Obstacles To Conservation On Midwestern Farms

North Central Regional
Publication No. 28

Agricultural Experiment Stations of Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, U. S. Department of Agriculture, and the Farm Foundation cooperating.

UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
J. H. Longwell, Director

BULLETIN 574 Columbia, Missouri JUNE, 1952

MISSOURI BULLETIN 574 MARCH, 1952

North Central Regional Publication 28

Prepared by
Obstacles to Conservation Subcommittee
of
The North Central Farm Management
and
Land Tenure Research Committees

Administrative Advisers

C. M. Hardin, Director, Michigan State Agricultural Experiment Station, East Lansing, Michigan
Noble Clark, Associate Director, Agricultural Experiment Station, University of Wisconsin, Madison, Wisconsin

State Members

North Central Farm Management Committee	North Central Land Tenure Research Committee
Illinois—P. E. Johnston, Univ. of Illinois	C. L. Stewart, Univ. of Illinois
Indiana—Lynn S. Robertson, Purdue University	O. G. Lloyd, Purdue University
Iowa—Earl O. Heady, Iowa State College	John F. Timmons, Iowa State College
Kansas—J. A. Hodges, Kansas State College	W. H. Pine, Kansas State College
Kentucky—Glenn Johnson, University of Kentucky	J. H. Bondurant, Univ. of Kentucky
Michigan—Karl Wright, Michigan State College	E. B. Hill, Michigan State College
Minnesota—George A. Pond, University of Minnesota	A. A. Dowell, Univ. of Minnesota
Missouri—O. R. Johnson, Univ. of Missouri	Frank Miller, Univ. of Missouri
Nebraska—A. W. Epp, Univ. of Nebraska	N. J. Anderson, Univ. of Nebraska
North Dakota—Cecil Haver, North Dakota State College	Rainer Schickele, N. Dakota State College
Ohio—J. I. Falconer, Ohio State University	J. I. Falconer, Ohio State University
South Dakota—Russell Berry, S. Dakota State College	Max Myers, S. Dakota State College
Wisconsin—P. E. McNall, University of Wisconsin	Philip M. Raup, Univ. of Wisconsin

U. S. Department of Agriculture, Bureau of Agricultural Economics
C. W. Crickman, O. J. Scoville, Russell O. Olson, Marshall Harris.
U. S. Department of Agriculture, Soil Conservation Service
E. L. Sauer, H. O. Anderson, Howard C. Jackson
Joseph Ackerman, Secretary, Farm Foundation

Members of Subcommittee in Charge of the Manuscript

J. A. Hodges, Kansas, Chairman
Ray Beneke, Iowa
John C. Frey, Iowa
O. R. Johnson, Missouri
Frank Miller, Missouri
Russell O. Olson, B.A.E.
Wilfred H. Pine, Kansas
O. J. Scoville, B.A.E.

TABLE OF CONTENTS

SUMMARY

The obstacles to greater use of soil conservation measures on midwestern farms are many. Some of them and some suggested means of overcoming them are enumerated and summarized briefly in the following paragraphs.

1. Reluctance of farm operators to change old methods of farming, insufficient skill to lay out the work, lack of accurate information on costs and benefits, and frequent changes in recommended conservation practices.

In some instances conservation practices are not adopted because of the attitudes of farm operators. Other important deterrents are lack of skill in laying out and building water control structures, insufficient information about costs and returns, lack of experience in handling new enterprises, frequent changes in conservation recommendations, community traditions and attitudes of neighbors.

Education can play an important role in raising the level of soil conservation and improvement. Greater awareness by farmers of the need for conservation and more complete knowledge of the available conservation and soil improvement procedures that are provided through research would contribute toward overcoming many of the obstacles listed here. With respect to such barriers as attitudes and customs that lead to soil exploitation, education is the most effective device available. In some instances the work needs to be undertaken on a community basis. In other cases conservation plans need to be developed for individual farms and the costs and benefits made known to others so they, too, will set up conservation plans and carry them to completion.

2. Organization problems on small farms where intensive crops are used to keep the family labor force gainfully employed.

Small farms often present special types of conservation problems, because of scarcity of economic resources and lack of managerial skills. As a rule, the operator finds it more difficult to obtain additional acreages than to increase the size of business by raising intensive crops that can be sold readily for cash from the acreage he already has under his control. Lack of funds to buy the animals and to make the necessary improvements for their care, poor markets, or personal aversion to milking cows may exclude dairy as an intensive enterprise. Money may not be available to build houses either for broilers or laying flocks. The desire to maximize income with the least capital outlay often leads to intensive cropping and exploitation of the soil. When operators are so inclined toward improvement and have the knowledge to carry out a well-developed

plan, this problem can be solved, in part at least, through more effective use of capital, better choice of enterprises and greater skill in handling them.

3. Land holding and rental procedures that restrict the interest of either owners or renters to periods which are shorter than the time required to carry out a conservation plan, or to receive benefits as great or greater than the cost of the improvements.

Conditions under which land is owned or rented influence the extent to which conservation farming practices are followed. Farmer interest in conservation appears to be directly related to the number of years of expected control of the land. Owner operators who are old or who expect to sell in a short time usually have very little interest in carrying out a conservation plan. Many tenants do not remain on any one farm long enough to carry through a conservation program and to realize substantial benefits from it. Another deterrent is the fact that the renter's future tenure is uncertain. Many tenants remain on the same farm for years, but most of them have no assurance that the lease will be continuous. This uncertainty reduces the desire to make long-time improvements.

In addition to shortness or insecurity of tenure, the absence of specific provisions in leases for compensating renters for conservation work and lack of cooperation by either the landlord or tenant presents barriers to the development of more effective conservation programs.

A number of adjustments are suggested in land tenure arrangements to encourage conservation farming. More widespread use of specific lease provisions which reimburse tenants for unexhausted improvements is recommended. This procedure is especially important where the land owner is not able or willing to pay the cost of building water control structures or of adding initial treatments or soil amendments such as lime and phosphate for the purpose of establishing a balance in plant nutrients that will increase the effectiveness of annual applications of fertilizers.

4. Reluctance of farmers to pay the out-of-pocket costs of making necessary changes in farm organization.

In the minds of farmers, one of the factors retarding the use of conservation measures is the cost. Substantial outlays of capital may be required for such items as terraces and other water control structures, materials for pasture improvement, initial fertilizer treatments to bring the plant nutrients in cropland into balance, additional livestock to make effective use of hay and pasture crops and equipment for the care of the animals. Even though these expenditures may prove to be highly productive, many farmers do not have adequate funds left from income after

meeting other business needs and family desires, and are reluctant to go into debt to cover the costs.

Limited financial resources do not present insurmountable obstacles, however. Erosion can be controlled by more than one procedure on most farms. Where lack of current funds is a barrier to adopting a conventional conservation program, alternative means of reaching the same objective with less capital can be adopted. In some situations, it is possible to avoid major adjustments in the farming system by relying upon such practices as contour farming and terracing to control erosion. On some farms simple changes in the cropping system so the intensive crops will be grown on the land that erodes least may stop serious deterioration of the soil. On many farms, the adjustments needed include an increase in the acreage of hay and pasture. Money can be invested in additional livestock to consume the increased forage, or this capital requirement can be reduced by increasing the proportion of forage fed to present livestock numbers.

Another way by which conservation objectives can be reached is to begin with a highly productive practice such as the use of fertilizer and spread the program over a longer period of years, thereby financing most of it out of earnings.

5. The time lag between cash outlays for conservation work and returns.

One of the reasons why it is difficult to get conservation measures adopted arises from the lag between capital outlays for such purposes and returns from them. The magnitude of this problem varies between soil types and systems of farming. This obstacle is often greatly exaggerated, however. It tends to be most important when major shifts are involved in cropping patterns and in the accompanying livestock systems. In many cases a practice that brings quick returns can be adopted early and the rest of the program financed out of increased income. A systematic program of development and a real desire to carry it out appears to be the answer to the problem.

6. The desire of owners and operators for high current income.

There is always competition between alternative uses of funds. Sometimes a decision must be made between one use which promises immediate returns and another use which might bring higher returns in the more distant future. Regardless of the productivity of investments in conservation in terms of future income, families must grant priority to living necessities. The choice of an exploitive cropping pattern which maximizes immediate returns at the expense of future production may be justified by pressure to meet current family living expenses. Even in

cases where a question of necessity is not involved, the family may feel that a dollar this year is equal to several a few years hence, if the money is to be used, for instance, for education or improved living for a growing family. On rented farms, the financial situation of the landlord may also be of importance. Many owners of rented land are dependent upon the income from their farms for a livelihood.

In some cases an effective system of conservation cannot be developed without sacrificing immediate returns. As a rule, however, people find ways to satisfy their most urgent desires. Absolute living necessities usually cost less than a family spends. The problem of soil exploitation to maximize immediate income usually disappears when the farm operator is convinced that self-denial now will pay large dividends in improved living standards in the future.

7. Uncertainty as to future prices and weather conditions, and the possibility of losing a considerable part of the money invested in the animals that are needed to process hay and pasture into readily salable products.

Risk and uncertainty have a direct bearing on the unwillingness of farmers to follow conservation programs. Risk is associated with price fluctuations, variable weather conditions and other production uncertainties that affect income. The effect of uncertainty is magnified among farmers who are heavily in debt, or whose financial reserves are limited. Exploitation of the soil increases risk, however, while efforts to maintain or increase productivity is insurance against future want.

8. Differences between maximum long-run income to the individual farmer and a socially desirable level of conservation.

Where increased returns from a conservation procedure exceed the cost, and the farmer can be persuaded to adopt it through education and the removal of technical or institutional barriers, there would appear to be no economic justification for public subsidies. Under some circumstances, however, the public interest may be served by extending direct payments for soil conservation. Such a situation may exist where the benefits from conservation practices accrue to persons other than those bearing the cost. Measures to prevent reservoir siltation and the clogging of streams so they will overflow are examples. However, insistence on full value for the public funds expended when measured in terms of loss prevention or production increases as compared to costs is absolutely necessary, if widespread waste of economic resources is to be avoided.

Land-use regulations are instruments of public action that can be used in promoting conservation. They may be used with educational programs, or in connection with the renting of public lands where a considerable area still remains in the public domain.

9. Relationship of conservation to the general problem of better farming.

In any well-developed farm management plan, terraces, grassed waterways, cropping systems that include sod forming grasses, systematic use of fertilizer to establish and maintain the balance of plant nutrients in the soil, and other practices required for a good program of soil improvement and maintenance are integral parts of efficient farm organization. These improvements should not be made, however, for the sole purpose of saving soil, but instead to aid in building up and maintaining the productivity of the farm so as to increase or stabilize income and provide a higher level of living for the family. Erosion control, higher levels of production through crop rotations and the use of fertilizers, and the development of complementary livestock enterprises should be a part of the individual farm plan. The conservation problem cannot be solved without building the soil improvement and maintenance plan around the welfare of the farm family. Profession of complete understanding of this fact is much more widespread than performance in our action and educational programs would justify.

OBSTACLES TO SOIL CONSERVATION ON MIDWESTERN FARMS

INTRODUCTION

Adequate systems of erosion control and water management are lacking on many midwestern farms. Some of the major reasons are set forth in this publication under the following headings:

1. Reluctance of farm operators to change old methods of farming, insufficient skill to lay out the conservation work, lack of accurate information on costs and benefits, and frequent changes in recommended conservation practices.
2. Organization problems on small farms where intensive crops are used to keep the family labor force gainfully employed.
3. Land holding and rental procedures that restrict the interest of either owners or renters to periods which are shorter than the time required to carry out a conservation plan, or to receive benefits equalling or exceeding the cost of the improvements.
4. Reluctance of farmers to pay out-of-pocket costs of making the necessary changes in farm organization.
5. The time lag between cash outlays for conservation work and returns.
6. The desire of farm owners and operators for high current incomes.
7. Uncertainty as to future prices and weather conditions, and the possibility of losing a considerable part of the money invested in the animals that are needed to process hay and pasture into readily salable products because of forced liquidation in poor crop years when livestock prices are low.
8. Differences between maximum long-run income to the individual farmer and a socially desirable level of conservation.
9. Relationship of conservation to the general problem of better farming.

These categories of obstacles are not separate and distinct. Instead, the various problems dealt with under them are closely inter-related. Changes to conservation farming involve labor and expense as well as additional investments in livestock and improvements. Farmers must make their decisions to incur the costs and to make the necessary additional investments in an uncertain environment. These facts underlie most of the difficulties encountered in getting the job done.

This publication suggests measures that can be used in dealing with some of these difficulties. In many cases they are only partial solutions.

In other instances the close relationship between the conservation problem and the solution of broader farm problems becomes evident. In addition to pointing the way out of some of the difficulties the discussion that follows emphasizes the complexity of the problem of overcoming the barriers to conservation. We also need unified programs of research, education and action which will get the knowledge we already have applied on individual farms, and which will reveal new measures that can be used with greater effectiveness and at less cost.

Meaning of Conservation

Too often the conservation problem is thought to be primarily a physical one. Economic and social aspects are sometimes ignored. As a result of this attitude there is a tendency to rely upon uniform solutions and the mass application of technical devices such as grassland farming, terraces, grassed waterways, dams and other water control structures without regard to the unique circumstances found on individual farms. Obviously there usually are several methods by which soil can be conserved or improved. In many instances effective conservation may be achieved merely by shifting the intensive crop to land that does not erode readily, shifting the hay and pasture to the land now used for these crops. In fact, there are many farms where the productivity of the land has been maintained or

Growing clean cultivated crops on sloping land without terraces, contour cultivation or other measures to control runoff leads to heavy soil losses from erosion.—Photo courtesy of the Soil Conservation Service.

increased without using the devices now considered by many people to be vital parts of conservation. It is also recognized that a great deal of useful work has already been accomplished through the efforts of the Soil Conservation Service, Soil Conservation Districts, Production and Marketing Administration, the Farmers Home Administration, the Agricultural Extension Service, Balanced Farming Associations, farm management groups, commercial banks, the Experiment Stations, organizations such as the Grange, the Farm Bureau, the Missouri Farmers Association, vocational agriculture instructors in high schools, veterans training teachers, editors of newspapers and magazines, chambers of commerce and other civic groups that have helped to popularize erosion control and water management.

When all farms are considered, however, the number of mechanical devices in use is far short of requirements to control erosion. Not enough lime is spread to correct soil acidity so legumes can be grown successfully in crop rotations. The quantities of phosphate and other fertilizers used are far short of requirements to control erosion, to get optimum yields of crops, and to bring the carrying capacity of pastures to a desirable level. On many farms, particularly in the Great Plains section, where rainfall is light and in the hog producing and cattle and lamb fattening sections of the Corn Belt, the proportion of tillable land in sod forming grasses is too low under present methods of farming. As a consequence, cropping practices are inadequate for effective control of wind and water erosion and for maintenance of soil humus at a desirable level. Unified community development programs that prevent a lack of water control on one farm from causing damage on other farms lying at lower levels on the slope are practically non-existent. These deficiencies make a careful analysis of the reasons for slow progress in conservation work highly desirable.

"Conservation" literally means "preservation while being used" but most discussions of soil conservation construe the word more broadly to include the idea of soil improvement. In order to maintain the productivity of a soil the annual input of plant nutrients through the use of soil building crops, manure and chemical fertilizers usually must be approximately equal to the withdrawals in harvested crops and the losses from leaching and wind or water erosion. To increase productivity the inputs of plant nutrients must exceed withdrawals and losses. The procedures followed to maintain and to improve soil productivity are about the same. The principal difference is in the intensity of application.

More Information Needed

Lack of accurate information is one of the more serious obstacles to conservation of soil resources. Much of the slow response that causes concern at the present time grows out of inconveniences associated with

the use of recommended practices, the failure of farm operators to appreciate the need for conservation, recommendations that are too general and reluctance to change existing practices. Contour farming, for example, is a simple practice. Nearly all studies indicate substantial increases in yields from it at little or no added cost. Some results from Illinois are given in Table 1. Contoured crops yielded from 12 to 17 per cent more than when grown in rows up and down hill. These data are taken from various parts of Illinois. Other studies conducted in this state from 1940 to 1943 indicate that, on farms where contour cultivation was practiced, labor, power and machinery costs were $18.06 per crop acre. The same items on comparable farms not farmed on the contour were $19.86 an acre.

Higher yields and lower costs due to contour farming have improved net farm income but this practice has not been widely adopted. According to an estimate made in 1943, an additional 6,870,000 acres of Illinois cropland should be planted on the contour.[1] As of the end of 1950, the Soil Conservation Districts, with the help of the Soil Conservation Service, had been able to get cooperating farmers to adopt this practice on only 572,000 acres.[2] In 1948, PMA practice payments were made to Illinois farmers for contour farming on about 229,000 acres of cropland.[3] While the total acreage of crops cultivated on the contour is probably somewhat in excess of the above figures, it appears to be far below the level that would be profitable to farmers.[4]

Increasing the proportion of cropland in legumes on farms where this crop is not common is another conservation adjustment which many farmers could profitably make. Returns on three groups of Illinois farms, as related to acreages of legumes, are shown in Table 2. These data indicate that under certain Illinois conditions net returns tend to go up until approximately 25 per cent of the tillable land is in legumes. It also appears that legume acreages may be increased without reducing total grain production. These conclusions are quite generally accepted by farmers. Yet they often do not expand legume acreages to the point that should give optimum returns.

Terraces help to control erosion so the fertility added by legume crops and by applying fertilizer is not carried away. By using these structures when they are not a serious handicap to tillage operations the productivity

[1]"Soil and Water Conservation Needs Estimate for the U. S." Soil Conservation Service, U.S.D.A. (revised), Washington, 1945. p. 34.

[2]Unpublished data from Soil Conservation Service.

[3]U.S.D.A. Agricultural Statistics, 1950, Table 760, about 64 per cent of Illinois cropland was in the Agricultural Conservation Program in 1948.

[4]There is some duplication between acreages reported in Soil Conservation Districts and in the Agricultural Conservation Program. Some land is contour farmed that is not included under either of these programs.

Table 1.--Increased Yields and Returns from Contour Farming, Illinois, 1939-1945.[6]

Crop	Average Yield Increase		Increased returns per acre at 1945 prices
	Bushels	Per Cent	Dollars
Corn	6.9	12	7.38
Soybeans	2.7	13	5.64
Oats	6.9	16	4.69
Wheat	3.4	17	5.37

[6] E. L. Sauer, "Contouring Produces and Conserves," Illinois Farm Economics, April-May, 1946, p. 353.

Contour cultivation aids in controlling erosion, usually increases crop yields and adds to net farm income.—Photo courtesy of the Soil Conservation Service.

of sloping land can be built up rapidly. In a relatively short period of time higher yields of crops can be obtained in most years.

In a Wisconsin experiment, corn yields of 58 bushels were obtained with contour cultivation, 63 bushels with contour strip-cropping, and 67 bushels with terracing. An analysis of records on individual farms in the same area indicated that, by using their own equipment, these farmers could build terraces at a total cost for labor, fuel and equipment of a little over four dollars an acre. The construction cost of terraces that, with proper care, would last 20 years would be 20 cents an acre on an annual basis. There would be some maintenance expense, but this item probably would be no more than 30 cents per acre per year. According to the experiment, the increase in corn yield, over strip cropping, was four bushels per acre.[5] In other words, for capital and labor expenditures of 50 cents farmers in this area could get four additional bushels of corn per acre.

While the Conservation Needs Estimate for 1943 indicated that an additional 435,000 acres of cropland in Wisconsin should be terraced,

[5] H. O. Anderson, "Effects of Specified Soil Conservation Practices on Yields and Costs." Soil Conservation and Wisconsin Agricultural Experiment Station (mimeo.) LaCrosse, Wisconsin, January, 1948.

Table 2.--Relationship Between Cropland in Legumes, Production of Crops, and Net Income on Sample Farms in 14 Northern Illinois Counties, 1947-1949.7/

ITEM	Proportion of tillable land in biennial and perennial legumes. Less than 20%	20% to 29%	30% and over
67 Farms with soil productivity ratings from 1.0 to 2.9*			
Number of farms	31	26	10
Per cent of land in legumes	13	26	39
Total Production per tillable acre:			
grain, lbs.	2504	2513	2225
hay, lbs.	271	465	937
pasture, lbs.	227	440	853
Return to capital and management per tillable acre	$58	$67	$48
44 farms with soil productivity ratings from 3.0 to 4.9*			
Number of farms	8	17	19
Per cent of land in legumes	19	28	42
Total production per tillable acre:			
grain, lbs.	1963	2002	1697
hay, lbs.	388	580	973
pasture, lbs.	253	413	660
Return to capital and management per tillable acre	$36	$48	$45

7/ Adapted from F. J. Reiss, "Does It Pay to Grow Grass and Legumes?" Illinois Farm Economics October-November 1950.

* The soil in the farms was rated on a scale of one as the most fertile and ten as the poorest.

farmers had applied these structures on only 34,000 acres up to the close of 1950.[8]

Some of the reluctance of farmers to use terraces may be caused by low yields, particularly in terrace channels, after these structures are built, and by short crops in occasional wet years. Other factors are inconvenience in using machinery on short point rows not adjacent to field boundaries and in places where sharp bends in rows are necessary to keep terraces on the contour. A considerable part of the tillable land lies on relatively even slopes where terraces can be run on nearly parallel, even curves. Under these conditions, terraces, when properly

[8]Conservation Practice Summary 1946-50, PMA-ACP Branch.

constructed, present few, if any, inconveniences. In many cases where the top soil is removed, productivity can be restored quickly by applying fertilizer or using a legume as a green manure crop. It is important, however, to tailor the water control practices to specific operating conditions. Terraces around sharp bends and contour cropping that leaves numerous irregular "islands" in fields make farm operators reluctant to adopt these practices. This inventory of obstacles, therefore, becomes a logical first step in organizing our efforts to lay out and promote an effective conservation program.

RELUCTANCE OF FARM OPERATORS TO CHANGE OLD METHODS OF FARMING, INSUFFICIENT SKILL TO LAY OUT CONSERVATION WORK, LACK OF ACCURATE INFORMATION ON COSTS AND BENEFITS AND FREQUENT CHANGES IN RECOMMENDED CONSERVATION PRACTICES

In some instances conservation practices are not adopted because the farmer is opposed to them or does not know how to apply them. He may be unwilling to make changes in his farming system because the labor involved does not bring early returns or because he dislikes going into debt. In other cases, he may not accept a practice because it is offered under a public program of which he does not approve. Attitudes of neighbors toward recommended conservation practices and community traditions also are factors that influence the acceptance of conservation measures.

Farmers are not always adequately informed in regard to the costs and benefits of improved farm practices. A study in 10 southern Iowa counties, for example, revealed that one-fourth of the farmers interviewed felt that contouring wouldn't pay, even on fields with a slope of 4 per cent or more.[9] Yet, studies indicate that contouring, where adopted usually will pay. The same Iowa study shows that a large proportion of farmers do not have adequate knowledge of the relative profitability of different kinds of livestock under a given set of conditions. Twenty-one per cent of the farmers interviewed in a survey in the Tipton and Princeton communities in Missouri indicated that greater efforts should be made to explain to farmers the benefits that would accrue from erosion control practices.

Lack of knowledge is not limited to an understanding of the profitability of practices. Some farmers need information about the methods of performing certain tasks such as laying out contour lines. They

[9]Earl O. Heady and C. V. Hess, "Why Not More Efficient Farming?" Iowa Farm Science, June 1950.

also need to develop skills in special tasks required to install and maintain a conservation system of farming. The extent of new information and skill may exceed that required by a conservation practice itself. It may also extend to new enterprises. Successful introduction of grasses or legumes into a rotation, for example, may depend upon ability to care properly for a new livestock enterprise.

Personal Preferences

Quite apart from knowledge, personal attitude may be important in determining whether or not a practice is used. The decision to adopt a practice or enterprise is made only partially on the basis of its estimated profitability. A farmer also may be influenced by his personal liking for, or aversion to the undertaking. In the Iowa survey previously mentioned, farmers were asked why they would, or would not, expand various livestock enterprises to utilize an increased supply of forage. Of the farmers who preferred not to expand the dairy enterprise, 16 per cent said they "didn't like to milk cows".

Another point at which attitude enters into farmers' decisions is associated with their willingness to give up leisure. Conservation work,

Silt from a watershed where erosion is not controlled clogs channels and causes streams to overflow. Operators of the farms where the erosion takes place do not realize that the soil which is removed can cause heavy damage in the valley.—Photo Courtesy of the Soil Conservation Service.

particularly during the period when water disposal structures are being built, requires extra labor. Increases in the size and complexity of the business often are necessary to make conservation pay. Some farmers prefer not to add to their labor and managerial burdens.

Occasionally, conservation programs are presented to the farmer in a manner that does not appeal to him although he may be in favor of individual practices. An acceptable practice may be tied in with one which he does not like, in such a way that he has to take both or none; or a practice may be a part of a program concerning which he has misgivings.

Neighborhood Influences

Occasionally, conservation practices are adopted slowly because farmers are reluctant to break away from accepted methods of farming. Straight rows were long taken as a mark of good workmanship, and tended to discourage the introduction of contouring. However, of the 120 farmers interviewed in southern Iowa, only one said that he did not contour because his neighbors refused to do so.

Probably a more important neighborhood factor is related to the adoption of those practices which are effective only if applied over a broad area such as a watershed. This problem arises, for example, where effective erosion control on one farm depends upon control of run-off from farms higher up the slope.

Ways of Overcoming These Obstacles

Where a lack of knowledge or skill impedes the adoption of conservation systems, increased emphasis upon education and technical assistance appears to be the remedy. The objective of education would be to raise the general level of technical proficiency. Technical assistance can also be made more widely available to supplement the knowledge and skills of individual farmers. One or more men in each individual community can be trained to run guide lines for terraces and contours. These men can work with their neighbors and aid in the adoption of a good many practices. Forty-six per cent of the farmers interviewed in the Tipton and Princeton communities in Missouri suggested that technical aid was needed in laying out and developing systems of erosion control and water management.

Where farmers' attitudes appear not to be based upon economic considerations, and do not coincide with the group interest in soil conservation, greater educational effort might be put forth. In cases of this kind the effort should be directed toward promoting a general understanding of the basic elements of the problem among all groups of society. By this procedure, the farmer can be encouraged to re-examine his objectives in the light of his own welfare and the needs of all of the people. Where obstacles to conservation arising out of custom, habits,

and attitudes are community-wide, the educational effort would need to be made on a community basis.

Another serious obstacle grows out of frequent changes in recommended practices. A few years ago, high terraces were emphasized. At the present time the low broad based terrace is approved. Brush dams were in vogue in the early 1930's. They were replaced by the earth dam. It is well known that the docket or list of practices for which conservation payments will be made seldom is the same two successive years. Changes like these may be inevitable as old measures are proven to be inadequate and new practices are adopted. The fact that recommendations vary from year to year, however, makes it difficult for a farmer to know what is desirable and to compare his own program with a given set of standards.

CONSERVATION PROBLEMS ON SMALL FARMS

The data presented in Table 3 show that erosion is most severe on low income farms. It also appears that the use of lime and fertilizer, two very important conservation measures, is lowest on farms where incomes

Table 3.--Distribution of Iowa Counties According to Erosion Hazards and Four Levels of Income, 1943.10/

Range in cash Income per farm 11/	Erosion Hazard		
	Little or none	Moderate	Severe
$9395-$11,035	11	10	3
$8100-$9394	7	11	7
$6900-$8099	8	7	9
$3500-$6899	3	5	17

10/ The classification of counties for erosion hazard was taken from "Adjusting Crop Acreages for War Production to the Soil Resources of Iowa." Iowa Agricultural Experiment Station Bulletin 324 by A. J. Englehorn and A. C. Bunce.

11/ The counties were classified on the bassis of 1943 cash farm income as reported in "Iowa Farm Income by Counties" issued by Iowa Crop and Livestock Reporting Service.

are small (Table 4). Under existing organization of farms in the midwest, income is closely related to farm size in acres. The land in small farms tends to be lower in productivity and subject to a greater erosion hazard than is true of larger farms. In southern Iowa and northern Missouri the operators of small farms have a higher percentage of their cropland in corn, even though the erosion hazards are greater than on large farms (Table 5).[12]

The data in Table 6 show that the operators of small farms in the

[12]Rainer C. Schickele, John P. Himmel and Russel M. Hurd, "Economic Phases of Erosion Control in Southern Iowa and Northern Missouri," Iowa Agricultural Experiment Station Bulletin No. 33, June 1935.

Table 4. --Relationship between Gross Income and Value of Lime and Fertilizer Used per acre of Cropland Harvested and Land Pastured, in Five Midwestern States, 1944.[13]

Gross income[14]	Illinois	Indiana	Iowa	Ohio	Missouri
	Value of lime and liming materials				
0-399	$0.18	$0.14	$0.02	$0.16	$0.04
400-999	.25	.19	.07	.21	.06
1000-3999	.32	.21	.14	.22	.10
4000-9999	.38	.32	.16	.25	.24
10000-& over	.40	.25	.18	.27	.32
	Value of commercial fertilizer				
0-399	$0.09	$0.30	$0.03	$0.34	$0.04
400-999	.11	.45	.06	.50	.09
1000-3999	.16	.67	.07	.82	.17
4000-9999	.24	.94	.12	1.17	.44
10000-& over	.46	1.17	.17	1.64	.53

13/ From U. S. Census of Agriculture, 1945: Special Report, Farms and Farm Characteristics by Value of Products.

14/ Gross Income is the same as value of Products sold or used by farm households as used in the Census.

Table 5.--Degree of Erosion, and Land Use, by Size of Farm, Southern Iowa and North Missouri. See Footnote 12 on Page 18.

Farm size acres	Number of farms	Erosion hazard[15]	Percentage of crop land in corn	Percentage of farm land in crops
100 and below	32	3.7	40	66
101-140	30	4.4	38	59
141-180	33	3.5	42	58
181-300	29	3.4	37	61
301 and above	24	3.2	33	58

15/ The erosion ratings are based on a composite index of factors that influence soil losses. The larger the index number the higher the degree of erosion.

Corn Belt plant as high or a higher proportion of their cropland to corn as do the men on the larger farms. Lower yields on the small farms indicate greater exploitation of the soil than is practiced on the large farms.

A study of 153 Cass County, Indiana farms showed that it would be more difficult to make needed land use adjustments on small farms than on large units.[16] This investigation indicated that, of the 153 farms studied, the attainment of needed land use adjustments could be best facilitated on seventeen by combining them with other tracts because they were too small to constitute economic units.

[16]B. R. Hurt, E. C. Young and Lynn Robertson, "Land Use Adjustments Needed on Farms in Deer Creek Township, Cass County, Indiana." Indiana Agricultural Experiment Station, Bulletin 466, 1942.

In a study of 144 farms in western Iowa, limited farm acreage, in combination with the problem of establishing a livestock enterprise, appeared to be a major obstacle to erosion control on 27 farms. On 14 farms the principal obstacle appeared to be a combination of problems associated with livestock, tenure, and size of operating unit.[17]

Table 6.--Proportion of Cropland in Corn and Yield of Corn per acre on Farms of Various Sizes in Selected Corn Belt States, 1944.[18]

Size of farm Acres	State				
	Illinois	Indiana	Iowa	Missouri	Ohio
	Average yield of corn per acre				
	Bushels	Bushels	Bushels	Bushels	Bushels
10-49	35.3	36.0	48.9	28.4	35.4
50-99	41.4	37.6	50.3	30.3	39.6
100-179	45.6	39.5	52.4	32.6	41.6
180-259	45.5	40.0	51.6	33.9	42.0
260-499	46.4	41.6	52.7	34.5	42.9
500-999	43.1	41.8	52.5	35.6	41.4
1000-up	46.0	40.0	50.6	38.0	42.0
	Proportion of cropland in corn				
	Per cent	Per cent	Per cent	Per cent	Per cent
10-49	45.5	45.5	52.3	30.8	32.3
50-99	46.0	42.0	51.7	36.2	32.3
100-179	45.2	41.2	50.3	37.2	33.0
180-259	45.1	41.9	50.6	37.4	32.8
260-499	43.6	41.8	50.7	36.5	35.5
500-999	43.8	43.9	51.7	34.5	37.6
1000-up	41.3	39.1	47.6	29.4	33.2

18/ Derived from U. S. Census of Agriculture, 1945: Farms and Farm Characteristics by Size of Farm.

Limited working capital goes hand in hand with inadequate land resources on many small farms to complicate the problem of finding a productive outlet for available labor so the family can have an adequate income. Efforts to solve this problem lead to a high percentage of the land in intertilled crops, particularly on farms where shortage of funds or lack of markets has prevented the development of intensive enterprises like dairying, commercial broiler or turkey production or laying flocks. A dairy enterprise makes it possible to make profitable use of relatively large inputs of labor with the feed grown on a comparatively small acreage. Pasture and forage crops can be emphasized and the concentrates can be purchased. Large quantities of forage, relative to grain, also can be utilized with beef cattle, but a small farm organized around a beef breeding herd does not make effective use of the available labor. For this reason, the operators of small farms tend to minimize the hay and

[17]John C. Frey, "Some Obstacles to Soil Control in Western Iowa", Research bulletin in process of publication, Iowa State College, 1952.

pasture acreage and to produce grain which can be sold for cash or processed through hogs and cattle fed in dry lot.

Facilities for making farm enlargement loans would be helpful in some cases, but operators of small farms in many communities find it difficult to buy additional land. In many cases the land is priced above its agricultural value, even for the man with a small unit who can increase the efficiency of his operations materially as a result of the purchase.

Where markets are available for fluid milk, dairy cattle make profitable use of pasture and hay crops and provide year around employment for the labor force on relatively small farms. The investment is smaller than for beef enterprises, but substantial sums are still required.

Most small farms have some land on them that can be used intensively without excessive deterioration from erosion and depletion. By revising the farm layout, this land can be used in short rotations while the land that deteriorates under intensive use can be kept in hay and pasture or in other crops that provide vegetative cover most of the time. The possibilities of increasing the size of a farm business on a small acreage through the use of crops like strawberries and blackberries in combination with breeding flocks that produce eggs for hatcheries, broiler production, turkey raising and other intensive enterprises have not been exhausted. Numerous examples can be cited of families who are making

satisfactory incomes on small farms. In many cases, the problem is one of classifying the land and putting crops on each grade that will not cause deterioration, then supplementing these crops with other enterprises that will provide satisfactory levels of income. Viewed in this way, the principal obstacles to conserving the land in small farms are inadequate capital for setting up intensive enterprises and lack of skill in choosing and handling these enterprises properly.

Intensive enterprises like broiler production can be used to increase the size of business on small farms, but considerable investment in equipment is required in addition to the funds needed for the enterprise itself.

LAND HOLDING AND RENTING PROCEDURES

Tenure on farms in the midwest is strongly influenced by the sequence of events associated with the agricultural ladder. At one time a farm is rented. Later, it is acquired by an owner operator, probably under a mortgage for a considerable portion of its normal value. If the business is successful, the loan gradually is paid off and the farmer becomes a debt-free owner operator. The average period of owner operation is only 16 years, and the time of unencumbered occupancy even shorter. As previously discussed, pressure to pay off the loan often restricts expenditures for conservation developments; and the need for income

to meet living expenses frequently decreases interest in soil saving and soil building improvements that require additional capital expenditures during the relatively short period of debt-free ownership.

Farm Tenancy and Conservation Problems

There is considerable evidence that tenant farming is associated with more exploitive use of land than owner operation, except on farms where the tenant and landowner are related. The proportion of farm land in hay and pasture often tends to be low on a rented farm. In a Minnesota study 88 per cent of the tenants interviewed felt that land use changes on their farms were needed in order to maintain or increase soil productivity.[19] In Iowa, owners and related tenants each reported 56 per cent of their cropland in corn and soybeans, compared with 66 per cent for tenants not related to their landlords. The proportion in grass and legume crops was 21 per cent for owners, 23 per cent for related tenants and 15 per cent for other tenants.[20]

As a rule, sons who are in business with their fathers follow better conservation practices than do other tenant operators.[21] An examination of PMA records in Washington Township, Polk County, Iowa showed that 87 per cent of the owner-operated farms received conservation payments; 95 per cent of the father-son units and 83 per cent of the resident tenants.[22]

Buildings and facilities for livestock and grain storage are less adequate as a rule on rented than on owner-operated farms. In the Minnesota study, previously cited, tenants reported that the capacity or condition of buildings and equipment was a definite handicap to livestock production. This problem was mentioned with respect to sheep by 30 per cent of the tenants, 36 per cent for cattle and 38 per cent for hogs. From 17 to 49 per cent reported that fences were inadequate. The Box Butte County, Nebraska study indicated that only 46 per cent of the tenants had barn space adequate to house all their livestock compared with 70 per cent for full owners. Yet the tenants had only 26 animal units of livestock per farm compared with 48 on owner-operated farms. A substantial proportion of tenants reported inadequate facilities for storing grain.

[19]G. A. Pond, "Farm Tenancy in Minnesota", Minnesota Agricultural Experiment Station Bulletin 353, 1941, p. 48.

[20]Rainer C. Schickele and John P. Himmel, "Socio-Economic Phases of Soil Conservation in the Tarkio Creek Area, Iowa Agricultural Experiment Station Research Bulletin 241, 1938, p. 369.

[21]Several types of special operating and transfer agreements are described in North Central Regional Publications 17 and 18. Copies can be obtained from your Agricultural Experiment Station.

[22]I. W. Arthur and G. N. Jennett, "How Tenure Affects Soil Conservation". Iowa Farm Science, Vol. 5, No. 6, December 1950, pp. 93 and 94.

Types of Leases and Lease Provisions

Farm land is made available to tenants under several types of leases. Crop-share and cash-and-crop-share contracts are the most common over most of the Corn Belt.

Crop-share rent when applied either to fields or to entire farms presents many difficulties from the standpoint of establishing and maintaining adequate systems of conservation. Under this type of lease, the land owner has no financial interest in the livestock kept on the farm. He is too often likely to insist upon readily salable crops such as corn, soybeans and wheat—crops that can be divided easily at harvest time. It has already been pointed out that adoption of conservation systems increases the investment in fences and buildings needed for the care of roughage consuming animals on many farms. Guarantee of an adequate return on this investment requires a larger share of crops or more cash rent than is customary in the community.

The crop-share lease is used in renting fields and entire farms where practically all of the acreage is in crops. It is replaced by the crop-share-cash lease on extensively improved operating units where there is an appreciable acreage in meadow and pasture. Under this type of rental agreement, the tenant gives the land owner a share of the crops grown on the cultivated land and cash for lots, buildings and permanent pasture. In some cases cash is also paid for hay land and rotation pasture. As a rule, the cash payment is made on an acre basis. The per acre rate usually is based on custom in the community where the farm is located. It does not vary enough to allow for differences in the quantity of feed that livestock can obtain from the pasture and for differences in the adequacy and condition of fences and buildings. A farm that is poorly improved, or one where the buildings and fences are in a run-down condition, frequently rents at the same rate per acre as an operating unit where these improvements are fully adequate for the storage of feed and the care of livestock. This situation causes many land owners to look upon improvements as expense for which they receive little or no return. But such improvement as buildings, water systems and fences are necessary for livestock farming and adequate systems of conservation.

If the owner of land provides funds for the purchase of roughage consuming animals and the improvements necessary for their care, he wants to know that he will get a return on his investment. Most of the contracts that are used at the present time do not give this assurance. Livestock-share leases which are in common use in many areas and are the dominant type of contract in some of the dairy sections, and special types of farm-operating arrangements encourage these expenditures. Contracts of these types have limitations, however. Many tenants who

can grow crops successfully are not skilled in handling animals. Poorly managed livestock enterprises usually are unprofitable. Investments in flocks and herds and the equipment necessary for their care increase the risk of the land owner. He shares the managerial responsibility with the tenant under a livestock-share lease or a special farm business agreement. Many rented farms are absentee owned. Others are owned by business and professional men who know very little about the selection and management of enterprises. Widows sometimes hold farms under life estates. These and other factors that influence property rights in land make it difficult to adapt leases completely to conservation needs.

Fifty-nine per cent of the tenant-operators in the Ida-Monona area of western Iowa stated that the term of the lease or the landlord's lack of cooperation would keep them from following erosion control plans. These tenure obstacles had a direct bearing upon erosion control. The erosion rating of farms where this obstacle was reported was 2.52 compared with 1.88 for the other farms examined.[23] The proportion of farmers in the two groups using 3 or more erosion control practices was 12 and 36 per cent, respectively.

The tenants reported several types of difficulties arising from their tenure arrangements. Some said they would have to pay an excessive cash rent for hay and pasture if a conservation system were adopted. Others said the landlord would object to a reduction in corn arcreage. On some farms, tenants said their landlords would not make the needed investments in conservation structures and buildings.

Definite arrangements for sharing the costs of soil-improving practices are lacking in many farm leases. If improvements of this kind are to be encouraged on rented farms, the costs must be distributed in approximately the same proportion as benefits from them.

Willingness to establish systems of erosion control and soil improvement is often influenced by the tenure expectancy of farm operators. This is true both for tenants and owner-operators. A number of studies indicate that interest in conservation is directly related to the length of time operators expect to control or use the land. Of 144 farmers interviewed in the Ida-Monona Soil Association area of western Iowa, 28 stated that they were not interested in their farms for a period of time long enough to justify the adoption of conservation plans.[24] On these 28 farms the average erosion rating was 3.01. Only 11 per cent of the operators on these farms had adopted 3 or more conservation practices. On the other farms, the erosion rating was 1.88, and 32 per cent had adopted 3 or more practices.

[23]John C. Frey, "Some Obstacles to Soil Erosion Control in Western Iowa", Research bulletin in process of publication, Iowa State College, 1952.

[24]John C. Frey, "Some Obstacles to Soil Erosion Control in Western Iowa", Research bulletin in process of publication, Iowa State College, 1952.

Seven of the farmers for whom short tenure expectancy was an obstacle were owner-operators. They had a short-run interest either because of advanced age or plans to sell the farm. Those intending to sell did not feel that investments in conservation practices would increase the sale price. Some of the renters who reported short tenure expectancies did not know whether or not their leases would be extended. Some were thinking of moving to another farm, and some were planning to retire or to quit farming.

As a rule, renters do not remain on the same farm very long. A survey of 820 tenant-farmers in Minnesota showed that, as of 1936, 65 per cent had been on their present farms four years or less.[25] A Nebraska study of 163 farm tenants in Box Butte County showed that 50 per cent had been on the farms they were operating four years or less.[26] In a Logan County, Kentucky study, it was reported that tenants had been on their present farms an average of five years compared with nineteen years for owner-operators.[27] In Kansas, a survey of 540 tenants in 1948 showed that 53 per cent had been on their farms five years or less.[28]

Occupancy of a farm for a period of four or five years usually is an insufficient period to carry through a conservation or soil improvement program and to realize satisfactory benefits from it. It should also be kept in mind that the renter's expectancy of tenure often is uncertain. Most leases are made from year to year. The tenant who starts a conservation program has no assurance that he will be permitted to complete the work and to enjoy the benefits from it.

Compensation Clauses

For those conservation investments which yield benefits over a period of years, the tenant must have assurance that he will receive compensation for the unexhausted improvements that he has made. Compensation clauses are seldom found in farm leases. In a study of 233 leases in southern Iowa, only 2 were found to contain provisions for reimbursing tenants for unexhausted improvements, and in both cases the compensation applied to limestone only.[29] Few of the leases studied in Box Butte County, Nebraska provided for conservation practices or reimbursement for unexhausted improvements.[30]

[25]G. A. Pond, "Farm Tenancy in Minnesota", Minnesota Agricultural Experiment Station Bulletin 353, 1941, p. 48.

[26]George Lambrecht and Lyman Wallin, "Farm Tenancy in Box Butte County, Nebraska", Nebraska Agricultural Experiment Station Bulletin 336, 1942.

[27]John Bondurant, "Land Tenure in Southern Logan County, Kentucky". Kentucky Agricultural Experiment Station Bulletin 464, 1944.

[28]Emery Castle and W. H. Pine, "Customary Farm Leasing Practices in Kansas", Kansas Agricultural Experiment Station, Agricultural Economics Report 41, February, 1950.

[29]A. J. Englehorn, "Landlord-Tenant Relationships in Southern Iowa". Iowa Agricultural Experiment Station Bulletin 372, 1938. p. 83.

[30]George Lambrecht and Lyman Wallin, "Farm Tenancy in Box Butte County, Nebraska," Nebraska Agricultural Experiment Station Bulletin 336, 1942.

In an Indiana study, 20 per cent of the leases provided for compensation to a tenant moving from the farm. In most cases, however, only such practices as fall plowing and clover seed used on new stands were covered. Compensation for more permanent investments, such as spreading limestone or phosphate, were seldom provided for in the leases.[31] Several experiment stations have included clauses in leases that provide compensation to tenants for unexhausted conservation work, but these contracts are not in general use. The Nebraska lease contains the following provisions:

If the tenant has built soil saving dams, terraces, drainage systems or other water control structures, he shall be reimbursed for his labor in constructing same on the following basis:

Four-fifths, if the structure has been used not over one year;
Three-fifths, if it has been used more than one year and not more than two years;
Two-fifths, if it has been used more than two years, and not more than three years;
One-fifth, if it has been used more than three years, and not more than four years; and no payment for structures used more than four years.

Some states recommend the use of a lease rider to cover compensation for conservation work on rented farms. The following steps in preparing the agreement are suggested by the Agricultural Extension Service of Iowa State College:

1. List the soil saving and soil building practices to be started on the farm during the year.
2. List the contributions to each practice to be made by the owner and by the tenant.
3. Estimate the cost or value of the tenant's contribution to each practice.
4. List the compensation due the tenant for unused value, if he leaves the farm before he has full return on his investment in or contribution to the practices.

It is suggested that government payments be taken into consideration and that the tenant's net contribution be written off in a period of five or six years.[32]

[31] O. G. Lloyd, H. S. Morine, Jr., and J. R. Hays, "Principal Methods of Share Renting and Compensation for Unexhausted Improvements in Four Type of Farming Areas in Indiana." Indiana Agricultural Experiment Station Bulletin 464, January, 1942.

[32] I. W. Arthur, "Save the Soil on Rented Farms", Iowa State College Extension Service, Circular FM-986. Methods of compensating tenants for unexhausted improvements in Indiana are described in Indiana Bulletin 464 cited above.

The sod on this waterway was not damaged by terrace runoff following a 4¼ inch rain that fell in two hours. Landowners will profit by reimbursing tenants for the cost of building structures like this.

RELUCTANCE OF FARMERS TO PAY THE OUT-OF-POCKET COSTS OF SOIL CONSERVATION

The additional outlays of capital for fertilizer, fencing, seed, livestock, and equipment, machine hire for terrace construction and other necessary items are sufficiently great to constitute an important barrier to a complete system of conservation on many farms. In one study of factors retarding a desirable shift toward more forage in the rotation in a southern Iowa area where there is a serious erosion hazard, nearly one-fourth of the group who thought such a shift would increase net returns indicated that limited capital was a major obstacle to such a change.[33] More than 20 per cent of a sample of farmers in North Central Kansas indicated that lack of funds, equipment and materials such as fertilizer and grass seed was an obstacle to the adoption of conservation practices,[34] and nearly 85 per cent of the farmers interviewed in a study in the Tipton and Princeton areas of Missouri stated that meeting the cost was one of

[33]Carroll V. Hess, "Forces Conditioning the Economic Use of Resources on Southern Iowa Farms." Unpublished Master's Thesis, Iowa State College Library.

[34]W. H. Pine and Merton L. Otto, "A Study of Selected Conservation Practices in North Central Kansas." Kansas Agricultural Experiment Station, Agricultural Economics Report No. 40. 1949.

the principal drawbacks to wider use of erosion control practices.[35] In a study of 156 crop farms in Deer Creek Township, Cass County, Indiana, the conclusion was reached that 38 per cent of the farmers lacked the financial means or the managerial ability to put into operation the changes in land use recommended for their farms.[36] It is probable that in addition to farmers who recognize the need of additional capital as a limiting factor there are many others who stress a more immediate obstacle, such as lack of landlord cooperation, but who would also be hampered by lack of capital once they actually set about making changes toward greater conservation.

Methods of Using Capital To Develop Farm Conservation Systems

From these studies, cost appears to be one of the factors retarding the use of conservation measures and restoration of productivity on eroded or depleated land. The outlay in terms of out-of-pocket expenses, labor and the use of equipment varies with the extent of water control measures required and the quantity of mineral elements that must be added. In rolling localities like those found in eastern Nebraska and Kansas, western Iowa, and northwestern Missouri, the cost on many farms will run as high as $40 to $60 an acre. Where the land is steeply rolling or needs drainage, water control structures will be the most expensive items in a complete program. In other sections, farmers may need to make heavy applications of lime, phosphate, potash and other materials to bring the productivity of the soil up to a desirable level, and then to make annual applications of the elements such as nitrogen required to maintain this level.[37]

In addition to the cost of structures and soil improvement, conservation farming requires other expenditures. Land that deteriorates rapidly under cultivation should be returned to grass cover permanently, and sod forming grasses and legumes should be used in the regular rotations on cultivated land where deterioration can be controlled. These procedures may lead to one or more of four additional types of expenditures. (1) Grass and legume seed must be purchased to establish stands on most farms. (2) Hay and pasture become important crops. Since these products are not readily salable, new livestock enterprises must be added or exist-

[35]Frank Miller, Unpublished study of the erosion control and water management situation in the Tipton and Princeton areas of Missouri, Missouri Experiment Station, 1951.

[36]B. R. Hunt, E. C. Young and Lynn Robertson, "Land-Use Adjustments Needed on Farms in Deer Creek Township, Cass County, Indiana." Indiana Experiment Station Bulletin 466, 1942.

[37]A discussion of the relationship between soil fertility and erosion control can be found in Missouri Agricultural Experiment Station Bulletin 518 "Cropping Systems for Soil Conservation" by Dwight D. Smith, Darnell M. Whitt and Merritt F. Miller, 1948.

The use of special equipment such as a whirlwind terracer leads to out-of-pocket expenses.

The use of lime, phosphate and other fertilizers is essential to large yields of crops and successful conservation in many areas of the midwest.

ing flocks and herds increased in order to convert forages into commodities that the market will accept. (3) Fences, water supply, feed storage facilities and shelter are essential to successful livestock production. (4) The operating unit may need to be enlarged in order to make efficient use of capital, labor and management under extensive use of land.

Changes in Systems of Farming

An adjustment toward a system of farming that will conserve the soil often involves a major shift in the cropping pattern and in the livestock enterprises. Data in Table 7 illustrate the changes in the cropping pattern required under two alternative plans to reduce annual soil losses on 144 farms in the Ida-Monona soil area of western Iowa to a level not to exceed 5 tons per acre. Two approaches are assumed. In one, such measures as terracing and contour cropping are applied to control erosion. In the other, small grains and sod forming crops are used so mechanical devices are unnecessary. In either case the acreage of grain crops is reduced while that of meadow and pasture is increased.

The effect of changes like those shown in Table 7 on makeup of the feed supply on two individual farms in the area is illustrated in Table 8. On Farm A the total output of grain would be increased although the acreage of cereal crops would be lower than under current practice. The output of hay and the acreage in pasture would increase markedly. Regardless of these facts, total grain production would be increased greatly.

Table 7.--Major Uses of Land on 144 Farms of the Ida-Monona Soil Association Area of Western Iowa in 1949, and Estimated Acres in Specified Uses, if Alternative Erosion Control Plans Were Followed.38/

	Actual Acreage 1949	Estimated Annual Acreage Plan I39/	Estimated Annual Acreage Plan II40/
Row Crops	9230	5429	3745
Small Grain	5730	3970	4164
Meadow 41/	4192	9298	10713
Permanent Pasture42/	4240	4704	4770

38/ John C. Frey, "Some Obstacles to Soil Erosion Control in Western Iowa". Manuscript in process of Publication as a research bulletin, Iowa State College, 1952.

39/ Based upon maintaining maximum row crop acreage consistent with reduction of annual soil losses to about 5 tons per acre. Terraces, contour listing and contour farming are applied.

40/ Based upon conservation plans which do not involve terracing or contour listing but which rely upon increased forage acreages to keep annual erosion down to 5 tons per acre.

41/ Included grass and/or legume seedings in the rotation plowed under for corn or small grain at least once in 7 years.

42/ Included grass and/or legume crops not plowed under for other crops for a period of at least 7 years.

Table 8.--Estimated Changes in Crop Production That Would Accompany Shifts to Erosion Control Systems of Farming on Two 160-Acre Iowa Farms in the Ida-Monona Soil Area.

Crop production before the change[43]				Crop production after change in rotation and addition of contouring, terracing, and fertilizer[44]			
Land Use	Acres	Average Yield	Total Production	Land Use	Acres	Average Yield	Total Production
			FARM A				
Corn	93.5	33.5 bu.	3132 bu.	Corn	67.1	60.0 bu.	4020 bu.
Oats	15.9	22.2 bu.	354 bu.	Oats	37.7	40.6 bu.	1532 bu.
Soybeans	7.0	10.0 bu.	70 bu.	Alfalfa brome pasture	26.3		
Alfalfa brome pasture	11.0			Alfalfa brome hay	26.4	2.0 T	53.3 T
Alfalfa hay	8.2	1.6 T	12.8 T	Other	2.5		
Permanent pasture waste	20.4			TOTAL	160.0		
Other	4.0						
TOTAL	160.0						
			FARM B				
Corn	70.0	45.1 bu.	3157 bu.	Corn	52.6	55.8 bu.	2937 bu.
Oats	47.0	39.0 bu.	1833 bu.	Oats	35.0	37.6 bu.	1318 bu.
Alfalfa hay	20.0	1.4 T	28 T	Alfalfa brome hay	31.4	1.6 T	57 T
Permanent pasture	12.0			Alfalfa brome pasture	31.4		
Other	7.0			Other	5.6		
TOTAL	156.0			TOTAL	156.0		

43/ Based on 1948 yields adjusted by ten year county average. The 1948 oat yield on Farm B appeared to be abnormally high.

44/ Production estimates allow sufficient time for major effects of revised cropping systems to be reflected in yields.

Analysis of costs shows that the fertilizer bill would go up $62 (1940-44 prices) and additional maintenance expenses for terraces would amount to about $82 a year. Under these conditions, increasing the acreage of forage would increase the quantity of grain produced. Net income would be increased, even if no additional investments were made in forage consuming animals. Hay crops could be plowed under for green manure.

On Farm B the total output of grain would decrease while the output of forage would increase. If the change is to pay on this farm, a profitable use must be found for the additional hay and pasture. The increase in yields of grain crops is not sufficient to make the shift pay in the absence of a market for the forage and pasture. In most cases a satisfactory market for this forage and pasture can be provided only by an increased investment in livestock. Lack of funds to purchase additional animals and to equip the farm for their care could be a serious obstacle to conservation on this farm.

A large investment is required to provide livestock for a pasture like this. Where a beef breeding herd is used the acreage in the operating unit must be fairly large in order to provide full employment for the labor force.—Photo courtesy of the Soil Conservation Service.

Importance of Livestock

The key role played by livestock in making "conservation farming" profitable is emphasized further by a study of the organization of farms with high and low rates of erosion on the Marshall soils of western Iowa. Here 90 farms ranging from 140 to 180 acres in size with similar soil resources were classified into two groups on the basis of the degree of erosion loss taking place. The land use and the feed production patterns on the "high" and "low" erosion farms are compared in Table 9. Not only was the total feed production somewhat greater on the 45 farms with the lower erosion loss but the ratio of forage to grain was higher. The low erosion farms reported a larger income, but the higher returns were closely associated with their heavier livestock programs. Data in Table 10 emphasizes this fact. Scarcity of funds for the purchase of livestock and lack of skill in the care of animals can be serious obstacles in making the change. Many farmers lose money on livestock because of inefficiency in the care of animals. For these people livestock are not an aid in solving the conservation problem.

Table 9.--Land Use, Yields and Feed Production on two Groups of Western Iowa Farms, 1948.45/

	Farms with a low rate of erosion	Farms with a high rate of erosion
Acreage		
Row Crops	62	84
Small Grain	30	25
All Grain	93	109
Hay	26	22
Rotation Pasture	14	9
Hay and Pasture	65	51
Corn Yield Per Acre (bushels)	63.9	52.9
Hay Yield Per Acre (tons)	1.9	1.7
Feed Units of Grain Produced 46/	4475	4866
Feed Units of Forage Produced 46/	2209	1564
Total Feed Units Produced46/	6694	6430
Per Cent of Total Feed Produced in Forage	33	24

45/ Carl W. Allen and Earl O. Heady "Erosion Control Can Pay Off." Iowa Farm Science. October, 1948.

46/ All feeds are converted to corn equivalent on the basis of total digestible nutrients (1 bushel of corn equals 1 feed unit).

Table 10.-Some Characteristics of the Organization of Two Groups of Farms Where Different Levels of Erosion Control Had Been Attained on Marshall Soils in Western Iowa.47/

	Farms with a low rate of erosion	Farms with a high rate of erosion
Gross profits	$7058 48/	$6056
Net sales of crops	258	1348
Net production of livestock	6773	4708
Livestock investment	4552	3850
Per cent feed fed in grain	69	68
Months labor used	16.7	15.8

47/ Carl W. Allen and Earl O. Heady, "Erosion Control Can Pay Off" Iowa Farm Science, October, 1948.

48/ All prices are in terms of the 1945 level.

The added investment in livestock discussed in the preceding paragraphs is only a part of the outlay of capital needed for the shift to conservation farming. In the study just cited, it was estimated that an investment of $3000 would be required to convert the low conservation farms to an erosion control system at 1945 prices. An estimated $1000 would be needed for alterations in fences and buildings and another $1000 would be required for investment in conservation practices. The remaining $1000 would be required for increasing livestock numbers. Similar

estimates are available on costs of conservation programs on slowly permeable soils in northeastern Illinois. (Table 11). These data are based on the opinions of operators of 69 farms averaging 273 acres per farm.[49]

[49]These costs are based on 1948 prices whereas 1945 prices were used in the Iowa analysis. Differences in the prices used and in the average size of farm explain, in a large part, the much higher estimates of capital outlays on the Illinois farms.

Table 11.--Estimated Cash Cost of Making All of the Farming Adjustments Needed in a Conservation Program on Slowly Permeable Soils in Northeastern Illinois. (Based on Opinions of Operators of 69 Farms Totaling 18,815 Acres and Averaging 273 acres per Farm, 1948). 50/

	Cost per farm	Cost per acre	Percent of total
Fertility Costs			
Limestone	$ 809	$ 2.96	12.2
Rock phosphate	1443	5.29	21.7
Potash	132	.48	2.0
Total	$ 2384	$ 8.73	35.9
Water-disposal costs			
Tiling	$ 512	$ 1.88	7.8
Grass waterways			
Seed	$ 9	.03	.1
Construction	49	.18	.7
Erosion-control Structures	109	.40	2.1
Total	$ 679	$ 2.49	10.7
Building, fencing, and equipment costs			
Fencing			
Woven wire	$ 310	$ 1.14	4.7
Barbed wire	119	.44	1.8
Water supply	123	.45	1.8
Repair or remodel buildings	702	2.57	10.5
New buildings	394	1.44	5.9
Livestock equipment	39	.14	.6
Machinery	449	1.64	6.7
Total	$ 2136	$ 7.82	32.0
Livestock costs			
Dairy cattle	$ 576	$ 2.11	8.7
Beef Cattle	305	1.12	4.6
Feeder cattle	466	1.71	7.0
Sheep	41	.15	.6
Hogs	1036	.13	.5
Total	$ 1424	$ 5.22	21.4
Total costs	$ 6623	$24.26	100.0

50/ E. L. Sauer, J. L. McGurk and L. J. Norton, "Costs and Benefits from Soil Conservation in Northeastern Illinois." University of Illinois Agricultural Experiment Station in cooperation with Soil Conservation Service. U. S. Department of Agriculture. Bulletin 540

Barns to protect the animals in bad weather, to store feed and to provide satisfactory conditions for producing a quality product are essential to successful livestock farming. The animals themselves and the equipment that is needed for their care require considerable investment.

Conservation Alternatives That Require Less Capital

There are at least two possible ways of overcoming scarcity of capital: (1) Reduce the amount involved in changing to methods of farming which control erosion; (2) Make greater amounts of capital available through the use of credit and leasing arrangements. These alternatives can be used separately or in combination. This section is concerned with possible methods of reducing the magnitude of the capital outlay required.

Some conservation practices can be used with little or no cost. For example, on moderate slopes contouring can be practiced, where needed, without incurring expense and with a fairly certain increase in net returns. Research already completed shows that marked reductions in soil losses can be achieved by growing crops on the contour without large increases in the proportion of sod crops. Table 12 compares estimates of soil losses on Marshall silt loam of predominantly 9% slope with and without mechanical practices for different rotations. The data show that soil losses can be cut in half for the four rotations considered, by performing all tillage operations on the contour.

Terraces differ from conturing in that they usually involve some outlay of cash, particularly if they are constructed with special equipment and hired operators. The data in Table 12 show, however, that terraces make possible marked reductions in soil losses even through the cropping system still contains a high proportion of grain. Not all soils lend themselves as well to contouring and terracing as do Marshall soils, nor would

Terraces and contour cultivation reduce erosion losses materially where crops are grown on sloping land.—Photo courtesy of the Soil Conservation Service.

Table 12. -Pattern of Land Use and Expected Soil Loss per Acre for Specified Rotations and Practices on Marshall Silt Loam Soils Where the Dominant Slopes Are About Nine per cent 51/

Rotation*	Percent of land in			Expected soil loss per acre per year		
	Meadow	Small grain	Corn	No mechanical practices	Contouring but no Terraces	Contouring and Terraces
	%	%	%	tons	tons	tons
CCOM	25	25	50	39.2	19.6	2.0
COM	33	33	33	28.0	14.0	1.4
CCOMM	40	20	40	25.2	12.6	1.3
COMM	50	25	25	16.8	8.4	.8

* C = corn; O = oats; M = meadow

51/ Earl O. Heady, Carl W. Allen and George M. Browning, What Will We Do To Control Erosion? Iowa Farm Science, Iowa State College, Volume 4, Number 5, November 1949. pp 4-68.

these practices be as effective in all areas if mechanically feasible. But these mechanical practices offer the possibility of reducing soil losses in many areas with a small outlay of capital. This is especially true in those cases where the farmer can construct his own terraces with ordinary farm equipment. Operator and family labor often can be used on such jobs when other farm work is not pressing. To the extent that erosion can be controlled through mechanical practices without marked increases in the ratio of forage to grain, the heavy investment in livestock necessary to process the added output of pasture and forage can be avoided.

Many farmers can increase substantially the quantity of forage they can utilize profitably with existing herds by developing feeding programs that make use of larger proportions of forage. In this way, more roughage can be used without a large increase in the amount of capital needed for additional livestock and buildings. The successful use of greater quantities of forage in livestock feeding is dependent upon progress in improving the quality of pasture and forage production. In spite of repeated demonstrations that limited quantities of high quality forage can be substituted for grain in swine production, large numbers of hogs are still produced with little or no pasture. Experience has shown that greater proportions of high quality forage can be used in feeding dairy cows than are now ordinarily fed.[52] High quality beef can be produced with a program of grain feeding on pasture, or with a short feed in dry lot after growing the animals out and fattening them on pasture and roughage; thus, substituting quantities of forage for grain and protein supplement.[53]

Spread the Cost

In addition to the alternatives that have been discussed, the capital needed at the outset can be reduced by spreading the conservation work over a longer period of years. While it may be technically possible to set up rotations, construct terraces, establish grassed waterways and build up livestock enterprises in a period of two or three years, it may not be economically feasible to do so. Family living expenses and service charges on debts always come first. Where the cost involved must be met out of current income, and the work must be done by family labor, proposing rapid changes may have the effect of making the adoption of a conservation program seem unattainable to the hard-pressed farm operator. Where the change is approached on a gradual basis, there is a greater opportunity to finance the program out of current earnings, especially if the program is started with some highly productive practice such as the use of fertilizer. In addition, a gradual transition permits

[52]J. B. Kitchin, Jr., C. B. Bender and E. Paisley, "Cows—Hay Burners or Grain Burners". New Jersey Experiment Station, Dairy Department, (processed).

[53]M. L. Peterson, C. C. Culbertson, and Earl O. Heady, "Good Pasture, Good Beef", Iowa Farm Science, June 1948.

the operator to learn the techniques of farming on the contour, constructing and maintaining terraces, handling new livestock enterprises and many other new and needed skills, before undertaking them on such a scale that mistakes might be costly.

If a farmer already has some livestock, the herd can often be expanded, about as rapidly as pastures can be developed, by retaining more farm-raised breeding stock. This procedure reduces current income, however, and the farm family must be able and willing to withstand this reduction. Gradual development of a complete conservation and soil improvement plan over a period of years reduces the amount of capital needed to initiate such a program. To the extent that conservation practices will bring additional income in excess of interest on funds that can be borrowed, highest profits would follow the immediate adoption of a complete system of conservation. But farmers often prefer the less profitable route that offers less financial risk and less disturbance to traditional methods of farming.

Adjustments Needed in Procedures of Financing Conservation Work

Funds for conservation work may be obtained from savings, inheritance, income in excess of current family living and business requirements and through loans. A farmer who has a good basis for credit and a farm that is already in a fairly high state of productivity usually has no difficulty in borrowing money to carry out a water control and soil improvement plan. A complete development plan is always essential. It can be the basis for credit, if borrowed funds are used. The money should be made available as needed to carry out each phase of the work. Repayment schedules should be timed to the increase in income that will result from the improvements and changes in the system of farming, as discussed in preceding sections. In other words, credit that is tailored to conservation and soil improvement is needed. Some work has already been done to fill this need. The Federal Land Bank of St. Louis is making improvement loans to farmers. The money can be used for the following purposes:

To clear land.
To build terraces and other water control structures.
To install tile and ditch drains.
To purchase lime and fertilizer.
To construct needed buildings.
To wire buildings for electricity.
To establish meadows and pastures.

The funds can be drawn upon as needed during a five-year development period. Repayment is made on a 20 to 34½ year amortization basis. During the period when improvements are being made, the amor-

tization payments are held to a minimum rate of one per cent of the original principal each year. One year after the advances have been completed the principal payments are increased to a rate that will liquidate the loan in the contract time.[54]

Some lending agencies may take into consideration the technical and financial assistance available through conservation programs in determining the soundness of the credit requested by the land owner or operator, but these aids are not major factors in the extension of credit.

Some commercial banks make loans for various phases of conservation work. In one city in Missouri, the commercial banks have organized a trust company expressly for this purpose. A borrower under their plan gives a mortgage to this trust company.[55] The mortgage specifies the farm improvements for which funds are to be advanced and the total amount that can be borrowed. It also outlines a repayment schedule. Funds can be obtained as needed over a ten year period for any one or all of the following purposes:

To build water control structures such as grass waterways, terraces, letdown devices, ponds, diversion ditches and silting basins.

To construct fences and other improvements.

To purchase lime and fertilizer.

The Farmer's Home Administration follows the practice of putting farms that are bought under the tenant purchase plan in condition for efficient operation and adding the cost to the loan. The improvements made often include soil treatments, water control structures and fences, as well as renovation and repair of buildings.

Limitations of Present Procedures

Customary lending procedures have some important limitations. In the first place, loans for conservation purposes are sometimes denied because the productivity of the investment is not taken into account in establishing maximum lending limits in relation to appraised value. For the Federal Land Banks, this legal limit is 65 per cent of the normal agricultural value of the farm. If a farm is appraised when it is low in productivity, there is no provision for raising the normal agricultural value and the amount loaned as improvements are made. The procedure followed at the present time makes it difficult to obtain funds for soil improvement programs where the present level of productivity is low.

Suggested New Procedures

It is possible that loans will never be made on conservation measures as such. Credit is always extended to a farmer on the basis of his in-

[54]A circular describing these loans can be obtained from the Federal Land Bank of St. Louis, Missouri.

[55]A copy of the trust deed used by the Empire Trust Company can be obtained from Mr. Webb Embrey, Chamber of Commerce, St. Joseph, Missouri.

tegrity, the financial progress he is making, his prospects of repaying the obligation on schedule and the colleteral he can offer as security as well as the purpose for which the funds will be used.

Experience has shown, however, that a considerable part of the productive value of farms in average or poor soil areas has been created by the treatments and improvements that have been placed on the land. Under these conditions many loans that would be well within the fixed limit of productive value after the improvements were made would be denied because the value before the program was developed would not justify the loan. To overcome this difficulty, a lending procedure is needed that takes into account the productive value of the farm after the necessary conservation improvements have been made. One approach would be to find the normal agricultural value of the farm before the conservation development is started and add to it the estimated cost of all permanent improvements that increase its productivity to arrive at a reasonable normal value after the program has been completed. If a farm in its present condition has a normal value of $12,000 and the cost of soil treatments, water control structures, fences, buildings and other development items is $9,500, the reappraised normal value after the improvements are made could be set at $21,500. With this amount as a normal value, a loan of $9,500 would be within a 65 per cent limit. If the outlays are all for productive purposes, this would be conservative procedure. The Federal Reserve Bank of St. Louis has found values arrived at by this method to be lower than

Legumes plowed under for green manure add humus and nitrogen to the soil, improve the tilth, add to the moisture holding capacity and help to control erosion.

the capitalized value of net landlord returns after the improvements have been made.[56]

Another procedure in financing improvements would be to reappraise the farm each year as improvements are made. Under this plan, improvements that have been made become a part of the larger normal value to support additional improvements.

Purpose of Expenditure

The major purpose of expenditures to improve and maintain soil productivity is to increase the long-run net income of the farm business. Returns from these investments, however, cannot be expected to accrue in one or two years. A series of loans is needed for specific jobs with repayment schedules and maturity dates geared to the increased income resulting from the new or enlarged enterprises included in the revised system of farming. A schedule of loan advances and repayments to finance an integrated farming system is suggested in Figure 1. The shaded areas in the successive circles show disbursement and repayment dates. Loans for semi-permanent land improvements like initial soil treatments and water control structures can be repaid in equal installments extending over a period of years. Funds for enterprises and improvements that provide a continuous flow of income, such as dairy cows, poultry houses, sanitary barns and milk coolers, can be paid in monthly installments. Loans for items like annual applications of fertilizer to maintain the soil productivity balance at the desired level can be paid at the end of the crop year. It has already been pointed out that farmers tend to restrict the use of fertilizer when money is scarce. Making funds available for this purpose encourages its use and helps to safeguard repayment of the longer term commitments.

It should be kept in mind that a good farm plan and determination on the part of the operator to carry it into effect are the most important factors in any conservation program. Many farmers need to work out a complete schedule of improvements and changes in farm organization. A careful financial plan should be a part of the program. Much of the work can be done by the farmer and his family. As pointed out previously, funds to do the entire job at one time are not necessary. It is possible to meet all expenses out of increased income, but the work may be done more rapidly and profits may begin to accrue earlier if funds can be made available to complete the program in a relatively short time.

A farm plan with a time schedule for making improvements and for paying off obligations would bring order into a great many disorderly farm businesses. Both the farmer and the lender would begin to think

[56]Darryl R. Francis, "Evaluation of a Balanced Farming Program." Journal of American Society of Farm Managers and Rural Appraisers, Vol. XII, Number 3, October 1948, page 135.

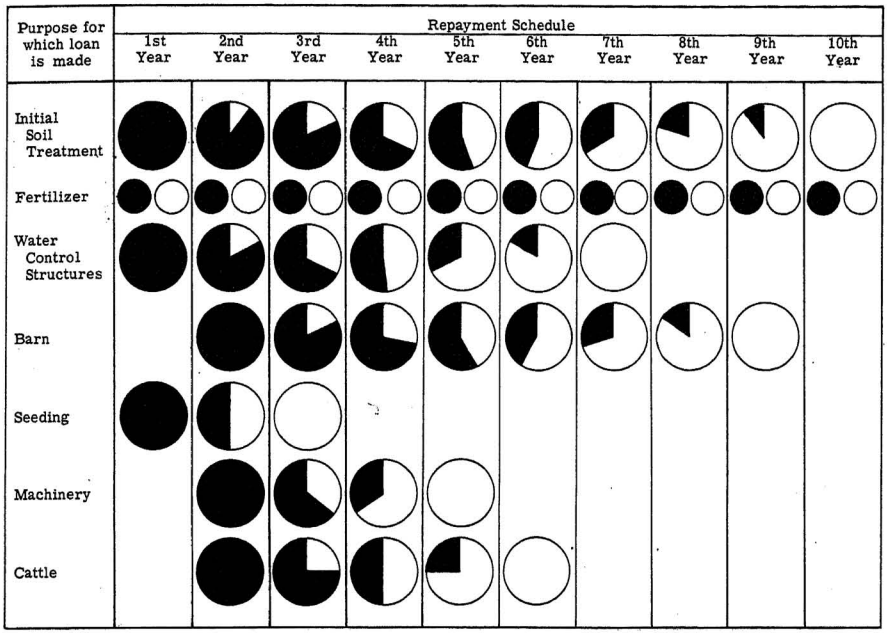

Fig. 1. Suggested schedule of loan advances and repayments for establishing a complete system of conservation on a farm. (The black circle indicates the year in which the loan was made for the improvement, and the white circle the year in which payment was completed.)

in terms of adequacy of physical plant including area and productivity of land, enterprises adapted to specific grades of land, practices and enterprises that are complimentary to each other, financial resources required to establish and maintain a profitable farm business and the amount of income needed to support the family and meet financial obligations. Such a plan would go a long way toward promoting a mutual understanding of conservation problems on the part of borrowers and lenders. It would help to overcome the obstacle of inadequate funds for conservation development during the early period when expenditures often exceed increased returns.

THE TIME LAG BETWEEN CASH OUTLAYS FOR CONSERVATION WORK AND RETURNS

While many conservation programs are profitable over a period of years, the individual contemplating a change to an erosion control and soil improvement system of farming must consider when the costs involved will occur and when the returns will come. Most of the estimates of improvement in net farm incomes as a result of conservation assume time for a major portion of the beneficial effects of the practices to be reflected in increased crop yields and increased carrying capacity of pastures. The timing of investment and returns will vary with soil types

and the kind and magnitude of adjustments required. The lag between conservation outlays and returns is not great under some conditions. An example is the installation of water control structures such as terraces and grass waterways on land where a systematic corn, oats, clover rotation is in use. Under these conditions crop production may not be reduced, particularly when fertilizer is applied liberally in terrace channels and other places where the soil is moved. Where there are large shifts in the cropping pattern and in the accompanying livestock system, farm income may actually be decreased while the change is underway.

On many corn belt farms the principal change the first year would be a greater acreage of small grains in which grasses and legumes would be seeded. The corn and soybean acreage would be reduced. Small grains typically yield lower returns than do corn or soybeans. The increased acreage of grasses and legumes would have no immediate yield increasing effect and would furnish little if any added forage during the first year. In the second year the acreage in forage crops ordinarily would increase. During this short run period the added forage output would be in direct competition with grain production. The increased acreage in hay and pasture could only mean a decrease in grain production during the first and second year. It is during the second year that the need for the added investment in livestock ordinarily comes. But even where forage consuming livestock is increased during the second year, added income may not be forthcoming until the third or even later years, depending upon the types of livestock enterprises added. In subsequent years the increased forage production will tend to increase grain yields. It is these increased yields coupled with the increase in livestock production which makes the change in the direction of greater conservation profitable over the longer run period.

The gap between the investment in and the returns from conservation ranges from a year or two up to perhaps four or five years or even longer. Many of the expenditures are direct out-of-pocket costs such as those involved for terrace construction and the building of other water control installations. The lines in Figure 2 show a common relationship between costs and increased returns. Data in this chart are based on results on a farm in a Missouri Balanced Farming Association. Records from other farms show similar relationships between costs and returns during the transition period. Estimates of the change in crop acreages and production over a five year period for a typical 160 acre farm in the Marshall soils area of western Iowa are given in Table 13 and estimates of the pattern of year by year income changes are given in Table 14.[57]

In the Iowa situation, incomes were lowered in each of the first three years of the program. This deficit was not made up through increased

[57]Costs and returns in the latter table are stated in terms of 1945 prices.

Table 13.-Changes in Crop Acreages and Production Accompanying the Development of a Conservation Program on a Typical 160 Acre Iowa Farm on Marshall Soils in Western Iowa.58/

	Existing Farming System	After start of conservation adjustment				
		First year	Second year	Third year	Fourth year	Fifth year
Crop Acreages						
Corn	77	59	57	55	58	60
Oats	31	51	24	34	29	26
Hay	35	31	64	56	58	59
Permanent pasture	12	12	8	8	8	8
Crop Production						
Corn (bu.)	3442	2970	3202	3055	3330	3559
Oats (bu.)	1054	1907	918	1397	1247	1118
Hay and pasture (tons of hay equivalent)	69.0	61.6	115.6	110.4	141.4	161.0

58/ Earl O. Heady and Carl Allen, "When Do You Get Return from Erosion Control," Iowa Farm Science, December, 1949.

Table 14.--Investment and Changes in Income That Would Accompany the Development of a Conservation Program on a Typical 160 Acre farm on Marshall Soils, in Western Iowa59/

	Year after start of conservation system				
	First year	Second year	Third year	Fourth year	Fifth year
Additional investment per year					
Roughage-consuming livestock	$ 0	$ 590	$ 0	$ 394	$ 294
Terraces	70	88	263	53	24
Waterways, etc.	0	48	35	66	0
Fencing, buildings, etc.	0	173	202	190	0
Total additional capital per year	$ 70	$ 899	$ 500	$ 603	$ 318
Change in income (above present system)	$-387	$-242	$-122	$+469	$+804

59/ Earl O. Heady and Carl Allen, "When Do You Get Returns from Erosion Control," Iowa Farm Science, December, 1949.

income until the fifth year. Outlays of capital were spread over a five-year period and were heaviest during the second to fourth years. Three-fourths of the total capital investment was for additional forage consuming animals.[60]

A study of a 1360 acre wheat-cattle ranch in southwestern North Dakota indicates that a desirable conservation adjustment would involve shifting about 90 acres of wheat and fallow to crested wheat grass.[61]

[60]Similar estimates have been made for typical farms on the Clarence-Rowe soils of northeastern Illinois. These indicate a similar distribution over time of conservation outlays and returns. E. L. Sauer, J. L. McGurk and L. J. Norton, "Costs and Benefits from Soil Conservation in Northeastern Illinois." Illinois Agricultural Experiment Station Bulletin 540, 1950.

[61]"Will More Forage Pay," U.S.D.A. Miscellaneous Publication 702, 1949.

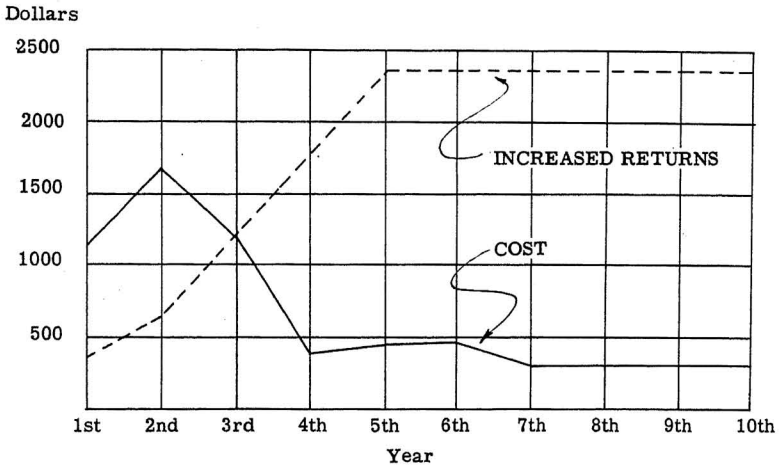

Fig. 2. Typical costs and increased returns in changing to conservation farming. Data were taken from records on a beef cattle and hog farm near St. Joseph, Missouri. Additional records from other farms where balanced farming plans have been followed show similar relationships between costs and returns.

This adjustment would reduce cash income for a period of 3 years while grass seedings were becoming established. Little increase in expense would be involved.

The period of waiting between investment and return is a barrier to greater conservation. It is particularly important where competition for the use of limited capital is keen among alternative investments which promise more immediate return or where pressure for income for family living is great. It takes on added importance where decisions must be made under highly uncertain conditions. The retarding effects of this waiting period are easily understood when considered in connection with pressure for immediate income, price uncertainty and insecure tenure.

THE DESIRE OF FARM OWNERS AND OPERATORS FOR HIGH CURRENT INCOME

The need for cash outlays in developing a conservation system of farming has been pointed out in previous sections. On a large number of farms the cost must be met out of limited farm income. Frequently, in the farm business, there are numerous competing uses for the funds that are available. But in addition, because the farm business is closely tied to the household on the family farm, use of available funds for investment in conservation must compete with their use for family living. Regardless of the productivity of investments in conservation in terms of future income, families must grant priority to living necessities. The

choice of an exploitive cropping pattern which maximizes immediate returns at the expense of future production may be justified by pressure to meet current family living expenses. In cases where a question of necessity is not involved, the family may feel that a dollar this year is equal to several a few years hence, if the money is to be used, for instance, for education or improved living for a growing family. On rented farms, the financial situation of the landlord may also be of importance. Many owners of rented land are dependent upon the income from their farms for a livelihood. Landowners of advanced age can be expected to prefer those farming methods which maximize current income and to avoid investments in conservation from which returns cannot be realized for several years.

Table 15.--Erosion Rating, Cropping System, and Corn Yields on Farms Mortgaged for Different Amounts Per Acre, in the Tarkio Creek Area of Iowa, 1927-1933.62/

Mortgage per acre 1933 (dollars)	Owners and related tenants 63/					Tenants				
	No. of farms	Erosion rating	Percentage of cropland in 64/ Inter-tilled crops	Percentage of cropland in 64/ Grasses and legumes	Average "normal" corn yields (bushels)	No. of farms	Erosion rating	Percentage of cropland in 64/ Inter-tilled crops	Percentage of cropland in 64/ Grasses and legumes	Average "normal" corn yields (bushels)
0-20	53	2.68	52	24	46	31	2.97	64	16	41
21-50	32	2.84	56	24	45	11	3.01	69	13	41
51-80	42	2.84	60	19	45	27	3.34	63	19	41
81-110	33	2.99	58	19	42	8	3.30	72	5	37
Over 110	9	2.84	60	14	46	7	3.24	77	5	38
All farms	169	2.84	56	22	45	84	3.15	66	15	40

62/ Rainer Schickele and John P. Himmel, "Socio-Economic Phases of Soil Conservation in the Tarkio Creek Area." Iowa Agricultural Experiment Station Bulletin 241.
63/ Including tenants related to landlords.
64/ The remaining land was in small grains.

Often pressure to maximize present income also arises out of the necessity for money to meet interest and principal obligations. Exploitation from this cause is more prevalent and serious during periods of unfavorable farm prices, and was evident on many farms during the 1930's. Schickele and Himmel found that the cropping systems on southern Iowa farms which were heavily mortgaged contained a higher proportion of inter-tilled crops and a lower acreage of legumes and grasses than farms with little or no indebtedness. These relationships are shown in Table 15. A study of lending experience on farms in seven east-central Illinois counties showed that farmers who were experiencing loan difficulties tended to follow more exploitive land use practices than other farmers.[65] The percentage of cropland in hay and pasture was significantly lower on farms where the loans were either delinquent or had been foreclosed while the percentage of cropland in soil depleting

[65]Joseph Ackerman and L. J. Norton, "Factors Affecting Success of Farm Loans," Illinois Agricultural Experiment Station Bulletin 468, 1940.

crops was greater. These relationships for farms on soils having different productivity levels are given in Table 16.

Table 16.--Appraised Value, Amount of Loan and 1935 Land Use on 338 Illinois Farms Grouped According to Soil Productivity and Success of the Owners in Carrying the Loans. 66/

Item	Farms on good soils		Farms on intermediate soils		Farms on inferior soils	
	Loan successful	Loan delinquent or foreclosed	Loan successful	Loan delinquent or foreclosed	Loan successful	Loan delinquent or foreclosed
Number of loans	84	11	112	32	66	33
Average acres mortgaged	112	116	100	116	99	118
Loan ratio, per cent	39.0	43.3	37.3	42.0	38.0	43.4
Loan per farm	$8,968	$11,100	$4,344	$5,547	$3,250	$4,632
Loan per acre	$80	$96	$43	$48	$33	$39
Appraised value per acre	$203	$227	$115	$112	$83	$92
Per cent of total land in hay and pasture	21.5	12.7	45.2	35.4	40.0	32.9
Per cent of land in soil depleting crops	86.4	92.5	67.3	73.6	60.8	67.5

66/ Ackerman, Joseph, and Norton, L. J., Factors Affecting Success of Farm Loans. University of Illinois Agricultural Experiment Station Bulletin 468.

Low Incomes and Soil Exploitation

Available evidence indicates that exploitive land use and a lack of conservation are closely associated with low farm incomes. Low incomes often are the result of insufficient capital, but there are other causes, such as long periods of depressed prices for farm commodities, or a low level of resource productivity. It appears that low incomes, from whatever cause, intensify the erosion problem and work against the adoption of farming methods and systems which will reduce erosion and increase productivity.

Areas in which farm incomes are low usually present severe erosion hazards. In an analysis of the relationship between low incomes and erosion, the 99 counties in Iowa were grouped into three classes according to the seriousness of the erosion hazard in the county as a whole. These counties were then divided into four sub-classes on the basis of differences in income. Table 3 gives the number of counties falling into each erosion class within each of the four income categories. It is apparent that in Iowa a greater proportion of the counties at the lowest income level have a more severe erosion hazard than is true for the upper income levels.

The manner in which low incomes limit expenditures for conservation measures is illustrated by the relationship between gross income per farm and outlays for lime and fertilizer. An analysis of their use

Exploitive land use often is associated with low farm income. About four years before this picture was taken the field was plowed up and planted to corn with the rows running up and down the slope. Erosion started ditches that continued to enlarge until the land produces only a small amount of pasture. The effort to increase income practically destroyed the land as a productive resource.

indicates that the per acre outlay for these two items tends to be much lower on low income farms than on operating units where incomes are high. The investment in lime and fertilizer per acre of cropland harvested and land pastured by level of gross income is given for five states in Table 4. Because their application plays an important role in most conservation programs, evidence that lack of funds limits the purchase of lime and fertilizer is in itself important. But evidence of this nature is also useful in studying conservation problems because it suggests that lack of funds on low income farms may hamper other desirable outlays.

RISK AND UNCERTAINTY ENCOURAGE SOIL EXPLOITATION

The uncertain environment in which farmers must make decisions tends to discourage conservation farming. Returns from most conservation measures come at some time in the future. As a result there is a tendency to attach heavy discounts to them. Uncertainty arises for a variety of reasons. Some of the more important ones are price variations, livestock production risks, weather fluctuations, illness in the family, and unpredictable changes in governmental farm programs.

Variable Prices

The erratic behavior of farm prices in the past causes farmers to regard their future movement as highly uncertain. Farmers paying out

cash and perhaps sacrificing current production cannot be sure at what price the increase in future output will be marketed. Under the favorable cost-price relationships which have characterized farming in recent years, there has been a tendency for some farmers to persist in cropping patterns which maximize current production at the expense of future output. Even though they realize that total physical production would be increased in the long run by a shift toward greater conservation, the uncertainty as to the prices they can expect from the future increased output induces them to grow all they can so the products can be sold at current high prices. As pointed out previously, a shift in the direction of greater conservation frequently involves a temporary decrease in yields of crops. Some farmers take the attitude that they should maximize production now while they know prices are favorable and wait until prices drop to reduce the acreage of highest paying cash crops.

In a western Iowa study, 39 of 144 farmers stated that future commodity price expectations (as of the first half of 1950) deterred them from following erosion control systems of farming. Twenty-four of these 39 operators expected livestock prices to decline over the next five years. Four expected a general decline in prices of all farm commodities, but more often the operators believed that grain prices would remain steady because of price-support programs.[67] In December 1947, a group of southern Iowa farmers indicated that they expected agricultural prices to drop by an average of about 47 per cent by December, 1956.[68] Eagerness to take advantage of current high prices results in increased soil exploitation. This eagerness is especially intense among farmers who have a heavy debt load. Measures that can be used to maximize current income are likely to be emphasized under these conditions.

Livestock Risks

When farmers consider the problem of fitting greater numbers of forage consuming livestock into their production programs, they not only are interested in the effect of the adjustment on average returns over a period of years, but also in what happens to year to year variations in income. Some farmers are reluctant to adopt or expand enterprises that increase the chance of short term reductions in income even though the change promises an increase over a long period of years.

Cattle and lamb feeding, beef cow herds, breeding flocks of sheep, and dairying are the principal alternatives available for utilizing large quantities of forage. Net returns from livestock feeding are highly sensitive to price changes because of the importance of margin on the

[67]John C. Frey, "Some Obstacles to Soil Erosion Control in Western Iowa", Research bulletin in process of publication, Iowa State College, 1952.

[68]A. G. Ball, "Expectations in the Agricultural Firm", Unpublished manuscript Iowa State College, 1950, p. 68.

original weight of the animals purchased. A sharp rise in price can bring large profits; a drop can result in sizeable losses. There is a great deal of variation between feeding programs and the amount of risk involved, but, in general, cattle and lamb feeding are probably the most risky of all major livestock enterprises. Risk, therefore, limits feeding as a method of processing increased forage on farms where one severe financial loss might hamper farm operations for several years.

Unlike cattle or lamb feeding income, that from dairy production and to a lesser degree that from beef breeding is not subject to sharp fluctuations from year to year. The price of dairy products has been more stable over the past several decades than the price of any other major farm product. However, both beef and dairy herds require a high fixed investment which turns over slowly. In either case a number of years passes before the initial investment can be liquidated out of income from the enterprise. Returns which will not materialize until several years in the future may seem highly uncertain to a farmer who must make a cash outlay now. Thus "risk" can be an important deterrent to expanding beef breeding or dairy herds.

Risks arising from other sources may also be important in keeping farmers from changing to programs which involve growing and processing great quantities of forage. Keeping roughage consuming livestock in substantial numbers would be a new experience for a great number of farmers. Each type of livestock enterprise requires a separate kind of special skill. For instance, cattle feeders must learn how to buy and sell wisely. They must also know how to keep cattle from going "off feed" while the rate of gain is maintained at a high level. Dairymen must develop, among other things, skill in relating the feed to the most profitable level of production and in controlling disease. The inexperienced operator runs the risk of making costly mistakes while expanding these enterprises and acquiring the necessary "know-how" to conduct them profitably.

Variable Weather Conditions

Weather uncertainty is an important barrier to greater conservation, particularly in the Great Plains area where farmers who are familiar with extreme fluctuation in carrying capacities of pastures and yields of crops are reluctant to develop beef breeding herds, dairy herds, or flocks of sheep. Provision can be made to carry feed over for a year or two of adverse weather conditions, but these safeguards are costly and are not wholly adequate to meet the feed shortage that would result from several consecutive years of drouth. Forced liquidation of flocks and herds at times when feed is scarce can result in heavy financial losses. While farming systems built almost exclusively around the production of cash grain crops involve a high degree of risk, they do not

Seasonal variations in the corn crop. Above: This field, in a favorable year, yielded 59 bushels per acre at maturity. Below: Corresponding field in a year of severe drouth. Yield 0.0 bushels per acre.*

*Kiesselbach, T. A. Unpublished data. Nebraska Agricultural Experiment Station.

include the possibility of losing the large inputs of capital invested in a beef breeding herd or a dairy herd.

In order to maintain a high level of conservation in the more arid sections of the Great Plains it would be necessary to follow a system of farming that is physically adapted both to wet and dry periods. Actually this procedure would limit the choice to some kind of grazing economy. Climatic changes in this region are so severe and unpredictable that it is difficult, if not impossible, to develop cropping systems sufficiently flexible to permit intensive land use in favorable periods, and a reversion to less intensive use in years of adverse weather.

The fluctuation in climatic types at Jamestown, North Dakota illustrates the basic problem. According to Thornthwaite's classification, the normal climate at Jamestown is of the dry, sub-humid type. But during a 35-year period the climatic types occurring at this station included one year that was humid; 15 that were moist, sub-humid; 13 dry, sub-humid; five semi-arid; and one arid.[69]

The relationship between climatic variability in the Plains and farm income possibilities is illustrated by a comparison of expected net labor incomes from alternative wheat and livestock systems under varying yield and price conditions (Fig. 3). With high yields, wheat farming would provide the higher income under all three price assumptions, while livestock farming would be the more profitable under the assumed low-yield conditions.

Stands of grass cannot be obtained readily in the Great Plains regions, particularly in dry years. For this reason grasses are little used in crop rotations. It is easier to shift from a livestock system to grain farming than to adjust in the opposite direction. Because of this inflexibility, the tendency is for farmers to gravitate toward wheat farming in favorable years and to attempt to carry this system through adverse periods.

Maintenance of conserving livestock systems in areas of high climatic variability would require farmers to forego the opportunity of maximizing short-run profits from cash crops. This might be accomplished by suitable land-use regulations, adjustments in the size of operating units, or by making direct payments to farmers who maintain soil-conserving systems when exploitive farming would be more profitable.

Government Programs

In recent years government programs have come to occupy an increasingly important place in planning farm operations. Acreage control in particular has influenced the manner in which farms are organized. Not only are the actual provisions of these programs of importance in

[69]C. W. Thornthwaite, "Climate and Settlement in the Great Plains." U.S.D.A. Yearbook, 1941, p. 180.

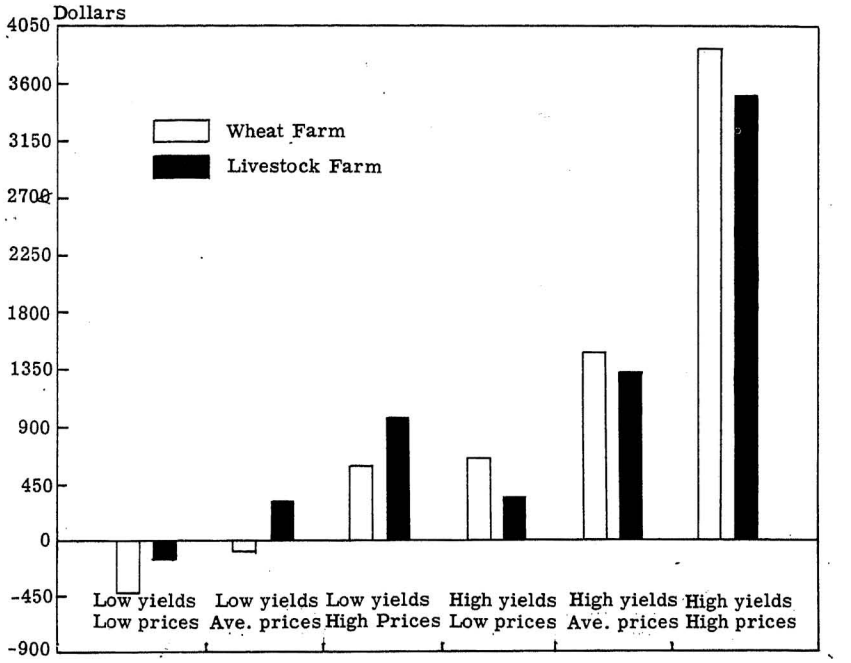

Fig. 3. Operators' labor income from wheat and livestock farms in north central South Dakota under different yield and price relationships. This situation shows actual average incomes on these farms from 1932 to 1939. Source: Nelson & Korzan, Should Farmers Emphasize Wheat or Livestock in North Central South Dakota? South Dakota Agr. Expt. Sta. Circ. 33, 1941, p. 41.

altering land use, but farmers' anticipations of what they might be in the future also have great significance. For instance, in recent years, some farmers have been reluctant to reduce the acreages of intertilled crops because they have been uncertain concerning the effect of this decrease on the historical base that would be used in setting up production controls.

Price support programs have no doubt reduced price variability due to market forces. But new uncertainties have been introduced in regard to commodities likely to be supported in the future, fluctuations in relative support levels between commodities and production restrictions that may be introduced.

DIFFERENCES BETWEEN MAXIMUM LONG-RUN INCOME TO THE INDIVIDUAL FARMER AND A SOCIALLY DESIRABLE LEVEL OF CONSERVATION

The preceding sections of this publication have dealt with a variety of factors that tend to discourage the adoption of conservation methods that could be made profitable to individual farmers. If these obstacles were removed, farmers would tend to make those decisions that would maximize their long-run incomes. Under these conditions they would find it profitable, as a rule, to conserve soil resources at a level acceptable to society. There are conservation measures, however, that are not likely to improve the welfare of a farmer in his lifetime. The period necessary to make needed conservation adjustments profitable extends beyond his economic horizon.

Situations of this kind are of three general types:

1. Soil and climatic conditions in which the socially desirable level of conservation requires a system of farming that is not the most profitable except over a very long period of time.
2. Situations where weather conditions are highly variable and the most profitable farming system for wet years differs materially from the most profitable in dry years.
3. Operating conditions in which the individual farmer is in a position to obtain benefits from exploitation while not having to bear all of the costs.

Conditions under which conservation does not pay except over a very long period of time are found in areas where the most profitable systems of farming result in soil deterioration at such a slow rate that farm operators tend not to take the decline in productivity into account in formulating income expectations. One of the problem situations in this category has to do with the exploitation of soil organic matter associated with crop production in dry-farming regions. In these areas, crop residues frequently are removed from the land to prevent tying up the nitrogen in the decay processes and no crop rotation is generally practicable that will maintain soil organic matter. Since rainfall is usually the factor that limits yields, the effects of this organic matter exploitation may become apparent only after the land has been farmed for many years.

Another problem in this category may arise in some grazing and pasture areas where a rate of stocking that involves some soil deterioration may maximize profits for a considerable period of time.

In situations such as these, some degree of soil exploitation is profitable over the time-span that enters into the calculations of most farmers. They usually do not take measures to prevent remote damages. Under

these circumstances, reaching a higher level of conservation requires the development of a feeling of responsibility for the welfare of future generations.

Situations where weather conditions are highly variable and the most profitable farming system swings from grain production, largely wheat or flax, in wet years to extensive grazing with cattle or sheep in dry periods can be found throughout the Great Plains region. Under these conditions changes from grain crops to hay and pasture cannot be made from year to year. A considerable part of the rain that falls comes in heavy downpours causing much damage from erosion. In dry years there is very little vegetation of any kind and wind erosion is a serious hazard, particularly on land that has been under cultivation. Adequate systems of conservation in these areas may require restrictions on land use.

Offsite Damage

In some areas, the principal damage from sheet erosion may appear to the casual observer to be siltation or sand deposits on bottom land; clogging of stream channels, drainage ditches, or irrigation canals; that is, reduction of the capacity of reservoirs rather than a decrease in soil productivity on upland. In practically all cases, however, a rate of erosion that leads to damaging silt deposits is harmful to the land from which the soil is removed. Even on some deep soils, there is evidence that removal of an inch of the top layer causes a decrease in crop yields. Productivity of the deeper soils, of course, can be restored more quickly after being eroded than can the shallow soils. When the gullying stage is reached on either, the damage usually is critical.

Wind erosion sometimes reults in off-site damage from soil accumulation that exceeds loss on the area from which the soil is removed.

While soil conservation usually is of primary benefit to the farm operator or owner, some water-retarding structures are of more primary benefit down stream. This is especially true of structures such as small dams and settling basins which are built to retard water or silt and thus are parts of flood control programs. When the cost involved in preventing damage down stream or on other land exceeds the long-run increase in returns that can be obtained on the farm where the improvements are needed, efforts should be made to share the expense equitably among the beneficiaries.

When a conservation procedure is sufficiently profitable to pay a farmer to adopt it, there appears to be no economic reason for subsidizing his investment. Reliable techniques are needed for separating the practices which are profitable for the individual farmer to adopt from those that are unprofitable to him yet are desirable in the public interest because of widepread benefits to society that clearly exceed costs. If

public funds are used to support conservation measures there should be insistence that the probable public benefits exceed the costs borne by the public. Otherwise, a considerable part of the money will be wasted.

RELATION OF CONSERVATION TO THE GENERAL PROBLEMS OF BETTER FARMING

In any well-developed farm management plan, terraces, grassed waterways, cropping systems that include sod forming grasses, and other practices required for a good system of soil conservation and improvement are integral parts of efficient farm organization. These improvements are not made for the sole purpose of saving soil, but to aid in building up or maintaining the productivity of the farm in order to increase or stabilize income and provide a higher level of living for the family. Erosion control, higher levels of production through crop rotations and the use of fertilizers, and the development of complementary livestock enterprises are a part of the individual farm plan. In Missouri the procedures used in achieving the goal of better farming for better living are incorporated in the Balanced Farming program.

It would be inaccurate to attribute the gains in volume of production and income resulting from the development of balanced farming plans to the adoption of conservation practices alone. The benefits grow out of increased efficiency in the use of land, labor, capital and management. In many ways, the problems of realizing higher levels of conservation are a part of the broader problems involved in increasing overall farming efficiency. Many of the measures which will improve efficiency will also promote more complete conservation. Imperfections in farm leasing systems, for instance, give rise to many undesirable farming practices of which soil exploitation is but one. To a large degree many of the same alterations in leasing systems that would encourage efficient livestock programs and proper care of buildings are the same changes that would promote greater conservation of soil resources. Similarly, revisions in credit institutions and practices which would facilitate the channeling of capital to the most productive uses should help to overcome the capital limitations obstacle as well as to promote greater efficiency in other phases of farming.

To the extent that low incomes and small farms constitute a barrier to conservation, the problem is associated with poor allocation of agricultural resources. Low income is a symptom rather than a cause. Efforts to improve the size and efficiency of farm businesses are being made by means of the tenant-purchase and rehabilitation programs, by the use of farm enlargement loans and through guidance in setting up well balanced farm businesses. As these programs improve the financial position of low income farmers, they will also aid in soil conservation. It is a

gross error to think of soil conservation as a list of erosion control and soil improvement practices that can be applied to land without giving first consideration to the welfare of the farm family. Most of the people who work with the soil conservation program realize this fact, but there is too much emphasis on the control of erosion for the purpose of saving soil. Profession of understanding of the inter-relationship between effective conservation and family welfare is more frequent than performance.

Mention has been made in a previous section of the effects of fluctuating prices and incomes on land use. Price and income instability have a two-sided effect. During periods of depressed returns, funds often are not available for conservation investments. On the other hand, when prices and incomes are favorable, the desire to take full advantage of the situation can in itself work in the direction of exploitive farm practices. Attempts to deal with price and income instability by means of price supports have not been entirely successful. Without doubt measures that have been closely related to adjustments in historical crop acreages have retarded land use adjustments. The influence of action programs of this kind upon desirable goals should be considered carefully before they are put into operation.

A more general adoption of conservation measures depends upon widespread acceptance of water control, tillage, fertilizing and cropping practices that are adapted to the use capabilities of the land. Acceptance will not be universal, however, until the size of operating units and the organization of farm businesses, where all desirable conservation measures are in use, are fitted to the specific needs and aptitudes of farm families.

Good pasture protects the soil from erosion, reduces the quantity of protein feed needed to produce hogs and helps to control parasites and diseases.