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Growing Broilers for Maximum Returns

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This article considers how producers of broilers may maximize returns above direct or cash costs. The author analyzes the effect of increased feed efficiency upon the weight to which it pays to feed broilers. His analysis indicates that the most profitable weight depends upon whether producers are interested in maximizing returns from an individual lot or from broilers raised continuously during the year. Broiler production is a conspicuous example of an industry that has adopted improved production techniques rapidly, to make possible a greatly expanded output at lower relative costs.

PRODUCTION OF BROILERS on a commercial scale is a relatively new industry in this country. Official estimates of commercial broiler production were first made by the United States Department of Agriculture for 1934. In the 18 years from 1934 to 1952 this industry increased its output from 34 million to 886 million broilers—from less than $20 million to nearly $800 million in value. This phenomenal growth was encouraged by favorable economic conditions, especially during postwar years. But the long-time expansion in broiler production as compared with other meats was due mainly to technological improvements that lowered real costs and improved the competitive position of broilers in relation to meats from other sources.

Changes in price relationships provide an approximate measure of the changing position of broilers with respect to costs of production. Average prices received by farmers for commercial broilers in relation to all meat animals were only half as high in 1950-52 as in 1935-39. Rapid adoption of technological improvements resulted in lower costs in terms of feed, labor, and other resources used to produce broilers, and made it profitable for farmers to expand broiler production with relatively lower prices.

The purpose of this paper is to indicate the extent to which these technological advances have improved the efficiency of broiler production and to suggest how broiler producers can take advantage of improvements in technology to maximize economic returns.

The improvement in efficiency that has taken place during the last 25 to 30 years may be measured by comparing the physical efficiency of feed at the beginning of this period with that found today. This can be done by comparing the input-output curves constructed from the data on consumption of feed and the corresponding gains in weight.

It is of great importance to producers of broilers to learn what effect the improvements in feed efficiency have had on the economics of broiler production. Is the level of feed efficiency an influential factor in determining the weight to which it pays to feed broilers? How is the most profitable weight affected by different price relationships for broilers and feed?

Finally, we may ask whether these changes and differences have the same effect on the efficiency of producers of commercial broilers who operate on a continuous basis as on that of producers who grow only one or two lots of broilers a year.

Feed-Production Relationship

In producing meat from broilers, as from other growing animals, the production function follows the principle of diminishing increment. The significance of this relationship is that the relative prices of feed and of broilers determine the point on the diminishing-returns curve to which it pays to feed.[1]

But, as is shown later, the weight to which it pays to feed broilers, is not the same under conditions of continuous production as it is when only an individual lot of broilers is considered.

Data showing input-output relationships for broilers at various weights are seldom available from commercial growers, and, in any case, they are limited to the first 10 to 12 weeks. It is necessary, therefore, to use experimental data although such data may not be identical with those which might be obtained on commercial broiler farms. One of the earliest experiments undertaken for the specific purpose of learning the input-output relationship in growing chickens was carried out by Jull and Titus at Beltsville in 1925.[2] This experiment was set up to test the application of the principle of diminishing increments as applied to growing chickens. A comparison of the results with those from a recent experiment may be used as a rough measure of the improvement in feed efficiency that has taken place in broiler production during the last 25 years.

The Jull-Titus experiment used 170 chicks that were hatched on April 24, 1925. The chicks were from a cross of Rhode Island Reds and Barred Plymouth Rocks. The data include weights of chicks and quantity of feed consumed at the end of each 2-week period up to 24 weeks of age. This information is available for cockerels and pullets separately. Total average consumption of feed was 10.4 pounds to bring the weight of the average broiler to 3.0 pounds. It took about 13½ weeks to reach this weight.

[1] Spillman, W. J., and Lang, E. The law of diminishing returns. 178 pp. illus. Chicago, World Book Co. 1924.

[2] Jull, Morley A., and Titus, Harry W. Growth of chickens in relation to feed consumption. Jour. Agr. Research. 36(6): 541-550. March 15, 1928.

A comparison may be made with a recent experiment conducted by Card and Scott at the University of Illinois.[3] Card and Scott used 50 chicks of each sex from a cross of New Hampshires and Barred Plymouth Rocks. The chicks were hatched December 17, 1951. The experiment was set up to obtain data concerning weekly gains and feed consumption beyond the age at which commercial broilers usually are marketed. Data covering weekly gains and feed consumption were kept separately for cockerels and pullets. The records were discontinued at 15 weeks for pullets and 18 weeks for cockerels. The average feed consumption to a weight of 3 pounds was 8 pounds of feed, 23 percent less than was used in 1925. Moreover, this weight was reached more than 3 weeks earlier. The rapid growth obtained in the Illinois experiment is not exceptional. It is about the same as that of broilers entered in the 1951 Chicken-of-Tomorrow Contest.[4] The average feed consumption of some 16,000 broilers in that contest was 8 pounds of feed to a weight of 3 pounds at an age of 10 weeks.

The main reason for increased efficiency of feed apparently lies in the rapid growth of the broilers. The cost of body maintenance of chickens is relatively high. Large savings in the quantity of feed used for maintenance are made possible by reducing the length of time a chick needs to reach a weight of 3 pounds.

A comparison of the input-output relationship in 1925 with that found in 1952 is shown in figure 1. The 1952 curve is steeper than the 1925 curve as a result of the reduction in the quantity of feed needed for each unit of gain. The curves for both 1952 and 1925 represent an efficiency of feed above the level reached by the average grower of broilers during the respective years. The difference between the two curves may be taken as a conservative measure of the improvement in the efficiency of feed that has taken place during this period as a result of improved breeding and advances in poultry nu-

[3] Card, L. E., and Scott, H. M. Maximizing returns in broiler growing. Paper presented at the 41st annual meeting of the Poultry Science Association, Storrs, Conn., August 12-15, 1952.

[4] Shrader, H. L. The chicken-of-tomorrow program. Its influence on "meat-type" poultry production. Poultry Science, vol. 31, No. 1, January 1952.

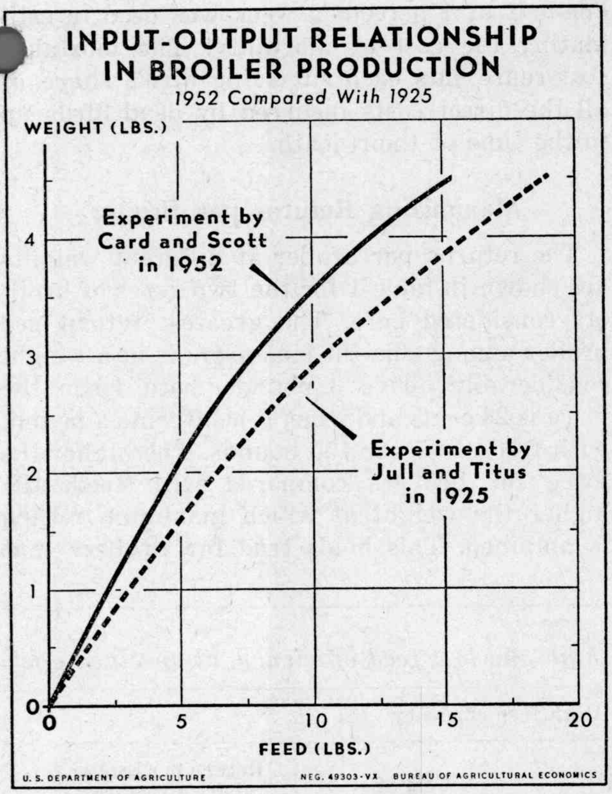

FIGURE 1.

ition. Commercial production of broilers was only beginning in 1925. Probably more growers of broilers lagged behind the experimental results in 1925 than in 1952. The effect of improved breeding on flocks in 1950 is indicated by H. L. Shrader in a recent article, from which we quote:

"There has been widespread use of the improved Chicken-of-Tomorrow breeding stock. A survey of the Chicken-of-Tomorrow contestants brought out that at least 67 percent of the commercial broiler chickens grown in 1950 carried these improved blood lines. This means that at least 400 million of the 616 million commercial broilers raised in 1950 carried some of these improved qualities. The average broiler will continue to improve as fast as the breeders can establish more multiplication flocks and complete further refinements in their blood lines."[5]

If the actual conditions that existed in 1925 and in 1952 with respect to use of feed by growers of broilers were fully known they might well show a greater improvement in the efficiency of feed for the average producer than the 23 percent shown for a 3-pound broiler in the experiments. A recent report from Virginia shows, for example, that during 1947-52 the quantity of feed used declined 23 percent and the time needed to produce broilers decreased 20 percent.[6]

Effect of Technological Improvements on Production Costs

Cost of feed represents the largest single expense in the production of broilers. Feed accounts for half to two-thirds of total costs, depending upon the level of feed efficiency and other factors. A reduction of 23 percent or more in the average quantity of feed needed to produce a 3-pound broiler is therefore of great importance so far as the competitive position of the broiler industry is concerned.

To examine what effect this improvement has had on the economics of broiler production, data from the experiments in 1925 and 1952 may be used to represent the range between an inefficient producer and a very efficient producer. The two curves in figure 1 represent the two extreme possibilities. Most producers lie somewhere between these two extremes. The average feed used for a 3-pound broiler in well-managed flocks was reported by McAllister and Bausman to be down to 9.3 pounds in 1948-49.[7] Since then the efficiency of such flocks has undoubtedly improved..

In addition to the cost of feed a producer of broilers has certain other cash expenses that must be covered before he obtains any return for his labor and fixed investment. These include the outlays for chicks, fuel, and medicine. Such costs as those of buildings, equipment, interest, and taxes must be covered over a longer period. Many costs are fixed—they go on even if no broilers are produced, once the investment has been made. Moreover, costs vary greatly among producers depending upon the type and quality of buildings and equipment used.

If broilers are produced with the use of family labor, that too takes on the nature of a fixed cost. In the Delaware study cited above, family labor accounted for 63 percent of all

[5] Ibid.

[6] KRUEGER, R. J. FIVE YEARS OF PROGRESS IN OUR VIRGINIA BROILER INDUSTRY. Va. Polytech. Inst., Dept. Agr. Econ. and Rural Sociol. Virginia Farm Economics No. 134, May 1953.

[7] MCALLISTER, W. T., and BAUSMAN, R. O. INFLUENCE OF MANAGEMENT PRACTICES ON COST OF PRODUCING BROILERS IN DELAWARE. Del. Agr. Expt. Sta. Bul. 282, January 1950.

labor used in producing broilers.[8] Even in the case of big producers who hired labor, this cost may be considered as fixed, as such labor is usually hired on a continuing or annual basis. Big producers look to the total returns for the year, for it is from these that they must pay the cost of labor before they are able to ascertain the returns on their investments.

To avoid becoming involved in the many variations in expenses incurred for labor and fixed costs among producers of broilers, the data in table 1 are set up to show returns to the operator after out-of-pocket or direct expenses such as feed, chicks, fuel, and medicine are deducted. For the purpose of presenting comparable estimates at different weights, a mortality rate of one-half of 1 percent a week was used in estimating the cost of mortality. The mortality cost represents each surviving bird's share of all the direct costs incurred by dead birds up to the time of their death.

[8] Ibid.

Maximizing Returns per Broiler

The returns per broiler at different weights are shown in table 1 for the two types of broilers considered here. The greatest return per broiler among efficient feed users is at a weight considerably above 3 pounds, both when the price is 25 cents and when it is 30 cents a pound, with feed at $5 per 100 pounds. The higher the price for broilers compared with feed, the higher the weight at which maximum return is obtained. This holds true for broilers that

TABLE 1.—*Weight cost and return per broiler, with high and low feed efficiency, at specified ages.*

Estimated age	Weight	Feed used		Cost of chicks, fuel, mortality, and medicine [2]	Return per broiler, above direct cost, when price per pound is —[3]	
		Quantity	Cost [1]		25 cents	30 cents
Days	*Pounds*	*Pounds*	*Cents*	*Cents*	*Cents*	*Cents*
	High feed efficiency					
58	2.25	5.3	26.5	21.3	8.4	19.7
62	2.50	6.2	31.0	21.6	9.9	22.4
66	2.75	7.1	35.5	21.7	11.6	25.3
71	3.00	8.0	40.0	21.9	13.1	28.1
75	3.25	8.8	44.0	22.0	15.3	31.5
80	3.50	9.8	49.0	22.3	*16.2*	33.7
85	3.75	11.0	55.0	22.7	16.1	34.8
90	4.00	12.3	61.5	22.9	15.6	35.6
96	4.25	13.7	68.5	23.3	14.5	*35.7*
101	4.50	15.4	77.0	23.8	11.7	34.2
	Low feed efficiency					
80	2.25	7.2	36.0	21.9	— 1.7	9.6
87	2.50	8.2	41.0	22.2	— .7	11.8
93	2.75	9.3	46.5	22.5	— .3	13.5
97	3.00	10.4	52.0	22.8	+ *.2*	15.2
101	3.25	11.8	59.0	23.1	— .8	15.4
108	3.50	13.0	65.0	23.5	— 1.0	16.5
115	3.75	14.3	71.5	24.0	— 1.8	*17.0*
122	4.00	15.8	79.0	24.4	— 3.4	16.6
127	4.25	17.3	86.5	24.8	— 5.1	16.2
132	4.50	19.0	95.0	25.3	— 7.8	14.7

[1] Cost of feed $5.00 per 100 pounds.
[2] Mortality estimated at one-half of 1 percent a week with cost of fuel, medicine, and chicks estimated at 20 cents per chick.
[3] Direct costs include feed, chicks, mortality, fuel, and medicine but not labor and fixed costs such as buildings, equipment, interest, taxes, and insurance. Cost of litter is estimated to offset value of manure.

convert feed into meat less efficiently. But for the less efficient users of feed it would not pay to continue to produce broilers with a broiler-feed ratio of 5:1 because 0.2 cents per broiler would not be a large enough return even if family labor were used. At a price ratio of 6:1 the returns above direct costs would amount to 15.2 cents per broiler at a weight of 3 pounds, and the largest return of 17 cents per broiler would be obtained at a weight of 3.75 pounds.

The assumed price relationships of 5:1 and 6:1 were chosen for this illustration because the annual broiler-feed ratio has been within this range for the last 4 years in the Delmarva area. The weekly ratio has varied erratically during each year, but it has fallen within these limits 56 percent of the weeks during these 4 years, with about as many weeks above as below.

If the broilers belong to a good meat-producing strain with high feed efficiency, the table shows that it would pay a grower of broilers using $5 feed to feed them to 3.5 pounds when the price of chickens was 25 cents a pound. It would pay to feed them to 4 or 4.25 pounds if the price was 30 cents a pound. After a weight of 3.25 pounds is reached the rate of increase in returns decreases with each additional quarter pound gain in weight. The increase per broiler is greater from 3.25 to 3.5 pounds than from 3.5 to 4.25 pounds. But in general, the higher the price of broilers compared with feed, the higher the weight of the broiler before the cost per unit of gain equals the value of the gain. This is illustrated in figure 2. Although most producers of broilers are probably not quite so efficient as the more efficient producer in this example, it seems clear from these data that it would pay them to feed broilers to more than 3 pounds under the assumed prices.

Among the inefficient broilers shown in the table the highest return with a broiler-feed price ratio of 6:1 was at a weight of 3.75 pounds. It would almost certainly pay producers whose flocks have a higher feed efficiency to feed broilers to a weight considerably above 3 pounds, that is, if they are concerned only with maximizing returns from individual lots. But this is not the case for commercial producers who operate on a continuous basis.

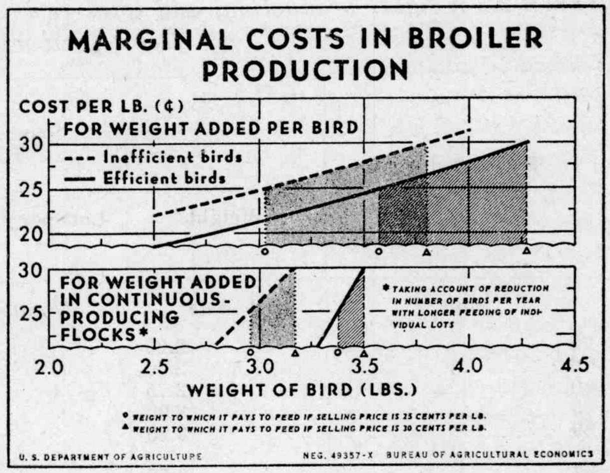

FIGURE 2.

Maximizing Annual Returns

Producers of commercial broilers with continuous production must consider another factor. If a continuous producer of broilers should keep his birds to a weight of more than 3 to 3.5 pounds (depending on efficiency), he would be likely to lose more in annual returns because of a reduction in the number of lots he could produce during a year, than he would gain by keeping the broilers to a higher weight. Highest net returns for the whole year is the goal for any producer. This goal is attainable when broilers are kept to higher weights in the case of producers who limit themselves to 2 or 3 lots a year.

Continuous producers, who allow only about 2 weeks between lots to get broiler houses cleaned and ready for the next lots, must, however, consider the possible reduction in annual returns they will incur by reducing the number of lots when they feed the broilers to higher weights. By adapting the data in table 1 to continuous production we may ascertain the age and weight at which returns are likely to be greatest for the year. This is done by adding 2 weeks to the age of broilers at each given weight, determining from this how many lots it is possible to produce a year, and computing the returns above out-of-pocket or direct cost on an annual basis.

The estimates that are shown in table 2 are based on an operating unit producing 12,000 broilers a lot. Annual returns above direct cash expenses were computed for the number

TABLE 2.—*Weight, production, and total return above direct cost of broilers, with high and low feed efficiency, at specified ages*

Estimated age plus 2 weeks	Weight	Lots per year [1]	Broilers produced annually [2]	Annual return, above direct cost, when price per pound of broilers is —[3] 25 cents	30 cents
Days	*Pounds*	*Number*	*Number*	*Dollars*	*Dollars*
High feed efficiency					
72	2.25	5.1	61,200	5,141	12,056
76	2.50	4.8	57,600	5,702	12,902
80	2.75	4.6	55,200	6,403	13,966
85	3.00	4.3	51,600	6,760	14,500
89	3.25	4.1	49,200	7,528	15,498
94	3.50	3.9	46,800	*7,582*	*15,772*
99	3.75	3.7	44,400	7,148	15,451
104	4.00	3.5	42,000	6,552	14,952
110	4.25	3.3	39,600	5,742	14,137
Low feed efficiency					
94	2.25	3.9	46,800	−796	4,493
101	2.50	3.6	43,200	−302	5,098
107	2.75	3.4	40,800	−122	5,508
111	3.00	3.3	39,600	+*79*	*6,019*
115	3.25	3.2	38,400	−307	5,914
122	3.50	3.0	36,000	−360	5,940
129	3.75	2.8	33,600	−605	5,712
136	4.00	2.7	32,400	−1,102	5,378
141	4.25	2.6	31,200	−1,591	5,054

[1] Estimated number of lots of 12,000 broilers each that could be produced per year allowing 2 weeks betwe lots for cleaning and disinfecting broiler house and equipment.

[2] The number of broilers started for each weight would be as much higher as the mortality at that particular age required. For example, in the high feed efficiency group at a weight of 3.0 pounds it would be necessary to start (51,600 x 105) 54,180 in order to sell 51,600 broilers.

[3] Direct costs include feed, chicks, mortality, fuel, and medicine but not labor and fixed costs such as buildings, equipment, interest, taxes, and insurance. Cost of litter is estimated to offset value of manure.

of broilers that could be produced at each weight.

Estimates were made on the basis of broiler prices of 25 and 30 cents a pound. In both, feed was assumed to cost $5 per 100 pounds. This corresponds to a broiler-feed price ratio of 5:1 and 6:1, which may be accepted to represent reasonably well the range in the current normal annual relationship between broiler and feed prices.

The table shows that, within the price assumptions used, broiler producers who operate continuously by starting a new lot of broilers within 2 weeks after the sale of the preceding lot obtain their largest annual return by selling the broilers at a weight somewhere between 3.0 and 3.5 pounds, depending upon feed efficiency. This result helps to explain why, in areas in which producers operate continuously, most broilers are sold at an average weight slightly above 3 pounds.

Producers who are interested in maximizing annual net returns to management and fixed resources must pay attention to the number of broilers produced as well as to returns per bird. Total net returns, of course, are determined by number of birds and net return per bird. In table 2 net returns obtained per bird produced are not maximized at weights between 3.0 and 3.5 pounds. But by selling broilers at these weights it is possible to produce more in a year and thereby to realize larger annual net returns. It should be evident, therefore, that the weight to which it is most profitable for producers to grow broilers does not depend solely upon the broiler-feed price ratio.

The marginal cost analysis, shown in the upper part of figure 2, indicates the weight to which it pays to feed broilers if maximum returns per bird is the objective. Broilers that are efficient feed converters reach a considerably higher weight than those that are inefficient, before the cost of the last pound of gain equals the price received. In the lower part of the chart (fig. 2) the marginal cost analysis is applied to continuous production of broilers. This lower segment brings out two important considerations: (1) The weight at which the average marginal cost equals the price received is lower for both types of broilers than in the segment above; (2) the marginal cost increases so sharply that the most profitable selling weight of the broilers would be increased so slightly by an increase in the price of broilers that a producer in practice could not take advantage of the change.

Many producers who grow from 1 to 3 lots a year sell their broilers at a weight of about 3 pounds, although the data presented in table 1 show that a higher return per broiler could be obtained by keeping them to a higher weight. For producers who grow only a few lots a year the length of time in itself is less significant as the broilerhouse stands empty part of the year anyway. However, with many of these farmers broiler production is a supplementary enterprise fitted into their regular farm operation and available labor supply. It may be that selling the broilers at about 3 pounds brings these farmers their largest annual returns because this is the highest profit combination for their farms.

To explain why farmers who produce less than 3 lots of broilers a year do not feed them to heavier weights, more information is needed. The supplementary nature of the broiler enterprise partly explains it, but more needs to be known about how broiler growing fits into the whole farm organization. For example, we need to know whether farmers who produce 1 to 3 lots of broilers a year follow a definite pattern each year in order to utilize available labor. It would also be useful to know whether the quantity of home-produced grain in the broiler ration used by these growers is greater than that in the ration used by other producers.

Variation in the weights at which broilers are sold in different parts of the country is apparently caused by local preferences. In New England a premium is paid for heavy broilers, which accounts for the high average weight of broilers marketed in this region, as compared with the much lower average weight of broilers in such States as Texas and Georgia. These differences in the market must be taken into consideration by producers when planning their production of broilers and deciding when to sell. An important factor in carrying broilers to higher weights is the risk resulting from a greater than average increase in cost of mortality as the broilers become larger and more valuable. Many producers may prefer to sell as soon as a market is available rather than incur additional risk that would reduce or might even wipe out their profits.

Conclusions

Data presented in this paper show that two different types of broiler producers may maximize returns above out-of-pocket costs in different ways.

A broiler producer who each year grows fewer lots than he can handle on a continuous basis would probably maximize his returns if he fed his broilers to a higher weight than the 3 pounds, which now is the national average. Efficient feed converters can be economically fed to higher weights than inefficient ones. From an economic standpoint, the weight to which both efficient and inefficient broilers can be fed varies directly with the relatively favorable or unfavorable character of the broiler-feed price ratio.

Broiler producers who operate continuously obtain their greatest annual return by producing somewhere between 3.3 and 4.1 lots a year, depending upon the feed efficiency of the birds. These producers sell broilers at an average weight of 3.0 to 3.5 pounds, most of them probably at an average close to 3.25 pounds, slightly higher than the average weight at which broilers usually are sold. It suggests that most commercial producers are feeding to a weight which gives them the greatest annual returns. The 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.