marginal cost analysis in figure 2 shows that continuous producers cannot significantly increase their annual returns by changing the average selling weight of the broilers.

Producers of broilers may take advantage of increasing prices to obtain a larger return on an individual lot, but a continuous producer who varies his pattern of production for this purpose could easily lose as much on succeeding lots during the year as he gains on an individual lot held to higher weights. With any change in original plans, both types of producers run into practical difficulties connected with the greater space needed for larger broilers.

Methods Used in Studying Obstacles to Soil Erosion Control

By John C. Frey and Buis T. Inman

Normative economics starts with a given objective of resource allocation. A prescribed use of resources that leads to the attainment of this objective might be called an "ideal" allocation. In research it serves as a standard for comparison. There exists at any given time an "actual" pattern of resource allocation, which may or may not be the same as the ideal. When it is not the same, ways are sought to make it conform in order to achieve the expressed objective. Difficulties in changing the actual pattern of resource use to make it conform to the ideal are often called obstacles. When these difficulties are economic they are also referred to as imperfections in administration of resources. In a true research sense they are problems within a broadly conceived problematic situation, and major concern rests with their removal. They must first be accurately identified, then ways must be found to help overcome or minimize them. By so doing, recommendations can be made which, if adopted, will lead to the stated objective of resource use. The purpose of this paper is to show how the normative analysis is followed in identifying obstacles to control of soil erosion in western Iowa and in providing alternative methods for overcoming them.

IN THE APPLIED SCIENCES a meaningful objective of resource allocation needs (1) to be identified with those who wish to attain it, and (2) to be quantified in either cardinal or ordinal terms. Although it is necessary to envisage the ultimate consequences of reaching an expressed objective, there must be a point of departure based on some immediate end-in-view. Otherwise, applied scientists would direct their attention to the ultimate objectives of life itself before treating existing problems of lower order. Moreover, if the objective of resource allocation is general and vague because of lack of measurement, observable problems will be general and vague. An explicit objective is necessary to identify an explicit problem.

To ascertain some of the obstacles to soil erosion control in western Iowa, a permissible annual rate of soil loss was selected as the objective.[1] Technicians of action agencies interested in soil conservation set this rate of loss at not more than 5 tons per acre per year. They believed that if soil losses were reduced to that rate the soil productivity would be maintained or improved and the formation of gullies controlled.

The objective was physical in nature and did not guarantee desirable economic consequences. An objective of soil erosion control that also met the tests of economic desirability would have been preferred to guide the investigation, but such a standard of perfection was

[1] A report of the first phase of this study is given in Iowa Agricultural Experiment Station Research Bulletin 391, SOME OBSTACLES TO SOIL EROSION CONTROL IN WESTERN IOWA, October 1952, by John C. Frey.

not available. It must await the results of empirical research. Implicitly, technicians expected desirable economic consequences to follow the achievement of this goal. In the meantime, conservation programs in the communities were not progressing so rapidly as the leadership thought was desirable.

Because this objective was both realistic and well quantified, it was accepted for the study. Technicians were hopeful that farmers would adopt the same norm of attainment, but they varied in their willingness to do this.

The Ideal System of Erosion Control

The relative effectiveness of different farming practices in reducing soil losses and the factors that influence their use would have to be known if an ideal system of soil erosion control were to be formulated. Because many different practices are effective and many of them can be used interchangeably, there is not just one ideal system. It must be recognized that use of specified erosion-control practices means that in many instances the entire organization of a farm must be changed.

Information on factors that affect the rate of soil loss in western Iowa and the relative effectiveness of different farming practices in reducing soil losses was obtained from agronomic investigations reported by G. M. Browning and others.[2] They associated seven factors with soil losses—(f_1) soil type, (f_2) length of slope, (f_3) percentage of slope, (f_4) rotations, (f_5) management (return of crop residues and use of fertilizers), (f_6) degree of past erosion, and (f_7) supplemental practices. The following formula was set up to estimate the average annual soil loss in tons per acre:

$$(f_1) \times (f_2) \times (f_3) \times (f_4) \times (f_5) \times (f_6) \times (f_7) \times (10) = \text{Average soil loss in tons per acre.}$$

A schedule of values for each factor had already been determined so that they could be substituted in the formula for any given field, and the rate of soil loss estimated. Also, given the soil type, length of slope, percentage of slope, and degree of past erosion, from a detailed soil survey, the rotations, management practices, and supplemental practices needed for a maximum soil loss of 5 tons per acre could be derived for any tract of land. Technicians used this procedure as a guide in drawing up farm plans.

The above formula was used in the obstacle study to learn the erosion-control practices necessary to meet the soil-loss objective on 144 randomly selected Iowa farms in the Ida and Monona soils area. The practices were portrayed as two plans for each farm, either of which would lead to a soil loss of 5 tons or less per acre. One plan was designed to reach this objective through practices that allowed a maximum acreage of corn. The other increased the acreage of meadow and pasture in the rotation, thus minimizing the need for terracing and contouring. Each plan included a list of the practices needed, a detailed soil map of the farm, an aerial photograph showing fields in which the practices were to be used, and an estimate of the number of acres in corn, small grain, meadow, and permanent pasture. Technicians adhered to the formula in designing the farm plans, but they visited each farm to verify the adaptability of the practices and to indicate on the aerial photograph where each practice should be used. The time and resources available limited the study to two plans for each farm.

Eight farming practices were considered in these plans — rotations, phosphate fertilizers, return of residues, terracing, contour-planting and cultivation, grass waterways, contour-fencing, and contour-listing. These were thought by technicians to be among the most important.

Generalizations for the entire study area were made possible after careful study of the two ideal systems of erosion control for each farm. For example, on 85 percent of the farms at least six different practices were needed to control erosion. Contour-planting and cultivation, grass waterways, and high-forage rotations were required on all farms, while phosphate fertilizers, terraces, and contour-fencing were needed on at least 90 percent of the farms. In order to control soil erosion, row crops

[2] See BROWNING, G. M., PARISH, C. L., and GLASS, J. A METHOD FOR DETERMINING THE USE AND LIMITATIONS OF ROTATIONS AND CONSERVATION PRACTICES IN THE CONTROL OF SOIL EROSION IN IOWA. Amer. Soc. Agron. Jour. 39:65-73. 1947. Also see Browning's Erosion Factors (Mimeo. Summary), Iowa State College, Dept. of Agronomy. 1948.

would make up only 15 to 22 percent of the total farmland, and meadow crops 37 to 43 percent.

The field data for the study were collected in 1950. The answers to questions relative to the opinions of farmers regarding practices and the extent of conservation farming reflect the conditions that existed at that time.

The Actual System of Erosion Control

To establish benchmarks for comparison, the different kinds of erosion-control practices that were in use, the type of land on which they were used, and the degree to which they were carried out according to recommended procedures, were ascertained for each sample farm. During an interview with each of the 144 farm operators, the practices in use were listed by fields on an aerial photograph of the farm. A planimeter was later used to measure the number of acres in each field so that the existing pattern of land use could be learned.

It was found that most farmers followed only one or two erosion-control practices. About half of the operators were contouring; fertilizers were used by 42 percent; a third had seeded grass waterways and were following high-forage rotations; and terracing was practiced by only 15 percent.

Farmers who were using the recommended practices did not always carry them out according to standards set by technicians. For example, some who said that they planted on the contour were not following true contour lines. Also, small earthen dams had been constructed in drainage channels instead of recommended grass waterways on 48 percent of the farms.

Lack of Conformity

Lack of conformity was rather apparent when the actual system of erosion control was compared with the ideal. The difference between the number of erosion-control practices recommended per farm and the number followed is shown in table 1.

Some erosion-control practices were used much more frequently than others. These were contouring, grass waterways, high-forage rotations, and the use of commercial fertilizers. Contour-fencing was recommended for a large

TABLE 1.—*Number of farms on which erosion-control practices were recommended and followed, by practices per farm, on 144 farms in the Ida-Monona Soil Association Area, 1949*

Practices per farm	Farms on which recommended	Farms on which followed
Number	*Number*	*Number*
0	0	26
1	0	42
2	0	36
3	0	22
4	4	9
5	17	9
6	99	0
7	24	0

proportion of the farms to facilitate contour-planting and cultivation. Only 4 percent of the operators had changed their field layouts for this purpose. Contour-listing, although generally recommended in western Iowa, was not proposed for many farms because of the two extreme types of plans used in the study. Three percent of the operators were practicing contour-listing. Attainment of the erosion-control objective under the ideal systems would require a reduction in acreages of row crops and small grains, a substantial increase in acreage of meadow crops, and a slight increase in permanent pasture.

Another method used to show a lack of conformity with the ideal set up by the technicians was to compare actual erosion losses on the sample farms with the original objective of 5 tons or less per acre. To do this, values for the different practices in use were substituted in the formula for estimating annual rates of loss. Actual erosion losses ranged from 0.2 ton to 68.5 tons per acre. The average annual loss for all farms in the study was 20.8 tons. Only 11 percent of the operators had reached the erosion-control objective as of the time visited (table 2).

Casual observations alone might have convinced an investigator that soil-erosion losses were "great" in western Iowa. Yet observations do not lend themselves to scientific inquiry unless they can be weighted and recorded in proper relation to other observations. The above type of analysis sheds light on such ques-

TABLE 2.—*Number and percentage distribution of farms, by rate of soil loss, 144 farms in the Ida-Monona Soil Association Area, 1949*

Soil loss per acre	Farms	
	Actual	Percentage distribution
Tons	*Number*	*Percent*
0– 5	16	11
6–10	25	18
11–15	20	14
16–20	20	14
21–25	14	10
26–30	14	10
31–35	5	3
36–40	13	9
41–45	7	5
46–50	5	3
51–55	2	1
56–60	2	1
61 or more	1	1
Total	144	100

tions as the following: Who desires more erosion control? What amount is desired? What means can be employed to bring it about? To what extent has it not been realized? If the above methods had not been established to answer these questions, the study would have been based entirely on vague assumptions. This framework permits the identification of obstacles to achievement of the goal in soil-erosion control.

Identifying the Obstacles

It is doubtful whether any one specialist could identify or classify all of the possible obstacles to soil-erosion control. It would require an understanding of many areas of knowledge. For instance, obstacles might fall into the realm of political science, psychology, or sociology, as well as economics. The possibilities are endless. Instead of trying to ascertain all of the obstacles in a given situation, an investigator might limit his inquiry to certain ones with which he is familiar and propose these as hypotheses to be studied. Attention can then be directed toward verifying empirically the obstacles in question and learning their relative importance. Such hypothetical obstacles in controlling soil erosion were set up in the western Iowa study. The following were proposed to explain the lack of conformity previously referred to:

(1) Changes required in the livestock system
(2) Type of rental arrangement and landlord's cooperation
(3) Number of acres operated
(4) Debt position and high operating costs
(5) Price expectations
(6) Inadequacy of machinery and power
(7) Field and road layouts
(8) Short expectancy of tenure
(9) Added risk and uncertainty
(10) Inadequacy of farm buildings
(11) Influence of custom and inertia
(12) Inadequacy of the labor supply
(13) Cooperation of neighboring farmers
(14) Ability to shift erosion losses
(15) Availability of credit

These possibilities were not entirely independent of one another in an economic sense. Neither were all conceivable obstacles included. The hypotheses used in the study served only as a first approximation of some possible causes of the difficulty.

The first step in verifying these possibilities was to find out whether farmers regarded them as obstacles. To do this, each of the 144 operators was shown the ideal erosion-control plans for his farm. During the ensuing interview the operator was asked whether each of the above possibilities had kept him from following the erosion-control practices set forth in the plans and if they would continue to thwart his efforts toward erosion control. Affirmative and negative responses were recorded as well as the operator's reasons for his position. The number and percentage of the 144 operators who confirmed each area of difficulty are shown in table 3. Each hypothetical obstacle was confirmed by some of the operators.

The operator's reasons for giving affirmative answers were summarized for each obstacle tested. For example, 59 percent of the operators who confirmed the livestock obstacle said that high livestock prices prevented them from increasing their livestock numbers; and 22 percent of the operators who confirmed the rental obstacle said that their landlords would object to the smaller quantity of corn that they would receive as rent if cropland were converted to meadow or pasture. In some cases the reasons reflected distinct biases and had little value as supporting evidence.

Additional evidence in support of some of the obstacles was obtained by comparing rates of

TABLE 3.—*Number and percentage of operators confirming each hypothetical obstacle on 144 farms in western Iowa, 1949*

Hypothetical obstacles	Operators confirming each obstacle	
	Actual	Percentage
	Number	*Percent*
Change required in the livestock system.	58	40
Type of rental arrangement and landlord's cooperation.	49	34
Number of acres operated	49	34
Debt position and high operating costs.	43	30
Price expectations	39	27
Inadequacy of machinery and power.	36	25
Field and road layouts	35	24
Short expectancy of tenure	33	23
Added risk and uncertainty	27	19
Inadequacy of farm buildings.	22	15
Influence of custom and inertia.	18	12
Inadequacy of the labor supply.	13	9
Cooperation of neighboring farmers.	11	8
Ability to shift erosion losses	10	7
Availability of credit	6	4

soil loss. When farm operators said that one of the proposed obstacles had kept them from following recommendations for control of erosion, it was expected that soil losses on their farms would be relatively greater than on those of operators who gave a negative response. Actual comparisons indicated that mean soil loss was significantly greater on farms of operators who confirmed one of the following: (1) Changes required in the livestock system, (2) type of rental arrangement and landlords' cooperation, (3) debt position and high operating costs, and (4) a short expectancy of tenure.

There was reason to believe that the opinions of the operators were valid for these obstacles as differences in rates of loss were too great to be attributed to chance. But with the high degree of interdependence, the 11 other areas of difficulty could not be disregarded entirely. It appeared that further refinement in classifying and interpreting the obstacles might prove that at least some of them were closely related to the four major obstacles.

Important combinations of two or more obstacles per farm were identified in the same way. Three of the combinations and the frequency of their occurrence are shown in table 4.

Additional exploration and analysis may reveal that the rate-of-soil-loss series can be predicted from one or more other continuous series of measurable values such as number of animal units, amount of mortgage indebtedness, acres in farm, age of operator, or expected length of tenure in years. In the first phase of the Iowa study, measures were not adequate to do this as a multiple regression analysis. Averages of some values on farms with and without the obstacles did suggest significant variations. Additional investigations in this direction might be worth while.

Objections to Individual Practices

In the preceding analysis the response of farmers had reference to a complete farm plan or system of erosion control. But action agencies can benefit by finding out which practices in the plans are most objectionable to farmers. In some instances alternative practices can be devised to accomplish the same results. To shed light on this question, the 144 operators were asked to indicate the practices that they would not be willing to follow. High-forage rotations

TABLE 4.—*Number and percentage of farms, by a combination of two or more obstacles per farm on 144 farms in western Iowa, 1949*

Obstacles	Sample farms	
	Actual	Percentage
	Number	*Percent*
Changes required in the livestock system and—		
Number of acres operated per farm.	27	19
Type of rental arrangement, and landlord's cooperation.	25	17
Type of rental arrangement, landlord's cooperation, and number of acres operated per farm.	14	8

appeared to be most objectionable, followed in descending order by terracing, contouring, contour fencing, commercial fertilizers, grass waterways, and contour listing.

Reasons why farmers did not want to follow the practices were recorded and classified. Some of the reasons did not agree with the findings of physical research. In other instances farmers pointed out undesirable consequences that technicians generally recognized but did not consider so important.

The study was not designed to measure the fund of information possessed by farmers relative to controlling soil erosion, but it did point out the need for additional research on this question. It would be of value to know whether lack of technical knowledge is a major reason for the failure of farmers to control erosion, or whether some of them are well informed and still decide against it.

Another Objective Discovered

In developing the study it was thought that farmers might have an objective of soil conservation that differed from the 5-ton maximum established by technicians. They might believe (1) that their present accomplishments are adequate, (2) that less erosion control is needed than they are now accomplishing, or (3) that more erosion control is needed than they are now accomplishing. If their objectives were known, research might be directed partly toward helping them to reach what they believe is needed until the obstacles previously mentioned could be overcome.

Information obtained in the western Iowa study made it possible to ascertain this objective in each case. In the field interviews, before presenting the erosion-control plans developed by technicians, operators were asked to list the practices that they believed should be followed on their farms. When values for these practices were substituted in the formula for estimating annual rates of soil loss, the reasons for the use of erosion-control measures by farmers were measured (fig. 1). In general, farm operators wanted to reduce their soil losses further. They gave such reasons as expectation of larger crop yields, prevention of gullies, conservation of moisture, and larger farm

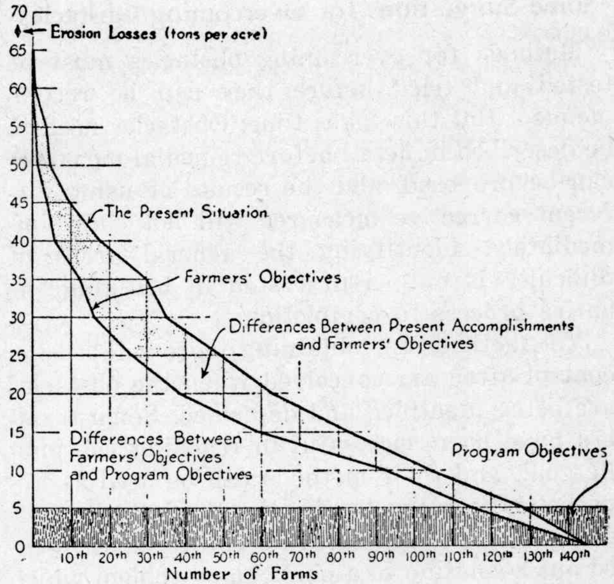

FIGURE 1.—Erosion loss on each of the 144 farms arrayed according to decreasing soil losses in tons per acre. Shown in terms of the present situation, farmers' objectives and program objectives. Ida-Monona Soil Association Area, 1949.

incomes. Only 12 percent of the operators did not envision benefits from more erosion control.

But the measures that the farm operators thought were necessary were still not sufficient to reduce soil losses to the level sought by the public agencies. It remains to be seen how static these individual objectives of erosion control are. An operator may well make a start with a few erosion-control measures and then, as he succeeds with these, recognize the additional work to be done. With a continuing process of setting up goals and making an effort to attain them, and then establishing new goals, the difference between the individual goals and the public goal could be reduced.

It appears that the task of helping farmers to overcome obstacles in achieving their own objectives of conservation would be much less difficult than the task of persuading them to go beyond to achieve the objective of public programs. Identification of the obstacles in achieving the objective of farmers should be of value to action agencies that must consider alternative ways of getting erosion-control measures adopted.

Some Suggestions for Overcoming Obstacles

Methods for overcoming obstacles must be tested and tried before they can be recommended. But this takes time. Obstacles need to be described in detail before remedial measures can be proposed, and the results of using different corrective measures will not show immediately. Identifying the general areas of difficulty is only a first step in bringing the entire process to completion.

Yet methods for obtaining more soil-erosion control often are conceived when the obstacles are being identified and described. Some farmers have been successful in reaching the public goal, and their methods can be used as hypothetical constructs of action for later investigations. If certain farm operators have worked out a solution to a particular problem which is hindering the adoption of erosion-control measures on other farms, is it possible to apply this solution to other cases?

In this study, suggestions of this nature were obtained from operators who did not have trouble with the obstacles. They told why their erosion-control accomplishments had not been retarded. Their reasons were analyzed, and from them corrective measures that might work on other farms were set forth. But a few methods were so nearly unique that general acceptance could not be expected.

Some of the changes successfully made by operators in their livestock systems were: (1) Custom-feeding livestock on pasture and pasturing cattle for others, so that losses from death, disease, or a decline in prices were shifted to cattle owners; (2) raising beef calves from breeding stock on pasture, with the alternatives of selling the calves or buying grain to feed them; (3) buying only young calves and carrying them on roughage feeds or grain-feeding them on pasture; and (4) utilizing roughages with dairy cattle, so that receipts from the dairy enterprise were forthcoming throughout the year.

Obstacles on tenant-operated farms had been overcome by (1) an adequate livestock-share lease, (2) landlords assuming most of the additional conservation costs, and (3) definite agreements whereby landlord and tenant shared the additional costs and returns.

On farms on which indebtedness and high fixed costs did not appear to be limiting factors, (1) farm-purchase loans generally had been amortized over a long period, (2) the erosion-control program had been developed over a period of years so that additional outlays were not large during any one year, and (3) financial assistance from the conservation program of the Production and Marketing Administration had defrayed part of the costs. Several tenant-operators had obtained financial assistance from their landlords under a livestock-share lease.

Tenant-operators who had a family relationship to their landlords appeared to be assured of longer tenure than average. In general, operators who owned their farms and expected an heir to take over were more interested in the future productivity of the land than were others who were not so situated. Several owners who expected to sell their farms believed that erosion control would lead to a higher selling price for the farm.

A Further Check Is Made

In an effort to discover more definitely the importance of some of the obstacle situations cited by the farm operators as reasons for not adopting cropping- and soil-management measures that would reduce soil losses, the same 144 farms visited in 1950 were revisited in the spring and summer of 1952. The four situations that were associated with the significantly greater soil losses in the first study were reexamined in greater detail. Had there been changes of any kind that affected (1) the livestock system, (2) the rental arrangement and the landlord's cooperation, (3) the debt position and operating costs, (4) the expectations of tenure, or (5) the size of the farm? Where changes had taken place since the previous survey that would tend to alleviate an existing obstacle situation, was there any evidence that a corresponding increase in the adoption of erosion-control measures had taken place? Conversely, where the situation had deteriorated, were erosion losses higher?

Preliminary analysis of the new data indicates that average soil losses have been reduced by 1.8 tons per acre annually during the 3 years. There was a tendency for farmers who had relatively low soil losses in 1949 to let their losses increase, whereas those with high losses brought about reductions. Answers to most of the above questions must await the completion of the analysis now underway.

A sample of 144 farms is relatively small. The number of changes in the various obstacle situations is likely to be too few to permit meaningful statistical testing. This is true, even though the turnover of farm operators and farm owners is comparatively great—42 changes in operators on the 144 farms during the 3 years, with a new operator each year on 2 farms and 3 different operators on each of 8 farms.

Offsetting the lack of meaningful statistical testing, however, is the information that the various case situations should yield, explaining why and how improvements in former obstacle situations have come about in individual instances, and in what way, if any, this has affected the rate of soil loss on the farm. Conversely, a study of those instances in which obstacle conditions have arisen or have become more aggravated should provide a clearer insight into the problem.

Both situations, it is hoped, will provide a test for the effectiveness of particular measures —methods of financing, the use of certain devices in leasing, changes in enterprises, modifications in Government programs, and so forth —in overcoming obstacles. The economist, who cannot manipulate groups or individuals to provide the tests and controls for the testing of his hypotheses, must learn to look for these situations when they occur.

In addition to reinterviewing the farm operators, the landlords were interviewed to complete the picture of factors that determine management decisions on rented farms.

Further study of some selected tenant-operated farms from the sample is underway. This proposes to provide information on how to overcome obstacles created by the rental arrangement—one of the four major obstacles. A budget analysis will be made of these farms and this will be compared with similar analyses of the operations on owner-operated farms where recommended practices are being followed, to learn whether the difficulties that are holding back the tenanted farms would probably be remedied under owner operation. If that is the case, an attempt will be made to discover what changes, satisfactory to both tenant and landlord, can be made in the rental arrangement to overcome this difficulty.

Although it is an advantage and a saving of research resources in a continuing line of research, such as is contemplated in the study underway, to utilize the fund of information that is being built up, it must be recognized that such a "laboratory" soon loses its representative character and becomes significantly biased. The research activity itself becomes an educational technique, and in a study in which lack of information may well be one of the difficulties, continued use of the same farm raises some real problems for the research worker.

A Critique

Development of a basic framework of analysis and empirical verification of a disparity between ideal and actual patterns of resource allocation are essential steps in the design of economic investigations that deal with applied issues. Yet some might believe that the normative framework of this study is not desirable because it is based almost entirely on physical measures. The goal is closely associated with the recommendations of action agencies and has not been tested. There is no assurance that a maximum annual soil loss of 5 tons per acre will bring about desirable economic consequences.

The weakness does not arise because the original framework starts with the objectives and recommendations of physical scientists, but because, in the progress of the study, these objectives and recommendations are not modified so that the ideal pattern of resource use is also economic. Although it appears logical to start with purely physical concepts if some relevant information on erosion control has already been ascertained, it is a serious error to accept unconditionally a maximum rate of soil loss as a final goal of land use. Every science is conditionally limited, but all knowledge is related. Once economic retardations have been ascertained, the objectives of the original framework need to be modified so that a new ideal and one that is economically desirable, is formulated. In this way obstacle studies help to make the transition from one specialized discipline of analysis to another in the continuum of knowledge.

Without completely making the transition to economic objectives, much attention is directed toward methods for overcoming obstacles. Obstacles may appear because an attempt is made to fit a complex system of human values into a simplified analytical framework. The framework needs to expand as the study progresses. Resolving the disparity consists not only in overcoming obstacles, but in reappraising objectives as the subject matter of more and more disciplines is brought to bear on the issue. Contrasting objectives of farmers and objectives of programs is a step in this direction, but the transition still needs to be made from physical concepts to those with social implications.

In the area of delimiting obstacles, certain limitations need to be recognized. One is that the obstacles are classified into such general categories that methods for overcoming them cannot be well designed until each area of difficulty is examined further and described in greater detail. It is difficult to trace down what lies beneath each generalized area of difficulty that actually prevents operators from taking action. Additional insight might be gained by continuing with more rigorous economic analysis of individual problem situations.

An additional limitation is that lack of conformity may be due to obstacles other than those considered in the study. In fact, some of the most influential obstacles to soil erosion control may lie outside the realm of the 15 hypotheses tested. Although this is not necessarily a weakness of the study, all of the disparity cannot be attributed to the obstacles thus far uncovered. It may be useful to isolate other areas of difficulty before much emphasis is placed on remedial measures.

The major obstacles to soil erosion control are only reasonably well founded in the study underway. Evidence for them is not complete. That any hypothetical area of difficulty is truly an obstacle depends on the logical weight of supporting propositions. These have not been exhausted in the study. More objective findings might still be offered to confirm the major retardations. For example, the comparison of average soil losses on farms whose operators confirmed the obstacles, as against those of operators who did not confirm them, does not measure the intensity of the various obstacles nor conclusively prove that they do exist. It only shows that operators who expressed a certain opinion probably were not bringing about as much erosion control as others in the study who held a different opinion. This is a significant finding but it does not bring the entire analysis to an end.

Opinions of farmers have value as supporting evidence, but such convictions are subject to change. In any event, they do not always indicate the course of future actions. As in many economic studies, the subject matter may soon be out of date. And, as previously mentioned, a continuing line of research with the same respondents has very definite limitations.

There is also the danger that the interviewer will suggest obstacles during the interview or that he will ask leading questions when only a few hypothetical possibilities are being tested. The interviewing techniques used in the study do indicate that an effort was made to avoid these dangers. At the beginning of an interview the farmer was asked to give affirmative and negative responses concerning the obstacles. At its close he was given an opportunity to indicate once again which of the 15 possible obstacles, if any, actually retarded his achievements in erosion control. This procedure does not give complete assurance of objectivity but it does provide for a desirable cross check on farmer responses.

Those who might look for well-established relationships between rates of soil erosion and different economic magnitudes will not find them in the results of this study, although the budget analysis on rental arrangements discloses some information of the sort. Somehow the obstacles have not been brought into the realm of traditional economic subject matter for treatment by economic analysis. It does seem probable that economic variables might be associated in some way with losses from soil erosion. If they are, a search for some of the forces that cause these economic quantities to change would add considerably to the analysis of obstacles and would provide the key for overcoming them. It is doubtful whether this study will actually satisfy its economic obligation until it reaches this stage of development. But in taking the first step in resolving a popular and controversial issue it does open up avenues for future research.

Pricing Milk to Farmers at Butter-Nonfat Dry Milk Plants

By Scott A. Walker

A new method of pricing milk to farmers at butter-nonfat milk plants that will reflect accurately and equitably the true net farm values of milk of various fat contents is urgently needed. On completion of a regional research study on the costs and efficiencies of 12 specialized butter-powder plants in the Pacific Northwest it became apparent to the author of this paper that such an accurate, equitable, and feasible producer pricing system could be devised.[1] The study was conducted in cooperation with the Bureau of Agricultural Economics and the Farm Credit Administration. This paper describes and analyzes the pricing plan that was developed from a detailed analysis of the physical and monetary input-output relationships in these plants. This plan is a simple and logical approach to the joint-cost problem that is so often a source of confusion in marketing studies. Essentially, it provides a formula for evaluating the differential in net farm value of milk, delivered to butter-powder plants, corresponding to differences in butterfat tests of milk. It does this in a way that gives a valid reflection of the differences in net returns from milk without involving allocations of overhead costs between the joint products. The paper is published with the approval of the Director of the Idaho Agricultural Experiment Station as Research Paper No. 368.

BUTTER WAS ONCE the principal product of the dairy industry and milk fat was the only constituent of milk that had appreciable market value. Milk plants, therefore, usually paid farmers for milk on the basis of the quantity of fat it contained. This method of paying for milk is still used by many butter-powder plants [2] in spite of the pricing inaccuracies and inequities that result from it.

A straight butterfat basis of pricing milk implies that the gross market value of the products made from milk, processing costs, and the net farm value of milk are directly proportional to the fat content. This implication is false because (1) the nonfat solids content of milk increases (and decreases) less than proportionately with an increase (decrease) in the fat content; (2) prices of butter and powder do not remain in a fixed relationship; and (3) processing costs are influenced by outputs of both butter and powder.

A specialized butter-powder plant produces two joint products. The proportions of these two products are fixed, for practical purposes, once the solids content of the milk received at the plant has been ascertained. The production theory applicable to such plants is essentially the same as for a single-product plant. This single joint-product relationship, however, presents no serious problems in the develop-

[1] WALKER, SCOTT A., PRESTON, HOMER J., NELSON, GLEN T. AN ECONOMIC ANALYSIS OF BUTTER-NONFAT DRY MILK PLANTS. Idaho Agr. Expt. Sta. Bull. 20, 1953. This bulletin reports results of research conducted under the Western Regional Dairy Marketing Project WM-1.

[2] A butter-powder plant produces butter and nonfat dry milk solids (dried skim milk in nontechnical language).