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Returns from and capital required for soil conservation farming systems: A study of a specific population of farms and soils

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Returns From and Capital Required for Soil Conservation Farming Systems

A Study of a Specific Population of Farms and Soils

by Earl O. Heady and Carl W. Allen

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AGRICULTURAL EXPERIMENT STATION, IOWA STATE COLLEGE
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SUMMARY

1. The data in this study serve as inferences for a restricted population of farms and soils. The sample was drawn from 160-acre owner-operated farms in the Marshall silt loam area of six southwest Iowa counties. In addition, farms were included in the sample only if they contained no more than 25 acres of Shelby soils, between 40 and 75 acres of bottomland soils or Marshall silt loam with a slope of 4 percent or less and with the remainder of the area made up of Marshall silt loam with a slope of more than 4 percent. These sampling controls and restriction of the study to a specified strata of farms were exercised to insure greater homogeneity (reduce the variance) in the quantity and quality of the resources on the farms. Owner-operator farms alone were included to facilitate the obtaining of certain historic data.

2. The study is concerned with the returns, the resource requirements and the organization of farms which have attained varying degrees of erosion control. Differences in these items cannot be imputed entirely to erosion control but are jointly the result of the quantity of resources employed and their organization (combination) on individual farms. In this sense the study describes the structure of farms which results in different degrees of erosion control. Two methods have been employed as a basis for estimation. These include (1) statistical analysis of data from 90 sample farms and (2) budget analysis of a subsample of 35 farms.

3. In the 90-farm sample, net income was positively related to conservation attainment at 1945 and 1937-41 prices. At 1931-35 prices, net income at first increased with erosion control but eventually declined. The latter is apparently due to the less favorable price/cost ratios existing in 1931-35 period and hence the fact that marginal (additional) costs became greater than marginal (additional) returns at a smaller volume of output than under 1945 or 1937-41 prices. For farms at the low end of the conservation scale, it is likely that both (a) a reorganization of given resources (better rotations, etc.) and (b) the relationship between marginal (additional) costs and returns allowed a greater net income even under the price/cost ratios of the 1931-35 period.

4. The greater output and income on high conservation farms was possible only through use of greater amounts of labor and capital. Farmers at the low end of conservation scale were organized in the direction of cash grain farms, while those attaining
the greatest degree of erosion control were in the direction of intensive livestock farms which used all of the farm-produced crops as feed. Low conservation farms might have increased income (especially at 1945 and 1937-41 prices) simply by feeding all of the grain produced. While practices which would control erosion might be applied to low conservation farms, income would not be as great as on the high conservation farms of the sample unless additional capital and labor were employed.

5. Under budget estimates, farms with a low degree of erosion control would have to reduce the acreage of row-crops by a large amount relative to farms already attaining a high degree of soil conservation. These adjustments ranged between a 35- and a 2-acre reduction. Accompanying these reductions would be a more systematic management of pasture land and crop rotations.

6. Feed output would increase slightly on high conservation farms and by a large amount on low conservation farms. Under the existing farming system, total feed production would include 21.7 percent grain while under the budgeted system, grain would constitute 29.4 percent of the farm-raised feed supply on the low conservation farms. The corresponding figures are 33.3 and 38.9 percent for the high conservation farms as a group.

7. Were all farms to adopt the projected farming systems, those at the low end of the conservation scale might expect an increase in income of approximately $1,520 at 1945 prices, while those at the extreme high of the scale might expect an increase slightly more than $100. Associated with these changes in income would be a greater total capital investment of $2,737 and $253, respectively. Labor requirements would increase by somewhat similar proportions.

8. These increments in income would not be forthcoming immediately but only as additional capital and labor are employed and become productive and as yield-increasing rotations and mechanical practices become effective. Too, the expected increase in income would be possible as a result of the application of soil conservation practices and the use of more resources only if the managerial ability of the operator were great enough to successfully operate with more enterprises and a greater amount of resources.

9. The majority of the farm operators from whom records were obtained expressed the belief that farming systems which attain soil conservation were profitable. Major reasons given for
not adjusting to these included lack of capital (and associated risk and uncertainty), changes (and prospective changes) in the level of prices, attempts to attain economic security and lack of technical knowledge. Within the framework of limited capital, economic insecurity and the variability and uncertainty of the market, it is likely that farmers who had not made full adjustment to farming systems which control erosion were making rational decisions within their own technical knowledge and economic environment. Removal of these economic factors would undoubtedly facilitate adjustment in the direction of greater conservation. However, for farms at the low end of the conservation scale, it appears that a considerable adjustment (in the direction of greater erosion control) would add to income without adding to risks or capital requirements. Especially important here would be the application of improved rotations which make possible greater grain production even from fewer acres and the use of contouring and terraces where the latter practices require no capital or only a small additional outlay.
Returns From and Capital Required for Soil Conservation Farming Systems

A Study of a Specific Population of Farms and Soils

By Earl O. Headly and Carl W. Allen

Soil conservation is one of the more basic and complex agricultural problems which face individual farmers and society. Given the physical means of preventing soil erosion, both are faced with questions of (1) the level of conservation which is economic and (2) the economic means of attaining the desired level of conservation. Long-range conservation policy should consider two types of conservation practices or plans: (1) Those which are profitable both to society and the individual farmer and adoption of which may be brought about by education and technical assistance. (2) Those which are economic to society but are unprofitable to the individual and which can be attained only as institutions are altered or as public assistance is put into effect. The individual farm is a focal point in either case. Cost and returns must be determined for the individual farm as a management or decision-making unit before complete evaluation can be made of alternative approaches to soil conservation.

Accomplishments in the direction of empirical research in conservation economics have not been great. This is partially due to the fact that relatively little research has been carried out in this specific area of investigation. Probably of equal importance, however, is the complexity of research relating to the economics of conservation. A few specific practices such as terracing or contouring can be evaluated readily on the basis of experimental results. The effects of other conservation measures which change the structure of farm organization are not easily isolated and cannot be studied through controlled experiments but must consider farms as entities and the interrelationships between farms of an area.

Progress in adoption of erosion control measures has not been rapid in many areas where such measures appear desirable. Isolation of those instances in which adoption of erosion control measures is profitable to the individual should facilitate an increased rate of adoption through educational channels. Equally

1Project 1085 of the Iowa Agricultural Experiment Station. This study would have been impossible without the guidance and assistance provided by A. A. Aandahl, G. M. Browning and Frank Riecken of the Iowa State College Agronomy Department and Frank Mendell and others of the Soil Conservation Service of the U. S. Department of Agriculture.
important is the isolation of any instances in which soil conservation is unprofitable to the individual. Only then can society determine objectively the extent and means by which it should aid the individual operator.

OBJECTIVES

This study is generally concerned with costs of and returns from soil conserving (erosion control) farming systems. The specific objectives are to estimate (1) returns from farming systems which result in various degrees of conservation, (2) capital employed under soil conserving farming systems and (3) the organizational structure of farms with varying degrees of erosion control. The investigation was initiated as an exploratory study. It relates to a specific group of farms and a specific association of soils. The study was restricted to a limited population in order to (a) provide findings which might apply to a given farm situation, (b) place the study on a manageable basis in terms of the detail involved and (c) appraise the feasibility of extending the methods employed to other farm situations. The procedures employed are reported in some detail for the benefit of others interested in the problem being analyzed and the procedures employed. Both the nature and limitations of the findings are outlined throughout the bulletin.

THE PROBLEM ANALYZED

For areas with an erosion hazard, problems of the soil break down into two related but somewhat distinct categories. One of these is the short-run problem of productivity as expressed in the relation of output of product (total yield of grain, forage or other crops) to input of variable production elements (fertilizer, seed, labor, tractor fuel, etc.). The economic problem here is one of equating marginal (additional) costs and marginal (additional) returns in the absence or the control of erosion. The second or long-run problem relates to productivity as permanently affected by erosion (and other factors associated with the structure of soil). The two aspects are partially interrelated. Adoption of erosion control measures, such as contouring or rotations including more legumes, may simultaneously increase the available supply of moisture and plant food elements. On the other hand, application of nitrogen fertilizer may increase crop yields without resulting in erosion control. The focal point of this study, however, is soil erosion control. Other aspects of productivity are studied as a by-product of and as related to erosion control. No attempt has been made to measure or evaluate aspects of soil productivity which are per se unrelated to erosion.

The analysis is largely in terms of soil conservation (erosion
control) as an integral part of the over-all management of a farm. A major part of the study relates to the organization, the capital requirements and the returns for farming systems which result in different degrees of erosion control. Erosion control practices and farming systems are viewed in a farm management framework in which the economy of varying techniques or organization is to be evaluated.

DESCRIPTIVE ANALYSIS

The current study is descriptive in the sense that simple empirical techniques are employed to suggest structural organization of farms which allow attainment of varying degrees of erosion control. Methods which might allow estimation of the interrelationship of (a) the several variables concerned or (b) the basis of the somewhat distinct production and decision-making relationships involved have not been employed. Basically, conservation (in its economic aspects) is a specific problem of more general production economics. The economic decision of whether or not to retain a specific soil structure parallels the decision of whether or not a dairy barn should be kept in repair or allowed to deteriorate over time. More detailed techniques of analysis thus must be applied to problems of soil conservation before refined estimates of the productivity of specific resource inputs or investment can be made. Two related but yet somewhat distinct sets of production economics models might well be employed as a basis for these inferences. Included here are (1) the derivation of more general production functions of the least squares or the simultaneous equation type with emphasis on the latter to allow estimation of the effect of variables entering into long-run decisions in respect to resource investment and (2) the derivation of more specific production functions in order to allow estimates of the marginal rates of substitution of grain for forage crops in both (a) the crop rotation and (b) the livestock ration. The first type of estimate may be accomplished from farm samples by production economists. The second can be best provided through cooperative projects by production economists and agronomists and animal husbandmen. While work is now being initiated which will allow refined estimates of the nature outlined, the purposes of the current study are in an entirely different direction.2

2Models and application of the procedures outlined can be found in the following: Hurwicz, Leonoid. Theory of the firm and investment. Economica, 14:259-264. 1946.
A production function adapted to a specific economic model is being derived from the sample data as an alternative approach to the productivity of resources employed. No attempt has been made, however, to incorporate these estimates into the current descriptive study.
SAMPLE AND METHOD OF ANALYSIS

The methods employed in this study are partially variations and refinements of those used in previous studies. In an attempt to evaluate the economic benefits from soil conservation farming systems, two somewhat distinct procedures have been employed in this study. These include (1) comparisons of returns, capital investment, and organization for a cross-sectional sample of farms at a given point in time and (2) budget estimates of the entire organization for a subsample of these farms. While the most appropriate sample for the study might have included a combination of cross-sectional and time-series data with the detail of the current study, the procedure was not feasible in terms of the time and funds available.

FARM POPULATION

Since possible limitations of previous studies have grown out of insufficient stratification of the sample farms by soil type and slope, general farming techniques and price environment, the steps outlined below have been observed: In the attempt to attain greater homogeneity in the basic resources of the farms studied, a random sample was drawn from a population restricted to 160-acre, owner-operated farms and a specific association of soils in the six southwestern Iowa counties of Page, Fremont, Montgomery, Mills, Cass and Pottawattamie. The 90-farm sample was drawn in this geographic area partially because of the rolling topography, heavy cropping program and erosion problem in general but also because experimental observation of crop yields and soil loss under terracing, contouring, rotations and other erosion control measures on the major soil type studied were available for budget analysis from the Soil Conservation Experimental Farm in Page County. The extent of adoption of conservation practices in southwest Iowa was an added reason why this geographic area was selected for study.

Farms were included or retained in the sample only if they qualified in respect to upper and lower acreage limits of certain soil types and degree of slope and irrespective of whether or not they had a formal plan in effect with the Soil Conservation District. Owner-operated farms alone were included in order to increase the accuracy of history in cropping systems and other conservation practices.

A considerable number of farms in the sample did have formal plans with the Soil Conservation Districts in the counties. Too, a fairly large number of other farmers were following recommended practices. Perhaps a greater proportion of farmers in southwest Iowa follow recommended practices than holds true in any other part of the state. A possible hypothesis explaining the latter is that farmers have been influenced by the Soil Conservation Experimental Farm in Page County, which has been mainly devoted to experiments related to erosion control, as well as the early conservation work on farms in southwest Iowa.
SOIL POPULATION

The predominant soil in the area is Marshall silt loam with slope ranges from 2 to 11 percent and with an initially high content of available phosphorus and potassium, and high base saturation. The erosion hazard is slight on the moderate slopes when the land is in intertilled crops but is severe for land with longer and greater slopes. Marshall silt loam is of loessial origin and is found in large individual areas in the six counties in which the study was made. The subsoil is moderately permeable, and the natural internal drainage is good. The surface soil varies from 5 to 24 and originally averaged around 11 inches. This soil is productive, and high crop yields are possible on well managed land.

Few if any farms in the area include Marshall silt loam alone, however. Because of the rolling topography of the area and the related factors associated with soil formation, Marshall silt loam is typically found on farms in association with some amount of either bottomland soils in the valleys, Minden silt loam on the level ridges or Shelby silt loam on the steeper slopes. Several of these soil types can often be found even within a 40-acre field. Although Marshall silt loam is predominant, many farms scattered throughout the entire geographic area have a large acreage of associated soils. In order to obtain a sample of farms reasonably homogeneous in respect to basic soil resources while still retaining a somewhat typical association of soils, upper limits were placed on the acreage of soils other than Marshall silt loam. Soil maps were made of each individual farm indicating the soil types, degree of slope and degree of erosion for each individual farm as a means of delimiting the farms to be retained in the sample. (Further details on sample selection can be found in Appendix A, page 359.) Farms retained in the sample contained no more than 25 acres of Shelby soils and between 40 and 75 acres in combination of bottomland soils or Marshall silt loam with a slope of 4 percent or less. The remainder of the area was thus composed of Marshall silt loam with a slope of more than 4 percent. A sample drawn at random within the entire boundaries of the soil association area might include farms which have adopted but few conservation practices yet show a relatively high level of output


5 While the estimates provided in this study refer to a strictly defined strata of farms and soils, the sample is not nearly so restricted as that for which the small plots in agronomy or the trial lots in animal husbandry serve as the basis for inference to a wider population of soil areas or species of animals. Too, there is basis for suggesting that a study which applies to a homogeneous population is more useful than one which is based on a heterogeneous population but applies strictly to no one particular strata in the aggregate population.
and income because of a large area of productive level, bottom or ridge lands. Or conversely, a farm which had adopted many conservation practices might show a relatively low level of output and income because it includes a large acreage of less productive or eroded Shelby and related soils. The sample was restricted to a population of farms with similar soils as a step in eliminating the possibility that difference in production and returns resulting from variations in soil might be imputed to the presence or absence of conservation practices.

ANALYSIS AND CLASSIFICATION OF DATA

The statistical technique most efficient in analyzing data of the nature investigated here has not been definitely established. The economic results should be conditioned partially or entirely by the underlying agronomic and engineering practices employed in erosion control. Differences in revenue (or costs) should correspond with the differences in yields and makeup of crop production under such combinations of practices as (1) terraces versus no terraces, (2) contour and strip cropping versus up-hill farming, (3) 3-year versus 4-year and 5-year rotations, and similar practices. In agronomic and engineering investigations analysis of variance is commonly employed to test the significance of differences between mean yields and these apparently discrete practices. The same statistical techniques should likewise apply to the dollars-and-cents counterpart of these yield differences. Yet the attainment of soil conservation on farms is actually one of degree growing out of varying combinations of practices, and the relationship might well be looked upon as one of a continuous functional relationship between economic returns and input of capital, labor or other resource invested in conservation practices. Too, the livestock organization becomes structurally related to the cropping system of the farm. For these reasons, two techniques of analysis and presentation have been employed. First, the 90 farms were classified into two groups on the basis of erosion control; experimental data on soil loss were related to mechanical practices and cropping systems (in the manner outlined below) in estimating the degree of erosion control. The two groups are referred to on the following pages as “high” conservation and “low” conservation farms for the purpose of presentation of certain data. Second, regression analysis was employed with the entire sample of farms to test hypotheses relative to the relationship between certain variables and degree of conservation or erosion control.

In order to describe and analyze farms which have attained various degrees of soil conservation, some index of conservation attainment was a necessary step in the study. Since numerical
values are not attached to the distinct and discrete practices which control erosion, an index of conservation based on soil loss was devised. Experimental data from the Soil Conservation Experimental Farm in Page County show the historical soil loss per acre for different crop sequences and mechanical practices applied to Marshall silt loam. These experimental data were employed to establish the “expected” tons of soil loss per year for each farm included in the study. The “computed” soil loss per acre (for the previous 5 years as indicated in Appendix B) was employed as the measure of erosion control. The soil loss per year was then converted into a conservation index. A farm averaging a zero (no) soil loss was given a conservation index of 100 while one averaging 40 tons loss per acre per year was given a score of 60. As indicated previously, agronomists estimate that a 5-ton loss for Marshall silt loam soils (a conservation index of 95) is permissible in terms of maintaining soil productivity. However, only two of the farms in the sample had a computed soil loss of less than 10 tons per acre annually. Only three farms had a computed soil loss of more than 60 tons. While the technique employed in estimating average annual soil loss and hence in establishing a conservation score for each farm is perhaps subject to error, it appeared more nearly acceptable than alternative approaches. The range of conservation index employed in presentation of regression estimates is 35 to 90.

While data for the high and low conservation farms are included in tabular form, interpretation of these should be made with caution. These figures tend to underemphasize the range in the sample for items such as income, capital investment and related items. For example, the differences in 1945 net income shown in table 3 amount to only slightly more than $1,000. However, the estimates based on regression analysis indicate a range of more than $2,000 for the extremes of the sample. The tabular data suggest differences only between farms falling at the mean conservation index for the two groups. The regression analysis provides a more appropriate basis for inferences between farms which fall at the extreme ranges or other points of the conservation index. While table 5 indicates a difference of approximately 1 month in quantity of labor used, fig. 5 indicates a difference of around 5 months from the lowest to the highest range of the index.

HOMOGENEITY OF FARMS

Data indicating the association of soils on the farms of the sample are included in table 1. Two statistical techniques were employed in each case where regression coefficients are employed, the possibility of both linear and curvilinear relationships has been tested. Where a curvilinear term was not significant at the 5 percent level of probability, the linear regression alone has been presented.
TABLE 1. MEAN ACRES PER FARM OF SPECIFIED SOIL TYPES FOR HIGH CONSERVATION AND LOW CONSERVATION FARMS.

<table>
<thead>
<tr>
<th>Conservation group</th>
<th>Acres of specified soils</th>
<th>Total acres (excluding roads)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bottom-land soils</td>
<td>Marshall silt loam, less than 4 percent slope</td>
</tr>
<tr>
<td>High conservation</td>
<td>24.9</td>
<td>35.0</td>
</tr>
<tr>
<td>Low conservation</td>
<td>25.3</td>
<td>39.4</td>
</tr>
</tbody>
</table>

employed to test homogeneity (or lack of homogeneity) of soils associations on the sample farms: (1) Regression coefficients (linear and curvilinear) were computed for the entire sample between the soil loss index and the number of acres of soil on each farm of (a) the various soil types, (b) the various slope groups and (c) crop acres. (2) Analysis of variance tests were made between these same items for the low and the high conservation farms. Neither the regression coefficients nor mean differences were statistically significant at the 5 percent level of probability. To the extent that lack of relationship between soil loss and slope or soil type is objective indication of homogeneity, the inference can be made that the farms represent a single population in respect to basic soil resources.

ADDITIONAL CONTROLS

The possibility also exists that a sample of farms homogeneous in respect to basic soil resources might differ in respect to other technical or economic attributes, which are unrelated to erosion control. Certain aspects of farm organization are related to the method or degree of conservation achieved. Thus any attempt to select a population of farms with given crop yields or which employ a single cropping system, livestock system and method of livestock production would simultaneously limit the range of conservation found on farms. There are other variations in farm operation, however, which are not functionally related to adoption of conservation methods. A possible one, differences growing out of seasonal price variations, was eliminated by reducing all saleable products of a given quality to a common price basis (when the possible variations were not related to the conservation farming system). Too, all farms were put on a common debt or income source basis by excluding interest payments, custom work and other off-farm receipts and expenses in computing net returns.

Two technical ratios, the only ones readily observed, were examined in an attempt to determine whether the farms differed in respect to techniques unrelated to conservation. There were (1) feed required per 100 pounds of pork produced and (2) but-
terfat production per cow. The analysis indicated no relationship between the soil loss per farm and either production per cow or feed used per 100 pounds of pork produced. (Regression coefficients were not significant at the 20 percent level of probability.) On the basis of these statistics, the farms appear to be similar in respect to the two nonconservation practices. It is entirely possible, however, that the sample does not represent a single population in respect to other nonconservation practices.

The survey records upon which analysis of the next section is based were taken over a year's period (1946). They are thus subject to the normal memory bias for data of this nature. Part of the financial and related schedules were taken directly from the accounts of individual farmers. Although nearly all of farmers in the survey kept accounts, access to these was not possible in all instances.

ANALYSIS OF INCOME

The analysis of this section deals with income, capital employed and general organization of the sample farms on the basis of the 1945 production patterns. Budget analysis of the sub-sample farms for an extended time period and economic evaluation of single practices follow in subsequent sections. The data of this section apply not only to the restricted farm population already outlined but also relate to 1945 as one sample in time as far as the pattern and level of physical production are concerned.

NET INCOME

Although the enumeration was made in 1946, net farm income was related to degree of erosion control for three different price and cost levels. Prices and costs for the single year 1945 and as averages for the years 1937-41 and 1931-35 were applied to physical production, sales and purchases to suggest possible differences in income which might grow out of varying price levels and price relationships (but not as a prediction that any one of these price relationships might hold in the future). Capital investment and other value figures in later sections refer to 1945 only.

Some important variations in price levels and relationships which might have impacts on the economic return of conservation farming did exist in the three periods (table 2). Price ceilings were still in effect during the high price period of 1945 and these favored some crops and livestock products more than others. In the period 1937-41, prices had recovered somewhat from the low of the depression years and the Agricultural Adjustment Act en-
TABLE 2. INDEX OF PRICES RECEIVED BY IOWA FARMERS FOR SPECIFIED COMMODITIES, 1945, 1937-41 and 1931-35. (1937-41=100.)*

<table>
<thead>
<tr>
<th>Commodity</th>
<th>1945</th>
<th>1937-41</th>
<th>1931-35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>192</td>
<td>100</td>
<td>88</td>
</tr>
<tr>
<td>Oats</td>
<td>244</td>
<td>100</td>
<td>107</td>
</tr>
<tr>
<td>Soybeans</td>
<td>232</td>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>Hay</td>
<td>179</td>
<td>100</td>
<td>115</td>
</tr>
<tr>
<td>Hogs</td>
<td>147</td>
<td>100</td>
<td>52</td>
</tr>
<tr>
<td>Cattle</td>
<td>151</td>
<td>100</td>
<td>66</td>
</tr>
<tr>
<td>Lambs</td>
<td>157</td>
<td>100</td>
<td>66</td>
</tr>
<tr>
<td>Butterfat</td>
<td>173</td>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>Eggs</td>
<td>200</td>
<td>100</td>
<td>71</td>
</tr>
</tbody>
</table>

*Based on data from Iowa Farm Science, Feb. 1946.

couraged relatively greater production but generally less favorable prices for hay (and hay-consuming livestock) than for grain (and grain-consuming livestock). During the depression period, 1931-35, all prices were low, grain production was large relative to hay and pasture, and the downward movement of prices in the first part of the period was unfavorable to the purchase of cattle and other roughage-consuming livestock fed out and sold at a later date.

Within the limits of variations in forage and grain (or forage-produced and grain-produced livestock) price relationships represented by the different periods, the soil-conserving farm system was economically advantageous (table 3 and fig. 1). Income for the high conservation group was 127.2, 131.7 and 120.0 percent greater than for the low conservation farms under the three respective price situations. There are, however, two considerations which are not adequately reflected in the static figures of table 3. One of these is the possible gain or loss growing out of price fluctuations. This is especially important for a farming system in which the increased roughage resulting from erosion control is utilized through livestock purchased at one time and sold at a later date or which required a longer period of production. Relative gains or losses from price variations are reflected somewhat in the price periods selected. However, during a downswing in the price level, a farming system which includes feeder stock may return relatively less than suggested by the figures. This diminution in income results as stock bought at one price level is sold later after a price decline. Similarly, an investment in a beef breeding or dairy herd during a period of high prices might return a lower or even a negative return were prices to fall

TABLE 3. NET FARM INCOME UNDER THREE PRICE LEVELS (DOLLARS).

<table>
<thead>
<tr>
<th>Farm group</th>
<th>1945 prices</th>
<th>1937-41 prices</th>
<th>1931-35 prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>High conservation</td>
<td>4,915</td>
<td>2,512</td>
<td>1,209</td>
</tr>
<tr>
<td>Low conservation</td>
<td>3,864</td>
<td>1,907</td>
<td>1,007</td>
</tr>
</tbody>
</table>
immediately after the investment. The revenue and income effect also holds true during a period of rising prices. Profits from an enterprise in which livestock is bought and sold or which requires a long production period to return the initial gain will be augmented by the changes in the price level as well as through the production process itself. Finally, the figures of table 2 are based on production data for the single year of 1945. Data for an average of several years might well differ from those of 1945.

NATURE OF RETURNS

The effect of low prices on income is more nearly indicated by the regression analysis of fig. 1 which indicates that although successively greater incomes were associated with greater degrees of erosion control and related farming systems under 1945 and 1937-41 price relationships, income would have reached a maximum and then declined under 1931-35 price relationships. This eventual diminution under 1931-35 prices might be explained as follows: The farms with the highest degree of conservation attainment were those specializing in large inventories and sales of livestock. Feeder cattle and hogs were the predominant types of livestock for this particular range of the sample. While cattle feeding was a profitable enterprise under 1945 and 1937-41 price relationships, it was an enterprise in which buying and selling prices alone resulted in losses for years in the period 1931-35. Too, the income data have been computed to include labor costs only for workers actually hired (to more nearly suggest income and cost changes which result as scale of output is extended beyond that which can be handled by operator and available family labor). Thus the livestock-price/labor-cost ratio was less favorable to increasing income through use of greater amounts of labor in the period 1931-35 as compared to the period 1937-41 or 1945. This appears to be one important explanation of the decrease in total net returns associated with the farming systems falling in the range of greatest erosion control. Generally, it was at this point (conservation index of 70) that labor employed extended beyond the 15 months ordinarily supplied by the operator and
family members on 160-acre farms. While labor costs do not enter into the accounting of total net farm income up to this point, they do become out-of-pocket costs as additional labor is associated with erosion-control farming systems. Other price/cost ratios may also help explain why greater degrees of erosion control and related farming systems finally result in a diminution of income under 1931-35 prices. Too, while greater degrees of conservation attainment were associated with lower incomes beyond an index of approximately 30 and at 1931-35 prices, it should be emphasized that the two were positively related (higher net incomes associated with greater erosion control) up to this point. Partly, the farms at the low end of the conservation scale were following rotations and other practices which were not the most profitable at any price level (e.g., a reorganization of given resources through better rotations, etc., would have resulted in a greater output without greater costs). Also, the marginal (additional) costs were less than the marginal returns for smaller volume of output (and resource employment).

Under 1945 and 1937-41 prices and costs, income was positively associated with conservation attainment throughout the range of observations sampled. However, the addition to income was less than proportional to the conservation index. Each additional degree of erosion control was associated with smaller and smaller increments to net income. While the data do not support the hypothesis that a range of decreasing total net returns might exist within the range of conservation attainment and farming systems observed, the statistics cannot be inferred to indicate that net returns might continue to increase indefinitely as capital investment and erosion control is extended to a point where no soil is lost (a range outside the observations of the sample). The computed annual soil loss per acre on the sample farms ranged from 65 to 10 tons. The lower limit of 10 tons is still two times greater than the 5-ton loss which agronomists estimate as permissible if serious deterioration through gully erosion is to be prevented.

Possible reasons why net income might increase at a diminishing rate include the following: (1) The nature of the basic physical and yield relationships involved. Conservation of soil generally requires two types of practices including (a) agronomic practices involving a shift of land from grain and row crops to grass and legumes or other close-growing crops and (b) engineering practices involving contouring, terracing and other mechanical inputs. Doubling the rate (reducing spacing by one-half) at which terraces, for example, are applied does not necessarily double the yields forthcoming as surface soil is retained and rainfall is conserved. Too, rotation experiments indicate that while
cropping systems which include a greater amount or proportion of legumes can result in an increased total grain production from a given land acreage, continued extension of the proportion of the land in grain eventually results in a decrease in total grain production. For example, data from the Soil Conservation Experimental Farm in Page County indicate that 100 acres of Marshall silt loam planted continuously to corn would have averaged 2,675 bushels per year in the period 1938-48. On the basis of these data, 100 acres of land under a 3-year rotation, corn-oats-meadow, would have produced 56 tons of hay and also 2,941 bushels of corn equivalent (including oats converted to a corn basis in terms of total digestible nutrients). However, it is likely that a greater proportion of land in forage would result in a decreased rather than an increased total grain production from a given land area. Thus those farms which have controlled erosion to the greatest extent and have longer rotations have undoubtedly extended forage to a point where it is competitive (reduces total grain output) rather than complementary (increases total grain output). (2) The order of adoption of soil conservation practices. The most widespread mechanical practice found on farms was contouring. Practically all farms in the sample were employing this practice as a basis for agricultural conservation payments from the Production and Marketing Administration. Farms with a medium degree of erosion control generally combined longer rotation with contouring, while mainly the farms highest in erosion control combined terraces with contouring and even longer rotations. Experimental evidence would also suggest that the greatest increment in yield and hence income would come within a range of conservation attainment falling at the extreme (low conservation) end of the sample observation. (3) The farming systems interrelated with erosion control. As has already been indicated, around 14-15 months of family labor were generally available on the 160-acre farms studied while labor was hired on those farms with the greatest output. Since livestock production and total output were positively associated with degree of erosion control (or vice versa), additions to total net returns at a decreasing rate also would be expected as a greater and greater proportion of the labor is hired. Too, the increased volume of livestock with which erosion-control farming is associated requires a relatively greater input of labor, purchased feeds, equipment and other cost inputs than the more nearly cash grain farming system found on farms where the degree of conservation attainment is smaller.

While the section above has related income to degree of erosion control or conservation attainment, it cannot be inferred that erosion control per se is the cause of the greater income. Perhaps more important is the system of farming of which erosion control is partly an effect and partly a cause. While many of the farmers in the sample had adjusted their livestock and general farm organization to erosion-control rotations, mechanical practices and general conservation plans, a large number were also producing a large amount of grass and legumes because this procedure fitted in with their normal operations of a heavy livestock program and the need for a large amount of pasture and forage. Finally, while many of the farms at the low end of the conservation scale might increase their returns alone through adoption of systematic rotations, contouring and terracing or other practices which add or conserve nitrogen, organic matter, moisture or other production elements to the soil, those of the higher end of the scale have successively higher incomes, perhaps mainly because of the added capital, labor and other resources or the general farming system employed. Rather than infer that the degree of conservation is the cause of the greater income, a more appropriate inference is that those farming systems which controlled erosion and employed greater labor and capital were profitable under the price and cost relationships of 1945, 1937-41 and 1931-35 to the extent that added returns were greater than added costs.

FIDUCIAL LIMITS

While the derived regression coefficients serve as a basis for the curves of fig. 1, it should also be emphasized that the range of the fiducial limits to which the relevant probability statements apply are of considerable absolute magnitude as is generally true of farm sample (or experimental) data. However, the range of these limits is undoubtedly much less than would have been true had the population not been so highly restricted and the sample designed accordingly.

GROSS INCOME

Figure 2 indicates the relationship between gross income at 1945 prices and the conservation index. While a given increase in conservation index was associated with a somewhat greater pro-

After inspection of the data, three equations were tried as alternative hypotheses as to the nature of the regression relationship between returns and conservation index. These were (1) $Y = a + bX$ (linear) (2) $Y = a + bX + cX^2$ (an increase in income at a rate smaller or greater than the increase in magnitude of conservation index or an increase and then a decrease in total net income) and (3) $\log Y = a + bX + cX^2 + dX^3$ (an increase in returns first at a greater and finally then at a lesser rate than conservation index) and (4) $Y = a + bX + cX^2 + dX^3$ (an increase and decrease in total net returns). While the second regression accounted for a significant portion of variance of income over the linear (1) the third and fourth regression equations were not significant over the second at the 5 percent level of probability for any set of prices. The equations derived from the data and used as the basis of fig. 1 are (1) $Y = -580.0 + 149.613X - .7941X^2$ for 1945 prices; (2) $Y = -1076.0 + 88.477X - .4849X^2$ for 1937-41 prices and (3) $Y = 1008.4 + 67.531X - .4843X^2$ for 1931-35 prices.
portional increase in gross income, it is unlikely that the explanation for this relationship is to be found in conservation practices per se. The direct effect of rotations or mechanical practices on gross income must be through increases in yields per acre. Preliminary inspection of a scatter diagram of corn yields on conservation index suggested the hypothesis that if a regression relationship existed it was curvilinear in the sense that the increase in yield was less than proportional to the magnitude of the conservation index. However, neither linear nor curvilinear regression coefficients were significant at the 5 percent level of probability.\(^\text{10}\)

**COST RELATIONSHIPS**

Other explanations for the nature of the relationship are (1) the possibility that managerial ability and efficiency is generally paralleled by degree of conservation attainment and (2) that the input of cost elements in total was proportionately greater for farms with a higher conservation index. Aside from the statistics mentioned earlier, measurement of the first has been impossible. The structure of costs as related to conservation index is indicated in fig. 3. Evidently the curvilinear regression between gross income and conservation index can be explained by a similar relationship between cost inputs and conservation attainments, as is suggested in fig. 3. This relationship is suggested by the U shape of the average cost curve in fig. 3. The downward sloping portion

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\(^{10}\)The regression equation upon which fig. 2 is based is \(Y = 7033.7 + 11.604X + .1935X^2\).
of the curve indicates successively lower costs per $100 gross income and is to be explained by the spreading of fixed costs over a greater output (a relationship involved in any type of production and entirely unrelated to erosion control) and the possibility of increasing physical returns (an increase in yields more than proportional to changes in rotations, mechanical and other practices associated with soil conservation) in the first ranges of erosion control. The positively inclined portion of the average cost curve indicated that the greater outputs on farms with higher erosion control were obtained with increasingly greater cost outlays. Furthermore, these increases in per unit cost were great enough to more than offset any decline in per unit costs directly associated with the spreading of fixed costs over a greater output.

Thus while the gross output (or gross profits) increased at a faster rate than degree of conservation attainment, costs increased at even greater rates with the result that net income at 1945 prices increased at a decreasing rate (e.g. each 1 percent increase in conservation index was associated with an increase of less than 1 percent in net income). While increasing at a decreasing rate, net income at 1945 and 1937-41 prices never reached a point of absolute decline because the addition to costs (marginal costs) were evidently less than the addition to gross return (marginal return). The reason for the increasingly greater costs on farms with higher degrees of erosion control are partially suggested in the following section on general farm organization.

GENERAL ORGANIZATION OF FARMS

On the farms studied several yield-increasing practices already mentioned were associated with erosion control. Corn yields averaged 11.3 bushels greater on the high conservation farms. However, as indicated previously, linear and curvilinear regression coefficients between erosion control and crop yields were not significant at the 5 percent level of probability. Many farmers in the low conservation group raised so few acres of legumes that returns would have been less than economically feasible even had all the land been level with no erosion hazard. Rotations on the high conservation farms also tended to be more systematic in the sense that corn followed regularly after meadows had been down 1 or 2 years. Some of the low conservation farms had nearly as great an acreage of grass or legume forage as found on some high conservation farms. However, they more often left one field in hay for 4 or 5 years while cropping another field to grain continuously for an equal number of years. Thirty-two

11The linear regression $Y = 34.9 + 0.433X$ (with $Y$ as corn yield and $X$ as conservation index) was significant at a level of probability greater than 20 percent. However, agronomic research would indicate that the regression would be nonlinear as far as corn yield is related to rotations and mechanical practices.
percent of the intertilled acreage on the low-conservation group had been in grain crops for 3 or more years in succession as compared to only 8 percent for the high conservation farms. Obviously, a given legume acreage is less effective in increasing yield and income and decreasing erosion when the latter method rather than a systematic rotation of the hay from field to field is followed. Each successive year in which the land is in legumes can be expected to add less to the yield of subsequent grain crops than the previous year of hay.

FARMING SYSTEMS AND VOLUME OF BUSINESS

Two aspects of the farming system found on high conservation farms are important in explaining a part of the greater returns. One of these is volume of business. The low conservation farms sold grain as an end product. This group of farms had corn sales of 1,002 bushels while the high conservation farms purchased 159 bushels per farm. The two groups of farms did not feed significantly different proportions of grain and forage crops. (Neither linear nor curvilinear regression coefficients for percent of feed in forage and soil loss were significant at the 5 percent level of probability). The high conservation farms utilized a greater forage production (resulting from a greater acreage) by producing livestock which also consumed grain. Accordingly, instead of selling grain as was true in the case of the low conservation farms, home-raised grains, plus some purchased grain, was fed along with the greater forage production on the high conservation farms. The greater roughage production was processed through livestock (which also required grain) which then became the end market product. Accordingly, the volume of business was greater and in itself accounts for a part of the greater in-
TABLE 5. MISCELLANEOUS ORGANIZATION CHARACTERISTICS OF THE FARM GROUPS.

<table>
<thead>
<tr>
<th>Item</th>
<th>High conservation farms</th>
<th>Low conservation farms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross profits*</td>
<td>$ 7,058</td>
<td>$ 6,056</td>
</tr>
<tr>
<td>Net sales crops*</td>
<td>285</td>
<td>1,348</td>
</tr>
<tr>
<td>Net production livestock*</td>
<td>6,773</td>
<td>4,708</td>
</tr>
<tr>
<td>Livestock investment (annual average)</td>
<td>5,110</td>
<td>3,850</td>
</tr>
<tr>
<td>Percent feed fed in grain</td>
<td>69.4</td>
<td>67.9</td>
</tr>
<tr>
<td>Months labor used</td>
<td>16.7</td>
<td>15.8</td>
</tr>
</tbody>
</table>

*Sales, inventory increase and home use less purchases and inventory decreases.

come. Volume of business\(^\text{12}\) and consequently income would have been greater even on the low conservation farms had they processed the entire farm-raised supply of grain through livestock rather than to sell part as a cash crop.

**CAPITAL INVESTMENT AND USE OF LABOR**

The other important farming system considerations are the amount of capital and labor employed. The greater output or volume of business on farms attaining greater degrees of erosion control was possible only as a greater total quantity of resources in these forms was employed. (All farms employed equal land inputs both in respect to quantity and quality as is evidenced in table 1.) The derived relationships between degree of conservation attainment and capital and labor employed are indicated in figs. 4 and 5, respectively. It is apparent that the higher net income on farms was a function of employing a greater total quantity of resources. Were greater income attributable to erosion control alone, equal or even fewer resources would be expected on farms with a higher conservation index. Or, in other words, conservation per se would bring in greater income simply by the rearrangement in use of given quantities of labor and capital on the 160-acre farms. While experimental data suggest that this direct relationship between income and soil conservation is possible for farms with very poor rotations, they do not indicate that farms with fairly high degrees of erosion control might make similar gains simply by holding resources employed constant while rearranging the cropping system and application of mechanical practices.\(^\text{13}\)

\(^{12}\)Except where indicated in the text, regression coefficients have not been computed for the items in tables 4 and 5.

\(^{13}\)The rotation experiments of the Soil Conservation Experimental Farm in Page County indicate that over a period of 20 years, a 3-year rotation of corn-oats-hay will eventually yield a greater total grain production from a given land area than will continuous corn. Thus a farmer with given resources could always have a greater return in the long run by using the rotation. However, this statement does not hold true for extending forage acreage indefinitely beyond the C-O-H rotation. The experiment mentioned (see Agronomy 41, 42, 43 and 45, mimeographed, Iowa Agricultural Experiment Station, Ames, Iowa) required 10 years before the C-O-H rotation yielded more grain (on a total land area basis) than continuous corn.
The major increase in capital invested on farms with a high degree of erosion control was in livestock (fig. 4). On the basis of the derived regression coefficients, total livestock investment (the average value of livestock on hand throughout the year) ranged from almost $2,000 to $5,600 on the basis of 1945 market values. While these figures represent the capital "tied up" in livestock throughout the year, it should be pointed out that in addition to breeding stock, they include growing pigs, fattening cattle and other animals in the process of being finished directly for the market. The amount invested in breeding stock (brood sows, milk and young stock, bulls, etc.) was less than the average investment in all livestock for all farms and amounted to no more than $500 for some individual farms. These were, of course, grain farms which derived most of their income from the sale of cash crops. Figure 4 emphasizes the relatively greater investment in forage-consuming livestock on high as compared to low conservation farms. As the slope of the regression lines indicates, investment in grain-consuming livestock was positively associated with the conservation index indicating that high conservation farms had a greater investment even in hogs and poultry (type of livestock entirely unrelated to conservation farming) than low conservation farms. However, the increase in investment as related to degree of conservation attainment was much greater for forage-consuming than for grain-consuming livestock.

The regression equations are (1) \( Y = -159.8 + 61.899X \) for all livestock, (2) \( Y = -421.9 + 38.821X \) for forage-consuming livestock and (3) \( Y = 1279.1 + 11.800X \) for grain-consuming livestock.
Ordinarily it is expected that farms which attain a high degree of erosion control must have a greater investment in roughage-consuming livestock. Outside of the range where forage is complementary with grain (results in a greater total grain production from a given land area), rotations which include increasingly greater quantities of forage are profitable generally as the additional hay or pasture is marketed through livestock. While this is not a necessary condition on farms where forage substitutes for grain at a high rate, it is true on a great number of farms where the ratio at which hay substitutes for grain in the rotation (e.g., where greater hay production reduces total grain production from a given land area) is less than the ratio of grain to forage market prices. However, in the sample of farms studied, the high conservation farms also had a greater investment in grain-consuming livestock. This aspect of capital investment is not at all closely related to erosion control. Hence, the income on the high conservation farms which is attributable to the latter forms of capital resources can be related to erosion control only remotely if at all.

Analysis was also made of the amount of capital invested in machinery and buildings. The regression coefficients for neither capital in machinery nor capital in buildings was significant at an acceptable level of probability. However, it was apparent that more of the farms with the higher acreages of forage (and generally those with the lowest rate of soil loss) had hay balers, choppers and similar types of equipment. Too, a greater proportion of this same group of farms had cattle sheds, milking parlors and other livestock equipment, since the high-forage farms were the ones with the greatest amount of forage-consuming livestock. However, the great variability within the sample in respect to the number of tractors, combines and cornpickers undoubtedly obscured differences in capital invested in haying equipment. Similarly, most 160-acre farms evidently have enough excess capacity in existing horse barns and other buildings to care for the greatest portion of livestock production found on farms with a high conservation index. The great variability between sample farms in size and construction of barns, granaries, cribs and hence in total building investment evidently offsets the relatively smaller adaptations in investment necessary to fit the farm organization to greater livestock production or increased forage output (and thus perhaps precludes the derivation of acceptable regressions of building capital and conservation attainment).

1Hogs and poultry were classified as grain-consuming livestock while sheep and cattle of all kinds were classified as roughage-consuming livestock.
2Numbers and value of farm machinery were obtained directly from the farmers. Value of buildings was estimated by subtracting an estimated value of land alone from the total value of land and buildings. While the latter undoubtedly resulted in an "observational bias," it was the only procedure possible from the data obtainable.
Practices such as terraces, dams, fence replacement and fertilizer directly related to erosion control also require some additional investment. However, reliable measurement of capital in these forms was impossible in the 90-farm sample since the investments had been made over a long-time period.

LABOR

The amount of labor used varied from slightly more than 12 months per year on farms with the lowest conservation index to almost the equivalent of one and one-half full-time men per year on farms with the highest conservation score (fig. 5).17 (A few farms had the equivalent of two full-time men). The labor figures include the time of the operator and members of the family plus hired labor. Part of the added labor requirements associated with increased forage and livestock production can be met by a more effective use of the operator's time during winter and other slack periods. However, a heavy livestock program such as that found on farms where erosion control was greatest could be carried only by the use of hired labor or if two or more male members of the family were available throughout the year. The relationship between conservation index and labor used (fig. 5) again emphasizes the necessity of imputing an indeterminate portion of the income on high conservation farms to the greater resources used rather than conservation per se.

Were the lowest farms in respect to conservation to shift to erosion control through terraces, contouring and longer rotations, labor requirements would be increased somewhat. However, changes in these practices alone would not increase labor requirements to the levels found on high conservation farms unless livestock production was also increased to levels similar to those found on high conservation farms.

CONSERVATION WITHOUT ADDED CAPITAL INPUTS

Again it should be emphasized that the data presented on previous pages describe the structure of costs, income and resource use on farms where different degrees of erosion control are being attained. They do not indicate directly the returns forthcoming from adoption of soil conservation practices but rather suggest the returns for farms which generally have adopted farming systems which either directly or indirectly help control erosion. It should be emphasized also that the application of rotations and mechanical practices can be applied to give a degree of soil conservation equal to or greater than that of the highest index in the sample and without the addition of the amount of capital and labor employed on farms falling in the

17 The regression equation employed is \( T = 4.2 + 0.279X + 0.0015X^2 \).
latter category. The additional roughage might, for example, be sold directly in the market. However, income would be less under this system of erosion control alone than under the farming systems found on farms with both a large livestock program and a high degree of conservation attainment.

**MANAGEMENT REQUIREMENTS**

Although measurement has been impossible, it is fairly obvious that managerial requirements or inputs are greater on farms with a high as compared to a low conservation index. The more nearly single-crop, cash-grain type of farming found on farms with a high computed soil loss certainly requires less knowledge and fewer decisions on the part of the farm operator than the greater number of enterprises and increased volume of output on the high conservation farms. Since these systems require additional capital and labor, it is also necessary that the operator's managerial abilities be great enough that these additional resource inputs can be employed profitably.

**BUDGET ANALYSIS**

A subsample of 35 farms was selected from the original sample for budget analysis. While the comparisons of the previous section suggest characteristics of existing farming systems which result in varying degrees of erosion control, the budget analysis has been employed to provide indication of changes which might result in organization, capital requirements, income and related items as given units shift to farming systems which result in greater erosion control and to provide certain estimates which were possible from analysis of the sample farms. The data for the previous section related to the year 1945 only in terms of yield and physical production. The budget analysis compares results between farming systems for estimated long-run "normal" crop yields and production. The time period assumed is long enough that the complete yield effects of erosion control measures might be reflected. (The years 1930-45 were taken as a base weather period for estimating crop yields.) Although the basic practice data used for classification of the farms in the previous section extended over 5 years, some of the high-conservation farms of the previous section had not had all practices in effect long enough to fully reflect crop yield and production changes.

**BUDGETING PROCEDURE**

The basic soil conservation and cropping plans upon which the budget analysis is based were drawn up by farm planners in each of the Soil Conservation Districts included and were altered
somewhat where farm operators deemed necessary. Long-run crop yield expectations under these plans were based on experimental data from the Clarinda farm and estimates provided by agronomists at Iowa State College. Yield data for varying rotations and mechanical practices were reduced from experimental results to a level deemed attainable under farm conditions. The livestock system fitted to each farm was that which the individual operator indicated he would adopt under the suggested changes in the cropping system. Although the system favored by the individual may not have always been the most profitable alternative, it allowed full consideration to farmer judgment and represented the enterprise which would be most likely to be adopted were the suggested changes to be made. Feed per animal, production per animal and other production coefficients (input-output ratios) unrelated to changes in the farming system were held constant in comparison between budget with existing plans for each individual farm. This step was taken in order to help avoid imputations of general farming efficiency to conservation farming practices and systems. After these changes in the cropping and livestock system had been planned, estimated changes in capital requirements and cost and returns were established. Extreme detail was exercised in preparing the budget expectations for each farm. Allowances were made not only for major changes but also for each specific cost consideration such as livestock death losses, seeding failures, protein feed costs, taxes, livestock trucking and marketing, and other costs. Income, costs and other value figures have been computed on the basis of 1945 prices only.

Again, the analysis of this section is in terms of income, capital and organization as related to the complete system of farming. Reorganization of the livestock system for each farm was made to conform with the recommendations of the operator. Each farmer indicated his choice of livestock adjustments if numerous forage-grain combinations were to result from changes in the cropping system. Nearly all indicated that were the grain supply to increase (or not be reduced materially), increased forage would be utilized by addition of more roughage-consuming livestock and reduction of cash grain sales (if grain were required for the roughage-consuming livestock). Under this arrangement most operators would hold nonroughage-consuming livestock as hogs and poultry constant. Forage-consuming livestock would be increased at the expense of grain-consuming livestock only as a second alternative and in cases where changes in total quantity and make-up of the feed supply so dictated. Accordingly, the major organization changes other than in the cropping system were the addition of forage-consuming livestock and the
contraction of grain sales on farms with a low conservation index. Farms with a very high conservation index tended to be growing a greater acreage of grasses and legumes than was necessary for erosion control were contouring and terracing also applied.

**FORM OF PRESENTATION**

The changes in production, resource inputs, investment, income and other items are presented on the following pages in the form of means for each of the two conservation groups. This procedure has been followed where estimates are made for a considerable number of heterogeneous items. Inferences based on these means have the limitations mentioned previously and should not be used as a suggestion of differences in adjustment between farms falling at either extreme of the conservation index. Estimated values for the more important items are presented in the form of regressions in order to indicate more clearly the differences in adjustment which might hold for farms which had attained (at the time of the survey) different degrees of erosion control. For example, returns from and capital requirements for shifting to a conservation farming system will vary depending on the present degree of erosion control being practiced on the particular farm. Budget figures were computed for each farm and linear and curvilinear regression coefficients were derived for the particular items. Based on a priori hypotheses, most of these relations were expected to be other than linear, but an additional curvilinear term was not significant (at the 10 percent level of probability) for numerous items. The data are presented in linear or curvilinear form depending on whether or not departure from linearity was suggested by the conventional probability analysis. Because of (1) the high degree of variability in the data and (2) the small sample and degrees of freedom, however, it is entirely possible that additional analysis might suggest a nonlinear relationship for particular items.¹⁸

**FARMING SYSTEM TRANSITION**

The data of the budget analysis compare existing farming systems with projected soil conservation farming systems on identical farms. First, income and capital investment were computed for the farming systems as they existed at the time of the study, except that crop yields and related organization were adjusted to a level deemed consistent with the weather of the 10 years

¹⁸Regression analysis has been used as more appropriate than tabular analyses in expressing the degree of adjustment required on farm which had attained various degrees of erosion control at the time of the sample. Because of the nature of the budget data, it is not expected, however, that the usual probability statements are strictly applicable. No attempt was made to derive regression coefficients for budget estimates where preliminary examination of scatter diagrams suggested a lack of relationship between the particular item and conservation index.
1936-45 taken as a base period. Second, expectations were established for a farming system which incorporated the changes in rotations, mechanical practices and the livestock organizations mentioned previously. All data presented are for prices and costs levels.

A transition period is ordinarily required for shifting from the existing system to a soil conservation farming system. Mechanical practices such as contouring and terracing may be put into effect in 1 year. It is only infrequently, however, that complete shifts can be made in rotations and livestock systems between 2 years. Even then, the changes brought about in 1 year are usually of small extent. The more common procedure includes a gradual shift from one complete rotation and livestock system to another over a period of 4 or 5 years. The full effect of rotations (and certain other changes which affect yields) on organization and returns is not ordinarily reflected the moment the full plan has been adopted. Additional time is especially required before improved rotations can have full effect on fertility and yields and before all new seedlings of forage are harvested in the form of pasture and hay.

The budget estimates of this section do not include, however, the period of transition. They reflect organization and expected returns after the plans and farming systems have been in effect long enough to express any increment in physical production and returns resulting from yield-increasing elements of the new plan (and with prices and costs at the 1945 level). These long-run figures might well differ widely from those for any one of the transition years. The income effect may be negative within any one transition year and positive once production related to the conservation plan has attained a full equilibrium. A prime objective of the present study, however, was to establish expectations of returns in the long run rather than in the initial period of adoption (were prices and costs to be at the specific level). (Variations in yields, production, organization and income through the transition period are illustrated by table 11 which has been prepared as a case study of one farm.)

LAND USE

The major changes in land use on the budget farms are indicated in table 6. Under the cropping pattern existing in the 5 years prior to the survey, the acreage of corn was somewhat greater on the low conservation farms than would hold under a rotation consisting of 2 years of corn and 1 each of small grain and hay. Under the planned systems, corn acreage would conform roughly to a rotation of 2 years of corn, 1 of small grain and 2 of hay or pasture on all farms. Actually two or more rota-
TABLE 6. LAND USE UNDER PRESENT AND BUDGET FARMING SYSTEMS.

<table>
<thead>
<tr>
<th>Item</th>
<th>High conservation farms</th>
<th>Low conservation farms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present</td>
<td>Budget</td>
</tr>
<tr>
<td>Acres in row crops</td>
<td>69.3</td>
<td>65.4</td>
</tr>
<tr>
<td>Percent rotation land in row crops</td>
<td>48.5</td>
<td>45.7</td>
</tr>
<tr>
<td>Small grain</td>
<td>32.4</td>
<td>28.1</td>
</tr>
<tr>
<td>Total grain acres</td>
<td>101.7</td>
<td>93.5</td>
</tr>
<tr>
<td>Percent rotation land in grain</td>
<td>71.7</td>
<td>65.4</td>
</tr>
<tr>
<td>Hay and rotation pasture</td>
<td>43.1</td>
<td>55.4</td>
</tr>
<tr>
<td>Permanent pasture and waterways</td>
<td>12.0</td>
<td>9.2</td>
</tr>
</tbody>
</table>

Titions were planned for each farm depending on the different soil types and slope groups. These ranged from 2 years of corn in a 4-year rotation on level land to 1 year of corn in a 6-year rotation on land with extreme slopes. (Each farm included some level land, the typical situation within the geographic area studied.)

SYSTEMATIC CROP AND SOIL MANAGEMENT

Another important change was the reduction in acres of permanent pasture. Numerous farms studied devoted a considerable acreage to bluegrass pasture which was weedy and unproductive. Frequently, the land used for permanent pasture was nearest the barnyard and presented less of an erosion hazard than fields which were being cropped. By integrating this land into the rotation, it would (1) be unnecessary to reduce grain acreage as much as would be true were cropping changes brought about only on existing rotation land and (2) make possible a greater production of hay and pasture from the same land because of higher yielding bromegrass and legume forages substituted for the bluegrass pasture.

Another important change not apparent in the data of table 6 is the shift to more systematic rotations. The budget plans were based on expectations that (for a given acreage of grains and forages and aside from failures due to weather) grain and hay would be grown in regular rotation sequence. This is in contrast to the existing practice followed on some farms. A given field is often planted to corn for 4 or 5 years in succession while another field on the same farm is devoted to hay for an equally long period. When two 20-acre fields, for example, are so handled the average is 1 acre of legumes for each acre of grain. Yet the effect of the rotation hay on subsequent grain yields is entirely different than were an acre of grain to follow successively after each year of legumes. Under the existing system of farming, 27 percent of the land on the subsample of low conservation farms had been in corn continuously for 3 or more years. The comparable figure was 13 percent for the subsample of high conservation
farms. Under the planned rotations none of the land would be in corn more than 2 years in succession except in years when a seeding failure necessitated readjustment in the following years' cropping plans.

The yield data are also based on the assumption that the manure resulting from the feed fed would be applied on second-year corn in any instance where 2 years of corn are grown in succession. This management practice would tend to offset the depletion of nitrogen by the first year of corn. This again is in contrast to the practice of applying manure on a hay or other field nearest the farm lot found on many farms. This practice again should be looked upon as one of general soil and farm management rather than erosion control per se.

RELATIVE ADJUSTMENT IN CROP ACREAGE

The adjustment in crop acreage necessary to bring about the planned conservation system would require widely different adjustments depending on the degree of conservation already being attained on the subsample farms. (See figs. 6 and 7.) A few farms at the upper end of the conservation index would be allowed a small increase in corn and all grain. This increase would be partly possible through the use of a greater number of mechanical practices which might substitute to a small extent for the already large amount of grasses and legumes found on these farms. Too, a few acres of permanent pasture could be

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Fig. 6. (Below.) Relationship between change in corn acreage reduction under budgeted farming systems and conservation index.

Fig. 7. (Right.) Relationship between grain acreage reduction for budgeted farming systems and conservation index.

---

19 The regression equations upon which these figures are based include (1) \( Y = 52.3 - 0.758X + 0.0021X^2 \) and (2) \( Y = 62.5 - 0.550X \).
TABLE 7. PATTERNS OF YIELDS AND FEED PRODUCTION UNDER PRESENT AND BUDGET FARMING SYSTEMS.

<table>
<thead>
<tr>
<th>Item</th>
<th>High conservation farms</th>
<th>Low conservation farms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present</td>
<td>Budget</td>
</tr>
<tr>
<td>Corn yield per acre (bushels)</td>
<td>60.2</td>
<td>65.1</td>
</tr>
<tr>
<td>Yield of grain feed units per acre in grain (corn and oats)*</td>
<td>45.8</td>
<td>50.1</td>
</tr>
<tr>
<td>Yield of hay per acre (hay and pasture land)</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Total feed units produced*</td>
<td>6985</td>
<td>7664</td>
</tr>
<tr>
<td>Total feed units grain produced*</td>
<td>4658</td>
<td>4680</td>
</tr>
<tr>
<td>Total feed units forage produced</td>
<td>2327</td>
<td>2984</td>
</tr>
<tr>
<td>Grain feed units produced as percent of total feed unit production*</td>
<td>66.7</td>
<td>61.1</td>
</tr>
</tbody>
</table>

*All feeds converted to a corn equivalent on the basis of total digestible nutrients (1 bushel of corn=1 feed unit).

brought into the rotation. Farms at the other extreme of the conservation index would require rather important shifts both in the cropping pattern and the use of mechanical erosion control practices (especially terraces). The relative change in row crops would be greater than for all grains. While corn acreage would be reduced especially on farms with a low conservation index, a greater oat acreage would generally be required as a nurse crop for an increased annual seeding of legume and grass.

CROP YIELDS AND PRODUCTION EXPECTATIONS

Crop yields under existing and planned rotations are indicated in table 7. Both have been adjusted to allow for a weather period comparable to that of the 10 years 1935-46 with allowances for seeding losses in 3 out of 20 years. In addition, crop yield expectations have been reduced from available experimental realizations to increase probability of farm attainment. Although less than realized under experimental conditions at the Clarinda experimental farm, the corn yield expectations are considerably above the state average. However, the major area of the farms studied is composed of bottomlands and Marshall silt loam, soils highly responsive to improved management practices.

FEED OUTPUT

On the basis of the budget data, total grain production would be increased slightly for most all farms in the subsample. On low conservation farms the greater grain production would be possible because of complementary effects between grain and forage and because of a more systematic management of a given legume
acreage. While the grain and forage acreage would be generally competitive, the reduction in grain acreage on high conservation farms would be offset by an increased acre yield due especially to more systematic management including (1) a regular rotation sequence with meadows down for a recommended time period (in contrast to continuous meadows side by side with continuous corn) and (2) manure on second-year corn (rather than on one field continuously).

Hay yields would be especially increased on farms with a low conservation index through substitution of brome-alfalfa or brome-clover mixtures for straight clover. Only slight increases in hay yields would be expected on the high conservation farms. Hay production would be more than doubled on the farms with a low conservation index while those already attaining the highest degree of erosion control would realize only a slight increase in hay and pasture production. The relative increase in all feed production would be greater on the low than on the high conservation farms (see fig. 8). Changes in the relative composition of total feed production would be greatest on the low conservation farms. Total grain production (measured in digestible nutrients) would drop only from 66.7 to 61.1 percent in the high conservation group.

LIVESTOCK PRODUCTION

Although adjustments in the livestock system were limited to expansion of an existing forage-consuming enterprise on most farms, some operators indicated a shift from one type of roughage-consuming livestock as feeder cattle to another as beef or dairy (milk) cows. A typical change was from a cattle feeding enterprise with heavy grain feeding to one including a greater proportion of forage and less grain in the ration.

Increase in livestock product sales was estimated at $2,112 for the low and $575 for the high conservation group. This

\[ I = 4240.5 - 62.314X + .2311X^2 \]

The regression equation for fig. 8 is \( I = 4240.5 - 62.314X + .2311X^2 \).
net increase in sales was made up entirely of forage-consuming livestock or livestock products. Actually, the gross increase in forage-consuming livestock sales was somewhat greater than this amount but was partially offset by a decline in hog and grain sales on most farms. Prospective gross sales of roughage-consuming livestock would also decrease on a few farms shifting from a cattle feeding program which required a large amount of grain and a small amount of hay to a cattle-raising, cattle-feeding combination or a straight feeding operation requiring a large amount of hay and pasture per animal. Gross farm sales would increase by a smaller amount than livestock sales on the greatest number of farms in the budget subsample. This difference arises out of the fact that although livestock production and sales would increase as more capital and labor is employed in this method of forage utilization, sales of cash grain would be diminished especially on farms where soil erosion is greatest. The difference between the additions to livestock sales and gross income would be much less for farms with a high conservation index and would result mainly as livestock sales include a greater proportion of forage-consuming and a smaller proportion of grain-consuming livestock.

COSTS AND RETURNS

Expected changes in costs and returns for the erosion-control farming system are indicated in table 8. The increase in net returns at 1945 prices does not include a charge against the use of available operator or family labor which would otherwise be unemployed on the farm or in off-farm activity. Hence, returns would be less than presented for low conservation farms if a charge were placed against all labor. This procedure would have little effect on farms with the highest conservation index, however, since they generally had no surplus family labor.

**TABLE 8. INCREASE IN INCOME AND EXPENSE UNDER BUDGET FARMING SYSTEM.**

<table>
<thead>
<tr>
<th>Item</th>
<th>Increase (dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>conservation</td>
</tr>
<tr>
<td></td>
<td>farms</td>
</tr>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>conservation</td>
</tr>
<tr>
<td></td>
<td>farms</td>
</tr>
<tr>
<td>Livestock sales (livestock and livestock products)</td>
<td>$575</td>
</tr>
<tr>
<td>Gross income*</td>
<td>482</td>
</tr>
<tr>
<td>Maintenance (depreciation) expense on conservation</td>
<td>35</td>
</tr>
<tr>
<td>installations and added fences and buildings</td>
<td>276</td>
</tr>
<tr>
<td>Net income</td>
<td>1075</td>
</tr>
<tr>
<td>Cash operating expense</td>
<td>210</td>
</tr>
</tbody>
</table>

*Sales, seed and home used product, less purchases of feed and livestock and reduction in inventory. Gross income computed in this manner is employed here rather than total credits in order to include only the on-farm production.

†Including custom work, labor, fuel, seed, taxes, veterinary, trucking and other items. Also includes annual lime and fertilizer cost.
Again, it should be emphasized that the income figures still do not reflect three important physical and economic considerations. (1) Although the erosion control system of farming is profitable at the 1945 level of prices, the results would be negative if the investment in livestock and other capital were made at the 1945 level of prices with an immediate drop in prices to the 1937-41 level, for example, and if the decrease in inventory value of the additional capital investment (and feed necessary for livestock) were charged to the change in the farming system. An equally rapid transition from a 1937-41 to a 1945 or other level of prices would have an opposite effect. The increase or decrease in returns in either case would be due not to the process of production but to changes in the economic environment. (2) Although crop production data have been adjusted for a time span long enough to average out weather fluctuations and to allow yield-effects of the improved rotations and practices to be reflected, the differences in income may underestimate the economic advantage of the conservation farming system over a long period of time. If the rotation and practices under the present system on low conservation farms were carried forward to the distant future, yields and income would likely decline by much more than would yields on the farm in the opposite range of conservation attainment. (3) Finally, the data present are static also in the sense that they do not indicate the economic advantage which might arise out of variations in rotations to meet variations in price levels. To the extent that soil erosion is controlled by mechanical practices and soil structure is not severely destroyed, income might be maximized over time by a cropping pattern which builds up fertility during a period of low prices but allows a greater sale of crops during periods of high prices. It has been impossible to integrate these dynamic problems into the current analysis because of the lack of data (especially for the rate of increase or decrease in crop yield as the rotation is varied over time).

Figure 9 again suggests that the addition to returns from projected farming systems would be relatively greater at the lower as compared to the higher ranges of the conservation index. Changes in income based on the regression equation range from $111 to almost $1,500 from the high to the low extremes of the conservation index found in the sample. This difference results from the fact that farm organization and total output of crop and livestock products (1) would be changed only slightly on farms already attaining the greatest degree of erosion control but (2) would be increased by large amounts on low conservation farms. The latter would be possible especially

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22The regression equations for fig. 9 include (1) \( Y = \text{3625.0} - 53.220X + .1925X^2 \) and (2) \( Y = \text{2729.1} - 41.694X + .1400X^2 \).
Fig. 9. (Above.) Relationship between changes in gross and net income under budgeted farming systems and conservation index.

Fig. 10. (Right.) Relationship between change in capital investment in conservation installations under budgeted farming system and conservation index.

from the value added to grain when processed through livestock rather than sold as a cash crop and also from a greater forage production processed in a similar manner. (Even were no changes made in cropping plans or feed production but all feed were processed through livestock, the increment to returns would still be greater for the low than for the high conservation farms. The low conservation farmers originally were selling an important part of their crops for cash while the high conservation farmers were feeding forage and grain.)

CAPITAL INVESTMENT AND LABOR

The projected farming systems would require the additional capital investment indicated in table 9 and fig. 10. The additional capital investment would be largely in soil improvements and in livestock employed to utilize the greater forage output.\(^2\)

It would be less under the proposed system than for the existing system on a few farms where the operators indicated a shift from short feeding of heavy or medium grade cattle to a beef cow herd with subsequent feeding out of the young stock to a cattle-feeding operation based on a high-roughage ration. Livestock investment remained nearly the same on two farms where the major land use adjustment was a shift from a combination of large acreage of permanent bluegrass pasture and a small

\[^2\text{The regression equation for fig. 10 is (1) } Y=1950.6-25.625X+.0601X^2 \text{ and (2) } Y=2242.6-24.049X.\]
TABLE 9. ADDITIONAL CAPITAL INVESTMENT, ANNUAL MAINTENANCE COSTS AND LABOR REQUIRED FOR SHIFT TO SOIL CONSERVING FARMING SYSTEM.

<table>
<thead>
<tr>
<th>Item</th>
<th>Additional requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High conservation farms</td>
</tr>
<tr>
<td>Livestock investment*</td>
<td>$289</td>
</tr>
<tr>
<td>Conservation investment</td>
<td></td>
</tr>
<tr>
<td>Terraces</td>
<td>126</td>
</tr>
<tr>
<td>Waterways and trees</td>
<td>120</td>
</tr>
<tr>
<td>Dams</td>
<td>55</td>
</tr>
<tr>
<td>Lime and fertilizer (necessary for seedings)</td>
<td>30</td>
</tr>
<tr>
<td>Total conservation investment</td>
<td>331</td>
</tr>
<tr>
<td>Fences</td>
<td>210</td>
</tr>
<tr>
<td>Building alterations</td>
<td>151</td>
</tr>
<tr>
<td>Annual maintenance on permanent conservation installations, added fences and buildings</td>
<td>...</td>
</tr>
<tr>
<td>Added annual labor requirements, days</td>
<td>29</td>
</tr>
</tbody>
</table>

*Includes capital required for breeding stock and first cost of feeder stock only. Does not include average investment over the year as in the case of the previous section.

Acreage of hay to a smaller acreage of rotation pasture and hay completely integrated into the crop rotation. The same livestock production could thus be supported with the smaller forage acreage which would not only complete the conservation plan but would also allow a greater production of forage per acre. Changes in livestock investment would range from $175 to around $1,400 over the extremes of the sample (see fig. 10).

ALTERNATIVE LIVESTOCK ADJUSTMENTS

A better indication of the investment alternatives for expansion in specific types of forage-consuming livestock is given in the data of table 10. These data have been prepared for a model situation which includes an assumed acreage of Marshall silt loam and with clover yields of 1.7 tons in rotations with 1 year of meadow and alfalfa-brome or clover-brome yields of 2.3 tons for the rotations with 2 or more years of meadow. The figures suggest the various possibilities in altering livestock investment to conform with the increased forage production in prospect were the rotation shifted to include a greater amount of hay or pasture on 100 acres. A shift from the number 1 to the number 3 rotation would double the total forage production. Similarly, the investment would be about double for each type of livestock indicated. The increase in livestock investment would amount to less than $600 for dairy cows, beef cows, or feeder cattle grazed and fed out but would amount to $3,569 for the medium grade yearlings and $5,993 for the 2-year-olds. However, the capital investment might actually be decreased were shifts made in the type of livestock. For example, a shift from the second to the fourth rotation would increase total forage pro-
### TABLE 10. INVESTMENT IN LIVESTOCK REQUIRED TO CONSUME FORAGE PRODUCED ON 100 ACRES OF LAND UNDER DIFFERENT ROTATIONS AND LIVESTOCK SYSTEMS. (FOR SPECIFIED HAY YIELDS AND AT 1945 PRICES.)

<table>
<thead>
<tr>
<th>Rotation</th>
<th>Hay yield per acre*</th>
<th>Acres in forage</th>
<th>Total production of hay-equivalent (tons)</th>
<th>Investment (dollars)</th>
<th>Months required for gross sale of livestock or product to return initial livestock investment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dairy cows (200 lbs. butterfat)</td>
<td>Beef cows (calves sold in fall as feeders)</td>
</tr>
<tr>
<td>1. CCCCOM</td>
<td>1.7</td>
<td>16.7</td>
<td>28.4</td>
<td>$ 576</td>
<td>$ 510</td>
</tr>
<tr>
<td>2. CCOM</td>
<td>1.7</td>
<td>25.0</td>
<td>42.5</td>
<td>866</td>
<td>753</td>
</tr>
<tr>
<td>3. COM</td>
<td>1.7</td>
<td>33.3</td>
<td>56.6</td>
<td>1,112</td>
<td>984</td>
</tr>
<tr>
<td>4. CCOMM</td>
<td>2.3</td>
<td>40.0</td>
<td>92.0</td>
<td>1,858</td>
<td>1,614</td>
</tr>
<tr>
<td>5. COMM</td>
<td>2.3</td>
<td>50.0</td>
<td>115.0</td>
<td>2,310</td>
<td>2,054</td>
</tr>
</tbody>
</table>

*Note: Months required for gross sale of livestock or product to return initial livestock investment: 15, 24, 4, 6, 12 1/4.
duction by a little over two times. Yet if the type of livestock enterprise were shifted from heavy 2-year-old steers with an initial investment of $6,035 to dairy cows, beef cows, or feeders grazed and fed out, the investment would drop by more than 65 percent in each case. Adjustment from one class of livestock to another (or from one cattle feeding system to another) would not always result in a greater income from the livestock segment of the business.

CONSERVATION INSTALLATION AND IMPROVEMENTS

The investment in conservation practices indicated in table 9 and fig. 10 includes the cost of installation with materials and labor charged at market rates. Many farmers could, of course, install terraces and other structures with their own labor and with smaller out-of-pocket costs were the work done during a slack period in the year. Conservation investment would decrease accordingly. Lime and fertilizer have been included as a conservation cost only to the extent that they might be needed to obtain grass or legume seedings. The additional investment in fences includes both temporary and permanent fencing. The increased building investment represents that needed for alteration of existing buildings to meet the change in livestock organization or to provide additional storage space for grain or hay. This item would be small on most farms, since a fairly large portion of the capacity in existing horse barns was unused or could be altered to meet the changed situation.

Two additional capital items might be considered as necessary for the projected farming system. One of these is the increase in cash operating expense. The other item includes the feed for the expanded livestock system. Part of the additional grain and all of the forage would be forthcoming as a consequence of the conservation system of farming. However, part of the added feed necessary under the reorganization on some farms would otherwise be sold and the proceeds used as a fund for operating expense throughout the year. In this case, a reduction in proceeds from grain sales might necessitate the borrowing of funds for current operations. Since this item varies so greatly throughout the year, it has not been estimated.

In contrast to the added livestock investment on farms which had attained various degrees of erosion control at the time of the study, investment in erosion control installations would be directly proportional to the conservation index (a straight line in fig. 10). Relatively greater livestock investments would be required on farms at the low as compared to the high end of the conservation scale, since the latter would require only a small adjustment in forage production. The total added investment in
livestock, plus conservation installations (including fences, etc.) would range from $253 for a farm with a conservation index of 90 to $2,737 for farms with an index of 35.

The greater income indicated for the erosion-control systems of farming again must be imputed as much or more to the additional resources employed and the change in farming systems as to the act of conservation itself. In the case of only one or a few practices would attainment of the conservation farming system be possible without investment in additional resources.

LABOR

Additional labor requirements for the conservation farming system have been estimated at the equivalent of 74 and 29 days for the low and high conservation groups respectively. Only a fraction of this additional labor was assessed as an out-of-pocket cost in computing changes in income. Labor was charged as a cash expense only in cases where the added load conflicted with use of the operator's time or where the present supply of family or hired labor was not available for a greater work load. These estimates were based on the operator's inventory of available labor and judgment of possible conflicting labor loads.

TIMING AND RETURNS

The estimates of this study indicate that for the farm population studied, the productivity of capital invested in farming systems which control erosion can be high once its income-producing effect can be fully reflected. The combined investment (livestock, conservation, installations, operating expense, labor and other resources) might be returned over a short period of amortization, especially on farms with a low conservation attainment and which employ small quantities of capital. A sharp fall in prices immediately following initiation of the plan with entire decrease in inventory value of the new investment charged against the period might, however, result in lower or negative results for the time span. Even then a drop from 1945 prices to a level as low as those of the 1937-41 period would still allow a positive return on the original investment were prices to remain at the latter level over a period of several years.

The additional capital investment as well as its income-producing effects would typically take place over a period of time. Table 11 presents the data for a single farm from the low conservation group as a case study to illustrate the early stages of this transition. Income would drop in the first year due largely to a substitution of oats for corn acreage in order to establish new seedings. Income would also decrease in the second year because
TABLE 11. PRODUCTION, INVESTMENT AND INCOME ADJUSTMENTS ON A FARM DURING TRANSITION PERIOD OF CHANGING TO AN EROSION CONTROL SYSTEM OF FARMING (AT 1945 PRICE AND COST LEVELS).

<table>
<thead>
<tr>
<th>Land use</th>
<th>Under present farming system</th>
<th>After adoption of proposed farming system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First year</td>
<td>Second year</td>
</tr>
<tr>
<td>Corn</td>
<td>75</td>
<td>59</td>
</tr>
<tr>
<td>Oats</td>
<td>31</td>
<td>51</td>
</tr>
<tr>
<td>Meadow</td>
<td>35</td>
<td>31</td>
</tr>
<tr>
<td>P. pasture</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Crop production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn (bu.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oats (bu.)</td>
<td>3825</td>
<td>3310</td>
</tr>
<tr>
<td>Hay equivalent (tons)</td>
<td>1058</td>
<td>1907</td>
</tr>
<tr>
<td>Investment in roughage-consuming livestock</td>
<td>69</td>
<td>62</td>
</tr>
<tr>
<td>Cost of conservation installations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terraces</td>
<td>xxx</td>
<td>xxx</td>
</tr>
<tr>
<td>Waterways</td>
<td>xxx</td>
<td>xxx</td>
</tr>
<tr>
<td>Other investment—Fencing</td>
<td>xxx</td>
<td>xxx</td>
</tr>
<tr>
<td>Total additional capital required by years</td>
<td>xxx</td>
<td>xxx</td>
</tr>
<tr>
<td>Increase or decrease in income from present farming system*</td>
<td>-387</td>
<td>-242</td>
</tr>
</tbody>
</table>

*Change in income expressed in dollars.

hay would be substituted for corn, but yields of the latter crop would not have been increased as a result of the rotation. Total income would increase in the third year on this particular farm because of higher expected crop yields under contouring and terracing and because the livestock added to consume the roughage would offset declines in income due to shifts in the cropping plan. By the fourth year additional increments in income would be expected because of a greater volume of livestock sales and because added yields due to the improved rotation would then be realized. Similar additions to income would be expected until the full plan was in operation.

The data in table 11 are for average yield and weather expectancies mentioned earlier. It is true, of course, that variations in weather would cause the outcome to be considerably different for single years. This qualification also applies to the data of the previous section. It supplies estimates of the outcome for the average of a period of years. Income in individual years may deviate widely from this mean outcome even were prices to remain constant.

The data of table 11 also suggest why the economic advantage of an erosion control farming system differs between tenants and owner-operators. While the returns average positive for the individual who will be on his farm for several years, the outcome would be negative (as compared to the existing farming system)
for a tenant who might be on the farm for as many as 3 years. Although the relative returns are positive in the third year this holds true only because of the increased volume of livestock which offsets lower crop returns. The tenant who expected to leave at the end of the third year and hence did not expect to utilize the forage would realize less returns in this year by following the conservation plan. Without the additional livestock he would break even between the alternative farming systems only in the fourth year when he might realize increases in yields due to the more effective rotation or the conservation of moisture through mechanical practices. Appropriate leasing arrangements would, however, allow mutual gains for both landlord and tenant.

In terms of the timing of returns for individual practices, contouring and terraces would more nearly have immediate benefits than would rotations. In years of average rainfall or less, additional yields and income would be realized in the first year of installation. However, increments in yield and income from improved rotations must partially or entirely await the process of (1) seeding legumes and forages within 1 year, (2) their utilization as hay or pasture for 1 or several years and finally (3) the production of grain crops on the particular field. The full returns from rotations might be realized mainly only after two (or more) rounds of rotations where soil nitrogen and organic matter are well depleted. The returns of mechanical practices in the first year would, of course, be low or nonexistent if rainfall were sufficiently great and well distributed in this year.

**MANAGEMENT AND RISKS**

A greater management input would be required on farms especially where an enterprise is added to consume the additional roughage. Mere expansion of an existing enterprise increases mainly the routine supervision required. However, addition of an enterprise requires that the operator must have knowledge not only over a wider range of production processes but is also faced with a more complex task of formulating expectations of buying or selling prices. Measurement of management input as it relates to soil conserving systems of farming has not been possible in this section. However, it is an important factor conditioning both the specific type of livestock which is best adapted to particular operators and the economic outcome of the enterprise adopted.

Another factor which also conditions the livestock enterprise best adapted to a given farm situation is the ability of the operator to withstand risks. Variability in year-to-year returns is greater for some livestock enterprises than for others. Whether or not the operator should adopt an enterprise which may result in extremely high returns in 1 year with negative returns in an-
other as compared to one for which the returns are less variable from year to year (and perhaps averages somewhat less over time) depends quite largely on his capital position. If he has a large debt relative to total assets, he might best avoid enterprises which may result in large losses in any one year and thereby jeopardize his financial structure. Or, if he has limited capital, he might select roughage-consuming livestock which will minimize the amount of borrowed capital necessary for utilization of a given forage production. This possibility is illustrated by the extreme variation among the few enterprises indicated in table 10. It should be remembered, however, that chance of loss is determined not only by the equity ratio but also by the length of time and possibility of price variations during the period of borrowing. In general, the turnover is slower for the low than for the high capital-investment enterprises, thus allowing a greater probability that prices will fall (or rise) before any borrowed fund can be repaid.

In the budget analysis of this section, no attempt other than the operator's own calculations was made to relate selection of livestock enterprises to the ability of the operator to withstand risk and uncertainty.

**RETURNS AND CONDITIONS OF ADOPTION**

In this study it has been emphasized several times that the estimates refer not to conservation practices per se but to farming systems which include erosion control as one element. The farming systems studied not only result in soil conservation but are also profitable given the availability of capital and sufficient managerial ability. No attempt has been made to determine the extent to which soil conservation itself (and in its narrow sense) is profitable. It is possible that some of the particular practices and degrees of erosion control employed in arriving at the returns estimate do not themselves increase returns. However, returns might still be increased due to the greater resources employed in the changed farming system as a whole.

**OBSTACLES TO ADOPTION**

Farmers in the entire sample were asked their reaction toward the profitability of soil conservation farming systems. While not all gave answers, the majority replying to the question indicated that they believed the practices necessary for erosion control were profitable in the sense that long-run returns might be greater than costs. Although the measurement is entirely subjective, farmers who had not adopted one or more of the soil conservation practices generally recommended in the area ranked
reasons for lack of adoption in this order: (1) lack of capital (including related risks), (2) adjustment to varying economic conditions, (3) limited remaining period of farm operation and (4) lack of technical knowledge. The low conservation farms especially included younger farmers and older men. Generally the young farmers operated with limited capital or a sizeable quantity of borrowed funds and were trying to secure their economic position before an expected price drop came about. In the case of extremely older men with low capital reserves, an attempt was evidently being made to capitalize on the high postwar price level to provide later retirement income. One older operator had all but 15 acres of the quarter-section unit in grain crops. On the side of techniques, some operators expressed the lack of know-how in going about the job of applying conservation practices as the limiting factor. Occasionally a farmer expressed the belief that terraces might “break loose” and thus that some risk of more severe erosion was a possibility. Operators expressing belief that application of practices would not be profitable gave lack of increased yields, the difficulty of weeds in corn drilled on the contour and the inability to successfully manage large livestock enterprises as the basis for their reasoning. Increased technical education and assistance would be especially helpful to this group of operators.

While the data presented in previous sections suggest the profitability of soil conservation farming systems which control erosion, it cannot be said that farmers are irrational in failure to adopt these even where profit expectations are consistent with possible realizations. The operator with limited capital may be making a sound subjective decision when he refuses to borrow additional capital, lower his equity position and hence endanger the survival of his farm business. Or, the operator with a large debt ratio and basing his price expectations on trends following World War I may similarly have been rational in placing a premium on immediate profits as a means of increasing his equity. These and other considerations mentioned above are limiting factors which must be removed if conservation farming systems are to be adopted to a fuller extent even on owner-operator farms.

However, farms at the low end of the conservation scale might make a considerable adjustment in the direction of greater erosion control and increase income without adding to costs or risks. Especially applicable here are rotations in which forage serves in a complementary capacity to grain (a greater grain production from fewer acres) and contouring or terracing where the latter adds little or nothing to costs.
Selection of the sample involved several detailed steps. First, a list was obtained of all 140- to 150-acre, owner-operated farms in the six-county area. One such list was obtained from the county treasurer and another from the AAA committee in each county. These were partially checked against each other to insure inclusion of all 160-acre units. County plat books were also examined to help isolate any 160-acre units which might otherwise be excluded because two portions of the farm fell in different civil divisions. After the list of 160-acre units had been compiled (the only deviation from 160 acres in the final sample was that due to roads and corrections from the original survey), the soil types on each farm were examined to determine whether the association of soils conformed to the limits outlined earlier. Those operating units which had been mapped by the Soil Conservation Service were checked against the soils map for the individual farm. Maps were available for only a fraction of the farms on the original list.

Where individual maps were not available, soils were checked against the available county soil maps and farms were excluded from the list where it was apparent that the combination of soils fell outside the limits set up as necessary for homogeneity. A county soil map was not available in Cass County. Accordingly, the aerial photographs made in 1938 under the Agricultural Adjustment Act were used to eliminate farms which fell mainly on river bottoms or otherwise did not qualify in terms of extent of Marshall silt loam or associated soils. A sample of 130 farms was then randomly selected from the remaining list. It was recognized that the combination of soils on all 130 still might not conform to the limits established previously. Thus detailed soils maps were made by soil scientists for each individual farm which was not already mapped. After these were completed, the final sample of 90 farms was selected on which the association of soils conformed to the limits previously set out.

The index of soil loss used in an earlier part of this study was computed by a detailed analysis of the cropping system and soil treatment over the 5-year period, 1941-45. As an initial step in deriving this index, a 5-year history was obtained on each individual field of each farm for the sequence of crops, the mechanical control practices and other treatments which might affect soil erosion. Next the results from the estimates based on the Clarinda experimental plots were used in estimating the annual soil loss of each field. Seven factors were employed in the computing of the index of soil loss on the basis of the 5-year history and include (1) the cropping sequence, (2) the degree of slope, (3) the length of slope, (4) the type of mechanical practice as strip cropping, contouring or terraces, (5) the supplemental soil management practices, (6) the type of soil and (7) previous erosion. The method is illustrated in the table.

Although the factors shown are those actually used, the data are not for a single farm but simply indicate the procedure. The standard employed in computing soil loss was Marshall silt loam on a 9 percent slope of 72 feet in length with moderate previous erosion, medium soil management, no mechanical practice, and a 3-year corn-oats-meadow rotation. Experimental results indicate an average annual soil of 10 tons per acre under this situation. Accordingly, the total factor product was multiplied by 10 to obtain the estimated soil loss per acre on each soil area examined.24

24For a complete discussion of the method see:
### APPENDIX TABLE 1. METHOD OF COMPUTING ESTIMATED SOIL LOSS PER ACRE.

<table>
<thead>
<tr>
<th>Area</th>
<th>Acres</th>
<th>Soil type</th>
<th>Slope (percent)</th>
<th>Slope length (feet)</th>
<th>Rotation</th>
<th>Supplement practices</th>
<th>Previous erosion</th>
<th>Management</th>
<th>Total factor product</th>
<th>Soil loss per acre</th>
<th>Total loss for area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Item Factor</td>
<td>16</td>
<td>Marshall 1.0</td>
<td>9</td>
<td>72.6</td>
<td>C-O-M   1.0</td>
<td>Up and down 1.0</td>
<td>Moderate 1.0</td>
<td>Medium 1.0</td>
<td>1.0</td>
<td>10</td>
<td>160</td>
</tr>
<tr>
<td>2 Item Factor</td>
<td>23</td>
<td>Marshall 1.0</td>
<td>11</td>
<td>72.6</td>
<td>C-O-M   1.0</td>
<td>Up and down 1.0</td>
<td>Moderate 1.0</td>
<td>Medium 1.0</td>
<td>1.3</td>
<td>13</td>
<td>299</td>
</tr>
<tr>
<td>3 Item Factor</td>
<td>21</td>
<td>Marshall 1.0</td>
<td>11</td>
<td>400</td>
<td>C-O-M   1.0</td>
<td>Up and down 1.0</td>
<td>Moderate 1.0</td>
<td>Medium 1.0</td>
<td>3.6</td>
<td>36</td>
<td>758</td>
</tr>
<tr>
<td>4 Item Factor</td>
<td>20</td>
<td>Marshall 1.0</td>
<td>11</td>
<td>400</td>
<td>C-O-M-M 1.0</td>
<td>Up and down 1.0</td>
<td>Moderate 1.0</td>
<td>Medium 1.0</td>
<td>2.2</td>
<td>22</td>
<td>440</td>
</tr>
<tr>
<td>5 Item Factor</td>
<td>17</td>
<td>Marshall 1.0</td>
<td>11</td>
<td>400</td>
<td>C-O-M-M 1.0</td>
<td>Contour 0.5</td>
<td>Moderate 1.0</td>
<td>Medium 1.0</td>
<td>1.1</td>
<td>11</td>
<td>187</td>
</tr>
<tr>
<td>6 Item Factor</td>
<td>14</td>
<td>Marshall 1.0</td>
<td>11</td>
<td>400</td>
<td>C-O-M-M 0.6</td>
<td>Contour 0.5</td>
<td>Severe 1.3</td>
<td>Medium 1.0</td>
<td>1.4</td>
<td>14</td>
<td>196</td>
</tr>
<tr>
<td>7 Item Factor</td>
<td>29</td>
<td>Marshall 1.0</td>
<td>11</td>
<td>400</td>
<td>C-O-M-M 0.6</td>
<td>Contour 0.5</td>
<td>Severe 1.3</td>
<td>Good 0.7</td>
<td>1.0</td>
<td>10</td>
<td>290</td>
</tr>
</tbody>
</table>

Average loss per acre in tons = 16.6