and is short on capital is faced with the need of a much greater additional investment to shift to a conservation plan than a farmer who is already doing a fair job of erosion control. This is why it is often easy to get the latter operator to adopt a conservation plan while the former is reluctant to make a complete shift in his operations. Plans that will allow gradual adjustments by operators faced with capital limitations need to be devised.

Labor Inputs

The alternative crop and livestock systems differ in amounts of labor required, which would make some more suitable than others for particular farmers. Some farmers want to integrate their operations so as to use only family labor. Others, because they have housing facilities available or do not look upon cash outlays for hired men as adding excessive risk, are willing to hire additional labor. As indicated in table 11, a dairy cow herd would require more labor than any other type of livestock except 2-year-old steers, which would require a very great amount of labor because of the many animals needed to consume the forage produced. This is also true to a lesser extent with other drylot systems of fattening cattle.

TABLE 11. LABOR REQUIREMENTS FOR A 160-ACRE FARM UNDER SPECIFIED SOIL-MANAGEMENT AND LIVESTOCK SYSTEMS.*

Livestock system (including hogs)	Soil-management system		
	Rotations	Rotations, contouring and terracing	Rotations, contouring, terracing and fertilizer
	(months)	(months)	(months)
Dairy cow herd	17.5	18.3	20.5
Beef cow herd	9.5	10.9	11.8
Yearlings wintered, pastured, fed grain in drylot	10.0	10.7	11.3
Yearlings wintered, fed on pasture, finished in drylot	9.8	11.0	12.0
Yearlings wintered, fed in drylot	13.1	13.2	13.5
Calves wintered, pastured, fed grain in drylot	9.8	10.5	11.1
Calves wintered, fed on pasture, finished in drylot	9.6	10.8	11.8
Calves wintered, fed in drylot	13.0	13.1	13.4
Two-year-old steers fed grain in drylot	19.0	18.3	20.1

*Does not include time of operator or his family that is available but not in use during slack seasons.

Days of hired labor needed per month above that provided by the operator and his family are shown in table 12 for operating the farms with several alternative soil-management and livestock systems. Many farmers probably could delay or plan some jobs ahead so that they could do the extra work themselves, except for the dairy system and the feeding of calves, yearlings and 2-year-olds in drylot. This is true for all of the soil-management systems.

Some of the hired work for the drylot fattening systems would arise because all the forage is harvested and fed as hay, whereas in the other livestock systems part of the forage is pastured. Considerable hired labor would be needed for yearlings fed grain on pasture.

Additional Investment in Buildings

Additional shelter for livestock and storage for grain and hay would be necessary on many farms if soil-conservation systems of farming were adopted. This is true even for those farms which now have large acreages of forage. In this study, space for the alternative livestock systems, including the drylot feeding systems, was considered necessary, even though it is well known that many feeders do not provide shelter other than windbreaks for short-fed cattle. This is somewhat

TABLE 12. DAYS OF HIRED LABOR NEEDED PER MONTH ABOVE THAT PROVIDED BY THE OPERATOR AND HIS FAMILY FOR SPECIFIED SOIL-MANAGEMENT AND LIVESTOCK SYSTEMS FOR A 160-ACRE FARM.

Soil-management and livestock system	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	(10-hour days)											
Rotations:												
Dairy herd—hogs	3	3	8	6	7	12	14	8	10	3	4	4
Beef cow herd—hogs	—	—	—	—	—	1	1	—	—	—	—	—
Yearlings wintered, fed in drylot—hogs	—	—	1	—	—	8	8	—	3	—	1	—
Yearlings wintered, pastured, fed in drylot—hogs	—	—	—	—	—	—	—	—	—	—	—	—
Yearlings, wintered, fed in pasture, finished in drylot—hogs	—	—	—	—	—	2	2	—	—	—	—	—
Two-year-old steers fed in drylot—hogs	17	17	24	—	—	11	11	—	6	16	20	20
Calves wintered, fed in drylot—hogs	—	—	1	—	—	8	8	—	3	—	1	—
Calves wintered, pastured, fed in drylot—hogs	—	—	—	—	—	—	—	—	—	—	—	—
Calves wintered, fed on pasture, finished in drylot—hogs	—	—	—	—	—	2	2	—	—	—	—	—
Rotations, terracing and contouring:												
Dairy herd—hogs	3	3	9	8	10	11	16	12	10	4	7	5
Beef cow herd—hogs	—	—	—	—	—	1	2	—	—	—	—	—
Yearlings wintered, fed in drylot—hogs	—	—	—	—	—	4	6	—	—	—	1	—
Yearlings wintered, pastured, fed in drylot—hogs	—	—	—	—	—	—	1	—	—	—	—	—
Yearlings fed on pasture, finished in drylot—hogs	—	—	—	—	1	1	3	—	—	—	—	—
Two-year-old steers fed in drylot—hogs	15	15	20	—	—	5	7	—	2	17	21	18
Calves wintered, fed in drylot—hogs	—	—	—	—	—	4	6	—	—	—	1	—
Calves wintered, pastured, fed in drylot—hogs	—	—	—	—	—	—	1	—	—	—	—	—
Calves wintered, fed on pasture, finished in drylot—hogs	—	—	—	—	1	1	3	—	—	—	—	—
Rotations, terracing, contouring and fertilizer:												
Dairy herd—hogs	7	6	14	13	15	14	19	17	16	9	14	9
Beef cow herd—hogs	—	—	—	—	1	1	3	—	—	—	—	—
Yearlings wintered, fed in drylot—hogs	—	—	2	—	—	3	5	—	—	1	3	1
Yearlings wintered, pastured, fed in drylot—hogs	—	—	—	—	—	—	1	—	—	—	1	—
Yearlings wintered, fed on pasture, finished in drylot—hogs	—	—	—	—	2	2	5	1	1	—	1	—
Two-year-old steers fed in drylot—hogs	21	21	28	—	—	5	7	1	3	23	29	25
Calves wintered, fed in drylot—hogs	—	—	2	—	—	3	5	—	—	1	3	1
Calves wintered, pastured, fed in drylot—hogs	—	—	—	—	—	—	1	—	—	—	—	—
Calves wintered, fed on pasture, finished in drylot—hogs	—	—	—	—	2	2	5	1	1	—	1	—

risky in some years, especially with calves. As it is generally considered less risky to provide shelter, it has been included for all the livestock systems. In providing space, it was often possible to use present space for cattle and provide new space for hogs. Largest additional investments are for the drylot-cattle systems (table 13). Next largest would be the beef-cow and the dairy-cow systems.

Most of the new buildings would be for hogs, especially for the soil-management systems that include fertilizer. Most of the sheds now on the farm are more suitable for cattle than for hogs. Individual farrowing houses are constructed when space for only a few animals is needed.

Additional Investment in Fences

The cost of additional fencing would be small in comparison with investments in livestock and buildings (table 14). It was assumed that farms would be fenced around the outside. The only additional fence likely to be needed would be a five-strand barbed wire fence around the pasture. New fencing could be of more temporary construction than that now used. Lower costs would be possible if an electric fence were used rather than conventional barbed wire. Additional hog fencing generally would not be needed as fewer hogs would be kept after changing to the conservation systems.

To avoid a large proportion of the point rows that might be necessary, all inside fences would be removed except where permanent pasture would be maintained. Information was obtained for each farm regarding the quantities of wire and posts that could be salvaged from old fence lines. As a result, very little additional fencing materials would be needed on many farms. In most cases an electric fence could be used, but in this study a more permanent fence—more costly but less difficult to maintain—was assumed.

TABLE 13. ADDITIONAL INVESTMENT PER FARM IN BUILDINGS FOR SPECIFIED SOIL-MANAGEMENT AND LIVESTOCK SYSTEMS AT 1940-44 PRICES.

Livestock system (including hogs)	Soil-management system		
	Rotations	Rotations, terracing and contouring	Rotations, terracing, contouring and fertilizer
Dairy cow herd	$ 928	$1,114	$1,855
Beef cow herd	1,002	968	1,859
Yearlings wintered, pastured, finished in drylot	708	827	1,351
Yearlings wintered, fed on pasture, finished in drylot	698	793	1,282
Yearlings wintered, fed in drylot	1,470	1,402	1,989
Calves wintered, pastured, fed in drylot	589	659	1,065
Calves wintered, fed on pasture, finished in drylot	615	650	1,044
Calves wintered, fed in drylot	1,139	1,082	1,582
Two-year-old steers, fed grain in drylot	6,276	6,002	7,461

As might be expected, more fencing was available on high-forage farms that already had livestock. Less additional fencing would be needed by farmers who have made part of the adjustment toward conservation through forages. Table 14 shows that about one-fifth as much fencing would be needed when high-forage farms adjust to conservation systems through rotations, terracing, contouring and fertilizer as when low-forage farms adjust by rotations alone.

Net Income From Alternative Systems

Net farm incomes, budgeted for the livestock systems in combination with three soil-management systems, are those which might be expected after the systems have been in effect long enough to obtain major increments in physical production and income resulting from yield-increasing elements of the new plan and with prices and costs at the 1940-44 level. Incomes shown in table 15 are for the farm as a whole after all expenses, except those for the labor of the operator and his family and interest on investment, were deducted. These incomes are the returns to operators for family labor, capital investment and management. They are considerably lower than the incomes that would be obtained at current price levels. But the relative differences among soil-management and livestock systems are of the kind that might be realized under any price level of the recent past.

TABLE 14. ADDITIONAL INVESTMENT PER FARM IN FENCING MATERIALS FOR SPECIFIED SOIL-MANAGEMENT SYSTEMS ON FARMS CLASSIFIED ACCORDING TO ACREAGE OF FORAGE IN 1947-48 (1940-44 PRICES).

Group of farms in 1947-48	Soil-management system		
	Rotations	Rotations, terracing and contouring	Rotations, terracing, contouring and fertilizer
Low forage	$ 108	$ 82	$ 75
Medium forage	66	46	39
High forage	53	27	21

A soil-conservation system of farming built entirely on rotations gives a much lower income than the other two systems because of the small acreage and production of grains and the relatively smaller production of all feeds shown in tables 3 and 4. Addition of fertilizer to the soil-management system is highly profitable when the feeds are processed through livestock. It permits a greater volume of business from a given area of land. But part of the higher net farm income (column 3 as compared to columns 1 or 2 in table 15) must be attributed to the greater livestock investment and the greater use of labor.

With 1940-44 prices, net farm incomes would be highest for the soil-management system including fertilizer and a dairy herd. The system of farming including dairy cows and hogs would produce a net farm income of about $3,270; beef cows and hogs, $3,160; and feeder yearlings wintered, pastured and fed grain in drylot, $3,220. But as indicated in table 11, dairy cattle and hogs would use considerably more labor than the beef-cattle systems. If all labor were deducted as an expense, returns to capital and management for the three systems of farming would be about $2,000 for dairy cows and hogs, $2,250 for beef cows and

TABLE 15. NET FARM INCOME FOR SPECIFIED SOIL-MANAGEMENT AND LIVESTOCK SYSTEMS AT 1940-44 PRICES *

Livestock system (including hogs)	Soil-management system		
	Rotations	Rotations, terracing and contouring	Rotations, terracing, contouring and fertilizer
Dairy cow herd	$1,579	$2,561	$3,271
Beef cow herd	1,316	2,410	3,158
Yearlings wintered, fed in drylot	1,156	2,118	2,931
Yearlings wintered, pastured and fed grain in drylot	1,390	2,455	3,219
Yearlings wintered, fed on pasture and finished in drylot	1,167	2,126	2,919
Two-year-olds fed in drylot	1,016	1,756	2,429
Calves wintered, fed in drylot	890	1,813	2,420
Calves wintered, pastured and fed grain in drylot	781	1,883	2,620
Calves wintered, fed on pasture, finished in drylot	561	1,647	2,283

*Return for capital and operator's and family labor and management.

hogs and $2,350 for yearling steers and hogs, with the steers wintered, pastured and fed grain in drylot. Dairy and beef cow herds compare favorably with other livestock systems under most cost situations partly because the number of hogs included in the farming system is larger. As previously mentioned, the farming systems were set up to include enough cattle to utilize all of the forage. After grain was withdrawn from the total supply to complete the ration for cattle, hogs were added to consume the rest. Numbers of cattle and hogs under each system are shown in table 7. Most of the hogs in the drylot steer-feeding systems are scavengers in feed lots. Some soil-management systems provide too little grain to support hogs in addition to cattle, and only purchased grain would be available for hogs other than the gleaning from the feed yard.

Organizations with calves are relatively less suitable for the use of large quantities of forage. Costs are larger for calves because the calves are on the farm longer. More grain is needed per head and, accordingly, less grain is left for hogs. Fewer hogs can be fed in the feed lots after the calves.

In other price periods, the relative incomes of the various livestock systems might differ greatly. In 1940-44, the slaughter price of utility grade cattle was high relative to the price of good and choice animals. Accordingly, the premium in feeding heavy 2-year-olds was small because of the price ratios among grades of cattle and the relatively small margin. Price ratios favored calves and yearlings, and, with these animals, profit arises more from feeding than from margins.

Figure 12 shows the difference in net farm income from a system of soil management which includes rotations, terracing, contouring and fertilizer, with yearlings wintered, pastured and fed out in drylot and from the systems used on the 40 farms in 1948. On farms that had the larger acreages of forage in 1948, the increase in income is less, reflecting the smaller additional investment and smaller change in grain and hay production. The regression line falls from an added income of about $1,175 at 30 acres of forage to about $370 at 70 acres.

Greatest opportunities to increase net farm income are on the farms that have not utilized forage for erosion control, for its complementary effects on yields of grain crops or for enlargement of the farm businesses with livestock.

In fig. 13 a similar relationship is shown between additional net farm income and acres in forage, with beef cows used to consume the forage. In comparison with a system that includes feeder yearlings, the additional income is somewhat more on farms on which the acreage of forage was small in 1948, and it slopes off at a faster rate on farms with larger acreages of forage.

COMPARATIVE RETURNS FROM CASH-GRAIN AND LIVESTOCK SYSTEMS

Since many farmers are short on capital, they are interested in a comparison of net farm incomes from cash-grain and livestock systems of farming. Data in tables 16 and 17 were computed as a basis for comparison of five farming systems.

The first cash-grain system assumes an exploitive cropping program, including a rotation of corn-corn-oats with a catch-crop seeding of sweetclover in the small grain for plowing under to provide nitrogen (table 16). This system is close to that used on many farms in the area. Small poultry and milk cow enterprises would normally be kept, but they are not included because they would be similar for all, and income would be increased by an equal amount in all cases. This system would not prevent excessive soil erosion. But for this comparison, no future loss of land area from severe gullying is assumed.

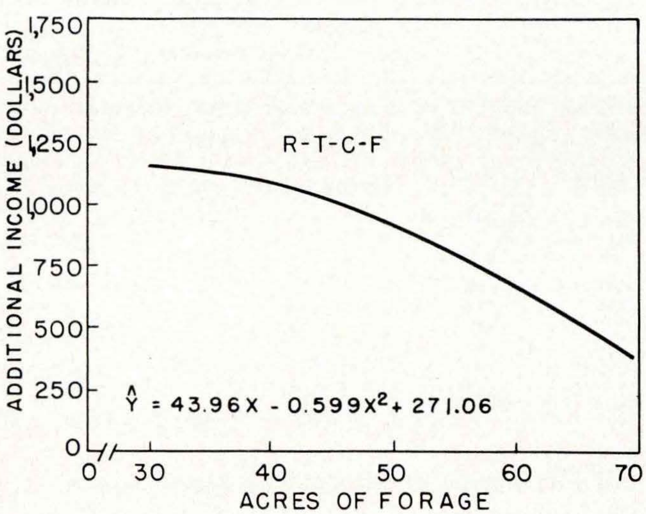

Fig. 12. Relationship between acreage of forage and additional net income with budgeted conservation farming systems that include yearlings wintered, pastured and grain-fed in drylot, 1947-48.

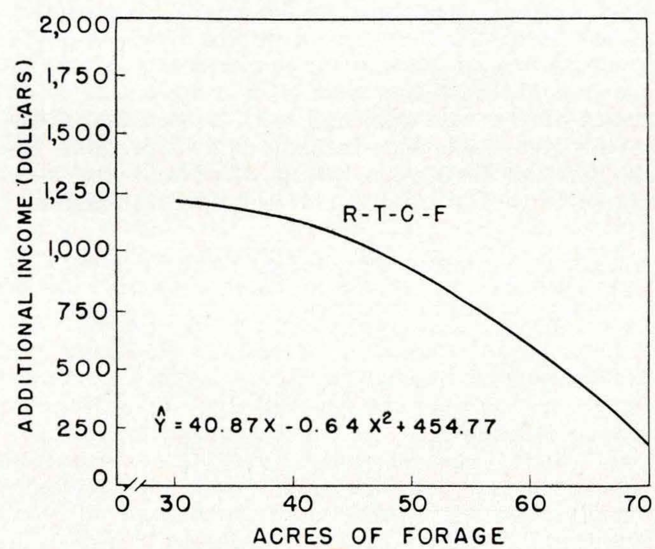

Fig. 13. Relationship between acreage of forage and additional net income with budgeted conservation farming systems that include beef cows, 1947-48.

The second cash-grain system assumes soil-management practices which would hold soil loss at 7 tons per acre per year. A crop rotation that would keep about 40 percent of the cropland in hay would be supplemented with contouring, terracing and fertilization. Yields upon which the production, incomes and costs in table 17 are based are taken from Appendix B, table B-2 in which it is assumed that all crops would be sold from the farm.

Livestock systems assume the same cropping program as for the cash-grain, soil-conserving system but with the crop yields taken from Appendix B, table B-1 for a livestock system of farming. All feeds were allocated to livestock with no grain or hay sold and only protein supplements purchased. The feeder-cattle system — yearlings wintered, pastured and fattened in drylot—and dairy and beef systems are the same as shown in table 15.

The chief difference in investment among the five systems of farming is for livestock and a smaller amount to cover outlays for terraces, fertilizer and fertilizer attachments (indicated as miscellaneous in table 17). The difference in investment between the conserving cash-grain and livestock farming systems, amounting to about $3,500 to $5,700, is important, however, for many

TABLE 16. ACREAGE, YIELD AND PRODUCTION OF CROPS AND NUMBERS OF LIVESTOCK FOR ALTERNATIVE SYSTEMS OF FARMING.

Item	Unit	System of farming				
		Exploitive	Conserving *			
		Cash-grain	Cash-grain	Dairy cow herd—hogs	Beef cow herd—hogs	Yearlings wintered, pastured, fed in drylot—hogs
Acreage						
Corn	acres	99.7	56	56	56	56
Oats	acres	49.8	34	34	34	34
Hay	acres	—	62	62	62	62
Yield per acre†						
Corn	bu.	34.5	52.4	58.1	58.1	58.1
Oats	bu.	23.7	35.4	39.7	39.7	39.7
Hay	tons	—	1.8	1.9	1.9	1.9
Farm production						
Corn	bu.	3,436	2,934	3,261	3,261	3,261
Oats	bu.	1,180	1,204	1,355	1,355	1,355
Hay	tons	—	112	116	116	116
Livestock						
Cattle	number	—	—	20	26	28
Hogs raised	number	—	—	155	192	144

*The soil-management system includes rotations, contouring, terraces and fertilizer, as explained earlier.
†Based on Appendix B, tables B-1 and B-2.

TABLE 17. COMPARATIVE INVESTMENT AND NET RETURNS FOR CASH-GRAIN AND LIVESTOCK SYSTEMS OF FARMING, 1940-44 PRICES.

Item	System of farming				
	Exploitive	Conserving			
	Cash-grain	Cash-grain	Dairy cow herd—hogs	Beef cow herd—hogs	Yearlings wintered, pastured, fed in drylot—hogs
Investment					
Power and machinery*	$4,473	$4,473	$4,473	$4,473	$4,473
Buildings†	6,833	6,968	8,138	8,426	7,729
Livestock‡	—	—	3,942	4,074	2,750
Miscellaneous	—	835	870	868	885
Land	9,682	9,682	9,682	9,682	9,682
Total	20,988	21,825	27,105	27,523	25,321
Gross income	3,143	4,278	7,748	7,141	7.047§
Costs					
Crop	1,738	2,258	2,275	2,275	2,275
Livestock	—	—	1,453	1,505	1,367
Hired labor	—	—	553	21	11
Miscellaneous	87	102	196	182	175
Total	1,825	2,360	4,477	3,983	3,828
Net farm income	1,318	1,918	3,271	3,158	3,219
Operator and family labor	398	559	1,230	923	864
Return on capital and management	910	1,359	2,041	2,235	2,355

*The same set of machinery is assumed for all systems supplemented by custom hiring where necessary.
†Includes present buildings adapted to particular type of livestock.
‡Includes breeding stock plus feeders.
§This figure is computed by subtracting cost of feeders from the sale value.

farmers who have limited capital. The operator who has only enough funds to make a down payment on a farm often finds that his small equity position prevents further borrowing for a large livestock enterprise. A cash-crop system that would attain conservation (in terms of the permissible loss of 7 tons of soil) would require a capital investment of only $837 more than the exploitive system. The additional outlay would be for the initial investment in terraces, fertilizer attachments for machines and for annual costs of fertilizer. While the exploitive system might give greater returns over a period of 1 or 2 years because of the larger acreage of corn, the soil-conserving system of cash-grain farming would give a greater return over a longer period of time. After 2 years much of the corn could be on hayland.

Livestock systems would require more capital, but they would give higher net farm incomes. Added net farm incomes at 1940-44 prices (for the livestock systems as compared to the exploitive cash-grain system) would be $1,884, $2,771 and $2,832 for the dairy, beef cow and feeder systems, respectively. With all labor subtracted as a cost, the added return on the added capital would amount to 17, 19 and 31 percent, respectively—which would be far greater than the cost of credit for the added capital of the dairy, beef and feeder systems.

Even so, operators who have low equities in their farm capital may need and prefer a farm plan which includes cash-grain sales and a very low livestock investment. If we compare only the two cash-grain systems, the soil-conserving system requires $837 more capital than the exploitive one. This is the amount that would be invested originally in terraces and annually in fertilizer. As compared to the exploitive cash-grain system, the conserving cash-grain system would return 15 percent on the additional capital when labor costs are included as an item of expense.

COMPARATIVE RETURNS UNDER HIGHER PRICE AND COST LEVELS

Farm prices are seldom stable, yet there is generally a sort of equilibrium or relationship between prices which farmers expect or base their decisions upon. Supplies of a given commodity may be low 1 year and command a high price, or supplies may be high and command a low price. Farmers react to these high and low prices. If farmers expect the price of hogs to be high relative to other livestock, they will produce more hogs. If they expect the price of hogs to be low relative to other prices, they shift out of hog production.

In formulating farm budgets which show long-time operating conditions, it is wise to select a pattern of prices which reflects the predominating relationships between prices. The price of hogs should bear a rather usual or likely relationship to the prices of cattle, dairy products, poultry and other farm commodities. Otherwise, the outcome of the budget will be biased in favor of one or another product.

In the foregoing analysis of this study, the average prices for 1940-44 were used. The level of prices in 1940-44 was a little higher than the level for 1925-29, but lower than in the World War I period; and, of course, lower than during World War II. The relationship of the price of hogs to the price of cattle was very close to the average relationship for the previous 20 years. This condition was also true of the relationship between hogs and butterfat. These are the main products sold on the farms studied. The various budgets show the effect of substituting one livestock enterprise for another in the farm organization. Therefore, it is important to have price relationships that reflect likely relationships among prices.

The five alternative systems of farming that were compared in table 17 with 1940-44 prices are now compared with a higher level of prices, which approximates the 1953 price situation. The two levels of assumed prices, with comparisions, are shown in table 18. The higher level of hog prices is slightly higher than in 1951 and 1952. Cattle prices are slightly higher than those for 1949. Butterfat is priced at about the average of 1944 and 1945—even lower than in 1949—which appears to be justified in view of the prospects of surplus supplies of fats and the alternative sources of supply in peacetime. Also, the prices of calves and the higher grades of beef cattle were adjusted upward as compared to utility beef. The higher grades appeared to be underpriced with respect to utility beef in 1940 to 1944. The hog-corn price ratio for the above prices is 14—about the same as in 1950 but slightly less favorable than

TABLE 18. ASSUMED 1940-44 AND HIGHER LEVEL PRICES WITH COMPARISONS.

Item	Unit or base	1940-44*	1952	Sept. 1953	Higher level†
Yearlings, fat, choice	cwt.	14.94	32.50	24.97	26.60
Yearling feeders	"	11.95	27.13	18.50	22.70
Feeder calves	"	12.05	29.14	17.58	22.80
Beef cows, cull	"	10.86	21.74	12.41	18.25
Dairy cows, cull	"	9.00	20.00	10.50	15.35
Hogs	"	10.94	17.40	24.00	18.50
Cottonseed meal	"	2.89	5.60	4.60	4.40
Tankage	"	3.64	6.40	4.95	5.76
Corn	bu.	0.75	1.45	1.44	1.32
Oats	bu.	0.48	0.77	0.71	0.70
Hay, alfalfa baled	tons	13.39	18.00	18.10	16.34
Butterfat	lbs.	0.415	0.79	0.70	0.60
Index of prices paid by farmers	1910-14 = 100	156	387	277	281

*A more detailed table of prices for farm products and items of cost is presented in Appendix F.

†Compared with prices in 1940-44.

in the 1940-44 period (14.5). The index of prices received by farmers is in the neighborhood of 250 to 255. The prices paid by farmers reflect an index level of 281 (1910-14 = 100) as compared to 156 for 1940-44. This allows for the squeeze between prices paid and prices received. This squeeze has been experienced by agricultural producers since World War II and is likely to be in evidence for some time to come.

The net farm incomes with the higher prices were $5,948 for the beef-cow-herd system, $5,518 for the dairy-herd system and $5,459 for the yearling-steer system (table 19). The price for feeder calves was increased relatively more than for the other livestock. Prices for butterfat were increased even less and the net incomes reflect these relative changes. Whereas incomes for the beef-cow-herd and dairy-cow-herd systems would be about the same with 1940-44 prices ($3,158 vs. $3,271), net income from the beef-cow-herd system would be somewhat higher than that from the dairy herd with the higher level of prices. The upward change in incomes from the dairy-cow system and the steer system would be about the same.

Little change can be noted in the relationships of the cash-grain systems of farming, either when compared to each other or to the livestock systems. The net income from the cash-grain system with conservation ($2,588) remains a little less than half the income of the dairy-cow system ($5,518) when the higher level is used. Income from the exploitive cash-grain system ($2,301) remains below the income of the cash-grain system with conservation ($2,588). The relatively greater increases in net income of the exploitive system than the conservative cash-grain system, with the higher level of prices, results from the greater increase in the price for grain as compared to the price of hay. The price for hay is increased only 22 percent as compared to 76 percent for grain prices.

Expenses shown in table 17 were adjusted to the higher price level by indexes for crops and livestock separately and weighted according to the amount of output. For example, expenses for dairy cattle were divided into the following items: supplemental feed, taxes, equipment, fencing and buildings. An appropriate index was applied to compute the expense at the higher price level. Thus, the expenses for each system of farming were weighted according to the input for that particular system of farming. Crop and livestock expenses were computed separately and added together.

TABLE 19. INCOME AND EXPENSES FOR CASH-GRAIN AND LIVESTOCK FARMING SYSTEMS USING 1940-44 AND HIGHER LEVEL PRICES.

Returns and expenses	System of farming				
	Exploitive	Conserving			
	Cash-grain	Cash-grain	Dairy cow—hogs	Beef cow—hogs	Yearlings wintered, pastured, fed in drylot and hogs
1940-44 prices					
Gross income	3,143	4,278	7,748	7,141	7,047
Expenses	1,825	2,360	4,477	3,983	3,828
Net income	1,318	1,918	3,271	3,158	3,219
Higher level prices					
Gross income	5,361	6,546	12,636	12,358	11,625
Expenses	3,060	3,958	7,118	6,410	6,166
Net income	2,301	2,588	5,518	5,948	5,459

Items of expenses for crops increased more than those for livestock between the periods of 1940-44 and January to September 1953. For example, three of the five indexes for crops were above 300 for January to September 1953, while only one of the five indexes for livestock costs was this high. Indexes of expenses for crops were: motor supplies, 160; farm machinery, 311; fertilizer, 350; seeds, 242; and taxes, 371. Those for dairy cows were: supplementary feed, 227; motor supplies, 160; equipment, 283; buildings and fences, 157; and taxes, 371.

APPENDIX A

Sampling Procedure

So that the farms upon which this study is based (and to which the findings apply) might provide a homogeneous producing situation rather than involve a set of hybrid and misleading relationships, extreme care was taken in delineating a single strata of the total population of farms in western Iowa.[21] First, soil scientists indicated those townships and parts of townships in each county in which soils of the Ida-Monona association predominated. Hamburg, as well as bottomland soils, except those occurring in close association with Ida-Monona soils, were excluded from the farm and soil strata to be sampled. Further steps in delimiting the association of soils to be studied were made as outlined below.

Because of limited funds, the decision was made to study only 160-acre farms (actually farms ranging in size from 150 to 170 acres) as this range includes a plurality of farms in this region, as well as in the entire state. The basic plan of the overall project is to study economic adjustments associated with conservation in each of the major soil areas of the state. This procedure is followed in contrast to the alternative which might include study of all farm sizes in a soil area and none in other areas. Given the limited funds and time of the workers involved, the procedure selected seems preferable. Extrapolations (which are necessary unless farming is to be closed down until all information on change can be provided without error) can be made more satisfactorily, for the particular problems, from one farm size to another within a soil area than for farms of different size from one area to another. (Except for certain high-cost machines, the nature of returns to scale are likely to have little influence on extrapolations between farm sizes from one farm size to another in computing returns from alternative farming systems.) Accordingly, as a basis for sample selection, a listing of farms ranging from 150 to 170 acres was obtained from county assessor's records.[22]

As one objective of the study was to show added costs, returns and capital investment for conservation adjustment, it was decided further to stratify farms on the basis of the current degree of soil conservation. Erosion control is a matter of degree; some farmers conserve soil more completely than others. As in weed control, some farmers may eliminate all or nearly all of the weeds in a row; they may go through the field with a hoe. Other farmers, who do not cultivate so thoroughly, will have very weedy corn.

Use of forages in the rotation of crops is probably the most universal method of erosion control, and some farmers have a large proportion of their land in forages. Others have little in the way of either forages or mechanical practices for erosion control. Hence, findings presented as averages would have little meaning to the farmer who does not fall at the mean of the distribution involved.[23] Suggestions concerning the extent of adjustment and the returns on capital, if they are based on means, would underestimate the situation for an operator who fell above the mean.

To better adapt the findings to the situations of most of the farmers, stratification was used. This was based upon the number of acres of forage on the farms. Farms were classified into 14 groups, and 10 were selected from each substratum. This procedure of sampling resulted in as many farms at the extremes as at the mean in respect to acreage of forage. Acreage of forage was used for stratification purposes as: (1) It was the only measure of conservation available in the secondary data for sampling purposes. (2) It is the main conservation practice used in the area. (3) The magnitude of required farm adjustment is closely tied to the acreage of forage.

When the first 140 farms were selected, substitutes were also selected. These were used to replace the original unit sampled when the previous farm did not qualify because of soil, abandonment, size, lack of information or other reasons. Both rented and owned farms were included in the sample. At the time of the first enumeration, farms were excluded from the original sample if they included more than 10 acres of bottomland and level ridgetops. Enumerators made these selections with detailed information obtained in the field from farm operators and from ASPC and SCS records. Only a few substitutions had to be made because of soil or other reasons. The study thus refers to a population made up of 160-acre farms on Ida-Monona soils with less than 10 acres of bottomland or level ridges. The majority of farms in the area fall into this soil and farm stratum.

The 140 farms thus obtained were further arrayed according to the acreage of forage on the farm in 1948. A subsample of farms was then taken randomly to obtain 40 farms. Approximately every fourth farm starting from the second farm (randomly chosen—it might have been the first, third or fourth farm) of the list and proceeding to take every third or fourth farm (the decision as to whether to take the third or fourth farm was chosen at random also) thereafter.

[21]For possible difficulties involved in estimating relationships for a non-homogeneous population of farms and soils, see Heady, Earl O. Elementary models in farm production economics research. Jour. Farm Econ. 30:201-225. 1948.

[22]The procedure involves a slight underestimate of the number of farms for a particular size for this reason: Some farms fall partly in one township and partly in another and do not appear in the records as 160-acre units. However, the number of farms so located is small and is not likely to introduce any particular bias into the study. This supposition was put forth by sampling statisticians. It is consistent also with experience in a previous study (Iowa Agr. Exp. Sta. Res. Bul. 381) where additional listing on farms was obtained from tax records and plat books.

[23]See Heady, Earl O. and Baumann, Ross V. Budgeting techniques in estimating farm adjustment and marginal returns. Agr. Econ. Res. AMS, USDA. 5:53-56. 1953.

This was done because resources available to carry on the study were not sufficient to permit preparation of budgets and soil maps for the entire 140 farms.

The farms provided the basic population. Schedules were obtained on these farms covering crop history and production, livestock inventory and labor available. From the material these schedules furnished, a general idea of the extent of soil-management practices, the livestock program and the extent of homogeneity among the farms could be obtained. The 40 farms selected from this group were resurveyed, and additional information was obtained on disposal of crops, purchases of feed, feeding rates to livestock, pasture utilization, building capacity, fencing inventory and detailed expenses on the farm. The first schedule took about one-half hour, and the second one took about three-quarters of an hour. This material, and the soils map made by the soil technicians, provided the basis data for budgeting.

The sample contains farms having a wide range in the acres of forage, although they are homogeneous with respect to physical size and soil resources. One farm could be operated with rotations having a large quantity of grain quite as well as another.

To test the homegeneity of soils represented by the farms included in the sample, regression analyses were made of the relationship between acres of specific soils and quantity of forage. Separate regressions were run for all Ida soil, Monona soil, Ida soil with a slope of 10 percent or more, Ida and Monona soils in combinations and all other soils (chiefly Napier in the bottoms). The regression coefficients were not significant, either for linear or curvilinear terms, and therefore we conclude that the soil makeup of the farms is homogeneous between different forage groups.

Acreages of Ida and Monona soils on farms on which various acreages of forage crops were grown in 1948 are presented in table A-1. Although total acreages of Ida and Monona soils appear to vary considerably, this does not prove significant when subjected to analysis of variance; the difference disappears when the two soils are broken down into steep and rolling phases. Soil scientists suggest that variation may grow out of varying classification procedures rather than actual differences.

TABLE A-1. AVERAGE ACREAGE PER FARM OF SPECIFIED SOILS ON FARMS GROUPED INTO THREE FORAGE INTERVALS, 1948.

Soil type	Acreage of soils on farms with:			
	0-33 acres forage	34-52 acres forage	53 and over acres forage	All farms
All Ida	56.0	43.8	56.4	52.1
All Monona	64.0	70.5	64.3	66.3
Steep Ida and Monona	69.7	62.9	63.3	65.3
All Ida and Monona	120.0	114.3	120.7	118.3
All other soils	39.7	42.5	38.4	40.2
Total*	159.7	156.8	159.1	158.5

*The steep Ida and Monona are included in all Ida and Monona and therefore are not added into the totals.

Inferences to Farms of Other Sizes

How well the findings for the particular size group apply to other farm size groups on the same soil depends on the nature of returns to scale. Under constant returns to scale, results from one size group could be used indirectly for another size group, with changes made only for scale. For certain major relationships (that is, livestock and crop yields for specific practices, soil-management systems and inputs) the relationships are probably of linear nature between farms of different sizes (but not in terms of proportionality returns relationships on any 1 acre of any one farm). Use of machines may involve some scale economics. But, these machine-scale economies would apply to all crops on smaller or larger farms and are not likely to affect the relative profitability of the different farming systems involved. Findings of the current study would be of little use for inference to other size groups only if economies or diseconomies to scale exist at different rates for the several farming systems.

APPENDIX B

Systems of Soil Management

The three systems of erosion control used as a basis for the analysis are estimated to be capable of reducing erosion to a loss of 7 tons of soil per acre or less, except where the land is too steep for terracing. (It is doubtful whether any presently known methods of terracing would reduce erosion to a satisfactory level for cultivation on such soils. These lands would be useful only for pasture or wildlife reserves.) A loss of 7 tons of soil per acre was used in the study, rather than the more commonly accepted level of 5 tons, because of lack of alternative types of erosion control at the 5-ton level for much of the land. By using 7 tons it was possible to control erosion with either rotations alone or rotations with mechanical practices.

The rotations and practices listed in tables B-1 and B-2, which are estimated to limit soil losses to 7 tons per acre, were arrived at by using the calculations from Browning[24] which assign specific numerical values to conservation practices. These values are based upon present knowledge from experiments and theories in agronomy about the relative usefulness in soil and water conservation of the usual practices, given certain soil characteristics and topography. The values were set up

[24]Browning, Parish and Glass. A method for determining the use and limitations of rotations and conservation practices in the control of soil erosion in Iowa. op. cit.

TABLE B-1. ESTIMATED AVERAGE YIELDS PER ACRE FOR CORN, OATS AND ALFALFA-BROME HAY UNDER DIFFERENT SOIL-MANAGEMENT SYSTEMS IN LIVESTOCK FARMING FOR EACH OF THE PRINCIPAL SOIL CONDITIONS IN THE MONONA, IDA, HAMBURG SOIL ASSOCIATION AREA OF WESTERN IOWA.*

Rotation†	Soil-management practices												
	None			Terraces and contour cultivation			Terraces, contour cultivation and fertilizer‡						
							Yield per acre			Fertilizer for each rotation			
										Corn		Oats	
	Yield of corn	Yield of oats	Yield of hay	Yield of corn	Yield of oats	Yield of hay	Corn	Oats	Hay	N	P_2O_5	N	P_2O_5
	(bu.)	(bu.)	(tons)	(bu.)	(bu.)	(tons)	(bu.)	(bu.)	(tons)	(lbs.)	(lbs.)	(lbs.)	(lbs.)
Eroded Ida silt loam, 12-20 percent slope, mainly shoulders and noses													
CCO	20	18	—	23	20	—	34	25	—	40	40	20	20
CCO$_s$	26	21	—	29	23	—	36	27	—	35	40	20	40
CO$_s$	28	23	—	32	25	—	38	28	—	0	40	15	40
CO$_s$COMM	30	25	0.8	34	27	1.0	40	30	1.6	0	40	20	80
CCOMM	28	23	0.8	32	25	1.0	40	30	1.6	35	40	20	60
COMM	30	25	0.8	34	27	1.0	40	30	1.6	0	40	5	60
COMMM	27	25	0.8	31	27	1.0	38	30	1.6	0	40	5	80
COMMMM	24	25	0.6	28	27	0.8	36	30	1.4	0	40	5	80
Eroded Monona silt loam, 12-20 percent slope, shoulders and noses													
CCO	25	20	—	28	22	—	40	30	—	60	30	20	20
CCO$_s$	32	23	—	35	26	—	42	31	—	40	30	20	40
CO$_s$	35	26	—	38	29	—	44	33	—	10	30	15	40
CO$_s$COMM	40	28	1.4	42	31	1.7	46	35	2.0	10	30	20	50
CCOMM	38	26	1.4	40	29	1.7	46	35	2.0	30	30	20	50
COMM	40	28	1.4	42	31	1.7	46	35	2.0	5	30	5	50
COMMM	37	28	1.4	39	31	1.7	44	35	2.0	5	30	5	60
COMMMM	34	28	1.2	36	31	1.5	42	35	1.8	5	30	5	70
Monona silt loam, 9-15 percent slope, lower slopes and coves													
CCO	36	24	—	40	26	—	54	35	—	60	20	30	20
CCO$_s$	45	28	—	49	30	—	56	37	—	30	20	30	30
CO$_s$	50	32	—	55	34	—	58	38	—	10	20	15	30
CO$_s$COMM	55	36	2.0	58	38	2.2	60	40	2.4	10	20	20	30
CCOMM	53	34	2.0	56	36	2.2	60	40	2.4	40	20	20	30
COMM	55	36	2.0	58	38	2.2	60	40	2.4	0	20	0	30
COMMM	53	36	2.0	56	38	2.2	58	40	2.4	0	20	0	30
COMMMM	51	36	1.8	54	38	2.0	56	40	2.2	10	20	0	30
Monona silt loam, 2-8 percent slope, broad ridges													
CCO	40	28	—	43	30	—	58	40	—	60	20	25	20
CCO$_s$	50	32	—	52	34	—	60	42	—	30	20	25	30
CO$_s$	55	36	—	58	38	—	62	43	—	10	20	15	30
CO$_s$COMM	60	40	2.4	62	42	2.4	64	45	2.6	5	20	20	30
CCOMM	57	38	2.4	59	40	2.4	64	45	2.6	20	20	10	30
COMM	60	40	2.4	62	42	2.4	64	45	2.6	5	20	0	30
COMMM	58	40	2.4	60	42	2.4	62	45	2.6	5	20	0	30
COMMMM	56	40	2.2	58	42	2.2	60	45	2.4	5	20	0	30
Napier silt loam, not subject to crop damage by overflow													
CCO	45	30	—	48	32	—	62	43	—	60	20	20	10
CCO$_s$	55	36	—	58	38	—	65	46	—	30	20	20	20
CO$_s$	60	42	—	64	44	—	68	48	—	10	20	10	20
CO$_s$COMM	65	45	3.0	68	47	3.0	70	50	3.0	10	20	20	20
CCOMM	62	43	3.0	65	45	3.0	70	50	3.0	40	20	20	20
COMM	65	45	3.0	68	47	3.0	70	50	3.0	0	20	0	20
COMMM	63	45	3.0	66	47	3.0	70	50	3.0	5	20	0	20
COMMMM	61	45	2.8	64	47	2.8	70	50	2.8	10	20	0	20

*It is assumed that all of the hay and grain would be fed on the farm and the manure would be spread mainly on Ida and Monona soils. Only one cutting of hay would be harvested the last year the meadow is down. All soil-management systems would have been followed long enough to produce major effects, but not any long-time (30-60 years) effects. Only those soil-management systems *below* dashed lines would keep soil erosion losses to 7 tons or less. The small difference shown in yields is not indicative of "degree of accuracy," but to estimate directions and magnitude of effects resulting from various soil-management practices.

†C-corn, O-oats, O$_s$-oats plus sweetclover, M-alfalfa-brome mixture.

‡Where the N application on corn exceeds 10 pounds per corn crop, it is assumed the rest is applied as a side-dressing.

TABLE B-2. ESTIMATED AVERAGE YIELDS PER ACRE FOR CORN, OATS AND ALFALFA-BROME HAY UNDER DIFFERENT SOIL-MANAGEMENT SYSTEMS IN CASH-GRAIN FARMING FOR EACH OF THE PRINCIPAL SOIL CONDITIONS IN THE MONONA, IDA, HAMBURG SOIL ASSOCIATION AREA OF WESTERN IOWA.*

Rotation†	Soil-management practices												
	None			Terraces and contour cultivation			Terraces, contour cultivation and fertilizer‡						
							Yield per acre			Fertilizer for each rotation			
										Corn		Oats	
	Yield of corn	Yield of oats	Yield of hay	Yield of corn	Yield of oats	Yield of hay	Corn	Oats	Hay	N	P_2O_5	N	P_2O_5
	(bu.)	(bu.)	(tons)	(bu.)	(bu.)	(tons)	(bu.)	(bu.)	(tons)	(lbs.)	(lbs.)	(lbs.)	(lbs.)
Eroded Ida silt loam, 12-20 percent slope, mainly shoulders and noses													
CCO	10	10	—	12	12	—	32	20	—	100	40	30	30
CCO_s	16	15	—	17	17	—	34	23	—	60	40	30	60
CO_s	20	20	—	23	22	—	36	25	—	10	40	20	60
CO_sCOMM	25	23	0.6	28	25	0.8	38	28	1.4	10	40	30	90
CCOMM	23	20	0.6	25	22	0.8	36	28	1.4	50	40	30	90
COMM	25	23	0.6	28	25	0.8	38	28	1.4	5	40	10	90
COMMM	22	23	0.6	25	25	0.8	36	28	1.4	10	40	10	90
COMMMM	19	23	0.4	22	25	0.6	34	28	1.2	10	40	10	90
Eroded Monona silt loam, 12-20 percent slope, shoulders and noses													
CCO	15	12	—	17	14	—	38	26	—	100	30	30	20
CCO_s	24	18	—	26	20	—	40	28	—	60	30	30	50
CO_s	30	23	—	34	25	—	42	30	—	20	30	20	50
CO_sCOMM	35	26	1.2	38	29	1.4	44	33	1.8	10	30	30	90
CCOMM	32	23	1.2	35	26	1.4	44	33	1.8	45	30	30	60
COMM	35	26	1.2	38	29	1.4	44	33	1.8	5	30	10	60
COMMM	32	26	1.2	35	29	1.4	41	33	1.8	5	30	10	80
COMMMM	29	26	1.0	32	29	1.2	38	33	1.6	5	30	10	90
Monona silt loam, 9-15 percent slope, lower slopes and coves													
CCO	30	20	—	32	22	—	52	32	—	80	20	30	20
CCO_s	40	25	—	43	28	—	54	34	—	50	20	30	30
CO_s	45	30	—	50	32	—	56	36	—	10	20	20	30
CO_sCOMM	50	34	2.0	54	36	2.2	58	38	2.4	10	20	20	60
CCOMM	46	30	2.0	50	32	2.2	58	38	2.4	40	20	20	40
COMM	50	34	2.0	54	36	2.2	58	38	2.4	5	20	5	40
COMMM	48	34	2.0	52	36	2.2	56	38	2.4	10	20	5	40
COMMMM	46	34	1.8	50	36	2.0	54	38	2.2	10	20	5	40
Monona silt loam, 2-8 percent slope, broad ridges													
CCO	35	22	—	38	25	—	56	38	—	80	20	25	20
CCO_s	45	28	—	48	30	—	58	40	—	50	20	25	30
CO_s	50	34	—	54	36	—	60	41	—	20	20	15	30
CO_sCOMM	55	38	2.4	58	40	2.4	62	43	2.6	10	20	20	60
CCOMM	51	34	2.4	54	36	2.4	62	43	2.6	40	20	20	40
COMM	55	38	2.4	58	40	2.4	62	43	2.6	5	20	5	40
COMMM	53	38	2.4	56	40	2.4	60	43	2.6	5	20	5	40
COMMMM	51	38	2.2	54	40	2.2	58	43	2.4	5	20	5	40
Napier silt loam, not subject to crop damage by overflow													
CCO	45	30	—	48	32	—	62	43	—	60	20	20	10
CCO_s	55	36	—	58	38	—	65	46	—	30	20	20	20
CO_s	60	42	—	64	44	—	68	48	—	10	20	10	20
CO_sCOMM	65	45	3.0	68	47	3.0	70	50	3.0	10	20	20	20
CCOMM	62	43	3.0	65	45	3.0	70	50	3.0	40	20	20	20
COMM	65	45	3.0	68	47	3.0	70	50	3.0	0	20	0	20
COMMM	63	45	3.0	66	47	3.0	70	50	3.0	5	20	0	20
COMMMM	61	45	2.8	64	47	2.8	70	50	2.8	10	20	0	20

*It is assumed that all of the hay and grain would be sold off the farm. Only one cutting of hay would be harvested the last year the meadow is down. All soil-management systems would have been followed long enough to produce major effects, but not any long-time (30-60 years) effects. Only those soil-management systems *below* dashed lines would keep soil erosion losses to 7 tons or less. The small differences shown in yields are not indicative of the "degree of accuracy," but to estimate direction and magnitude of effects resulting from various soil-management practices.

†C-corn, O-oats, O_s-oats plus sweetclover, M-alfalfa-brome mixture.

‡Where the N application on corn exceeds 10 pounds per corn crop, it is assumed the rest is applied as a side-dressing.

to serve as a guide in developing better land use.

As many estimates had to be used where experimental data were lacking, the practices necessary to reach a certain level of erosion control are approximate. In general, available data are not adequate to judge the precise level of conservation that can be attained by the various conservation practices, nor is there complete agreement as to the precise level of erosion control necessary to maintain crop yields and soil productivity at a constant state. Actually, whether it is 5 or 7 tons is of little consequence. The consensus is that soil losses from erosion must be in this neighborhood rather than 20 or 30 tons (some are as high as 80 or 100 tons) as at present. Despite these limitations, no other methods of arriving at a suitable level of erosion control seemed quite so feasible.

Estimates of Crop Yield

The first step in evaluating the various alternatives available for control of erosion and utilization of forages was to develop estimates of yields of corn, oats and hay under different rotations by soil types, irrespective of erosion control.

Rotation experiments are now being conducted at Castana, Iowa, but little information on yields under different soil-management practices has been available previously for soils in the area studied. Estimated yields in table B-1 and B-2 were synthesized from (a) experiments in the area which cover part of the information, (b) experiments in other areas and (c) experience of farmers in the area.[25] Estimates are provided for various soil situations, rotations, conservation practices and fertilizing systems in cash-grain and livestock systems of farming. These estimates of yield serve as the basis for the budgets of farming systems.

The rotation actually included in the conservation plan for the area of land was the rotation with the smallest acreage of forage or, conversely, the greatest acreage of grain that would control erosion at the desired level—7 tons per acre per year. No attempt was made to maximize returns beyond that point. In other words, the rotations selected may not represent the exact point of maximum returns. Although unlikely, greater returns might be obtained by producing more forage than outlined. Production of forage is not likely to be in the complementary range for many of the rotations. When forage serves in a complementary capacity to grain, total production of grain from a given area of land increases as the acreage of forage increases. This gain is possible where the nitrogen, organic matter and erosion control furnished by the forage increases grain yields per acre by a percentage sufficiently greater to offset the decrease in acreage of grain.[26] Under certain conditions, some of the rotations include competitive forage as the increased acreage and production of these crops necessitates a reduction in total production of grain from a given land area (even though grain yields per acre increase).

[25] These predicted yields are subject to estimational error of various sorts. The alternative to the procedure followed would have been to (1) not make the study and let farmers find out these things for themselves over a period of 25 or 30 years or (2) close down farming in the area for 25 years until controlled experiments could be run. The procedure followed formalizes that used by agronomists or conservation experts who recommend rotations to farmers in the area. These recommendations suppose that something is known about yields and, therefore, that the rotation suggested, in ordinary soil conservation planning or agronomic extension work is "best" from the agronomic and economic standoints.

[26] For a more detailed exposition on forage as a complementary or competitive crop, see Heady, Earl O. and Jensen, Harald. Economics of crop rotations and land use. Iowa Agr. Exp. Sta. Res. Bul. 383; and Heady. Economics of rotation with farm and production policy applications. op. cit.

APPENDIX C

Livestock Systems[27]

A brief discussion of the several types of livestock systems is presented below.

Milk cows: Butterfat production used in budgeting was 323 pounds per head annually. Although this is higher than the average for all farms in Iowa, it is not as high as for the better dairy herds of the state. The system assumed a grain ration of 43.6 bushels of grain (corn or corn equivalent in other grains) and 5.2 tons of forage (3.2 tons of hay and 1.21 acres of pasture) per cow, which includes the feed necessary to produce the replacements. Replacement of the cow herd was assumed each 5 years with a 90-percent calf crop. Thus, in addition to the butterfat, 200 pounds of cull cow and 180 pounds of veal calf would be sold annually. In addition, the skim milk would displace some of the protein requirements for hogs.

Beef cows: The beef cow herd would be used mainly to produce 500-pound feeder calves for sale. A 90-percent calf crop was assumed with replacements every 8 years; that is, 150 pounds of cull cow and 390 pounds of calf would be sold per cow each year. Considerable variation in methods of feeding beef cows is used throughout the area. Some farmers feed grain during the dry weather while on pasture; others feed no grain except just before calving. In some cases the cows get fat when pastures are lush and lose weight in the winter and during the dry part of the summer when pastures are short. Although it is not con-

[27] Based upon the following reports:
Seventh Annual Report of Soil Conservation Experimental Farm, Page County, Iowa, 1950. Iowa Agr. Exp. Sta. FSR- 38. 1951.
Wilcox, R. H., et al. Costs and methods of fattening beef cattle in the Corn Belt, 1919-23. USDA Tech. Bul. 23. 1927.
Beresford, Rex. 151 questions on cattle feeding and marketing. Iowa Agr. Exp. Sta. and Ext. Serv. Bul. P-99. 1949.
Iowa Agricultural Capacity Studies, 1945 (unpublished).
Jensen, E., Woodward, T. E. et al. Input-output relationships in milk production. USDA Tech. Bul. 815. 1942.
Sallee, George A., Pond, George A. and Crickman, C. W. Farm organization for beef cattle production in southwestern Minnesota. Minn. Tech. Bul. 138. 1939.

templated that a great deal of gaining and losing of weight would occur, this system is used in the budget analysis. The ration consists of 4.2 bushels of grain and 3.91 tons of forage.

Yearlings wintered, fed in drylot: This is the most usual feeding system in western Iowa at present. The ration for these cattle was 54.5 bushels of grain, 1.74 tons of hay equivalent (1.5 tons hay and 0.11 acre pasture) and 148 pounds of supplement. To compare more closely the gains from this system with the others, it was assumed that the cattle were bought in the fall and wintered before starting on drylot feeding about the beginning of the pasture season. The starting weight was assumed to be about 595 pounds and the gain 465 pounds.

Yearlings wintered, fed on pasture and finished in drylot: These steers were comparable to those in the drylot system. They were fed grain in addition to pasture after having been wintered. As soon as the flush grass season was over, the steers were confined to a drylot for finishing. Their ration consisted of 51.07 bushels of grain and 3.36 tons hay equivalent in forage (1.24 tons of hay and 0.9 acre of pasture) and 73 pounds of protein supplement. The gain was assumed to be 525 pounds.

Yearlings wintered, pastured and finished in drylot: These steers were wintered and pastured the entire summer and finished in drylot with grain. Their ration consisted of 40.18 bushels of grain, 3.59 tons of hay equivalent (1.32 tons of hay and 1.65 acres of pasture) and 38 pounds of supplement. In this case pasturage would be about three-fourths of an acre per head more than required for those fed grain on pasture. The gain was assumed to be 557 pounds.

Calves wintered, fed in drylot: The beginning weight was assumed to be 440 pounds and the total gain 560 pounds. The ration was 63 bushels of grain and 1.72 tons of hay equivalent (1.48 tons hay and 0.11 acre pasture).

Calves wintered, fed on pasture and finished in drylot: This system is similar to the one for yearling steers. The gain was assumed to be 600 pounds. The ration consisted of 55.9 bushels of grain and 3.15 tons of hay equivalent (1.16 tons of hay and 0.8 acre pasture).

Calves wintered, pastured and fed in drylot: As with calves fed on pasture, this system follows the system on yearlings pastured. The gain was assumed to be 665 pounds. The ration included 46.1 bushels of grain and 3.53 tons of forage (1.30 tons hay and 1.55 acres of pasture).

Two-year-old steers fed in drylot: Although fattening 2-year-old cattle has not been so common in the last few years as it was 20 years ago, the system is presented for comparison purposes. These cattle were assumed to be about 840 pounds when put on feed and were expected to gain 360 pounds. The ration included 48 bushels of grain and 0.55 ton of hay equivalent (0.48 ton hay and 0.07 acre of pasture).

APPENDIX D

Additional Labor Requirements

Additional labor requirements over and above that presently available were computed, and a charge based on seasonal wage rates was included in the expenses of the organization. Returns shown in the budgets include a charge for any labor that would be required above operator and family labor. The general assumption is that this would be any labor required above 320 hours per month. Most farmers could provide the equivalent of one and one-fourth men for 240 weekdays and 16 Sundays. Farmers may not put in 10 hours of productive work each day of the year, but there are numerous days in the busy season when many hours may be put in for a limited time. The cost of labor was computed on the basis of daily farm wages seasonally; that is, when the labor was required. Some systems, such as yearlings fed on pasture, required extra labor during the period when farm wages are high. Other systems, such as 2-year-old steers fed in drylot, required labor in winter when farm wages are lower.

TABLE D-1. LABOR REQUIREMENTS AND PERCENTAGE DISTRIBUTION BY MONTHS BY KIND OF CROP AND BY KIND OF LIVESTOCK.

Enterprise	Unit	Labor per unit (hours)	Percentage of total labor											
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Hogs, including breeding herd*	Head	4.4	6.6	6.6	9.8	8.2	8.0	8.4	8.2	9.2	10.0	8.9	8.5	7.6
Yearling steers:														
Wintered, pastured, finished in drylot†	"	10.9	1.8	1.8	1.8	1.8	0.9	0.9	0.9	0.9	17.4	24.8	23.8	22.9
Wintered, fed on pasture, finished in drylot‡	"	19.0	1.0	1.0	1.0	1.0	10.5	10.5	10.5	11.6	12.6	13.7	13.2	13.2
Wintered, fed in drylot†	"	15.3	16.3	16.3	16.3	—	—	—	—	—	2.0	16.3	16.3	16.3
Two-year-old steers fed in drylot†	"	12.6	16.7	16.6	16.6	—	—	—	—	—	0.8	15.9	16.7	16.7
Calves:														
Wintered, fed on pasture, finished in drylot†	"	21.5	1.0	1.0	1.0	1.0	10.5	10.5	10.5	11.6	12.6	13.7	13.2	13.2
Wintered, pastured, finished in drylot†	"	12.5	1.8	1.8	1.8	1.8	0.9	0.9	0.9	0.9	17.4	24.8	23.8	22.9
Wintered, fed in drylot†	"	17.4	16.3	16.3	16.3	—	—	—	—	—	2.0	16.3	16.3	16.3
Dairy cows and replacements:														
Cows for home use*	"	170.0	9.2	8.7	9.2	8.5	8.1	7.7	7.9	8.2	8.2	8.2	7.8	8.3
14 cows or below*	"	135.0	9.2	8.7	9.2	8.5	8.1	7.7	7.9	8.2	8.2	8.2	7.8	8.3
Above 14 cows	"	113.0	9.2	8.7	9.2	8.5	8.1	7.7	7.9	8.2	8.2	8.2	7.8	8.3
Beef cow and calf*	"	8.0	13.6	13.6	15.1	10.2	5.1	5.1	5.1	5.1	5.1	5.1	6.7	10.2
Hens‡	100	196.0	7.6	7.6	8.2	9.8	15.1	10.5	8.2	7.6	7.3	5.8	6.5	5.8
Chickens‡	100	56.0												
Horses‡	Head	63.0	8.0	8.0	8.0	9.4	9.3	9.3	8.0	8.0	8.0	8.0	8.0	8.0
*Corn**	acres	7.0	—	—	—	11.8	22.0	13.1	10.7	—	2.0	14.8	20.4	5.2
*Oats**	"	5.0	—	—	7.1	17.9	—	—	37.5	37.5	—	—	—	—
*Hay**	"	13.0	—	—	—	—	—	38.9	33.1	—	28.0	—	—	—
*Soybeans**	"	7.0	—	—	—	10.0	24.0	15.0	11.0	—	3.0	31.0	6.0	—

*Unpublished material.

†Adapted from USDA Technical Bulletin 23.

‡Ind. Agr. Exp. Sta. Res. Bul. 478.

APPENDIX E

Housing or Space Requirements and Costs

Additional housing investment was arrived at by using the Midwest Plan Service as a basis for material requirements. Material lists were shown for certain buildings which were recommended for a specified number of animals. Costs of construction at 1948 prices were computed and then reduced to the 1940-44 price level by applying Bureau of Labor Statistics series for lumber. Labor was assumed to be 40 percent of the total costs. Buildings which were useful only for animal housing or feed storage were figured separately. Overhead storage of feed is more expensive than ordinary ground-level systems. Plans which were similar to those used in the area and which would be useful in adding to present farm facilities were selected. It is possible that, on some farms, sheds could be built onto present barns at less cost but, in general, the costs used here are considered a minimum requirement.

TABLE E-1. BUILDING SPECIFICATIONS AND COSTS AT 1948 PRICES.

Space for	Midwest plan No.	Dimensions in feet	Capacity	Cost		
				Materials	Labor*	Total
Beef cows	72,501	24 x 32	13 head†	$ 778	$ 518	$ 1,296
Yearlings	72,501	24 x 32	17 head	778	518	1,296
Calves	72,501	24 x 32	22 head	778	518	1,296
2-year-olds	72,501	24 x 32	15 head	778	518	1,296
Dairy cows‡	75,203§	24 x 16	12 head	1,643	1,906	2,739
	75,201§	8 x 8				
	72,502§	22 x 42				
Sow	72,602	6 x 8	1 sow	63	42	105
Hay barn	73,101		50 tons	1,645	1,098	2,743
Grain bin	73,213		2,000 bushels	770	513	1,283
Corn crib	73,201		2,050 bushels	1,296	864	2,160

*Labor computed as 40 percent of total cost.
†Includes space for calves.
‡Milking parlor, milk storage plus loafing shed.
§Adapted.

TABLE E-2. BUILDING COSTS PER HEAD OF LIVESTOCK OR PER UNIT OF FEED AT 1948 AND 1940-44 PRICES.

Space for	Unit	Space per unit	Cost at 1948 prices		Cost at 1940-44 prices		
			Material	Labor*	Material†	Labor‡	Total
		(sq. ft.)					
Beef cows	head	50	$ 59.85	$ 39.85	$ 24.86	$ 22.00	$ 46.86
Yearlings	"	40	45.76	30.48	19.00	16.80	35.80
Calves	"	30	35.36	23.55	14.70	13.00	27.70
2-year-olds	"	50	51.87	34.53	21.55	19.06	40.61
Dairy cows	"	—	136.92	91.33	56.85	32.40	89.25
Sow	"	14	63.00	42.00	26.20	23.20	49.40
Hay barn	tons	—	32.90	21.96	13.68	12.12	25.80
Grain bin	bu.	—	0.385	0.25	0.16	0.14	0.30
Corn crib	"	—	0.63	0.42	0.26	0.23	0.49

*Computed from table E-1.
†Computed from lumber index 1926 = 100 and 1948 = 313, 1940-44 = 130. Bureau of Labor Statistics, May 1949, p. 21.
‡Estimated from farm wage rates per hour on Corn Belt farms; Hog-beef fattening farms 1940-44 = $0.69 and 1948 = $1.57, Agricultural Statistics, 1949, p. 582.

APPENDIX F

TABLE F-1. PRICES FOR PRINCIPAL FARM PRODUCTS AND ITEMS OF COST, IOWA, 1940-44.

Item	Period	Unit or base	Price or percent
		(unit)	(dollars)
Corn	Annual	bu.	0.75
Oats	"	bu.	0.48
Hay, alfalfa baled	"	tons	13.39
Fat yearling steers	December	cwt.	14.94
	November	"	15.37
	October	"	14.61
Fat 2-year-olds	December	"	13.65
Calves	"	"	14.09
Cull cows, beef	Annual	"	10.86
dairy	"	"	9.00
Feeders, yearling steers	October	"	11.95
2-year-olds	August	"	12.13
calves (440 lbs.)	October	"	12.05
Fat lambs (92 lbs.)	Annual	"	12.58
Feeder lambs (55 lbs.)	"	"	11.12
Hogs	"	"	10.94
Chickens	"	lb.	0.179
Eggs	"	doz.	0.256
Butterfat	"	lb.	0.415
Cottonseed meal	December	cwt.	2.89
Tankage	"	"	3.64
Fertilizer, N	Annual	lbs.	0.083
P_2O_5	"	"	0.067
Fencing materials	"	rod	0.81
Terrace construction	"	ft.	0.016
Wage rates without board	Dec.-Feb.	day	3.12
	Mar.-May	"	3.46
	June-Aug.	"	3.90
	Sept.-Nov.	"	4.11
Taxes, personal property		dollars	0.015
Interest		"	0.06
Insurance		"	0.004
		(base)	(percent)
Building materials		1926 = 100	130
Prices paid by farmers		1910 – 14 = 100	156

APPENDIX G

Variation in Data

Considerable variation is present in the correlations between additional investment in livestock for consuming the forage in a conservation system of farming and the acreage of forage in 1947-48. The relationships, as shown by the curves, appear logical and properly ranked but the correlation is so low, and the variation about the curve so great, that a mean represents the average tendency as well, or better than, regression.

When the study was planned, it was estimated that stratifying the farms on the basis of size and soil type would be sufficient; that is, using only 160-acre farms and confining the soils to the Ida-Monona association group with no more than 10 acres of level land. That this has not been sufficient caution, or at least that there are probably several ways of eliminating variation caused by factors other than those closely related to the problem, is brought out in the study. Further stratification probably should have been undertaken, particularly with respect to size of business and efficiency of the operator in utilizing his resources.

Some farmers bought considerable quantities of grain and feeding cattle in 1947-48. In evaluating the effect of applying conservation measures to these farms, most of the livestock enterprises were restricted to the number of animals that could be fed from the feed produced on the farm. Comparisons on these particular farms were between the rather large businesses in 1947-48, including livestock feeding from purchased grain, and the budgeted conservation systems with livestock restricted to the quantity of feeds grown on the farms. When the budgeted cattle system included drylot feeding, the reverse was true. Considerable additional grain was necessary to balance the rations if all of the forage produced on the farm was to be consumed. Hence, considerable variation was introduced where individual farms had not used purchased grain in 1947-48.

Extremes in efficiency of operators was another source of variation. One operator, for example, was pasturing cattle which were later fed grain in drylot. He had enough animals to consume all of the forage, even during the lush part of the pasture season. When the pastures began to get short, he removed some of the cattle and put them in drylot for grain feeding. At the opposite extreme were operators with idle cropland which, to some extent, was due to improper planning of farm work rather than to low or wet ground. In the budgeting procedure it was assumed that the system of pasturing would provide ample forage during the entire pasture season. Also, it was assumed that all cropland would be farmed—none would remain idle. Measuring these more or less "normal" situations against the organizations having extremes in efficiency allowed considerable latitude for variation in the regressions which was not due specifically to the change to a conservation type of farming.

The variation shows up most conspicuously in the regressions for investment and the net income figures which are the end result of all computations. Net income figures compare the returns for the farm organizations as they were in 1947-48 with the budgeted systems using the alternative erosion-controlling systems. The regression coefficients are low and the variation large (table G-1). In this study the mean might be considered as a more accurate measure of the change than the regressions because of the variation resulting in the latter.

Two examples of the application of regressions to the data on adjusting farms to a conservation program are shown. The regressions have a very low statistical probability of explaining the relationships. The correlation coefficients are very low, and the t's are quite low (table G-2). The first relationship is between acres of forage in

TABLE G-1. PARTIAL REGRESSION COEFFICIENTS AND FIDUCIAL LIMITS FOR RELATIONSHIPS BETWEEN ADDITIONAL INVESTMENT IN LIVESTOCK AND ADDITIONAL NET INCOME AFTER ADOPTING SOIL-MANAGEMENT SYSTEMS AND ACREAGE IN FORAGE, 1947-48.

Relationship	Livestock system	Soil-management system	Partial regression coefficient by 1, 2	L_1	L_2
Change in investment in livestock and acreage of forage, 1947-48	Yearlings*	R†	73	172	—26
	"	RTC‡	60	158	—37
	"	RTCF§	49	151	—52
Change in net income and acreage of forage, 1947-48	Yearlings*	RTC‡	36	148	—77
	"	RTCF§	44	154	—66
	Beef cows	RTCF§	41	155	—74
	Dairy cows	RTC‡	29	141	—84

*Wintered, pastured and fed in drylot.
†Rotation.
‡Rotation, terracing and contouring.
§Rotation, terracing, contouring and fertilizer.

TABLE G-2. CORRELATION COEFFICIENTS AND "t's" FOR THE RELATIONSHIPS BETWEEN ADDITIONAL INVESTMENT FROM ADOPTING A CONSERVATION SYSTEM OF FARMING WITH CALVES WINTERED, PASTURED AND FED IN DRYLOT, AND ACREAGE OF FORAGE ON THE FARM, 1947-48.

Soil management system	Correlation		Value of t	Significant to level of
	Coefficient	Value		
Rotations	r	—0.52	1.19	0.3
	Squared term	—	2.11	0.05
	R	0.59	—	—
Rotations, terracing, contouring	r	—0.53	1.15	0.3
	Squared term	—	2.08	0.05
	R	0.60	—	—
Rotations, terracing, contouring, fertilizer	r	—0.54	0.97	0.4
	Squared term	—	1.92	0.1
	R	0.59	—	—

1947-48 and additional investment in livestock with calves wintered, pastured and fed in drylot to utilize the forage. This is calculated for three soil-management systems: (1) rotations, (2) rotations, terracing and contouring and (3) rotations, terracing, contouring and fertilizer.

The curves in fig. G-1 indicate that, if rotations alone were used for erosion control, a smaller investment in livestock would be needed than for the farm as it was set up in 1947-48. And, in general, much less investment, relatively, for those farms that had the higher acreages of forage (above 30 acres). If rotations, terracing and contouring were used in the adjustment to erosion control, more investment would be needed for all farms which had up to about 41 acres of forage in 1947-48. The same situation holds for the soil-management system of rotations, terracing, contouring and fertilizer except that it holds for farms having up to 50 acres of forage in 1947-48. Beyond these acreages of forage, less investment in livestock would be required.

These curves seem logical within themselves, but the problem arises in the probability that we can predict only with a rather low degree of accuracy. The correlations are quite low, as shown by table G-2. None of the correlation coefficients are more than —0.54 and none of the t's are significant to more than the 0.3 level. The regression relationship had as little variation as any for the large number of relationships that were included in the study.

A second group of curves are shown for the same three soil-management systems (fig. G-2). The relationships are between the change in income after adopting a soil-conservation program and the acreage of forage on the farm in 1947-48.

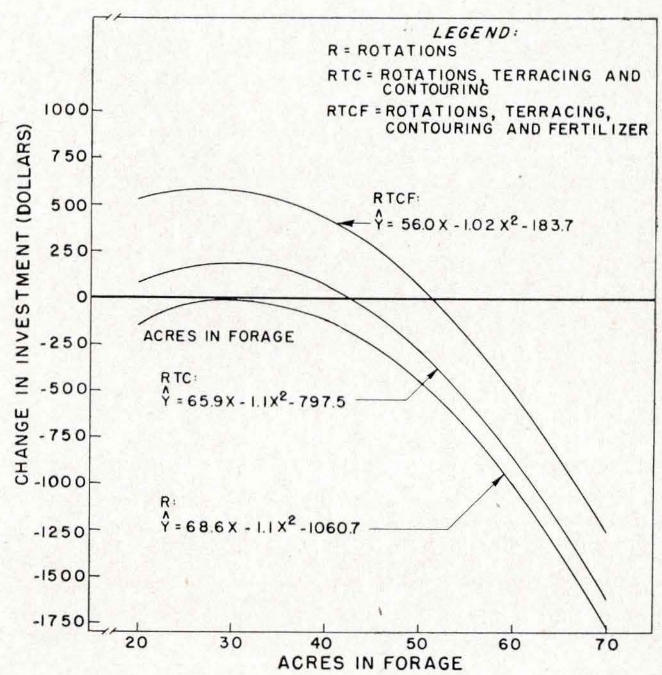

Fig. G-1. Relationship between acreage of forage and changes in investment with budgeted conservation farming systems that include calves wintered, pastured and grain-fed in drylot, 1947-48.

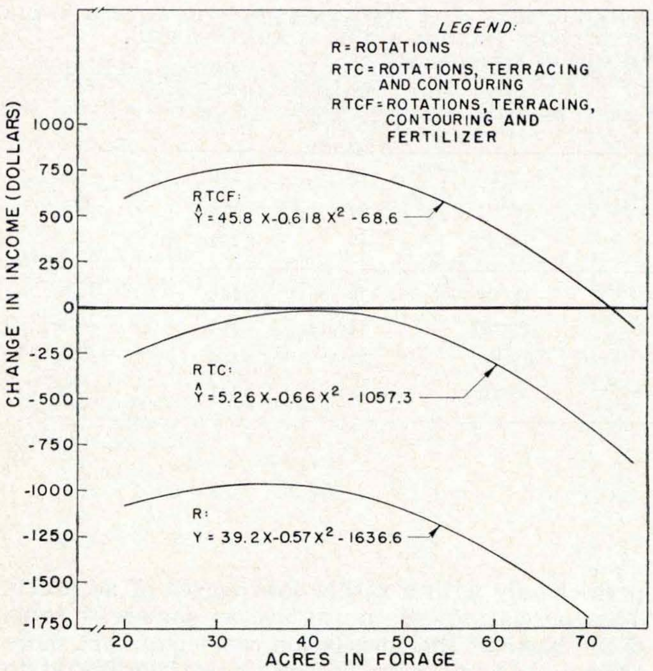

Fig. G-2. Relationship between acreage of forage and changes in net income with budgeted conservation farming systems that include yearlings wintered, grain-fed on pasture and finished in drylot, 1947-48.

Yearling steers wintered, fed grain on pasture and finished in drylot are used to utilize the forage. The r and R with corresponding t's are shown in table G-3. The curves in fig. G-2 show that income would be decreased for two of the soil-management systems but increased considerably for the system which includes fertilizer. This relationship holds for all farms up to those having 75 acres of forage in 1947-48.

Here again the curves appear in logical sequence, and they appear to be quite plausible. The soil-management systems are ranked logically, and the relationship appears to be sensible. But the variation is so great that one cannot be very sure of the probability of the relationship. As shown in table G-3, the r's and R's are exceedingly low and the significance of the t's also is low. None of the coefficients are above —0.23 and the t's are not significant above an 0.5 level. Even though the curves fall within plausible limits (appear to be logical and explainable), the variation is too high to warrant any degree of confidence through statistical means available at present.

TABLE G-3. CORRELATION COEFFICIENTS AND "t's" FOR THE RELATIONSHIPS BETWEEN ADDITIONAL INCOME FROM ADOPTING A CONSERVATION SYSTEM OF FARMING WITH YEARLINGS WINTERED, FED ON PASTURE AND FINISHED IN DRYLOT TO CONSUME THE FORAGE, AND ACREAGE OF FORAGE ON THE FARM, 1947-48.

Soil-management system	Correlation		Value of t	Significant to level of
	Coefficient	Value		
Rotations	r	—0.23	0.60	0.6
	Squared term	—	0.94	0.4
	R	0.27	—	—
Rotations, terracing, contouring	r	—0.19	0.79	0.5
	Squared term	—	1.08	0.3
	R	0.25	—	—
Rotations, terracing, contouring, fertilizer	r	—0.21	0.70	0.5
	Squared term	—	1.03	0.4
	R	0.27	—	—