Soil Erosion Control in Process in Western Iowa

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RESEARCH BULLETIN 460 AUGUST 1958 AMES, IOWA

FOREWORD

The considerable public interest in soil conservation, which is evidenced in part by the large expenditures of public funds to foster conservation practices on privately owned land, makes soil conservation a public as well as a private problem. Because of this interest, the Iowa Agricultural and Home Economics Experiment Station and the Farm Economics Research Branch, Agricultural Research Service, USDA entered into a cooperative study of the heavy soil losses in western Iowa.

The initial research was begun in 1949, at which time a sample of 144 farms in the area was studied to learn why progress in reducing erosion losses had been slow. Results of the initial phase were published in Iowa Agricultural Experiment Station Research Bulletin No. 391. From that study a number of factors, largely economic in nature, were identified as obstacles to the adoption of the practices necessary to reduce or hold soil losses to a low level.

Having identified the obstacles, the next step was to discover how these obstacles change over time as a basis for developing various means to overcome them. The second phase of the study was set up to do this. After a lapse of 4 years following the first phase, the same 144 farms were revisited. Changes in soil losses during the interim, and reasons for these changes, are presented.

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CONTENTS

SUMMARY

A previous study of the problems of controlling soil erosion losses on a sample of 144 farms in western Iowa indicated that several factors, largely economic in nature, were usually responsible for the failure of farm operators to use the practices necessary to reduce soil losses. Built upon the findings of this earlier research, the purpose of this second study was to examine further each farm situation and to determine whether changes in these obstacle factors were responsible for corresponding changes in the rate of soil loss. A second objective, to be treated in another bulletin, is to develop measures to overcome some of the obstacles in order to encourage a more effective and wider use of erosion-control practices.

Progress among farmers in reducing soil erosion losses in western Iowa has been slow. This analysis of practices in the 144 sample farms showed an average decline of only 1.5 tons per acre in the annual rate of soil loss from 1949 through 1952. This average decline is misleading, however, because 69 farms increased erosion losses about 7 tons per acre per year, while 70 farms decreased erosion losses about 9 tons per acre per year. Individual farms revealed wide variations. The modal group's loss was 5 tons greater in the resurvey. The average rate of loss on all farms was still nearly 20 tons per acre annually. As a group, the operators had not succeeded in reaching their own goals of erosion control (16 tons per acre annually) which they had suggested 4 years earlier. If those goals had been reached, the average annual soil loss would have been reduced by 4 tons per acre, which is still about four times the conservation technicians' goal of 5 tons per acre of permissible soil losses.

Erosion-control practices of contouring, use of commercial fertilizers, terracing and grassed waterways, showed a gain in use. The use of contour listing and high-forage rotations, however, declined. Habit, custom and lack of knowledge concerning the benefits that might be obtained from erosion-control practices continued to be responsible for heavy soil losses. In those instances in which farm owners and farm operators became more fully aware of the extent and effects of erosion losses on their farms, they took steps to reduce these losses.

There was little incentive for farm owners and farm operators to sacrifice immediate incomes or to make erosion-control investments if they had insufficient assurance that they would receive compensating benefits. On farms where adjustments had been made to meet this problem, greater success was achieved in reducing the rate of soil loss. Conversely, where there was less assurance of receiving compensating benefits from erosion-control measures, there was a tendency for soil losses to increase.

Efforts to overcome the obstacles to soil erosion control must vary with the situations encountered. Problems not only differ from farm to farm; they also differ on the same farm from time to time. What was acceptable to an operator under a particular tenure situation, with given price and cost ratios, with a given financial situation and given objectives and with a given attitude toward the problem of soil erosion, may be unworkable with changes in any or all of these factors.

The major causes for failure to reduce soil losses during the period studied apparently were uncertainty of tenure, lack of adequate finances, greater reluctance to assume risk and lack of confidence in recommended practices. The major causes of success in reducing soil losses appear to be an increased appreciation of the seriousness of soil losses, an increased security of tenure and increased appreciation that a shift to more grass on the steeper slopes and an increase in livestock inventories was conducive to erosion control and profitability of farming over the long pull.

The control of erosion is a continuing problem rather than one that is amenable to a permanent "once and for all" solution. Even so, it can be less of a problem in the future than it is now if the socio-economic factors that make it a problem are more fully understood and the techniques used to cope with the problem are kept flexible to meet changing situations.

Soil Erosion Control in Process in Western Iowa[1]

BY R. BURNELL HELD AND JOHN F. TIMMONS[2]

Efforts to control soil erosion losses on rolling lands in western Iowa continue to fall short of desired objectives. Farm owners and farm operators are familiar with many of the physical techniques necessary to limit erosion, yet they are not using them to the extent desired. Consequently, if erosion losses are to be reduced in line with objectives of public programs, the reasons these practices are not used more widely must be determined, and means must be found for overcoming these difficulties. This report summarizes the progress made in erosion control, analyzes the factors involved in the obstruction of further progress and suggests the means whereby the adoption of erosion-control measures may be accelerated.

PUBLIC INTEREST IN EROSION CONTROL

The problem of soil erosion is a public problem for several reasons. A farming system conducive to a high rate of soil loss may be profitable to a particular farmer only because the costs associated with the soil loss can be transferred to someone else. Eventually this could mean an unnecessarily high cost for agricultural products. Similarly, some measures which retard erosion may be of value to others because damage to their property is prevented. But the person called upon to put the measure into practice may find that the costs involved exceed his expected returns.

Resources should be directed toward those uses in which the net value of goods or services produced is greatest over time if the public is to receive the highest possible benefits from its funds. To continue investments in erosion control long after the returns from such investments have fallen below those possible in other investment opportunities would deny consumers goods and services they might have enjoyed otherwise. But failure to make investments in erosion control up to this point may be even more detrimental than overinvestment if nonrenewable soil resources are lost.

THE PROBLEM OF EROSION CONTROL

Erosion losses are direct consequences of physical practices which in turn are caused by and are subject to change by man. But why do some land users alter these physical practices so that erosion losses are accelerated while others adopt practices that tend to reduce soil losses? In most instances, the explanations lie in economic considerations, in custom and habit or in government policies and laws.

In an earlier study, the soil loss rate was calculated for each of the 144 farms included in the sample studied.[3] Nearly half of these farms in the area were losing more than an estimated 20 tons of soil a year from each acre through erosion. The average annual loss on all farms in the sample was estimated at 20.8 tons per acre and ranged from 0.2 to 68.5 tons per acre.

More than 70 percent of the operators interviewed in the earlier study objected to the high-forage rotations which were suggested as a means for reducing soil losses to the annual loss rate of 5 tons per acre deemed permissible by conservation technicians.[4] Nearly 60 percent objected to the use of terraces which were recommended in an alternative plan in which the amount of forage was reduced. Forty-seven percent of the operators objected to both terraces and high-forage rotations.

Only 11 percent of the operators used all the practices deemed necessary by technicians to reduce erosion losses to the goal of the public agencies. However, nearly three-fourths of the operators believed that soil erosion was a serious problem on their farms. They be-

[1] Project 1094, Iowa Agricultural and Home Economics Experiment Station.

[2] At the time of the study, the senior author was jointly employed by the Iowa Agricultural Experiment Station and the United States Department of Agriculture; at present, he is on the staff of Resources for the Future, Inc. The junior author is professor of economics. The authors are indebted to many people who gave valuable assistance in making the study; especially, Val Silkett of the U. S. Soil Conservation Service and Frank F. Riecken of Iowa State College. Buis T. Inman of the Farm Economics Research Branch, Agricultural Research Service, helped plan the study and advised in all major phases of the work. Appreciation is also expressed to members of the U. S. Soil Conservation Service and the Iowa State College Cooperative Extension Service who helped design erosion-control plans used in the investigation. Special appreciation is due the soil conservation technicians in western Iowa who planned the sample farms included in this study. Guidance given by Raymond Jessen and Norman Strand of the Iowa State College Statistical Laboratory in drawing the sample and in helping plan the analysis has been very helpful. Finally, special thanks are reserved for the farm owners and operators who freely gave their time in making available much of the information upon which this study is based.

[3] John C. Frey. Some obstacles to soil erosion control in western Iowa. Iowa Agr. Exp. Sta. Res. Bul. 391. 1952.

[4] The concept of a permissible rate of soil erosion is a physical rather than an economic concept. It is that rate of loss at which the level of fertility can be maintained by offsetting soil losses with practices that increase fertility. It has also been assumed, but has not been proved, that gully formation commences or accelerates at any higher rate of soil loss.

lieved that it was severe enough to warrant the use of more erosion-control practices, but only 21 percent of them were planning to use sufficient practices to bring their loss rates down to the 5-ton level.

Objectives of Study

The major problem posed for this investigation was to determine whether changes in obstacle and success factors were responsible for corresponding changes in erosion losses. In other words, how do the previously identified obstacles prevent farm operators from using measures deemed necessary to reduce soil losses on their farms to the levels that farmers consider desirable and conservation technicians consider to be in the public interest? Based upon evidence obtained in the earlier study, we hypothesized that obstacles to erosion control may develop, or may continue to exist because of one or more of the following situations: (1) Farm owners and operators are not aware of means already available that might be used to overcome difficulties or objections to erosion-control measures. (2) Customary practices in rental arrangements do not encourage adoption of erosion-control measures. (3) Off-site damages or benefits arise that discourage the land owners and farm operators from changing their present use of the land. (4) The farm operator is not sufficiently secure in his expectations of tenure to permit the use of certain practices. (This would be especially true where the practices tended to defer income to a future period when he is not able to establish a claim.) (5) The farm operator does not have the resources to carry out the type-of-farming system that would be required, or the ability or perhaps the desire to obtain these resources. (6) Price relationships are such that the conservation plans will result in a system of farming that is not the most profitable for the farm operator.

To test these hypotheses, we set out to determine what happened to the soil loss rates over a period of time if any or all of the conditions listed changed. We expected to find, in those situations in which these difficulties were reduced or eliminated, an increase in the use of erosion-control practices and hence a lower soil loss. On farms where an obstacle had developed, we expected to see a decrease in the use of erosion-control practices and greater soil losses. In addition, we wished: (1) to determine the extent to which farmers had succeeded in controlling erosion and to determine the factors responsible for any changes since 1949; (2) to determine more exactly the nature of the situations which the 1949 investigation indicated were major obstacles to the adoption of erosion-control practices; and (3) to determine, in those instances in which obstacle situations had changed, the factors responsible for change.

Area and Sample Farms Studied

The farms that were studied are located in western Iowa on the Ida, Monona and related soils. These soils cover an area of more than a million acres (fig. 1). A fringe of bluffs separates the area on the west from the Missouri River and its bottoms. The soil area merges with the Marshall soils to the east and south and the

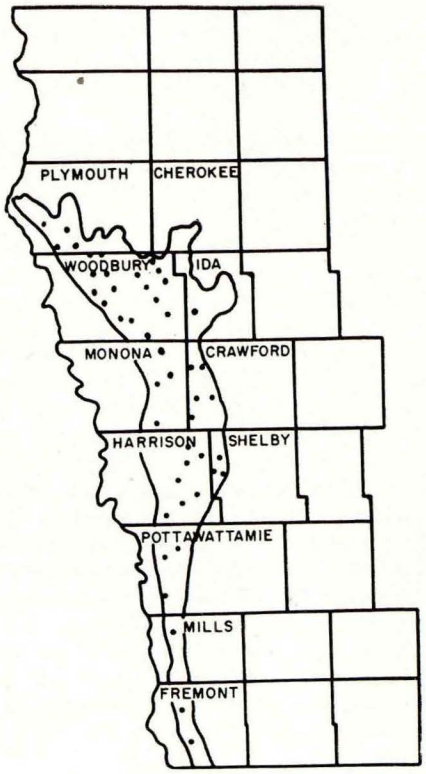


Fig. 1. Western Iowa showing the approximate location of the Ida-Monona soil area and the 48 sampling units.

Galva-Primghar-Sac soils to the north and east as the topography becomes less steep. It extends in a north-south direction from the southern part of Plymouth County to the Iowa-Missouri state line.

Although this area has been fully settled and farmed for less than 80 years, erosion has made rapid strides. Gullying is severe and widespread. Sheet erosion, while less obvious, is also extensive. Farming efficiency has been reduced since access to fields has been made more difficult and an increasing area of wasteland is being created. The construction and maintenance of roads and bridges in the area is more costly than in other areas of Iowa where topography is somewhat comparable. Runoff from the hills drains through the productive bottomlands, frequently flooding them and destroying crops. On the Missouri bottoms, where drainage is necessary, the siltation of drainage ditches and farming land is a constant problem.

There are about 4,800 farms in the area. Available resources restricted the 1949 study and the present study to a sample of these farms. The sampling procedure devised for the study yielded 48 sections of land, or sampling units (fig. 1).[5] Observations were made on 144 farms in 1949 which became 143 farms in 1952, wholly or partly within these 48 sampling units.[6]

[5] Frey, op. cit., pp. 952-953.

[6] The headquarters of all 144 farms in 1949 and corresponding 143 farms in 1952 were located in the 48 sampling units. All land in these farms came into the study regardless of whether or not part of it was outside the sampling units. Land within the sampling units included in farms with headquarters outside the sampling units was omitted from the study. The reduction in number of farms studied from 144 in 1949 to 143 in 1952 resulted from the application of the "headquarters" rule. Thus, the headquarters of only 143 farms fell in the sampling units in 1952 as compared with 144 in 1949.

Most of the landlords of the rented farms were also interviewed.[7]

Methods of Obtaining and Analyzing Data

The 144 farms included in the 1949 study were revisited in this investigation. The earlier study provided the benchmark data necessary for an anlysis of soil loss changes and the factors associated with these changes.

The operators and owners of the farms in the sample were reinterviewed, and each was shown two plans that had been prepared for his farm. Both plans had been designed to limit erosion losses to an annual 5-ton soil loss.[8] The respondent's attitude toward the various practices recommended in the plans was noted and compared with that in 1949. The reason for any change in the operator's attitude toward the practices between the two visitations was obtained.

Information from the 1949 interview record was transcribed on the new interview forms before returning to the farms for the second interview. This included such items as tenure status, farm size, major farm enterprises, acres in row crops and, if applicable, lease type and rent paid, amount of borrowed capital, amount of terracing and contouring and the major obstacle conditions on the farm. The cropping situation and land use practices by fields for 1949 were also noted.[9]

Where changes in these situations were found, the operator was questioned in detail in an effort to determine the factors responsible. If no change had occurred and present conditions remained an obstacle to the adoption of the erosion-control measures suggested in the farm plans, inquiry was made to learn what particular difficulties were involved and why the obstacle situation had not been overcome. In those instances in which the obstacle situation had been partially or completely overcome, the factors making this possible were sought.

Soil loss rates were computed for each farm based on information obtained in the interview.[10] These loss rates were compared with the soil loss rate that had been computed for the farm based on 1949 conditions. The difference between the two rates was designated as a plus change if the soil loss had increased. If the loss had decreased, it was shown as a minus change. In several instances, the computed loss was the same for both surveys. These were designated as "no change." The farms were then grouped according to whether the different obstacle situations had lessened, had remained the same or had become more of a problem. Changes in soil loss were computed and compared using the analysis of variance technique to determine whether there was a significant difference.

The data, however, contained some confounding factors. As might be expected, changes tending to facilitate the adoption of erosion-control practices as well as changes tending to obstruct the adoption of such practices were often found in the same farm situation. Abstracting one attribute at a time from the total situation and comparing the change in the attribute with the change in soil loss would produce a misleading impression of the true situation. A weighting of the attributes and their simultaneous consideration appeared to be the most useful solution for such a problem. Each change in obstacle situation, depending on the direction of the change, was given a positive or negative weighting unit. The algebraic sum of the weights determined the grouping of farms for analysis of variance.

In an attempt to overcome some of the difficulties of limited data on infrequent obstacles and complex interrelations of factors, a group-case method was tried. This method permitted a limited amount of generalization, depending upon the number of cases that were similar enough in the various attributes to be grouped. At the same time it preserved the relationship of the various factors in a farm situation which helped to determine whether or not a farm operator would adopt certain erosion-control practices.

Other confounding factors were the changes in operators and owners of the sample farms and changes in size of ownership and operatorship units.[11]

The question of what influence, if any, the 1949 interview had on the operators who were reinterviewed was considered, since their attitudes may have been altered by the first interview. In explaining why he had adopted specific erosion control, one operator indicated that the previous interview had started him thinking about terracing, and he had decided to try the practice. Others may also have been influenced but did not indicate it. A test was made to determine whether there was a significantly greater difference in soil loss on farms where the same operator was interviewed in two points in time than on those farms where operators had changed during the interim. Although, as table 1 indicates, the difference between the two groups was small enough to have been caused by chance alone, it is noteworthy that there was less variation in soil loss among operators who had been reinterviewed before than among the new operators. Farm operators interviewed in both surveys included operators with longer tenure stability and hence might be expected to have more soil erosion-control practices in operation.

Where farm operators had changed, the problem was avoided in part in the statistical analysis by examining

[7] Information on the owners of 12 farms was not obtained. Four landlords were out-of-state residents, and the remaining eight could not be contacted because of illness or extended trips.

[8] These plans were the same plans that were prepared for and used in the 1949 study. A set of these plans is shown, with the accompanying maps, in the research bulletin reporting that investigation. Frey, op. cit., pp. 1002-1005.

[9] Copies of questionnaires are on file in the Department of Economics and Sociology, Iowa State College.

[10] Soil losses were computed using the system of factors devised by Browning which take into account, and weight various physical factors which affect erosion. These are soil type, amount of organic matter, vegetative cover as expressed in terms of rotations, use or non-use of contouring and terracing, degree of slope, length of slope and extent of previous erosion. The weight given each factor varies with the circumstances in each situation. It is based on experimental data for the particular condition found. The product of the factors represents the estimate of the amount of soil lost from an acre in 1 year given normal weather conditions. For a detailed explanation of these factors see: Browning's erosion factors. Iowa State College. Department of Agronomy. (Mimeo.) 1948.

[11] In three instances, a tract of land that had been operated as a separate unit in 1949 had been consolidated with another farm (two of these consolidations took place within the sampling unit), and in two other instances, tracts of land that had been operated as one farm in 1949 were operated as two farms in 1952. Additional land from outside the sampling unit was added to 8 farms by either purchase or rental, while 10 farms lost land to other farms outside the sampling unit. These shifts resulted in the net decrease of one farm from the sample between 1949 and 1952.

TABLE 1

OPERATORS INTERVIEWED BOTH IN 1949 AND 1952 AND OPERATORS INTERVIEWED FOR THE FIRST TIME IN 1952 WITH CORRESPONDING CHANGES IN SOIL LOSS FOR THE FARMS THEY OPERATED.

Change group	Operators interviewed		Soil loss change* (tons per acre)	
	No.	Percent of subgroup		
Old operators	106			
Soil losses increased	47	44.3	6.3	
Soil losses decreased	55	51.9	— 8.5	
No change	4	3.8		
Average change				—1.6
New operators	37			
Soil losses increased	22	61.1	7.6	
Soil losses decreased	15	38.9	—14.4	
No change	0	0.0	0.0	
Average change				—1.2
Average change, all farms	143		0.0	—1.5

* Differences in soil loss change are not significant at 5-percent level of probability.

the situations apart from those in which the operator had not changed.

Where farm size decreased, the 1952 situation was used as the base, and the soil loss for 1949 was recalculated after excluding the land that had dropped out of the farm since then. When a tract of land came into the farm in 1952 from outside the 1949 sampling unit, it was not used in calculating the soil loss for 1952 because 1949 data were not available and could not be determined. If it came from within the sampling unit, it was used, and the 1949 soil loss was adjusted to show what the loss would have been then if the tract had been part of the farm.

CHANGES IN LAND USE PRACTICES AND EROSION LOSSES

Changes in Rates of Soil Loss

The over-all situation in western Iowa with respect to erosion control did not change significantly. The average change in the rate of soil loss calculated for the 144 farms sampled was a reduction of one-half ton of soil lost per acre. The average rate of soil loss in 1952 was 19.8 tons per acre a year, which was 0.5 ton lower than the 1949 average.[12] The modal group in the frequency distribution of the rate of loss, however, was 5 tons higher in 1952 than in 1949 (fig. 2).

More farms in 1952 had soil loss rates of less than 20 tons than was the case in 1949. However, this was not a clear gain in erosion control because there were fewer farms in 1952 with loss rates of less than 10 tons than there were in 1949. On nearly two-thirds of the farms the change in the soil loss rate, whether an increase or a decrease, was less than 10 tons. Figure 3 shows the frequency distribution of the changes. The largest changes were not randomly distributed among the farms in the sample. Some of the greatest decreases in soil loss rates occurred on those farms that had the heaviest soil losses in 1949 (fig. 4). Many farms that

[12] A slight change was made in the method of calculating soil loss rates from that used previously in the case of land in permanent pasture that was wooded and had never been under cultivation. Such land was excluded from the calculation of soil loss. To obtain comparability with 1949, the soil loss was recalculated on these farms from the 1949 data. The over-all change was slight. The mean loss calculated originally from the 1949 data was 20.8 tons for the farms in the sample. Recalculated, excluding land that was no longer in the sample, it was 20.1. The final calculation, which excluded the pasture land, gave a mean in 1949 of 20.3.

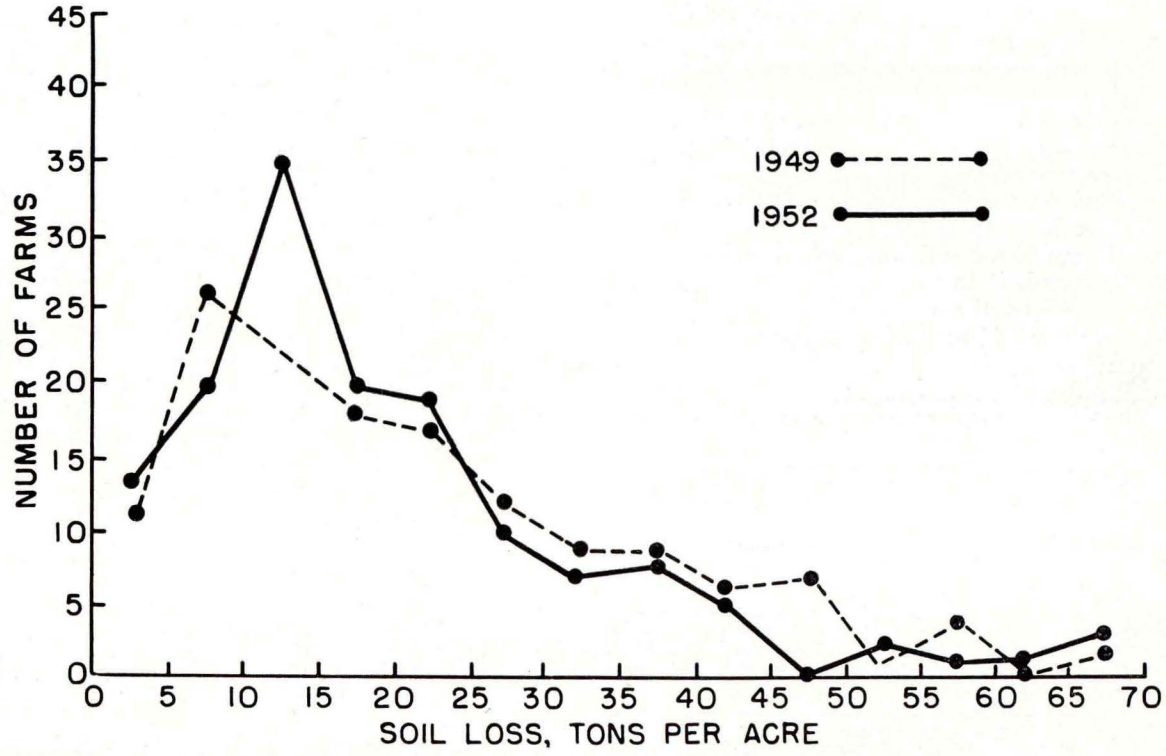


Fig. 2. Frequency distribution of the 1949 and 1952 soil loss rates on 144 farms from the Ida-Monona soil association area.

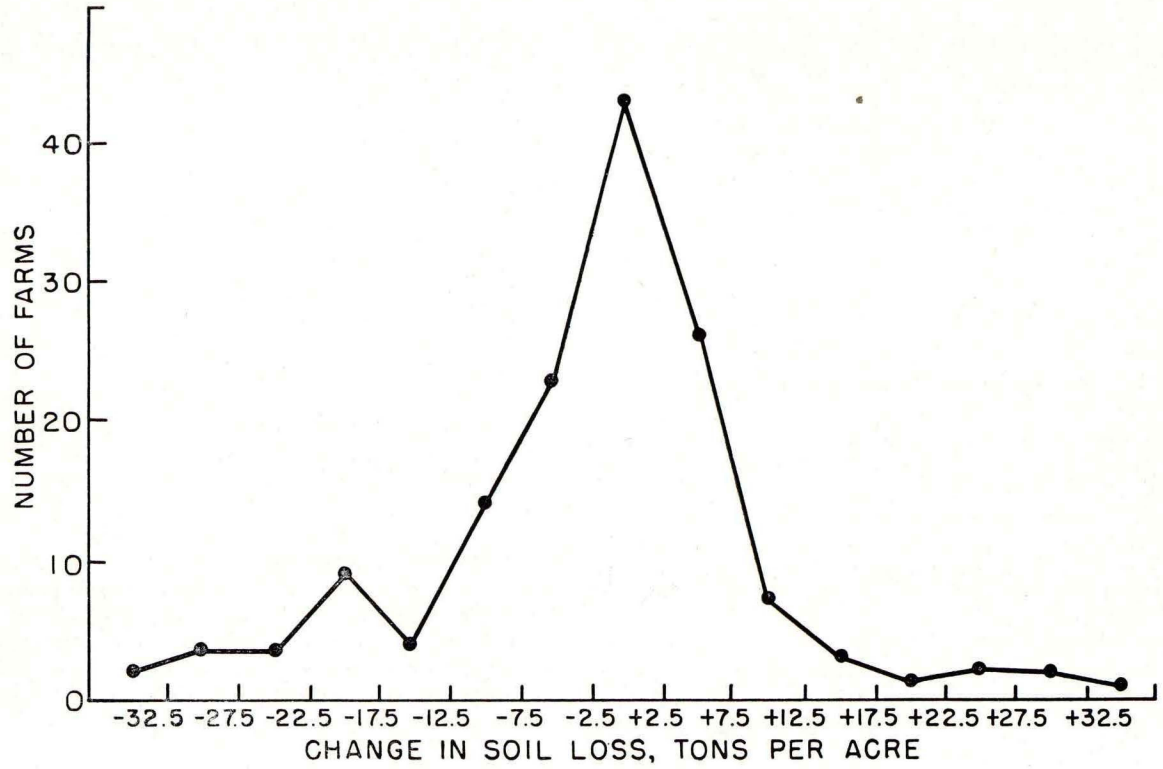


Fig. 3. Frequency distribution of changes in soil loss from 1949 to 1952.

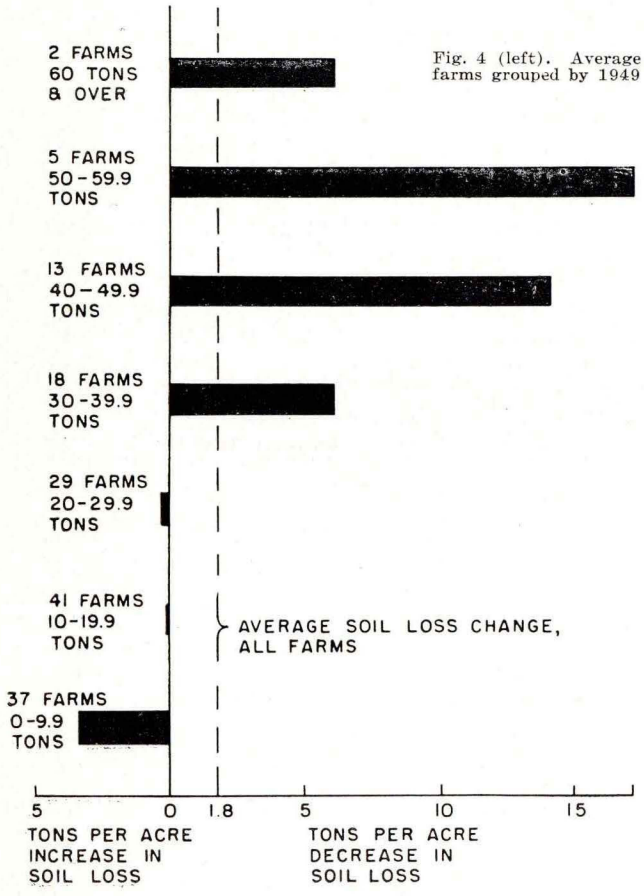
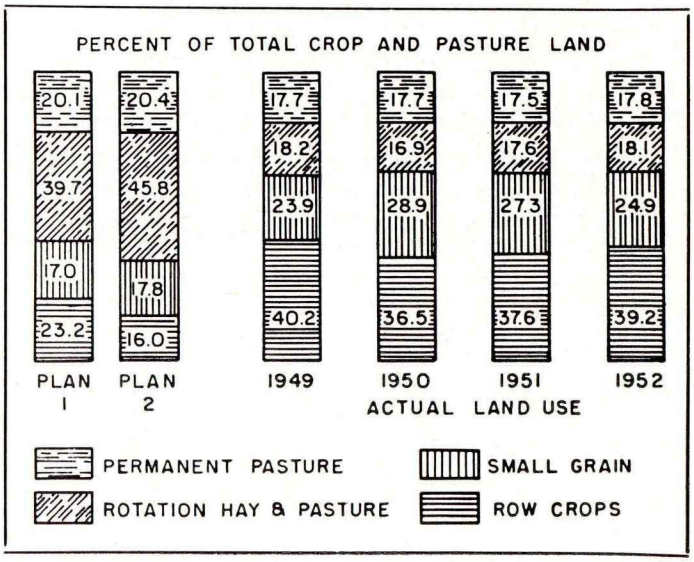


Fig. 4 (left). Average change in soil loss rates from 1949 to 1952 by farms grouped by 1949 loss classes.

Fig. 5 (below). Recommended land use and actual land use from 1949 through 1952 on 144 farms in the Ida-Monona soil association area.



had low losses in 1949 actually showed small increases in the soil loss rate in 1952.[13]

Both the 1949 and 1952 observations call attention to the difference between what farm operators were doing to control erosion and what would be desirable from the public point of view. If the 5-ton soil loss is the highest loss consistent with the public interest, then the annual soil loss must be reduced approximately 15 tons per acre on the average farm to be consistent with public interest.

Cropping Changes

Small changes in the cropping system took place during the period from 1949 to 1952 (fig. 5). Acreages of grains and forage crops remained about the same. Sixty-five percent of the crop and pasture land in the area was in corn and small grain. If the conservation plans that included the use of terraces had been followed on these farms, only 40 percent of the crop and pasture land would have been devoted to grain crops. The plan in which no terraces were used would have reduced grain production to 24 percent of the crop and pasture land.

Acreage allotments, which were in force in 1950, reduced the acreage of corn by 9 percent from 1949 on the farms studied.[14] There was also a 7-percent reduction in rotation hay and pasture while the acreage of small grain increased. The Korean conflict brought acreage controls to an end and set counteradjustments in motion so that by 1952 the cropping system again approached the 1949 situation.

The proportion of cropland in corn on some farms fluctuated considerably each year.[15] One rented farm, which has had a different operator each year, had corn successively on 66 percent, 45 percent, 73 percent and finally, on none of the farmland.[16] Eight farms on which the operators had an average of 46 percent of their cropland in corn in 1949 had cut corn acreages back to less than 25 percent of the cropland in compliance with acreage allotments in 1950. For the next 2 years, however, the corn on these farms averaged 39.3 percent of the croplands.

Land Use Practice Changes

The most pronounced changes from the 1949 situation were those which came about with adoption of practices other than rotations. Contouring continued to be the most widely accepted practice of all the recommended measures for reducing soil losses (table 2). Although 65 percent of the farm operators reported that they were contouring on at least part of their land, there is some question as to the extent to which their reported compliance conformed to the standards for contouring established in the recommendations. The practice of farming across the slope, but not necessarily with the contour, is referred to by some farmers as contouring. In many instances, the corn was planted and cultivated on the contour. However, plowing and other seedbed preparations were not done on the contour.[17]

TABLE 2

COMPARISON OF THE EXTENT TO WHICH 144 FARM OPERATORS IN THE IDA-MONONA SOIL AREA WERE USING CERTAIN PRACTICES RECOMMENDED FOR EROSION-CONTROL PURPOSES IN 1949 AND 1952.

Recommended practices	Percentage of farms on which practice was recommended	Percentage of farms on which recommended practices were used		Percentage change in use of practice from 1949 to 1952
		1949	1952	
Contouring	100	50	65	+28.7
Grassed waterways	100	33	46	+39.4
High-forage rotations	100	32	25	—21.7
Commercial fertilizers	98	34	60	+77.0
Terraces	91	15	27	+80.0
Contour listing	20	17	13	—23.5

Commercial fertilizers gained more new users than any of the other practices and showed the second largest percentage gain. Fertilizers were used for the first time by 47 farm operators, an increase over previous use of 77 percent.

Terracing showed the largest percentage gain although the number of new users was relatively small. Terraces were installed on 10 farms where none had been used before. This was a gain of 80 percent in adoption over 1949. The practice of contour listing, in use on only a small number of farms in 1949, was found on fewer farms in 1952. There was a moderate increase in the use of grassed waterways but the practice was still used by less than half the farm operators. There was also a decrease in the use of high-forage rotations.

Table 3 reveals (1) the extent to which the increased use of certain practices on some farms had been offset by the decreased use of the practice on other farms, and (2) the extent to which the new users of a practice had been offset by operators on farms where the practice was used in 1949 but was no longer followed in 1952.

Farmers' Erosion-Control Goals

When the farm operators were interviewed in 1949 they were asked what practices, if any, were needed or should be used to a greater extent if erosion losses were to be further reduced on their farms. Many of them indicated some additional practices would be desirable. The 1952 survey provided an opportunity to determine the extent to which these additional practices had been adopted or used.

[13] An analysis of variance computed on these data indicates that 84.8 percent of the variance of the soil loss changes for the sample can be explained by grouping farms according to their 1949 losses (significant at the 5-percent level).

[14] Iowa farmers as a whole reduced corn acreage by 14 percent in 1950 in response to the acreage control program goal of a 19-percent reduction.

[15] The coefficient of the variation computed on the percentage of farmland in corn averaged 34.8 percent for the 4 years. The coefficients of variation are as follows:

1949	34.4	1951	36.4
1950	31.1	1952	37.4

The coefficient of variation is computed by dividing by the standard deviation for the proportion of cropland in corn on the farms in the sample by the average proportion in corn for the sample. The statistic indicates the manner in which the observations for each year are grouped around that year's mean. Thus, the greatest variation occurred in 1952 with two-thirds of the observations expected to fall within the range of 62.6 percent to 137.4 percent of the average proportion of cropland in corn. The least variation occurred in 1950, indicating the effect of the acreage allotment program.

[16] In 1952 the operator was renting this farm on a crop-share basis but was operating his own farm which provided his major source of income. The rented farm was in such an unproductive state that he left the roughest portion of it idle and seeded the rest to oats and sweetclover.

[17] Where it was possible to observe that the "contouring" reported by the operator was little better than farming up and down hill, it was not recorded as contouring. However, a large part of the interviewing was done before and during the corn planting season, making it necessary in most instances to take the operator's word that he was contouring.

TABLE 3

PERCENTAGE CHANGES IN USE OF EROSION CONTROL MEASURES ON 144 FARMS IN WESTERN IOWA, 1949-52.

Practice	Practice adopted since 1949	No change in use from 1949	Used in 1949, increased use, 1952	Used in 1949, decreased use, 1952	Used in 1949; no longer used	Total farms using practice to some extent, 1952
Contouring	20.8	30.5	4.9	8.4	6.9	64.5
Terracing	6.9	13.9	3.5	0.0	0.0	24.2
Contour listing	1.4	1.4	0.0	0.0	1.4	2.8
Grassed waterways	9.7	25.0	11.1	0.0	0.0	45.8
Commercial fertilizers	32.6	16.7	9.7	0.0	6.3	59.0
Gully-control structures*	1.4	31.2	8.3	0.7	2.1	41.0
High-forage rotations†	6.9	0.7	11.1	6.3	13.9	25.0

* Includes concrete structures but are predominantly small earthen dams.
† Defined to mean rotations in which 30 percent or more of the cropland is in forage crops.

TABLE 4

COMPARISON OF THE ADOPTION OF EROSION-CONTROL PRACTICES ON FARMS WHERE A NEED FOR THE PRACTICE WAS RECOGNIZED IN 1949 WITH ADOPTION OF THE PRACTICES ON FARMS WHERE THE PRACTICE WAS NEITHER USED NOR RECOGNIZED AS NEEDED IN 1949.

Practice	Farms on which practice mentioned in 1949	Farms on which practice had been adopted since 1949	Farms on which practice mentioned in 1949; adopted by 1952	Practice mentioned and adopted, as percent of all farms adopting
Contouring	35	30	11	36.6
Terracing	27	10	3	30.0
Grassed waterways	18	14	0	0
Commercial fertilizer	17	47	10	21.2
Gully control	35	3	3	100.0
High-forage rotations	16	10	0	0

Recognition of the need for a particular practice is a necessary condition for its adoption but in itself it is not enough. Some operators who had indicated the desirability of using particular practices had carried them out, in part at least, yet often an operator who had not mentioned the need for additional practices in 1949 had nevertheless adopted some during the interim. But of the 35 farms whose operators in 1949 considered contouring a practice that was needed, or needed to a greater extent than currently used, only 11 had adopted the practice 4 years later. None had shown an increase in the use of contouring. However, by 1952, the practice had been adopted on 19 farms, and its use had been increased on seven farms whose operators had not previously mentioned the practice as a goal. The situation was much the same for other practices except for gully control (table 4). The proportion of farms on which practices that were mentioned in 1949 and had been adopted by 1952 averaged only 11.3 percent for all practices. Nearly a third of the farms on which particular practices had been mentioned as needed in 1949 had a change of operator during the period. This explains a part, but not all, of the low rate of adoption of the practices.

Farmers' goals were again determined in 1952 and are shown in fig. 6. The number of farms on which practices were not used, but whose operators considered the practices essential to an effective system of erosion control, is shown as an extension of the number of farms now using the practice. However, it should be remembered that this does not indicate that either the current practices or the goals, if adopted, were or would be used to the fullest extent possible.

After the farm operators had specified those erosion-control practices they considered necessary on their farms, they were asked whether they intended to start using these practices within the next 2 years. Some operators, including those who were then using practices they believed should be increased, said that under existing conditions it would be difficult or impossible for them to carry out the practices they named (table 5).

If in 1949 farm operators had been following all the practices they agreed were desirable and necessary for the control of erosion, erosion loss rates for that year would have averaged 15.6 tons per acre on the sample farms instead of more than 20 tons per acre, or a reduction of 25 percent of actual losses. Similarly, if the practices mentioned as desirable in 1952 had actually been in effect, the average rate of loss for all the 144 farms would have been 15.5 tons per acre, again approximately 5 tons less than the losses calculated on the basis of actual land use in 1952. Thus, there was no over-all change in the goals of the operators from 1949 to 1952.

On some farms, practices that had been indicated as desirable in 1949 were not mentioned in 1952. In some instances, the previously mentioned practice had already been adopted. In others, a change in operators had occurred, and the new operator's opinion differed from that of the former operator. The rate of adoption of the practice on those farms where it was no longer reported as a goal varied with the practice as shown in table 6.

Contouring was designated as a needed practice in 1949 by 24.5 percent of the operators. By 1952, only 37 percent of those who had mentioned the practice in 1949 still named it. However, the rate of adoption was much higher among those who did not mention contouring as a goal again in 1952 then among those who did.

A turnover of more than a third of the operators accounted for part of this difference; 10 percent of the adoptions were made by the operators who replaced those favorable to the practice in 1949.

Farms on which the operator mentioned contouring as a goal for the first time in 1952 partly offset farms on which the operators no longer indicated it as a goal. For all other practices, those operators who mentioned the practice for the first time in 1952 completely off-

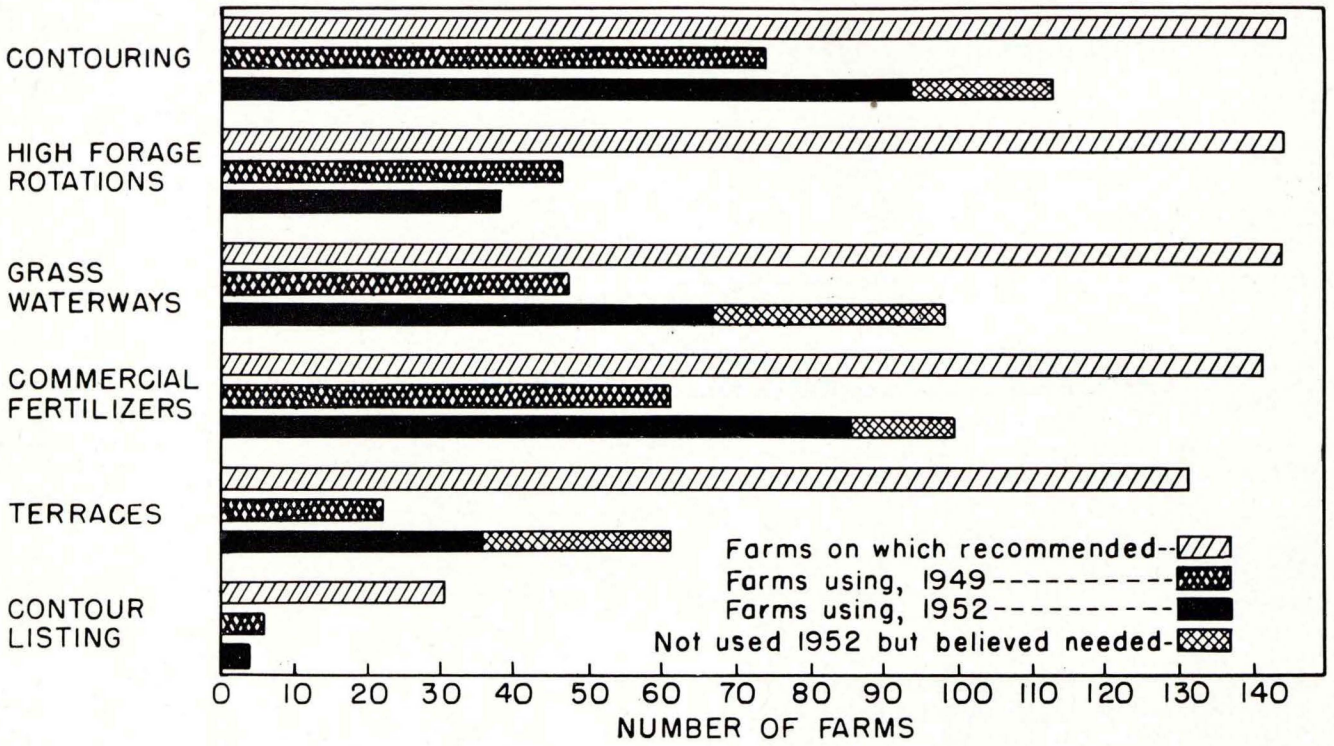


Fig. 6. Progress in adoption of recommended erosion control practices on 144 farms in this study between 1949 and 1952.

set the number of operators who no longer mentioned it.

At least 58 percent of the farm operators, in both 1949 and 1952, believed that use of the various practices to the extent recommended in the plans was not required to control erosion on their farms. These farmers often used *some* of these practices to a limited extent. Terracing, gully control and high-forage rotations, however, were used by only a minority of these operators.

Most farm operators, however, had an erosion-control objective in mind, even though it seldom coincided with—and usually fell short of—the public objective. The extent to which farm operators had succeeded or failed by 1952 to reach the objectives they mentioned in 1949 is shown in fig. 7. The figure translates these goals into soil loss rates and shows how the farmer goals for 1949 and 1952 compare with the 1952 losses. The farms are grouped according to the 1949 soil loss rates, and group averages are indicated in the figure.

Eight of the 13 groups of farmers increased their soil loss goals from 1949 to 1952. None of them, with the exception of one high-loss group, reduced losses sufficiently to meet the goals mentioned in 1949. While the average goal for the entire sample would reduce soil losses to 15.5 tons per acre, there was still a difference of 10.5 tons between it and a loss rate of 5 tons per acre.

The decision to use one practice may well be subject to influences that differ from those which determine whether or not another practice is used. It is also probable that after deciding to use a particular practice, an operator may think that another practice is no longer needed. This could mean the simultaneous increase in the use of some practices and a decrease in the use of others, as shown in table 7.

On the 43 farms where offsetting changes in practices were found, contouring and rotations were the practices most frequently involved in such changes. In 12 instances, the increased use of forage crops in the rotation was not sufficient to offset other less favorable changes, and the soil loss rate on the average increased by more than 6 tons. With contouring, the use of which was increased in 19 instances, the result was different. The soil loss rate was reduced by an average

TABLE 5

EROSION-CONTROL GOALS OF FARM OPERATORS AND THE EXTENT TO WHICH THE ACHIEVEMENT OF THESE GOALS IS BLOCKED.

Practice	Farms on which operator recognized need of practice		Farms on which circumstances prevent adoption of recognized practice	
	Number of farms	Percentage of all farms	All farms	Farms on which practice has never been used
Contouring	31	21.6	8	5
Terracing	46	32.1	9	6
Grassed waterways	54	37.8	4	4
Commercial fertilizers	26	18.2	4	3
Gully control	43	30.0	9	4
Increased forage in rotation	24	16.8	6	7

TABLE 6

THE RATE OF ADOPTION OF PRACTICES ON ALL FARMS WHERE THEY WERE MENTIONED AS GOALS OF THE OPERATOR IN 1949 BUT WERE NOT MENTIONED IN 1952.

Practice	Adoption rate (percent)
Commercial fertilizers	73.3
Contouring	45.5
Grassed waterways	33.3
Gully control	17.6
Terracing	15.4
High-forage rotations	8.3

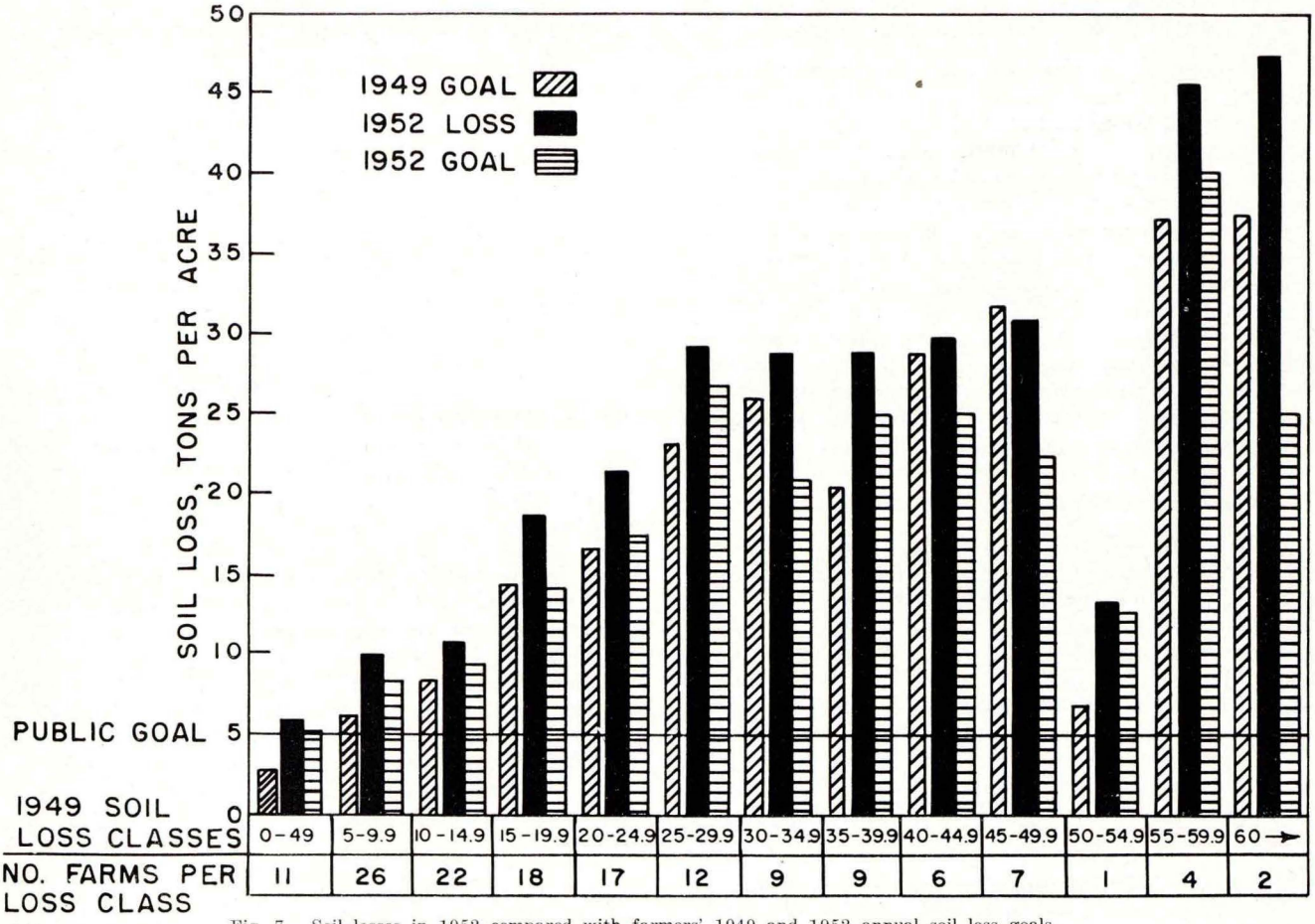


Fig. 7. Soil losses in 1952 compared with farmers' 1949 and 1952 annual soil loss goals. (Correction: the 1949 soil loss class which reads 0-49 should read 0-4.9).

of 7.1 tons per acre, even though other factors were present that tended to increase the loss rate.

Practices such as contouring, terracing and grassed waterways do not have as much effect upon immediate production as does a change in a cropping system or the use of commercial fertilizer. Rotations, in particular, can be expected to respond much more quickly to changes in economic conditions than the practices listed.

TABLE 7

INSTANCES ON 43 FARMS IN WHICH A CHANGE OF PRACTICES TENDING TO REDUCE EROSION LOSSES WAS OFFSET BY PRACTICES CONDUCIVE TO EROSION.

Offsetting practices	Frequency*		Average soil loss change per acre from 1949 to 1952† (tons)
	Number of farms	Percentage of all farms	
More contouring; less forage	16	11.1	— 6.3
Better organic matter management; less forage	9	6.2	— 3.7
More terracing; less forage	6	4.1	— 0.2
More forage; less contouring	6	4.1	6.5
More forage; poorer organic matter management	6	4.1	6.1
More terracing; poorer organic matter management	4	2.8	3.0
More contouring; poorer organic matter management	3	2.0	—11.5
Better organic matter management; less contouring	2	1.4	6.9

* Eight farms included twice.
† Minus sign indicates that erosion loss was lower in 1952 than in 1949.

Contouring, terracing and grass waterways are all means of erosion control that run counter to the established patterns of farming. This reason, in addition to the fact that their effects on production is of longer run nature, accounts for their slower acceptance.

Terracing, waterways and gully-control structures, because of their relative permanence when once installed, can be expected to continue to be effective for a number of years if properly maintained. Instances can be cited, however, where the works have been destroyed. Some instances were found where these practices were objectionable and were not maintained.

Changes made in land use from 1949 to 1952 had resulted in a reduction of soil loss rates. Gains were made in the use of all major practices except in the use of contour listing and high-forage rotations. Percentagewise, the gains were greatest for terracing. In terms of number of new users, commercial fertilizers made the most outstanding gain of any practice.

The reduction in the average soil loss on all farms in 1949 and in 1952 is relatively small compared with the reduction that must be made to reach the public goal of a 5-ton permissible soil loss. This reduction in loss is important for at least two reasons. First, it came about through the increased use of practices to which there is a resistance. Second, the largest reductions came from those farms that in general had the highest losses in 1949.

FACTORS RESPONSIBLE FOR CHANGES IN PRACTICES AND EROSION LOSSES

The question of why the gap between the level of erosion control achieved and that which is desirable has not been closed and must be answered before substantial progress can be made in overcoming the obstacles. A change that eliminates or reduces a former obstacle situation should be accompanied by a decrease in soil loss. On the other hand, a change that creates or intensifies an obstacle situation should be accompanied by increases in soil loss. Farms on which conditions were unchanged in 1952 from what they had been in 1949 presumably would show no change in soil loss. These results would be most likely if there were only one obstacle. Indeterminate situations might result if more than one factor was involved and if two or more factors changed in opposite directions.

Changes in Factors and Rate of Soil Loss

Changes in soil loss result from changes in land use. In turn, changes in land use are brought about by changes in socio-economic factors. It is important then that the operation of these socio-economic factors be understood if erosion-control activities are to be undertaken. Their effect on the use of land is difficult to establish because these factors must first have their effect upon the farm operator. This introduces the possibility that factors other than the one observed have entered into the response the operator makes. The data that follow should be viewed with that in mind.

CHANGES IN OPERATORS, OWNERS AND TENURE ARRANGEMENTS

The factor that caused the greatest change in land use, and hence, the erosion loss, was a change in operators, both the average increase and average decrease in soil loss were greater on farms where there had been a change in operator than on farms where no change had occurred (table 1). Forty-eight changes in operators occurred on the sample farms over the 4-year period and involved 42 farms (table 8). Thirty-two farms had two changes each in operators, eight farms had three changes each, while two farms had a new operator in each of the years.

TABLE 8

CHANGES IN ALL OPERATORS AND CHANGES IN THE TENURE STATUS UNDER WHICH THE FARMS WERE OPERATED, 144 FARMS, FROM 1949 TO 1952.

Type of change	Frequency (number)	Average yearly change (percent)
Operator only		
Field renter to field renter	2	0.35
Tenant to tenant	21	3.65
Owner-operator to owner-operator	6	1.04
	29	5.04
Tenure status only		
Tenant to part-owner	3	0.52
Tenant to full-owner	2	0.34
	5	0.86
Operator and tenure status combined		
Resident owner to field renter	1	0.17
Owner-operator to tenant	8	1.39
Tenant to owner-operator	9	1.56
Owner operated to nonfarm	1	0.17
	19	3.29
Total operator changes	48*	8.33*

* Total operator changes do not include the five "tenure status only" changes, which consisted of change in tenure status on the same farm.

TABLE 9

COMPARISON OF TENURE STATUS OF OPERATORS FOR 144 FARMS, 1949 THROUGH 1952.

	1949	1950	1951	1952
Owner-operators	59	66	67	66
Part-owners*	7	7	6	6
All tenants	78	72	72	71
Related tenants	(33)	(31)	(33)	(34)
Nonrelated tenants	(45)	(41)	(39)	(37)
	144	145†	145†	143†

* Includes only those operators whose own land as well as the rented property are in the sample. Other part-owners, classified as owners or tenants depending upon the ownership of the property, are in the sample segments. All except one of the part-owners were related to the landowners.
† Fluctuation in total number of farms caused by divisions and consolidations of farms that took place.

The aggregate change in tenure status was small, and the changes were largely offsetting (table 9). Eight farms that had been operated by owners in 1949 had become tenant-operated farms by 1952. Ownership also changed on all except three of these farms. Eleven other farms that had been operated by tenants in 1949 were operated by their owners in 1952. Two of the new owners were the former tenants.

Table 10 sets forth the changes in tenure status that occurred from 1949 through 1952 and the accompanying change in soil loss. The greatest turnover of operators, both in absolute terms and relative to the proportion in which they are found in the sample, was among tenant operators who were not related to their landlord. More than half of the operator changes came in this group.

The tenure of operators who were on the sample farms in 1949 and who were still there in 1952 averaged 10.7 years. Those operators whose tenure had terminated between 1949 and 1952 had been on their farms for an average of 6 years. The tenure of owner-operators and part-owners in both groups was the longest, followed by that of tenants with a related tenancy and finally, tenants with a nonrelated tenancy (table 11).

Expectations of long tenure were more certain among those operators who had been on the farms for the entire period than among those who had moved onto farms since 1949 (table 12).

LEASING CHANGES

Leasing changes of various types had been made on

TABLE 10

CHANGES IN TENURE STATUS OF FARM OPERATORS ON 24 FARMS AND CORRESPONDING CHANGES IN SOIL LOSS, 1949-52.

Nature of change in tenure status	All changes	Soil loss changes			Average loss change (tons/acre)
		Increase	Decrease	None	
	(No.)	(No.)	(No.)	(No.)	
Owner-operator to tenant					
Related to landlord	4	3	1	0	— 6.7
Unrelated	2	1	1	0	4.5
Related tenant and landlord to unrelated	1	0	1	0	—21.6
Tenant to owner-operator					
Related to landlord	3*	2	1	0	0.9
Unrelated	8	0	7	1	—17.9
Unrelated tenant to related	3	1	2	0	— 9.0
Tenant to part-owner	3†	2	1	0	— 3 2

* No change in operator in two instances.
† No change in operator in three instances.

TABLE 11

AVERAGE LENGTH OF TENURE OF 107 OPERATORS WHO WERE ON THE FARMS FROM 1949 THROUGH 1952 AND OF 37 FORMER OPERATORS WHO CHANGED AFTER 1949.

Tenure status of operator	Number	Average length of tenure
Same operator		
Owners and part-owners	58	12.2
Tenants related to landlords	26	9.6
Tenants not related to landlords	23	8.1
Operator no longer on farm		
Owners and part-owners	13	9.8
Tenants related to landlords	5	7.6
Tenants not related to landlords	19	3.0

TABLE 12

EXPECTATIONS OF SECURE OR LONG TENURE ON 28 FARMS RELATED TO CHANGES IN SOIL LOSS RATES.

Expectations of long tenure	Frequency (No.)	Soil loss changes			Average loss change (tons)
		Increase (No.)	Decrease (No.)	None (No.)	
Same operator					
More certain	1	0	1	0	—2.5
Less certain	6	4	1	1	3.8
Uncertain, no change	3	1	2	0	—3.5
Operator change					
More certain	6	4	2	0	7.1
Less certain	1	0	1	0	—8.6
Uncertain, no change	11	6	5	0	—1.0

TABLE 13

RELATIONSHIP BETWEEN CHANGES IN THE NUMBER OF FORAGE-CONSUMING LIVESTOCK ON 60 FARMS AND CHANGES IN SOIL LOSS RATES, 1949-52.

Nature of change	Frequency (No.)	Average change (A.U.)	Soil loss change			Average loss change (tons)
			Increase (No.)	Decrease (No.)	None (No.)	
Same operator						
Increase in number	29	11	9	20	0	—3.2
Decrease in number	15	— 9	9	4	2	1.2
Operator change						
Increase in number	5	11	3	2	0	1.4
Decrease in number	11	—12	4	7	0	—7.6

22 of the sample farms from 1949 to 1952. Thirteen of these changes were accomplished when either the landlord, the tenant or both changed. The lease term was increased on two farms, but it was also decreased on two farms. One of the farms on which the term of the lease was lengthened was a farm on which the lease type had been changed from crop-share to livestock-share. On the other farm, it was changed from an indefinite to a definite term lease to permit the tenant to participate in the Veterans Administration farm-training program.

The operators had changed in those instances in which the term of the lease was shortened. This was true also when the written lease was replaced by an oral lease and when the oral lease was replaced by a written lease. In the latter instance, the landlord had also changed.

CHANGES IN THE RESOURCE SITUATION

Livestock numbers changed little during the 4 years. Of particular interest are changes in forage-consuming livestock, which could provide a market outlet for the production from the recommended increase in meadow. Measured in terms of animal units, there was a slight over-all increase in forage-consuming livestock.[18] The increase, which came on 34 farms of the sample was nearly 11 forage-consuming animal units per farm (table 13). The net increase was 126 animal units, or less than one animal unit for each farm.

With only two exceptions, the increases in mortgage debt represented obligations created by the purchase of land (table 14). The most important of these increases, from the standpoint of their proportion in the total increase, were those incurred by new operators in their purchase of farms. Some had bought land for farm enlargement. One operator obtained additional funds with which to build a house. Another operator had encountered financial difficulties not related to the farm business.

The use of short-term credit increased by $174,589, or 2.5 times more than the net increase of $69,207 in mortgage debt.[19]

Livestock loans averaged $9,000. They accounted for 82 percent of the increased volume of credit but loans of this type had been made to only 38 percent of the operators who had increased their borrowings. More typical were the 45 percent of the operators whose outstanding loans had increased by approximately $1,100 on the average. They had used these funds for miscellaneous operating expenses and the purchase of machinery. In seven instances, or 17 percent of the cases, the funds had been obtained by the operators to get started in farming. These loans averaged $1,300.

CHANGES IN FARM SIZE

Changes in the size of farm units occurred on 14 percent of the farms in the sample (table 15). Ten farms were increased a total of 594 acres while another 10 farms were decreased by 492 acres. Sixty percent of the farms that increased in acreage were units of less

[18] One animal unit is the equivalent of 1.0 head of cattle 2 years and older, 2.0 head of cattle 1 to 2 years old, 4.0 calves under 1 year old, 1.5 beef steers, 1.0 horse 2 years and older, 3.5 sows, 7.5 pigs, 7.0 sheep, or 14.0 lambs.

[19] Four operators would not reveal the amount of loans outstanding but indicated a change and the direction of the change.

TABLE 14

CHANGES IN DEBT SITUATION ON 77 FARMS RELATED TO 1949-52 CHANGES IN SOIL LOSS RATE.

Nature of change	Frequency * (No.)	Average debt change ($)	Average debt after change ($)	Soil loss change			Average loss change (%)
				Increase (No.)	Decrease (No.)	None (No.)	
Same operator							
Mortgage debt increased	6	3,067	7,083	5	1	0	—1.2
Mortgage debt decreased	17	1,923	4,894	7	8	2	—1.6
Short-term debt increased	25	5,752	7,212	8	16	1	—3.7
Short-term debt decreased	8	1,237	1,337	2	6	0	—5.0
Operator change							
Mortgage debt increased	6	13,916	16,833	4	2	0	6.9
Short-term debt increased	18	2,593	2,639	14	4	0	1.8
Short-term debt decreased	4	1,375	350	2	2	0	1.8

* Changes in both mortgage and short-term debt on six farms.

TABLE 15

RELATIONSHIP BETWEEN CHANGES IN SIZE OF FARM UNITS AND CHANGES IN SOIL LOSS RATES, 20 FARMS, 1949-52.

Nature of change in size	Frequency	Average change as percentage of original size	Soil loss change			Average loss change (tons)
			Increase (No.)	Decrease (No.)	None (No.)	
Same operator						
Size increased	8	38	4	4	0	— 3.2
Size decreased	5	22	1	3	1	— 2.7
Operator change						
Size increased	2	39	1	1	0	—10.2
Size decreased	5	24	5	0	0	—10.8

than 160 acres. The average size of these 10 farms was increased from 155 to 214 acres.

The farms that decreased in size averaged 213 acres before the loss and 164 acres afterward. While on half the farms the decrease in size was an operator's decision, or one in which he concurred, the decision was not made by the operator in the other instances. With one exception, the farms were small.

Changes in the kind and amount of family labor were closely connected with changes in farm size. One operator had reduced the size of his farm because of poor health. On another farm, the landlord, who was related to the operator, had sold an outlying tract when the operator's son was no longer available to help on the farm. The operator of another farm had bought additional land so that his son might farm with him.

Decreases in farm size were accompanied by increases or slight decreases in soil loss (table 15). Increases in farm size were accompanied by decreases in soil loss. The association of farm size and erosion loss was much more sharply defined on those farms whose operator had changed concomitantly with the change in farm size.

Significance of Changes

Statistical tests were made to determine the probability that the changes in soil loss which were observed had actually been brought about by changes in obstacle conditions, or to determine the probability that the changes in soil loss on farms where obstacles had been overcome differed significantly from loss changes on other farms.[20] To eliminate the possible effect of offsetting changes in obstacles, two tests were made with selected farms. The 34 farms on which only one obstacle condition had been determined in 1949 were grouped according to the status of that obstacle situation in 1952. To this group were added those farms on which an obstacle had developed since 1949. The mean change in rate of loss for each group was determined as shown in table 16.

The changes in rate of soil loss indicate a tendency toward the elimination or lessening of obstacle conditions to permit the reduction of soil loss.

For the second test, farms on which more than one obstacle had been observed were included if changes in the obstacle situations had all been of the same nature. That is, if there were changes in three obstacle situations from 1949, all of the changes must have been such as to intensify the obstacle or all of them must have been such as to lessen the obstacle.[21] The results of this test are shown in table 17.

Table 18 accounts for all farms on which the obstacle

[20] The analysis of variance technique was used to make this determination. The results, shown in tables 16, 17 and 18, were not significant at the 5-percent level of probability, indicating that one might expect such results from chance alone in more than 5 instances in 100.

[21] This handling of the problem assumes that it is not necessary for an obstacle situation to be completely eliminated before a change in land use is possible. If this assumption is erroneous and there is an interrelation between the obstacle situations, then one unchanging obstacle could offset all other improved circumstances and a test of this type would be of little value.

TABLE 16

EFFECTS OF CHANGE IN OBSTACLE SITUATION ON CHANGE IN SOIL LOSS ON 34 FARMS WHERE ONLY A SINGLE MAJOR OBSTACLE WAS FOUND IN 1949.

Obstacle situation 1952	Frequency	Soil loss change per acre (tons)	Difference between 1949 soil loss and 1952 goal per acre (tons)
No change in obstacle situation	10	—3.1	—5.2
Obstacle lessened	18	—2.4	—7.7
Obstacle increased	6	2.9	2.3

TABLE 17

EFFECTS OF CHANGES IN OBSTACLE SITUATIONS ON CHANGES IN SOIL LOSS ON 66 FARMS ON WHICH ALL OBSTACLES ON EACH FARM CHANGED IN THE SAME WAY.

Obstacle situation, 1952	Frequency	Soil loss change per acre (tons)
No improvement or change toward intensifying obstacle	28	1.1
Obstacle lessened or overcome	30	2.4
Obstacle situation developed since 1949	8	0 7

TABLE 18

STATUS IN 1952 OF PARTICULAR OBSTACLE SITUATIONS AND ASSOCIATED CHANGES IN OPERATORS AND RATE OF SOIL LOSS FOR 144 FARMS.

Obstacle situation	Frequency (No.)*	Frequency (percent of all farms)	New operators (number)	Soil loss change per acre (tons)
Leasing arrangements				
No change	25	18	5	— 1.7
More adapted to erosion-control objectives	19	13	6	— 2.8
Less adapted to erosion-control objectives	3	2	3	+19.7
Length of interest in farm				
No change	19	13	8	— 0.6
More adapted to erosion-control objectives	11	8	5	+ 1.0
Less adapted to erosion-control objectives	5	4	3	+ 0.4
Enterprise organization				
No change	33	23	9	— 1.9
More adapted to erosion-control objectives	26	18	10	— 3.9
Less adapted to erosion-control objectives	10	7	5	— 1.5
Financial position				
No change	14	13	5	+ 0.6
Improved	25	18	11	— 1.2
Worsened	7	5	3	+ 4.9
Farm size				
No change	28	20	5	+ 3.6
Less of problem	23	16	12	+ 1.0
Greater problem	3	2	3	+ 6.0

* Some farms included in more than one group because more than one obstacle situation was observed on the farms.

situations were found in 1949 or 1952 and the nature of the changes in these situations if any. It also indicates the average change in rate of soil loss and the number of instances in which there were also changes of operators. The changes in rate of soil loss associated with the changes in the different obstacle situations are comparable to those shown in tables 16 and 17.

The changes in rate of soil loss are surprisingly consistent throughout. Those situations in which obstacles have been reduced show a reduction in the rate of soil loss, or a greater reduction than those instances in which the obstacle has increased. The only exception is that involving the obstacle, "length of interest." There is less difference here in the changes in the rate of soil loss than for the other obstacle situations but the percentage of new operators is also largest for this obstacle. This may explain some of the difference.

The changes in soil loss rates associated with the changes in tenure status, lease type, etc., do not test the validity of the hypothesis that changes in these attributes will produce corresponding changes in soil loss rates. The tables record *all* changes whether or not the condition was considered an obstacle by the operator.

The changes recorded in table 18, however, are expressed in terms of obstacle changes. They are derived only from those instances in which the change was noteworthy, either because the earlier situation had been an obstacle to the adoption of erosion-control measures, or because the situation had become an obstacle. In some instances, obstacle changes were recorded in which nothing but the operator's attitude toward the situation had changed. Given time, these operators may act in accordance with their changed attitudes.

Changes in operator, which accompanied almost all the changes in tenure status, also introduced confounding factors. The differences of attitude as well as differences in financial status associated with the new operators frequently accounted for the major changes that occurred.

CHANGES IN CASES AND CASE-GROUPS RELATED TO EROSION CONTROL

A mere accounting of changes may well be misleading if the changes are abstracted from the social and economic contexts within which they occurred. Particular obstacles or success elements may be relatively unimportant compared with other obstacle or success elements that may be found to exist in the same farm situation. For these reasons, farms were inspected individually and then grouped into classes of similar erosion and obstacle characteristics.

Classification of Cases

The farms on which the greatest changes in soil loss rates had occurred, both increases and decreases, omitting changes in loss rate of 5 tons or less, are indicated by code number in fig. 8.[22] Reference to these farms in the text will be made by indicating the code number of farms as identified in fig. 8. The 1949 loss

[22] The cut-off at 5 tons was considered sufficiently large to insure that changes larger than that were not due to errors in calculating soil losses,

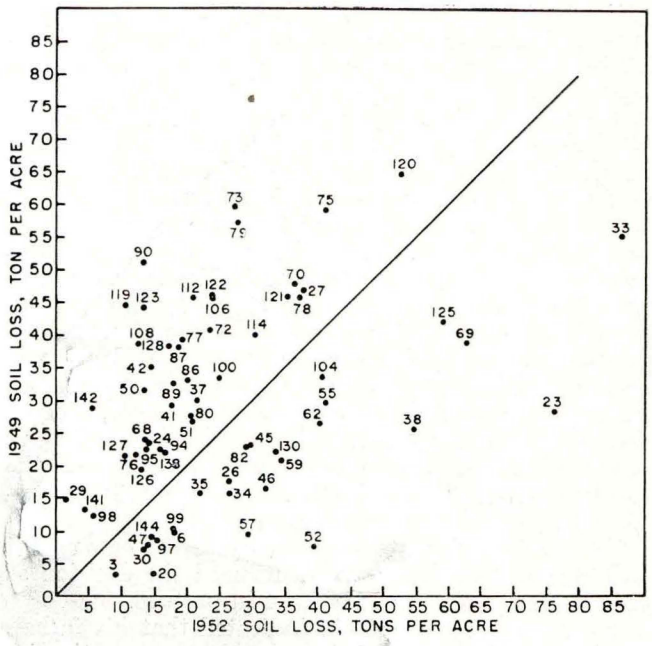


Fig. 8. Soil losses on 67 farms on which soil losses had changed (increased or decreased) by more than 5 tons per acre per year from 1949 through 1952.

rate is plotted on the vertical axis of the figure. The horizontal axis indicates the 1952 loss rate. Farms on which no change in soil loss had occurred, if shown, would have been plotted along a line drawn from the origin at a 45° angle. Farms on which soil losses had increased fall below this line. Those on which losses had decreased are plotted above the line.

Each of these farm situations was studied to determine the decisive factor or factors responsible for the physical changes. In some instances, a change in one factor only was obviously responsible for the change in soil loss. In other instances, a combination of several factors determined the change. Where it has been possible, the farms have been grouped by the major characteristic common to all of them. The circumstances of the farms within these groups have been summarized but where particular farm situations differed from the group, the salient factors have been indicated. The farms on which the rate of soil loss increased will be examined first.

Factors Contributing to Changes in Soil Losses

The examples that follow illustrate both the factors leading to an increase in the rate of soil loss on some farms and, in contrast, those factors that have enabled other farm operators to reduce the rate of loss. The cases range from farms with low losses and few obstacle conditions to those farms with high losses even after their soil loss rate was decreased.

RENTAL DIFFICULTIES

Factors that contribute to increases in soil loss can be found to be directly related to rental situations. Farms 20, 38, 46 and 69 represent situations of indifference on the part of the landlord and also the problem of the influence of customary practices. Although

it was evident that in these instances, the fault did not lie with the landlord, the tenants had a more favorable attitude toward the recommended practices than did the landlords.

Farms 38 and 46 were operated by related tenants. The others were unrelated tenancies. Farm 38 changed ownership and decreased in size. The farm originally had been one of 200 acres. It had been sold to settle an estate but an unimproved 80 acres from the farm was reserved for one of the heirs. The best land was withdrawn from the new farm unit. However, 40 acres of old pasture, badly cut into strips by two gullies, were retained in the farm unit. The farm plans recommended that the old pasture be broken and cropped and that the steeper portion of the farm be farmed less intensively. Both tenant and landlord objected to this. Although the tenant was apparently willing to contour, the landlord would not permit it. On the positive side, a livestock-share lease arrangement replaced the crop-share arrangement that existed previously, and the livestock inventory of the new tenant was larger. This may have influenced the decision as to the acreage of land to be kept in pasture.

The operator on farm 46 indicated that his father, an aged man, was not willing to make conservation investments in the farm. His father not only considered that fertilizer, additional forage and terracing would cost too much, but he also believed "the old way" was the best. The son had operated the farm for 10 years. Buildings and fences were in poor repair. The father's attitude and advanced age, and the existence of other heirs, created a situation providing the operator with little incentive to control erosion. Contouring was not "worth the bother," he said, as any soil loss was not his loss. He had increased production of corn in an effort to recoup his losses from a poor corn crop the previous year. The number of cattle had been increased but the acreage of forage crops had been reduced. He no longer plowed under a green manure crop but pastured his cattle on the oats and sweetclover. As a result, losses from erosion had more than doubled since 1949.

Farm 20 was owned by a woman, but management decisions were made by her aged father, a retired farmer, who had given it to her. He had previously farmed on the Missouri River bottoms and had only begun to appreciate the problem of erosion on upland farms. A soil conservation plan had been drawn up for the farm in the past, and several terraces had been installed. The difficulty lay in the elder man's inability to see the need for forage crops in the rotation. All pasture and hay land, except for that in the waterways, had been plowed up at his insistence. The tenant's livestock inventory of 13.5 animal units was lower than it had been in 1949, the tenant said, because of the lack of pasture. However, there was evidence that the tenant was relatively unskilled as a livestock farmer.

IMPROVEMENTS IN RENTAL ARRANGEMENTS

There were very few instances in which lease types changed and only two in which soil loss rates had been reduced by more than 5 tons. One of these instances was the change from a crop-share to a livestock-share lease on farm 38.

The other instance occurred on farm 27. Here the ownership of the farm passed from cousin of the operator to the operator's brother. Neither the new owner nor the operator looked with favor upon such practices as contouring and terracing. Both opposed the rotations suggested in the plans. The owner did insist upon a livestock-share lease with the result that more cattle were winterfed. As some forage was required for the cattle and the operator had been following a rotation of corn-corn-oats, the owner suggested a 2-year rotation, especially on the steepest land. Twenty acres also owned by the landlord were added to the farm, and this increased its size to 160 acres. This partly offset the reduction in acreage of corn which was brought about by adoption of the new rotation.

SMALL FARMS

Farm 97 illustrates a situation in which a small farm was adequate for a tenant who was semiretired but proved insufficient for a young tenant with a family. As a result, soil losses were increased. The new operator increased the livestock inventory from 4 to 8 animal units. However, he expanded his acreage of corn at the expense of pasture land and was pasturing his cattle on small grain. He also attempted to work off the farm much of the time with a construction company but this arrangement proved to be unsatisfactory.

No contrasting instances in which an increase in the size of the farm was primarily responsible for a reduction in the rate of soil loss occurred in the sample.

DECLINING INTEREST IN FUTURE OF FARM

The "conservation" problem in land use is largely a problem of deciding when and under what conditions the exhaustible resources of the soil shall be exhausted or disinvested. A farm operator whose expectation of tenure is short will discount future earnings from the land at a higher rate than will an operator with a longer interest.

An operator's gradual retirement on the farm could logically bring about situations conducive either to greater erosion control if he were financially secure, or, to greater erosion. On farms 35, 59 and 144 (and to a certain extent, farm 55, discussed later), the operators fall into the latter category.

These operators were all 60 years old or older. The first two farms contained 160 acres each and were owner-operated. The major part of farm 35 had been rented out for the 4-year period, however. Farm 144, a 104-acre unit, was tenant-operated under a livestock-share lease. In all instances, the increase in soil loss came about with an increase in the acreage of corn. The reason given for this shift was the inability of the operator to continue to care for a large number of cattle and the desire to avoid debt and risk.

The owner of farm 35 reported the only debt, a small mortgage which he expected to be able to pay off by the end of the year. He was in favor of contouring but had not pressed the issue because of a short-term interest in the farm and because the tenant objected to contouring.

INCREASED EXPECTATIONS OF LONG TENURE

If a change occurs that permits an operator to plan his operations over a longer period, he might be expected to discount future income less heavily and to be more concerned with the measures that would protect the capacity of the land to produce.

Farms 41, 42 and 50 changed ownership from 1949 to 1952 and became owner-operated farms instead of tenant-operated farms. Because these operators had longer interests in the farms than either the previous tenants or the landlords and had a recognition of the need for the practice, they were farming on the contour. Their larger livestock inventories also made it profitable for them to increase forage production.

REDUCTION OF LIVESTOCK ENTERPRISES

Changes in kinds and number of livestock can be expected to be reflected in changes in soil loss. The cattle inventory had dropped sharply on farms 6 and 84 during the period. The change on farm 6 came about with a change in operators. A 26-year-old tenant with 4 animal units of cattle replaced a 68-year-old tenant who had been on the farm 13 years and had 11 animals units of cattle. The new operator had plowed up some steep pasture land and put it into corn. The tenant on farm 84, who was operating under a livestock-share lease from his mother, had also plowed up pasture and put it into corn. The prospect of losses in cattle feeding had influenced him to do this.

The owner-operator of farm 52 had succeeded in reducing his mortgage debt and had improved his general financial position, but he had decreased his livestock numbers because of the unfavorable outlook for cattle. His intentions in 1949 had been to increase his livestock inventory but in 1952 he had 11.2 animal units of cattle as compared with 28.6 units in 1949. He expected to buy dairy cows because he believed there was less risk in this enterprise. However, he believed that he needed more corn than he had been producing.

His increase in soil loss would have been only half as great if he had continued to farm on the contour as before. He intended to resume the practice, however, after removing old fences and laying out a new field arrangement.

Livestock numbers had increased to some extent on farm 82, but this did not bring about increased production of forage. The cattle had been obtained to make use of permanent pasture which had not been fully utilized before. The risk and uncertainty introduced with a livestock enterprise had prevented the operator from expanding his inventory beyond the point at which increased production of forage would have been required.

ENTERPRISE REORGANIZATIONS

The organization of farm enterprises to make possible the production and use of greater quantities of forage and less corn, and thus the possibility of lower rates of soil loss, to some extent depends upon the operator's financial status. It also depends upon his ability to assume risk as well as his certainty of tenure.

The number of cattle on farms 29, 68 and 90 increased because the operators were moving toward longer rotations with more forage crops. Additional livestock were required to consume it. Farms 29 and 68 were operated by owners who had been in a favorable financial position in 1949 but who were in an even better position in 1952.

The operator of farm 90 had just moved to his farm in 1949 after buying it with a loan from the Farmers' Home Administration. One condition of the loan was that the borrower initiate a conservation program on the farm. The 1949 soil loss rate was actually a reflection of the farming practices of the tenant who was the previous operator. While the rate of soil loss was reduced through the use of terraces and by farming on the contour, it was also accomplished partly because the operator had been willing and able to increase his production of both forage and livestock.

The operator of farm 94 increased production of both forage and livestock but his livestock enterprise was still not adjusted to production of the additional forage recommended in the plans.

The lack of livestock was one of the major difficulties in 1949 that prevented the tenant-operators on farms 79, 123, 127 and 128 from reducing soil losses. By 1952, they were more secure financially and had invested in cattle and had improved their rotations. This expansion into feeder cattle had required two of these operators to borrow $10,000 while a third borrowed $30,000 in order to expand feeder cattle enterprises.

UNFAVORABLE FINANCIAL CONDITIONS

The financial circumstances of the operators on farms 26, 33, 45 and 55 appear to have been largely responsible for the increases in rate of soil loss on the farms. All the farms were owner-operated. Mortgage debt reported for these farms ranged from $7.50 an acre to $55, and averaged $28.40 an acre. Each of the four operators said that the debt would need to be reduced considerably or be completely paid before he could consider reducing his acreage of corn.

The operator of farm 45 had increased his mortgage to buy an additional 40 acres. The operators of farms 26 and 55 had decreased their mortgage debt but had increased their short-term debts. On farm 26, debt was increased to buy livestock and machinery and on 55, to buy seed and tractor fuel. The operator of farm 33 had not been able to pay anything on his mortgage and had acquired a short-term debt of equal size as a result of crop failures and medical expenses.

These operators had increased their production of corn or had shifted more of it to steeper ground. According to one operator, corn was a much more certain proposition than livestock. The turnover with cattle was slow, he said, and there was also price uncertainty. Corn, he pointed out, brought a return within a year. The price was supported at that time. For these reasons, he planned to raise as much corn as he could so that he might pay off his mortgage as soon as possible. After that he would consider more forage and terracing. He was contouring, however, for the first time. The operator of farm 82, a tenant who had increased production of corn but who reported no debt, had a somewhat similar attitude with respect to the relatively greater certainty in corn production.

Financial circumstances were also a factor in the change in loss on farm 3. This developed with a change in operators and a change in tenure status. It was largely the result of a difference in objectives of the old and new operator. The former operator, a bachelor, operated his elderly mother's farm. Some years before, the courts had awarded a judgment against him which was a lien on his income. It had removed any incentive that he might have had to maximize his income. The new operator was a young married man with a $30,000 mortgage to pay and a desire to pay it as soon as he could. As a result, the new operator farmed the land much more intensively and subjected it to a greater erosion hazard.

No change in the financial status could be detected on farm 23—a farm that has had a different operator each year since 1949. Dissatisfactions with the farm and the rental arrangements appear to have been the cause for the unstable tenure situation. The major part of the difficulty could be assigned to the landlord, a 50-year-old transport employee, who had farmed it himself 1 year and had rented it out since. He was trying to pay off the $33 an acre mortgage still remaining against the farm.

By his own admission, the farm was too small to permit either tenant or landlord to receive a sufficient income to provide an adequate family living and to make investments in erosion control. The farm's 120 acres were badly eroded. All recommended changes for the farm would have required an investment by the landlord or a temporary sacrifice of income. Although recognizing the need for such practices, the landlord was opposed to them. He said he was "pinched for money" and did not want to increase his debts. Although the 1949 tenant had contoured, the landlord would not permit the tenant on the farm in 1952 to contour because he did not want "weedy corn" which he believed resulted from contouring. The new tenant, a 30-year-old farmer, had no particular objection to the plans but showed little interest in trying to overcome the landlord's objections.

IMPROVED FINANCIAL SITUATION

Just as soil losses tend to increase on farms where the operator or landowner suffers financial reverses, they tend to decrease as the financial situation of the operator or owner improves. The financial position of the operators on farms 76, 87, 95, 108, 119, 120, 121, 122, 138 and 141 was sufficiently improved in 1952 over that of 1949 to permit them to make certain changes in land use. These in turn made reductions in the rate of soil loss possible.

Six of the 10 farms had mortgages against them in 1949 (76, 87, 108, 119, 122 and 138). Farms 87 and 119 had both been sold and the mortgage debt actually increased on them during the period. The mortgage debt on farm 76 was unchanged, and on the others it was reduced. The mortgage on farm 122 had been completely paid off. The five mortgages in force in 1952 averaged $53.58 per acre. Total debts on the 10 farms averaged $29.36 per acre.

The operator on farm 76, age 45, bought the farm in 1948 and had paid off a $5,000 note since 1949. His mortgage debt had remained the same ($85.50 per acre) and was the highest of the group. He had recognized, however, that he was losing soil and had reduced his acreage of corn, largely by eliminating corn from the rotation on the steep slopes. He had also adopted better organic matter management practices and had continued to farm on the contour. In terms of animal units, he had increased the number of his cattle by five during the period. He felt that further measures to decrease soil loss would depend upon reducing his mortgage sufficiently to permit the purchase of additional cattle.

Increases in animal units of cattle on farms 108 and 138 had also permitted the operators to take the steeper slopes out of corn production. Both operators, who were aged 42 and 47, respectively, expected to reduce further their acreages of corn and to increase dairy cattle numbers.

The changes on farm 108 were begun by the tenant before the owner took over operation of the farm in 1949. The present operator needed the intervening period to overcome the financial difficulties he had mentioned in 1949 and to establish the hay and pasture needed for the expanded livestock enterprise he was starting.

The situation on farm 138 was somewhat comparable. The operator, who was a tenant on the place in 1949, bought the farm from his father-in-law the next year. The operator had been renting 80 acres in addition to the 99 acres he owned. By 1952, he had paid off $2,200 on his mortgage and repaid a $2,900 bank loan. He no longer considered debt an obstacle to the adoption of the recommended rotations, and he planned to seed more land to grass and to increase cattle numbers.

Farms 87 and 119 changed ownership during the period. The new owners, both of whom owned other farms, had purchased these farms for investment purposes. Their increased resources enabled them to carry out the recommended practices. Farm 87 was operated by the owner with the help of a hired man who lived on the farm. Farm 119 was operated by the owner's son who had just started to farm for himself. Contouring and terracing had been initiated on both farms, and the acreage of corn had been reduced slightly. In both instances, however, the new operators had smaller inventories of roughage-consuming animals. There were 34 fewer roughage-consuming animal units on farm 87, and 9.5 units less on farm 119. The cattle inventory for farm 87 would probably be increased in the future if the outlook for beef cattle brightened. The other operator was building up a small dairy herd by saving his heifers.

Farms 120 and 121 were held in a life estate by an elderly woman. Uncertainty of tenure was a problem for the tenants on this farm in 1949 as well as in 1952. Three different operators had operated farm 121 during the 4 years. Even though leasing problems still existed on both farms, reductions in soil loss had been accomplished largely because the operators were willing and able to finance the purchase of cattle to utilize the increased forage produced on the steeper ground. One operator had begun to farm on the slope although not on a true contour. The other expected to contour if he stayed on the farm another year.

A more favorable financial position and an increase in cattle numbers were responsible for similar changes

on farms 95 and 122, both of which were owner-operated. Both owners had also started contour farming.

Farm 141 was operated under a livestock-share lease by the owner's 26-year-old son. He took over operation of the farm when his father retired in 1948 and, when first interviewed, was just establishing himself in farming. He had a short-term loan of $1,000, a debt he still owed in 1952. He still regarded financing a problem in 1952. He had accumulated a larger inventory of livestock which provided an outlet for the increased acreage of forage. The night school classes in agriculture sponsored by the Veterans Administration, which this operator attended, had stimulated new interest in erosion-control measures. A conservation plan had been developed for the farm, and the operator was making an effort to apply it. Longer rotations had been used, waterways had been grassed and additional terraces had been installed. Although the father paid all the terracing costs, the son said the other measures were possible only because of his improved financial position and larger livestock inventory.

The operator had the additional advantages of tenure certainty and of operating under a livestock-share lease. Both made a larger livestock enterprise feasible. While some of these circumstances had existed in 1949, their combined influence could not be observed until 1952. There was little opportunity for difficulties to arise under the leasing arrangement; for, because of his father's infirmities and advanced age, the son had been given full responsibility for decision-making under the livestock-share lease.

INDIFFERENCE TO SOIL LOSS

The chief factor behind the increases in soil loss on farms 47, 57, 82, 104, 125 and 130 appeared to be the operator's indifference to these losses. Some were rented farms on which the increase in erosion was partly the result of the landowner's unawareness of the true situation. On others, the difficulty was the inability of the landlord to manage the farm in his or her own interest.

Farms 47 and 57 were operated by owners. Farm 47 increased in size as both an ownership unit and an operatorship unit since 1949. The operator inherited an 80-acre tract he had formerly rented and purchased an 80-acre farm (50). Soil losses had increased on his farm, however, because he had stopped contouring. He had no real objection to the practice except for the extra effort involved. His mortgage debt was greater because he had purchased the additional land. His livestock inventory was also greater. However, neither of these factors appeared to have any bearing on the case.

Farm 57 was situated between a bluff and a small stream with forty percent of the cropland being subject to overflow. The rest had sufficient slope to warrant contouring and the use of more forage crops. The field layouts were such that some included both bottom and hill land and those with bottom land had been kept in corn almost continuously. However, since 1949, when the farm was bought by the operator, production of corn had been increased on the upland fields.

The operator owned and operated three other farms and carried on an extensive cattle and hog feeding enterprise. Although his income and net worth were not determined, he appeared to be in an especially strong financial position. The increase in corn production on his farm was not prompted by financial pressure but by the belief that the resultant loss in soil was inconsequential and that his gains far outweighed it. He indicated, however, that he might start to farm on the contour the following year.

Farms 104 and 125 were owned by women whose husbands had died since 1949. The woman who had inherited farm 104 had little knowledge of farming. She had been in favor of using fertilizer on the farm but the tenant had argued against it. The other farm, a 40-acre tract, had been the home of the owner, an elderly widow. It had been owner-operated in 1949. She lived with her daughter who actually made the decisions on the farm rental. Neither woman had any interest in the farm, except as an immediate source of income.

Farm 130 had been operated by the owner, except during the last 8 years. He was nearing 80 and seldom "bothered the tenant." He believed the farm was in much the same condition as when he had operated it. At one time, it had been one of the Soil Conservation Service's demonstration farms. Fences had been changed and terraces had been constructed at that time but these improvements had not been maintained.

Farm 125 was field-rented by a 35-year-old operator who owned an 80-acre farm. Farm 130 was operated by a 30-year-old man who lived on his parents' farm. Neither operator had any livestock on these farms, and production of corn had been increased sharply since 1949.

The operator of farm 104, a middle-aged tenant, reported that his lease was the only obstacle to carrying out erosion-control measures. Evidence indicated that his own indifference and lack of ambition were also important obstacles.

AWARENESS OF EROSION PROBLEM

As indicated earlier, operators of some of the farms on which the soil loss rates in 1949 were extremely high made the most notable reductions in soil loss. Figure 8 shows that many of the instances discussed here have come from the higher loss groups. The changes made appear to have been brought about by the operators' recognition of the seriousness of their soil losses. Of equal or of greater importance as the change in rotations on these farms was the adoption of contour farming. These and other farmers, notably the operators on farms 72, 78 and 86, had been convinced of the need for the practice after comparing the damage done in their corn fields by a series of hard washing rains with damage in the contoured fields of neighbors. These contoured fields had lost relatively little soil. The landlord required contouring on farm 37 when the tenant took over. On farm 106, the new operator started the practice on his own initiative.

The operators of farms 75 and 77, both new tenant operators, recognized the need to use more forage. Others shifted production of hay and pasture to the steeper slopes without increasing the total acreage of forage crops. The operators on farms 24, 70 and 80 had done little more than that. Some operators

brought about small changes in erosion loss by plowing under heavier green manure crops, as on farm 100, or by using a corn-oats-clover rotation instead of corn and oats with sweetclover, as on farm 114, although other problem situations kept the operators from adopting additional erosion-control measures.

Even though tenure uncertainty was a problem on farms 89 and 142, soil losses decreased because of an increased awareness of the erosion problem. The status of the operator on farm 89 had changed since 1949 from that of tenant-operator, with an undivided eighth interest in the farm, to that of tenant-operator with an undivided five-eighths interest. He wished to buy out the other heirs but he was uncertain as to whether to meet the price asked or to sell his share. He had taken a greater interest in the farm, however, and was beginning to farm on the contour. He had adopted a rotation that incorporated more forage crops than previously. His cattle numbers remained the same. There was small chance that he would expand the cattle enterprise until cattle prices adjusted to what he considered a more normal relationship with other prices.

Farm 142 was tenant-operated in 1949 and 1952, but both the owner and operator had changed. The farm was operated under a livestock-share lease for the entire period. The first owner, while working toward an erosion-control program, was renting to a 60-year-old tenant who was quite indifferent to it. He was uncertain as to his future tenure but he opposed most of the practices on other grounds. The new owner and his young son-in-law took over in 1951. They installed 10 miles of terraces and greatly expanded the livestock enterprise, while cutting back the acreage of corn. About a year after buying the farm the owner died. With the family difficulties that followed, the tenant was almost certain that his lease would expire because the farm would be sold within a year. He indicated that his corn acreage for 1952 was greater than it otherwise would have been because of this circumstance.

Farms Showing No Important Soil Loss Changes

Some of the reasons for the changes in soil loss rates, if they were of a magnitude of at least 5 tons, have been examined. Why were there no important loss changes on the 81 remaining farms? Some of these farms showed little change because the operators had been successful in maintaining the low losses that existed in 1949. When the farms were sorted using an arbitrarily picked standard of a 10-ton loss rate, 30 of the 81 farms were within the group having losses of 10 tons or less in either 1949 or 1952. Twenty-four farms had such losses in *both* years, and 6 farms had losses of 5 tons or less for both years. This leaves 51 farms, or 35 percent of the 144 farms, which had soil losses of 10 tons or more and on which no important change in soil loss rate had taken place. The obstacle situations found on these farms had not changed sufficiently since 1949, either for the better or for the worse. Six of these 51 operators, however, were persons who believed that the practices were unnecessary or would do no good, and they expressed this belief in both 1949 and 1952. The soil losses on all except one of these farms were below the average for the sample.

One operator had installed terraces on the farm since 1949 but he had also increased his production of corn at the expense of forage production. The rotation change offset the benefits of terracing enough to increase the rate of soil loss slightly.

The landlord of another farm was responsible for the more favorable soil loss. He was using a livestock-share lease. A conservation plan had been developed for the farm, and the owner required the tenant to follow it. The full cost of the fertilizers applied during the first year of a tenancy was paid by the landlord. The costs were shared thereafter. When the tenant left the farm he was considered to have balanced the account with his share of the unexhausted value of fertilizers that had been applied.[23]

The difficulties involved came with a change in operators. The previous operator who had been on the farm for 6 years was replaced by a new operator in 1952. Although he voiced no opposition to the plans, he had no real interest in fulfilling them. This was evidenced by his "contour" listing in which almost as many rows ran up-and-down hill as followed the contour.

The tenant operating farm 117 was the owner's son-in-law, who made the operating decisions. While adoption of the practices proposed in the plan would create no difficulties, he opposed them, believing them unnecessary. He thought the recommended terraces would be in the wrong locations. He did not want to follow anyone's plan or have anyone tell him what he could or could not do. In this respect, he was typical of a number of other operators although they also expressed other objections.

Of the remaining 45 farms, 25 had no changes that would tend to lessen existing obstacle conditions. On 10 farms, however, one or more of the existing obstacles had been lessened to some extent but other obstacles continued unabated or actually increased. On the other 10 farms, all obstacles had been lessened or eliminated but only three operators intended to put into practice measures that would appreciably reduce soil losses.

Results of the study reported here indicate that even though progress may be made in reducing the major obstacle conditions, continued efforts will be necessary to overcome such noneconomic obstacles as lack of information, custom and inertia. It is not enough that an obstacle be removed. If the measures required to reduce soil loss are to be used, there must also be confidence that they are necessary and will be effective. There must also be the will to act when it means breaking long-established patterns of farming and replacing them with new ones that require new skills. There is also the psychological problem of overcoming the resistance of some farm operators to accepting assistance from educational and conservation agencies which provide help in developing their farm conservation plans.

Implications of Obstacle Changes for Erosion Control

Seventy farms in the sample had changes in soil loss rates of 5 tons or more. On the 27 farms on which

[23] This arrangement, although not a perfect solution, was admittedly better than none. A similar arrangement was found on another farm. No other compensation schemes were found to exist on the farms in the sample.

soil loss rates increased, changes in obstacle situations that would tend to increase soil losses occurred more frequently than the changes that would tend to reduce soil losses. Leasing difficulties were more of a problem on seven farms and less of a problem on two. The inventory of cattle was lower on five farms, but higher on only three. The financial position of five operators was less favorable; it was more favorable for only three. Size was less of an obstacle on two farms. Four operators indicated that their short-term interest in the farm was even more of a problem than was the case 4 years earlier. Offsetting changes in obstacle circumstances occurred on four of these 27 farms.

Of the 43 farms on which soil loss rates decreased, 11 farms had leasing difficulties in 1949. On six of these farms, the problems had been overcome or an owner had replaced a tenant. The cattle inventory had either increased on 20 farms or was less of an obstacle. It was still a problem on nine farms. Financial problems were less of a difficulty than they had been in 1949, or an increase in debt was not regarded as an obstacle on 22 of these farms. It was considered to be a more acute problem on only four farms. A change in the number of acres farmed was either no problem or an improvement over the previous situation on seven farms and no additional problem on any of the farms. While the operator's expectation of short tenure had become more of a problem on four farms, it was less significant on five farms. Offsetting changes in obstacle circumstances occurred on 4 of the 43 farms.

The observations made in this investigation indicate that changes in the rate of soil loss may come about on a farm with a change in only one obstacle situation. In other instances, erosion losses may not change unless a combination of obstacles is overcome. It is also possible to overcome one obstacle condition only to have it replaced by another obstacle. Thus, reductions in soil loss may not be possible, or if they do come about, they may be much smaller than had there been a new obstacle. Changes in soil loss may not come about even though the only apparent obstacle has been overcome. Conversely, they may come about without a change in any obstacle mentioned by the operator.

These apparent contradictions are possible for several reasons. Of the five major obstacle situations considered, only the lack of a long-term interest in the farm might have any direct bearing on the decision of a farm operator to farm with the contour. Although this was probably an obstacle to the use of contouring in some instances, it was never mentioned. The reluctance of farmers to break with established farming practices prevents the further use of contouring, especially since the practice requires some additional effort when used for the first time.

These farm operators who had adopted the practice of contouring since 1949 were apparently influenced favorably by neighbors, by their own observations, and by a new awareness of their erosion problem, rather than by a change in any of the obstacle conditions studied.

Much the same thing can be said about the increased use of terracing. Although cost was apparently a very real factor in a few instances, the biggest obstacle to the further use of terracing was the dislike for the practice. Many farm operators do not appreciate what a properly constructed system of terraces is capable of accomplishing in the control of runoff water. After mentioning the inconveniences they believed they would experience with terraced fields, many operators concluded with the remark that nothing could be done to control the runoff from heavy rains anyway.

Increases in acreage of corn at the expense of forage crops occurred on some farms, even though there was no significant reduction in forage-consuming livestock. As in 1949, these operators indicated that additional livestock would be required before they could increase forage production. Factors which they indicated would make a shift into higher forage production difficult or impossible included uncertainty of tenure, difficulty in adjusting rental arrangements from a corn-hog enterprise to an enterprise in which greater cattle numbers would be required, and the problems of financing cattle, together with the risk and uncertainty.

However, as noted in some of the examples discussed, other farmers had reduced soil losses on their farms without greatly reducing corn acreages. They had accomplished this by making some comparatively simple adjustments in their rotations. They no longer used one rotation for the entire farm. Instead, they cropped most intensively the land where erosion was not likely to be a hazard and increased the use of forage crops in the rotations on the steeper and longer slopes. This also represented a departure from the practice of producing the major portion of the forage crops on the same field year after year.

In summary, the major elements of failure in the changes that took place between 1949 and 1952 appear to be found in the limitations imposed by uncertainty of tenure on the planning horizon or the periods of time farm operators could plan ahead; the further limitation of financial resources brought about by crop failures and livestock losses, the decline in farm prices and the prospect of greater declines or increased family expenses; a greater reluctance to assume risk; and the lack of confidence in practices that had been tried once. Apparently, the major elements of success are to be found in an increased appreciation for the seriousness of the erosion problem and a realization that erosion losses could reduce farm income, an increase in the length of planning horizons, a shift to more grass on the steeper slopes, and an increase in livestock inventories with evidence that on such land a forage and livestock enterprise is more profitable than production of corn.