Cost of Production in Agriculture

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SUMMARY

An understanding of the meaning and implications of "cost of production" is essential to anyone who would form an intelligent opinion on several present day proposals for agricultural reform.

Interest in farm cost has been expressed by various groups in the United States for about 40 years. The source of demand for "cost of production" prices depends on the direction of current price movements. When prices were rising consumers have demanded that prices of foods and other necessities of life be kept down to the costs of producing them. When prices were falling groups of farmers often demanded that prices be kept up to the level of costs.

Studies of farm costs were undertaken after the war in a large number of states, including Iowa, when it was thought the government might continue to fix prices in some arbitrary manner. Results of these studies were disappointing to the people who made them. When prices rose in 1922 and following years, farmers lost interest since "cost of production" prices would have caused them losses under these circumstances.

There are three principal methods of obtaining data needed in efforts to determine production costs. These are by estimation, by surveys and by actual records kept on farms. Only the latter has any serious claim to validity. Even this method has certain drawbacks; since the men who are interested in keeping the necessary records are likely to be better than average farmers.

The basic elements of cost are wages on labor, interest on capital used, rent on land and the earnings of management. In placing valuations on these factors, on the ordinary farm, it has not been possible to solve some difficulties. Much of the labor is usually done by the farmer himself or by members of his family. Part or all of the capital may be owned by him. Much of it may represent previous investments which would not be repeated in their present form and which cannot be liquidated. No certain valuations can be placed on these factors of production contributed by the farmer. Rent on land is determined by prices of farm produce, not the value of produce by the rate of rent. Therefore, rent cannot be used as an element in the determination of necessary price. The fourth element, returns on management, varies from farmer to farmer with ability in planning and operating the business.

Even if valuations on the factors of production were agreed upon, there would still be serious difficulties in the way of apportioning them to individual products—unless the farm produced a single marketable crop. The farm is operated and should be treated as a unit. Many expenses apply in indivisible pro-
portions to two or more products, as wool and mutton in the production of sheep, or grain and straw, or cotton and cottonseed.

So-called cost figures obtained under these conditions are without significance as far as necessary price is concerned. The results depend too much on arbitrary methods and change with the method used.

"Cost of production" figures are discredited as a basis for price fixing and for tariff determination. They have been used in various public hearings but figures which are more easily understandable and not open to challenge would ordinarily be preferable as well as more pertinent.

When constructed with some care, figures of this same nature are, however, usable as indicators of efficiency in particular enterprises as between farms. Such use should be limited to groups of farms operating under essentially similar conditions and in the same year. In fact, they are seldom used in this manner because of the expense involved in their collection.

The "cost of production" indexes are found to have certain well defined statistical characteristics. They tend to vary in a proportional rather than an absolute manner between farms; suggesting that the further efficiency in production is increased, the more difficult it becomes to increase it further. Also a farm with high cost indexes in one year tends to be found in this same relative position the next year.

The common assumption that "price must equal cost" should be examined carefully before an effort is made to base any practical program on it. In strict logic, such a relationship would be necessary only in case of a long continued static economic condition. Price would tend to equal cost if methods of production, price levels, volume of demand and of production remained unchanged for a protracted period. Over a short period of time in a dynamic world, there is no necessary relationship between cost and price.

Different costs have different significance. Producers will continue to operate their farms or factories without getting back all of their investments in long lived improvements, provided the price is sufficient to cover operating expenses plus something on fixed charges. The wide-awake business man operates his plant with more of an eye to future opportunities than to past investments.

The alert farmer will find his interest served better by careful budgeting or planning for the future than by any reckoning of his past costs. This method of budgeting or planning is practically usable and represents the process of thought which is followed by business-like farmers. It has the advantage of being applicable to the farm as a whole and shows each enterprise in its proper relationship to the rest of the business.
Cost of Production in Agriculture*

BY JOHN A. HOPKINS AND PAUL A. TAYLOR

The purpose of this bulletin is to explain the significance and implications of cost of production as it affects agriculture and to review the history of cost studies. A correct understanding of the nature of costs and of their relationship to value of products provides a foundation for certain types of practical economic programs. At the same time it makes clear the defects of certain other types of programs.

The problem of improving the economic status of the farm population is extremely complex. Farmers are certainly entitled to as high a standard of living as any other group. They should not permit themselves to be turned aside from this objective. But they should be careful that they do not adopt programs which would yield them something less.

What is the meaning of "cost of production?" Does this term represent a figure that can really be discovered for the individual farm, and does it have a significant variation between farms? Has any attempt been made to discover or compute "cost" for the principal farm products? In what relationship does "cost of production" stand to the prices of farm products? Would prices equal to "cost of production" provide the farmer with a satisfactory income both during periods of rising and falling price levels?

What the producer is interested in primarily is not price per unit but rather income for the year. Further it is not a matter of gross but of net income. The relationships between price of product and net income are quite complex. So we shall need to be careful, in the discussion, that we do not make some misstep in our logic and arrive at a false conclusion. An illustration may make the nature of the problem clearer.

In 1929 the price of hogs was about $9.00 and corn about 70 cents. By the end of 1932 hogs had dropped to around $3.00 and corn to 12 to 15 cents during the marketing season. This represents a decline of about 65 percent for hogs and 80 percent for corn. How did farm income fare in the same period? Records kept on over 700 farms in 1929 and on 570 farms in 1932 showed that gross income declined from an average of $6,900 to $2,849. This decline amounts to about $4,000 and is about 60 percent of 1929 gross income. However, it gives but little indication of the decline of the net income, which these farmers received for their work and the use of their resources. Net income on the same farms declined from an average of $2,796 to a net loss of $648 which cannot be compared directly with any percentage loss in price or gross income. In number of dollars the

* Project 383 of the Iowa Agricultural Experiment Station.
decline in net income amounted to $3,444. A still greater de-
cline was not experienced because expenses were reduced from
an average of $4,100 to $3,500 in the same period.

Also it should be noticed that net income was affected by
changes in the value of salable crops and livestock carried from
one year into the next. In 1929 the value of such inventories
increased by an average of $245. In 1932 they decreased by
$741 and in 1933 rose by $1,091. If these be omitted, the net
income figures become $2,555 in 1929 and $93 in 1932.

By the end of 1933 corn had risen to about 40 cents while
hogs were also considerably higher, at least in the middle of
the year. Consequently gross income on the farms studied rose
from an average of $2,849 to $4,101, while net income rose from
a loss of $648 to a gain of $1,771—from $93 to $680 if changes
in inventory be omitted. In this period the rise in gross income
was not accompanied by corresponding changes in expense, and
net income received the greater part of the benefit.

Probably enough has been said already to indicate that the
problem of farm earnings is a complex one. Still, one addi-
tional point should be made. The economic well-being of the
farmer is not directly represented by his net income when that
is expressed in dollars. How much this income will buy de-

dpends on the prices of things bought. Had the farmer received
the same net income in 1932 as in 1929 he would have been
much better off in 1932 because the prices of things farmers
buy had fallen 30 percent. Also if a farmer made the same net
income in the last half of 1933 as in the same months of 1932 he
would have been worse off in 1933 because, in the meantime,
prices of things farmers buy had risen 13 percent.

Evidently we will have to examine the implications both of
income and of cost before we are able to arrive at a sound con-
clusion regarding the relationship of farm costs to farmers’
well-being. We shall start by reviewing the history of farm
cost studies in the United States and particularly in Iowa.

HISTORICAL SKETCH OF COST OF
PRODUCTION STUDIES

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Studies of cost per unit of farm products have passed through
several fairly distinct stages. During the depression of the
early 1890’s a number of estimates of costs were made to de-
 monstrate that farm prices were too low and that something
should be done about them.

Following the recovery of prices in the late ’90’s, public in-
terest in “costs” flagged for awhile, but in the meantime the
subject was taken up by the Department of Agriculture. For
a number of years prior to the Spanish-American War the De-
partment of Agriculture carried on a campaign to make the
United States independent of other areas in sugar production.
Estimates of costs were used to convince farmers that sugar could be produced at a profit in this country. The same use of "cost" estimates was made by various experiment stations in encouraging the use of new crops and new methods of production. The figures used were arrived at by estimates rather than by any records kept under actual farm conditions.

In 1902 a study of farm costs on a group of farms was begun under the supervision of the University of Minnesota. Detailed records were kept and these were supervised by a field man who visited the farms. The method was not widely adopted until after the European war. A compromise in the form of the farm "survey," however, found wider use at Cornell and elsewhere.

By 1907 or 1908, the rising prices of farm products began to alarm urban dwellers. This led to a new pressure on the agricultural experiment stations and on the Department of Agriculture to study "costs" of production in order to discover cheaper methods of farm production. This was accentuated by the sharp rise of prices during the war. In this period the demand for "cost of production" figures generally came from consumers rather than producers. "Cost" figures were wanted to provide an upper limit to prices rather than as a basis of price guarantees to producers. It was said that, "The price-fixing movement in this country has derived its chief and permanent emphasis from the desire to lower the urban cost of living, and this in turn has been, more than anything else, an effort to counteract the rise in the values of farm products."

Not all nor even the greater part of the price-fixing measures attempted during the war, however, were in the interest of the urban consumer. The governmental boards concerned with price-fixing were generally trying to avoid unnecessary expenditures of government funds. The general effort was to prevent prices from skyrocketing to unnecessary levels on such wartime essentials as copper, coal, steel, sugar, wheat, etc. The boards soon found it necessary to consider the interests of the public and to recognize the needs of consumer and producer groups as well as those of the government.

In the case of wheat a need was felt to stimulate production in order to provide for the needs of this country and for the serious needs of our allies. The price announced for wheat was therefore intended to stimulate production rather than to protect the government.

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1 Bennett, Merrill K. Farm cost studies in the United States, Chap. II, Food Research Institute, Leland Stanford Junior University, 1928.
3 Taussig, who was close to the developments of this period and was himself a member of the Sugar Equalization Board, says: "The prices established were not in strictness fixed; they were maximum prices. The sole exception as already indicated, was wheat; here there was a guaranteed minimum price. In every other case, the published prices were not to be exceeded, but need not necessarily be reached." Taussig, F. W., Price Fixing as Seen by a Price Fixer, in Quarterly Journal of Economics, February, 1919.
In fixing prices, a need was felt both by the producers and the government for figures on costs and expenses in the industries concerned. The few available records were used but it was necessary to resort to estimates in most cases. The recognition given to "cost of production" figures by price fixing boards and the feeling of need for such figures by producers provided the main stimulus to cost studies for the next 8 or 10 years.

It was said by G. F. Warren, "The food-control and price-fixing campaigns have magnified both the importance of food control and the injustices that exist. At the same time the protecting power of the government has been magnified. In popular opinion the government has come to have many of the attributes of the Deity. The government can raise wages, make products abundant and cheap to the consumer and at the same time give the producer cost plus. Since each class shares these hopes, each in turn will call on the government for help."

As the war advanced other groups of producers came to demand that they too be given price guarantees of the nature accorded the wheat growers and producers of essential wartime products. Where maximum prices had been set, the pressure from producers was to raise the limit.

THE POST WAR REACTION

The collapse of the wartime price inflation brought a profound change in the attitude of producers. The prices which had been set as upper limits at which the government would buy supplies (and which had been opposed by producers) were now demanded as minimum prices in order to avoid losses. The minimum price which had been more or less guaranteed on wheat in order to stimulate its production, came to be regarded as the just due of the producer. This demand was particularly strong while prices were falling from 1920 until recovery was fairly well advanced in 1922 and 1923.

The effect of price movements on public interest in "cost" as a basis of price guarantees should be kept in mind in considering this period. As long as prices are falling, expenditures in the operation of farms (or other industries) are incurred at one level price but the product is sold later at a lower level. Under this condition, producers feel that the market is moving against them. Therefore, they wish for prices comparable to the costs they incurred several months before.

When prices are rising the interest of producers is entirely changed. Under this condition, the market is moving in their favor and since costs were incurred at lower levels, it is in their

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See also Elder, Wilfred, the Wheat and Flour Trade Under Food Administration Control, 1917-18, Quarterly Journal of Economics, November, 1918.

interest to take full advantage of the market movement. Therefore, they wish prices to be as independent of previous costs as possible. A return of the same amount of money after prices have risen would buy less than the same amount of money when it was invested in the production process and would actually mean a loss of purchasing power. When the price level is rising, as during a period of inflation, the only thing worse for farmers than cost of production prices would be cost of production prices combined with more inflation.

POST-WAR COST OF PRODUCTION STUDIES

Partly as a result of wartime price fixing and partly because of the decline in prices after 1920, many agricultural experiment stations set out to find cost of production. Bennett states that there were six states conducting cost investigations by means of detailed cost accounting routes in 1920. By 1924 there were routes in operation in 14 states. In 1926-27, 23 states were operating 35 of these routes. Further reference to this method will be made later.

The number of cost investigations by other methods also increased greatly. A rough count by Bennett of the Classified Lists of Projects carried on by Agricultural Experiment Stations, showed 82 such projects in 1920, 87 in 1921, 96 in 1924-25 and 190 in 1925-26. These figures, however, do not give an accurate record of the growth and subsequent decline in this type of study.

In the first place the large increase in 1925-26 resulted from an increase in funds available for research purposes under the Purnell Act. In the second place, the term "cost study" is applied to a wide variety of investigations. It covers cost of production per unit of product, cost of operation per acre of crop or per head of livestock, cost or expense of operation of the entire farm, cost of performing specific operations such as plowing, silo filling, etc. Also any one of the "costs" listed may be expressed either in monetary terms or in terms of physical requirements, as pounds of seed, feed, fertilizer, hours of labor, etc.

As experience with "cost of production" studies increased, monetary "costs" were found highly disappointing in a number of respects to be discussed later. But "costs" or requirements in terms of labor, feed, etc., were found highly useful in planning the operation of the individual farm as well as in examining the variations in efficiency on different farms. Many investigations to which the title "cost" was applied soon developed into studies of subjects other than monetary costs per unit of product. With a generally satisfactory level of prices and development of a forward rather than a backward looking spirit

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* Ibid., p. 21.
on the part of farmers, this was a natural consequence and represented a correct interpretation of farmers’ interests on the part of staffs of agricultural experiment stations.

COST OF PRODUCTION STUDIES IN IOWA

The history of "cost" investigations in Iowa is in many respects similar to that in the country as a whole. At the end of the war the Iowa Farm Bureau Federation, like a number of other organizations, became deeply interested in obtaining figures on cost of production. This interest seems to have rested partly on a desire to have figures available in case any further price fixing were to be undertaken by the government, partly to find ways by which the farmer might reduce his costs and partly for other reasons.

The Iowa Farm Bureau Federation consequently, provided a large part of the needed funds to undertake a study of "costs" in Marshall County beginning April 1, 1920. This investigation was under the supervision of the Agricultural Economics and Farm Management Section of the Iowa Agricultural Experiment Station. The report of the first year's study was published in the Iowa Farm Bureau Messenger for November, 1921. The data were obtained by the detailed cost accounting method on 26 farms. These were visited periodically by a trained worker who spent his entire time on this project, and a great deal of care was used in obtaining the most accurate records possible.

On Jan. 1, 1921, a similar study was started in Shelby County in order to obtain information under a different set of conditions. Each of these studies was continued through the year 1924. These records were hardly started, however, until it became apparent that the era of wartime price-fixing was past.

The foreword from the "Preliminary Report of the Farm Accounting and Cost of Production Work for 1920," published by the Iowa Farm Bureau Federation and the Iowa Agricultural Experiment Station indicates the strong current interest in the subject.

The foreword was as follows:

"One of the first lines of work provided for by the Executive Committee of the Iowa Farm Bureau Federation was that of determining accurately the cost of producing crops and growing livestock in Iowa. A committee of practical farmers and agricultural economic specialists was appointed to draft plans and supervise the method of conducting it.

"The need of this work is ably expressed in the November issue of the Iowa Farm Bureau Messenger by Dr. E. G. Nourse, as follows:

"The Iowa Farm Bureau Federation is constantly being called on to be the spokesman of Iowa farmers on all sorts of questions which relate to the economic situation of the farmer and the cost of producing his crops. Officials of the Federation have been determined that their utterances should be based only on actual facts and that if called upon to back that up they could produce proof which would be unquestioned at court or in an official hearing or by the most critical private audience.

"In this connection the Officials have not been content to dig out the figures or estimates that other people have prepared or to go to second-hand sources of information. They decided to secure actual accounts of the operation of real farms in the State of Iowa so located and selected as to be as typical as possible of farm conditions in general.

The report contained the summaries of incomes and expenses of the farms studied, a tabulation of "Losses or Gains" on cattle, hog and poultry enterprises, statements of detailed costs on oats, corn and hogs and costs per hour of the use of man labor, horse labor, machinery and tractors, all by individual farms.
Interest in "cost" figures as a basis for price determination declined rapidly. Also practical difficulties in computation and bothersome questions as to the soundness of the figures when they were finally obtained were already arising.

In this and in some of the other early reports on Iowa cost of production studies it seems to have been taken for granted that the costs per unit were self-explanatory and little or no comment was made as to what they showed. The first (and most detailed) report on the Marshall County study for 1920, said simply:

"Insofar as the figures in this report are representative they show two things unmistakably. They show, first, that farming was a decidedly unprofitable business in 1920. In the second place they show that even under adverse business conditions good organization and careful management count in keeping losses at a minimum or in actually achieving modest profits."

As time went on more attention was devoted to influences on the income of the individual farmer. The reports which the Iowa Farm Bureau Messenger published each year on "Cost of Production" added data on the yields of crops, acres of crops raised, size of hog enterprise, etc., for comparison with the "cost" figures for these enterprises.

Meanwhile, interest in cost of production was dwindling rapidly and for 1924, the last year of this study, the Farm Bureau Federation did not even bother to publish a report. 8

In later studies better management practices received more attention as did questions of efficiency within individual enterprises. It was observed that the "cost" figures were capable of being used as a fairly satisfactory index or measurement of the efficiency with which a crop was produced on different farms, as long as the comparison was confined to a limited area, to farms of similar type and to a single year. This shift in emphasis occurred between 1921 and 1927.

8 An indication of the shift in emphasis which was taking place in "cost" and farm management studies at this time is given clearly in the introductory discussion in the I.F.B.F. report of "Iowa Farm Costs and Incomes in 1923."

"Not only have data from this study been used effectively in freight rate cases, etc., in the interest of the Iowa farmer, but a further detailed study of this material is yielding something far more valuable in the form of principles of farm organization and farm management by which the individual farmer may be guided in operating his farm for greater profit.

"... The figures for 1922 and 1923 show the 'average' profit or loss to be very small. At the same time there were considerable profits made by some of the farmers and heavy losses by others, after allowances were made for wages for the farmer's own labor and interest on his capital. ...

"In other words, the range in profits between different farms in the same neighborhood, operating under the same conditions and producing essentially the same crops, is much greater than the difference in 'average profitableness' brought about by changes from low to high price levels or vice versa. ...

"The question of whether some particular farm is to make a profit will, of course, depend on the price at which its product is sold; but it will depend even more on the man who is operating it. Prices are made by forces which are practically beyond the control of the individual. But the wise choice of farm enterprises, and the cost at which farm commodities are produced, are definitely subject to influence by the individual producer. Attempts to control prices are, at best, doubtful as to consequences, and would require the cooperation literally of millions of persons, whereas costs can be reduced and profits thereby increased by the individual without the cooperation or acquiescence of anyone else. ..."
Among other studies which utilized "cost" figures may be mentioned a study of the feeding of beef cattle in Pottawattamie County from 1918 to 1923 which was carried out in cooperation with the United States Department of Agriculture.\textsuperscript{9} A study of the production of hogs in Humboldt County was also made in cooperation with the United States Department of Agriculture.\textsuperscript{10} In both of these studies "costs" per 100 pounds of gain were computed. These figures were used primarily as indications of efficiency in comparison of the different methods used.

From 1925 through 1927 a detailed accounting study was made of a group of about 25 farms in Iowa County. In this study costs per unit were computed again, as in the investigations just described.\textsuperscript{11} This was partly a concession to the continuing (though diminished) demand for such figures but more largely for comparison of farm efficiency.\textsuperscript{12} The same practice was followed in a study of the production of corn in seven Iowa counties in 1927 and 1928.\textsuperscript{13}

Wherever these figures were published by the Iowa Agricultural Experiment Station, carefully worded qualifying statements accompanied them. It was stated that they were designed simply as indexes of economic efficiency to assist in comparisons between farms, that they did not represent absolute costs and that they had no known relationship to price. Nevertheless there was considerable confusion. The use of such figures for this purpose was not generally adopted, and economists elsewhere continued to view them with suspicion while farmers and the general public seemed unable to consider them as anything but indications of necessary price. In more recent studies, therefore, no such figures have been computed.

It should not be thought that the time and money spent on cost accounting routes in Iowa and other states was wasted. This would be far from true. It would be better to say that the term "cost route" had become a misnomer. The detailed farm record studies, even most of the earlier ones, yielded invaluable information on farm practices, amounts of feeds, seeds, labor, power, etc., actually used in farm production per acre or per unit of product. Data such as these had been seriously needed in research on farm management problems, in extension work,\textsuperscript{9} Bulletin 242, Iowa Agricultural Experiment Station, An Economic Study of the Cattle Feeding Enterprise in Iowa.
\textsuperscript{10} Bulletin 255, Iowa Agricultural Experiment Station, An Economic Study of the Hog Enterprise in Humboldt County.
\textsuperscript{11} Bulletin 261, Iowa Agricultural Experiment Station, The Crop System in Iowa County. Also Bulletin 270, The Livestock System in Iowa County.
\textsuperscript{12} For instance the following statement appears in Bulletin 270, page 217: "By adding together the values of the factors of production used on each farm, we obtain an index summarizing the economy of the farmer in keeping down his expenses. This 'cost per hundred pounds' (on hogs) is intended merely as an index of performance for comparison between farms and not as showing an absolute cost which stands in any particular relationship to market price."
\textsuperscript{13} Bulletin 289, Iowa Agricultural Experiment Station, Costs and Utilization of Corn in Seven Iowa Counties.
for classroom use and otherwise. The routes provided a more dependable factual basis for recommendations regarding farm organization and operation. Greater confidence was felt in many of the data from actual records than in corresponding figures from surveys or estimates. There seems to be little doubt that these by-products of the "cost studies" justified the use of funds in most states.

**SOURCES OF FARM COST DATA**

Many different methods of computing "cost of production" have been considered or tried out during the past 15 or 20 years. It would serve no useful purpose to enumerate or describe any large number of these. It may be useful, however, to give the general characteristics of a few of the most common types. Methods of obtaining the basic data for cost figures can usually be grouped under three general headings: the method of estimation, the survey method and the detailed accounting method.

**METHOD OF ESTIMATION**

The method of estimation implies that secondary material (that is, data already gathered by someone else) or general information is used as the basis of the final figures. Rough estimates are sometimes used because the figures are wanted immediately and there is insufficient time to conduct a careful and accurate study. Sometimes the limitation is one of funds available for collecting records from actual farms. This method was used more widely in the early years of the century before accurate and detailed farm records became common.

The sources of data for such estimates are, of course, widely diverse. Cost studies already made by someone else may be used to some extent. Census publications and the publications of the United States Department of Agriculture as well as of agricultural experiment stations on farm income and expense of various types have been used as a basis of estimates.

Estimates which are not based on actual records, of course, have no definite validity. Since reputable economists are notoriously chary of making offhand estimates, the standing of such figures is seldom very high.

**THE SURVEY METHOD**

The second method of obtaining the basic data for "cost" figures is by the survey. By this method farmers are asked to answer questionnaires after the end of the farm year, usually by trained enumerators who visit them. Sometimes, however, brief questionnaires are distributed by mail.

The questions asked in the survey may either cover the entire farm business or may be restricted to a single enterprise. If
the corn crop were the subject of investigation it would be necessary to ascertain the amount of labor spent in raising and harvesting the crop, the number of horses used and amount of time they were worked, what fertilizers were used and their prices, amount and value of seed, etc. If total cost is to be computed it is also necessary to include a charge for the use of machinery, covering interest on investment, repairs, depreciation, etc., and also a charge for the use of land and buildings.

The use of the questionnaire instead of an actual record assumes the dependability of the farmer’s memory. At least it assumes that errors in one direction will be equalled by errors in the opposite direction. In some types of data this may be true. On other questions there is a tendency for the majority of errors to run in the same direction. It is generally admitted that wide errors are common in the information given by individual farmers. The advantage of the survey method is that it is much less expensive than detailed records and permits information to be obtained from a greater number and variety of farms with the same amount of funds. Also it generally permits the data to be gathered in considerably less time, where results are wanted urgently.

USE OF DETAILED RECORDS

The method on which most dependence was generally placed was the detailed accounting or “route method.” This method is still used in collecting other types of farm management data as well as for cost finding in a few states.

The detailed accounts of farm receipts and expenditures are kept, usually, by the farmer himself but under the supervision of a “field man” or “route man” who visits each farmer periodically to check up on entries, take inventories, etc. In order to be able to distribute or allocate expenses to individual products it is necessary to find out how many hours of labor were spent on each enterprise, how much feed was consumed by each livestock enterprise, what amount of manure was applied to each field, etc. This involves the use of an elaborate set of labor records, feed records, etc.

After these records are checked up by the field man, they are sent to the experiment station or other central office to be posted and summarized. About 25 farms are generally considered as many as a field man can handle. In addition to the field man it is necessary to use considerable clerical help in posting the records currently and in working out the summaries at the end of the year. Both the field work and the process of summarization require supervision. In addition it is necessary for someone to spend considerable time and thought in interpreting the results and preparing reports. When travel and other expenses of the field man, accounting forms, etc., are added it is
found that $5,000 to $6,000 per year is a rather common total of expense for obtaining the “cost” and other data from a detailed accounting route of this type.

The question whether the results are worth any such sum of money is, of course, a serious one. As far as the “cost” figures themselves are concerned, the consensus seems to be clearly in the negative. Also the number of farms from which data can be obtained by such a method is too small for much confidence in their being typical. In fact, the high degree of cooperation required from farmers who keep such records makes it pretty certain that the data will be obtained from better than average farmers.

The most important favorable consideration regarding detailed records is that the basic data they yield are the most accurate and dependable of those obtained by any method. Whatever criticism may be made of the final results should be directed at manipulations to which the data are subjected after they are taken from the original farm accounting books. This is concerned mostly with the distribution of expenses among various farm products.

ELEMENTS OF COST

The economic factors of production may be grouped under these four headings: Labor, capital, land and management. Returns from the production of crops or livestock may be broken down into some combination of wages, interest, rent or returns to management. These may be considered the elements of cost corresponding to the basic factors of production.

What sort of a test can we apply to a charge to see whether it really is a necessary cost element? About the only indisputable test is to raise the question whether production of the commodity would cease or be notably reduced if the charge in question should not be paid. For instance, the application of hired labor would soon stop without the payment of wages. Production of commodities would stop at the same time. Therefore, we are unquestionably to consider wages as one of the necessary elements of cost. The same is obviously true as regards interest on capital, since labor would be helpless without equipment, buildings, etc.

When we come to management the case is not so clear. The manager or operator of a business combines several different functions. First he generally does some actual labor which compares to that of the hired man. Regarding the status of wages for this labor there is no question, particularly if there is really an opportunity of converting this labor into cash by working for someone else. In addition, the operator of a farm or other business generally supervises the work of other persons who are employed by him. This function of supervision is often hired in large businesses where the owner cannot look
after the entire laboring force himself. It corresponds to a high grade of labor.

But the business manager or operator also has the problem of deciding what to produce, when and how to buy and sell, what methods of production to use, etc. Also he must obtain the needed labor, capital and land for the farm or other business. For the use of these factors of production, the operator must agree, beforehand, to pay the going market rates. But the returns will depend on market prices prevailing when the product is sold. This involves a serious element of risk which the operator must bear. He becomes the buffer between present and future market prices. These services must be performed by someone, but how shall we decide the remuneration which a particular man should receive for them? Since each farmer or other business operator differs from his neighbors in the success with which he performs these services there can be, obviously, no standard rate of remuneration.

The simplest and most satisfactory way out of the dilemma seems to be to let the business operator receive whatever return he can get above the market rate of remuneration for labor and the use of capital. In other words, what the man actually makes may be considered the fairest measure of his ability as a manager.

With land, also, the problem is not to be solved by assigning some rate per acre or per dollar investment as an indication of cost. The difficulty here comes from the fact that the value of the land depends on the value of what it produces, not the other way around. When the price of corn rises from 40 to 60 and then to 80 cents per bushel, (farm expenses and other things remaining unchanged) prospective tenants are willing to pay a higher rent in order to get the use of the land. As the rent rises from $5.00 to $6.00 or $7.00 per acre, persons who have funds to invest are willing to pay a higher price per acre for land.

To the individual, rent appears to be the same sort of an expense as any other. But the rent which one individual pays is determined largely by the bids which his neighbors are willing to make for the use of the same or similar land. These in turn depend on the income which they believe they can get from the use of the land, that is to say, on the price of the products. For the country as a whole, therefore, we can say that rent is determined by price rather than price by rent. At between different farms, the only service which rent could perform as an element of cost computations would be to equalize the different advantages of various pieces of land, and to equalize the advantages of productive land with land so poor or so rough that it yields nothing above the value of the labor and capital used on it.

The people who maintain that rent should be included in price, are, in effect, simply demanding a continuation of the
price structure of the recent past (which, in turn, determined the rates of rent).

THE PROBLEM OF VALUATION

Even after deciding that a given item is to be counted as an element of "cost" the problem arises, just what rate of valuation should be placed on it. In some cases this is easy to answer, in others it is impossible to solve except in an arbitrary manner.

Where the cost element was recently bought outright on the market there is little room for argument. The purchase price provides a better basis for valuation than any possible alternative. This will apply to feeds bought for specific livestock enterprises, seeds bought for crops, labor hired to work on special jobs, as threshing small grain or picking corn.

Often, however, the difficulty is not solved so easily. First there are many cases in which the cost element is used jointly by two or more enterprises so that there is no basis for making any division of the expense between them. We shall return to this later under a discussion of joint costs.

Second, there is the problem of valuation of cost elements when no actual outlay occurs. In farming a relatively large part of the total cost is composed of elements of this type. This includes the labor of the farmer himself, and of members of his family, use of the farmer's own investment in buildings, equipment, etc., rent of owned land, and farm produce which is carried over from one enterprise to be used in some other.

At what rate are elements of this type to be valued? In the case of farm raised grains which are to be fed to livestock on the farm, there is often a quoted market price which is capable of serving as a guide. Still the question of market grade needs to be decided correctly, as well as the particular market and the date or dates on which the price is to be taken. Also the question needs to be decided whether the price used should be what the farmer would probably have received for the product if he had sold it at the farm, or whether it should be the price at which the commodity could be delivered to the farm from the market. In most cases of farm-raised raw materials, the accepted policy is to follow the former method.

As regards the farmer's own labor, the use of his own capital and his own land, the problem of valuation is more bothersome. The practice usually followed is to estimate what the farmer would have to pay a hired laborer to do the same work. As reasonable as this basis seems, it does not always avoid controversy. There is some work which the farmer does himself, but which he would not do if he had to pay for it. Also there are enterprises which serve largely to utilize labor in slack seasons. It would obviously be misleading and not true to the

 Valuation refers to the recording of market value and should be distinguished clearly from the determination or cause of value.
facts if the rainy day project were charged as high a rate per hour for the labor it uses as the corn crop.

Similar perplexities arise with regard to the use of capital owned by the farmer. For instance, what rate should be charged for the use of a barn? Perhaps the building was erected under a different level of prices and perhaps methods of construction have changed. Further, in many cases buildings are now used for purposes other than those for which they were originally intended.

A little thought will convince us that with these long-lived capital goods, somewhat as with land, the line of cause and effect does not run from the original amount of investment to the prices at which their product sells. Usually it runs in the opposite direction. The price of the product determines what the resource which produces it is worth. That is: the resource is valued for what present users or potential buyers believe they can get out of its use in the future. The market is essentially forward and not backward looking.

The problem of valuation of the cost elements thus leads into the necessity for deciding the nature of the "costs" which we are to compute. If an effort is made to compute what has actually been put into the product in the way of past expenditures, the resulting "costs" will simply be a matter of historical record. As we have just seen this has practically no connection with the price at which the product will sell, because present demand and supply conditions are different from those when the resources were originally obtained.

If, on the other hand, present market prices of the factors of production are used, we find ourselves reasoning in a circle. Present prices rest partly on the present outlook for future prices. Such a computation, therefore, cannot be used to explain these same future prices. The only object of computing such costs would be to see if the market or the persons making the original estimates had good judgment regarding the probable course of future prices.

If we want a correct record of what has actually happened we should charge feeds, etc., at what it actually cost to produce them. If we are interested in comparing the efficiency and judgment of different producers, we shall find the computations easier and simpler if we use prevailing market prices. Unfortunately few people are likely to realize the difference in significance of the two sets of "cost" figures which could be derived from the same farms by these two different methods of valuation.15

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15 An interesting and pertinent comment on this point was made by L. C. Gray in the American Economic Review, Supplement, Vol. 9, 1919, pp. 269-270: "There has been much discussion of late concerning costs as a basis for the determination of agricultural prices. . . . The controversy has centered about the difficulties of determining costs, especially the question whether products such as grain and hay used for feeding dairy cattle should be counted in the final costs at their market value or at their actual cost of production. As a problem of accounting, the question has but one answer: The accurate
ALLOCATING EXPENSES TO THE VARIOUS PRODUCTS

In any study of the cost of producing farm products the investigator soon comes up against the problem of allocating or distributing expenses among various products of the farm. The only case in which this problem can be avoided is where the farm produces a single product. The farm which produces nothing but wheat, for instance, offers a relatively easy problem. Here all that is necessary is to charge all expenses against this one crop. The dairy farm which sells nothing but milk seems to be almost as simple. But few farms are of this type. Even if milk is the only important product marketed, there are still calves to be sold. What part of the expenses of operating the farm should be charged against them?

On the typical Iowa farm there is likely to be some corn sold and some fed to livestock. Part of the grain which is fed goes to horses which produce the power for all or part of the field work. Part of it goes to hogs and part to cattle. The cattle produce, let us say, some butterfat, and also calves which are sold as baby beef. In the feeding of corn, it is at least mechanically possible to handle the problem of allocation. But not all the materials and services necessary in farm production have known market prices.

A more difficult problem arises with regard to the allocation of labor expenses. Let us assume for simplicity that all the work on the farm is done by hired labor (to avoid the question of what the farmer’s own labor is worth). Suppose the year’s labor bill comes to $600. The farm produces 60 acres of corn, 30 of oats, 30 of hay, 5,000 pounds of hogs and includes 15 cows which produce 3,500 pounds of butterfat besides calves. In order to find out what is done with the labor, the farmer keeps a labor record which shows that, in the course of the year, he spent 750 hours of labor on corn, 250 hours on oats, 150 on hay, 150 on hogs and 700 hours on cattle. (There will also be a considerable amount of labor spent on fences, buildings and general maintenance, but for the sake of simplicity we will leave this out of account.)

The most common method of distribution of this labor bill is
to divide the $600 by the total number of hours of labor used (2,000) to find the cost per hour as an average throughout the year. In this case it is found to be 30 cents per hour. This rate is then multiplied by the number of hours spent on each enterprise. A labor charge may be made of $225 for corn, $75 for oats, $45 for hay, $45 for hogs and $210 for cattle.

But suppose that the farmer decides his cattle are not yielding enough returns and disposes of them. If this method of allocating costs were correct, his labor expenses the following year should be smaller by $210. This is not likely to be true. The cattle had provided employment in slack seasons, and actually added but little to the total labor bill of the year. If the cattle enterprise were eliminated we would find perhaps $500 of labor expense to be distributed amongst the remaining enterprises with resulting increases in their "costs." This is a common experience in farm "cost" finding. Changing the size of one enterprise often results in a change in the so-called "costs" on others—demonstrating that in such cases the "costs" have no definite meaning for that product alone, but only for the farm when taken as a whole.

JOINT COSTS AND THE ALLOCATION OF EXPENSES

The situation which we have just discussed is an example of what is known as joint costs. That is, in such cases costs are incurred on groups of products rather than on individual and separate ones. Thus the expenses of keeping horses comprise a joint expense against everything the horses work on. It would be necessary to keep the same number of horses on the farm just discussed whether oats were raised or not. The feed which is consumed by a cow leads both to the production of milk and to the production of a calf, the care and feed given to a sheep produces both mutton and wool. It is not possible to tell in such a case what proportion should be charged to the one product and how much to the other.

Of course not all expenses on a farm are of this type. The twine to bind the oats and the extra labor which is hired to thresh them are entirely chargeable to oats and no other crop. The money which is paid to have milk hauled is entirely chargeable to this product, etc. But there are enough joint costs involved in the operation of the ordinary farm so that it is impossible to make anything that approaches a complete distribution of expenses among the different products.

Various methods of computation have been used in efforts to overcome or minimize this difficulty. The nature of joint costs, however, dooms any efforts at their apportionment. Perhaps the most common method for attempting such a distribution is on the basis of relative market prices of the products. Let us suppose, for instance, that the value of feed plus
other expenses per ewe in a flock of sheep amounts to $7.00 per year. The production of the flock amounts, let us assume, to 7 pounds of wool and 80 pounds of mutton per ewe per year. The wool sells for 30 cents per pound or $2.10, and the lamb for 8 cents per pound or $6.40. The total income is $8.50. Now what is the cost of the wool and how much does the lamb cost?

Advocates of dividing the expenses in proportion to market price would say that the cost of the wool is 210/850 of the $7.00 total expense. This would make the wool cost $1.73, or 24.7 cents per pound. By the same method, the mutton would cost 640/850 of the $7.00. This would be $5.27, or 6.6 cents per pound.

But suppose a tariff on wool were to raise its price, for instance, from 30 cents per pound to 40 while total farm expenses and the price of mutton remained the same. Now, applying the same method again, the wool would appear to cost more per pound although no change had occurred in the expenses of keeping the sheep. Perhaps the tariff on wool was raised under the impression that it would “equalize costs of production at home and abroad.” By this method the apparent increase in cost (resulting from an increase in price) would call for still another increase in tariff!

Of course the method is an entirely arbitrary one and has no foundation in reason. If the mutton cannot be produced separately from wool, “cost” for mutton has no meaning apart from cost of wool on the same sheep.

**BY-PRODUCT METHOD**

A second method is that of considering the less valuable crop as the by-product and deducting its market price from the total expense in an effort to find the cost of the main product. If the price of the by-product rises, this appears to lower the cost of the main product. There are cases where the discovery of new uses for a by-product makes it more valuable than the former main product. Now, by this method, it would be necessary to subtract the price of the former main product from total expense to find the cost of the old by-product.

**APPORTIONMENT OF TOTAL FARM EXPENSE ON BASIS OF GROSS INCOME**

An interesting attempt to circumvent joint costs is the method of Dr. Ernst Laur of the Schweizerischen Bauernsekretariate (Swiss Farmers’ Union or Farmers’ Confederation). This method is also used by one of the farm organizations in this country.

Dr. Laur recognizes that the farm is an organic whole and that figures purporting to measure expenditures on one part of

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the farm are really dependent also on other enterprises. As mentioned on a previous page, this is particularly true of labor which is used on several enterprises, or of buildings which are used by the whole farm business. Consequently Dr. Laur adds together all expenses on the entire farm for the year (including an allowance for interest on the farmer’s own capital). Next he computes the income for the entire farm and finds the ratio between total income and total expense. He then assumes that the cost of each product stands in the same ratio to its market price as the total farm expense to the total farm income.

An illustration may, again, help clarify the method. Let us suppose that the total expense on a farm operated by Mr. A amounts to $5,000 while the total income amounts to $4,000. Then the expense is 125 percent of the income. Now let us suppose that this farmer sells corn, hogs and butterfat, and that the price received for corn during the year in question was 50 cents, while hogs were $6.00 and butterfat 30 cents. According to Laur’s method if the total farm expense was 125 percent of the income, then the cost of corn was 125 percent of 50 cents or 62.5 cents. The cost of hogs would be 125 percent of $6.00 or $7.50, and the cost of butterfat would be 125 percent of 30 cents or 37.5 cents per pound.

An accounting method should give results which are consistent and reasonable under wide ranges of conditions. If the method is sound it will do this. Applying it to various conditions is one of the surest ways of testing it for certain types of defects. Let us see how Dr. Laur’s method behaves under two other hypothetical sets of conditions which may be compared with the farm of Mr. A, mentioned in the last paragraph.

First let us suppose that Mr. B, a neighbor of Mr. A, raises his hogs by the same methods, uses the same amounts of feed, the same amounts of labor, etc., and gets the same rate of gains. His feeds are of the same market value and he pays the same rate of wages. We should suppose that the “cost” of hogs would come to the same figure on the two farms. But this second farmer had poorer cows and less butterfat to sell. Consequently, his income was only $3,500, while his expenses were the same as of Mr. A, that is, $5,000. Consequently his expenses were 143 percent of his income as compared with 125 percent for Mr. A. He sold his hogs for the same price as the first man; $6.00 per hundred pounds. When we apply this 143 percent factor to the price of hogs we find that his hogs appear to have cost $8.68 instead of $7.50. This difference in cost of hogs should not be attributed to the hogs at all, but to Mr. B’s unproductive cows.

A second type of inconsistency which might result from this method is related to the relative prices at which the different products are sold. Let us suppose that Mr. C lives near Mr. A and Mr. B. He produces the same crops as Mr. A, using the
same methods and getting the same yields. His expenses are identical, and his total income is also the same. But this income is made up of different amounts from the three crops. We will assume that Mr. C sold his hogs on a better market than Mr. A, getting $8.00 for them instead of $6.00. His corn, however, was sold at 40 cents instead of 50, and his butterfat for 28 cents per pound instead of 30 cents. The expense in this case is again 125 percent of the income. But when this percentage is applied to the price received for hogs, we find that they appear to have cost $10.00 per hundred pounds instead of $7.50 as with Mr. A. On the other hand, since the corn was sold for only 40 cents, it appears to have cost only 50 cents as contrasted to 62.5 on A’s farm and the cost of butterfat appears to be 35 cents instead of 37.5.

In other words, using this method, a farmer could lower the cost of an individual product by selling it for a lower price. If he succeeded in getting a higher price than his neighbors for another crop, this would make it appear to have cost him more per bushel or per hundred pounds, provided he did not get a proportionally higher price for all his products. In this latter case, the higher prices would have no effect on the apparent cost.

All of these erratic variations would appear in the apparent “costs” of individual products, in spite of Laur’s admission at the start that the farm expenses are significant only when considered for the entire farm and not for individual enterprises. Laur and other users of this method have become so involved in its mechanics that they have lost sight of their own principle that, in fact, one enterprise cannot be separated from another on the ordinary farm. Since this principle is true, it follows, that the cost of one product cannot be separated from that of another.

It should always be remembered that as far as the individual producer is concerned cost and price are two completely separate and independent sets of facts. The costs of the favorably situated producer and of the inefficient or unfortunately situated producer may differ widely. But the two may sell for exactly the same price. In the same manner, total outlay of a producer for a given year is also largely independent of the income which he receives for that year’s product, except that considerations of probable future income may lead him to expand or contract his expenditures. But there is no basis for using present income as a means of computing previously incurred costs on individual products.

A little thought will show that this method rests on the same foundation as the two previously explained. That is, the prices (or income from sale) of the different products, is used as a basis for allocating total expenditures among the different products. If one of these methods is unsound, it follows that the others are also.
COST AS A HISTORICAL RECORD OF INPUT

If "cost" is to be based on an incontrovertible record, there seems to be only one possible method of procedure. That is to record the outlays that have actually occurred, sometime in the past, on the product in question. We have seen that there are some elements on which such a record can be kept. On the strictly one crop farm all expenditures are of this nature. On the farm producing more than one crop some elements of cost as for twine, fertilizer bills, commercial feeds, special labor which is employed to work on one enterprise only, are of this type.

Farm raised feeds which are readily salable may usually be added to the list as things of definite value which may be charged to specific enterprises or products. Farm raised feeds which are not salable leave us up in the air because we have no sure means of placing valuations on them. The same is true of the farmer's own labor, the use of old buildings, etc. On a rather large number of farm expenditures we have also the problem of joint costs. That is, certain expenses simply cannot be divided up amongst different products by any method which would stand a critical scrutiny.

USES OF COST OF PRODUCTION FIGURES

Many different uses of "cost" figures have been made or attempted. Five of the most prominent are: as a basis for price guarantees, as a basis for tariff rates, in railway rate hearings, as a means of arousing interest in farmers' discussions, and as farm efficiency factors.

COST AS A BASIS OF PRICE GUARANTEES

It has already been said that "cost of production" has proved disappointing in efforts to guarantee prices. In the first place the problem of what price to guarantee has not been solved satisfactorily except in isolated and unimportant cases. The only level at which price could be stabilized for an indefinite period, without rigid control of production, is at the level determined by competitive costs on the one hand and competitive demand prices on the other.

Since prices have a tendency to gravitate towards the point where competitive costs and competitive demand meets, it may be claimed with a good deal of force that the most effective efforts in this direction would be to remove the barriers to a free, competitive market. The question might also be raised whether it would be desirable to peg a price even at this natural point of balance between supply and demand. As methods of production change it is socially desirable to permit values to adjust themselves to the changes in relative costs. This may be
appreciated more readily if a non-agricultural product is used as an illustration. For instance if an improvement in methods of making farm machinery makes it possible to produce such machines more cheaply, there is no good reason why competition should not be permitted to lower the price of implements to farmers. Where competition prevails values are continually shifting in accordance both with costs and with demands.

Second, if price is to be stabilized at some artificial level, the question immediately arises; how to keep it there. To maintain an artificial price implies that some agency with great resources would stand ready to buy all the product offered at the stated price if other purchasers do not appear, or to sell the product from some source, whenever buyers want more than producers are willing to produce for that price. So far experiments in this direction have not been promising.

Third, we may raise the question, why the level of costs previously incurred need be used as the basis for artificial price control. Previously incurred cost in a dynamic world seldom equals the price which brings about an equilibrium between demand and supply. Presumably, if the government, or some other agency, were able to maintain prices at the “cost” level, it could also maintain price at some (or any) other level.

Fourth, the question may be raised: Whose costs would the price approximate? It will be shown a little later that, on ordinary farm products, the so-called “cost” figures vary widely. If price is to be forced to equal “cost,” should it be the cost of the farmer who can produce corn at 30 cents per bushel, or the one whose “cost” is 75 cents? The answer that price should equal “average cost” is quite unsatisfactory to the producers since this might cause half of them to lose money each year.

Fifth, for logical completeness, it should again be mentioned that, even if all these perplexing questions should be solved the use of “cost” would be prevented by the fact that on most farm products, cost cannot actually be determined.

Finally attention might be given to the practical problem of collection of “cost” data. Experience at the Iowa and other experiment stations has shown that figures of this type are highly expensive and requires a great deal of time for their compilation. Commonly, at least 3 to or 4 months after the end of the farm year are needed to close the necessary cost accounting records on any large number of farms. Crops such as wheat, potatoes, etc., are harvested in various parts of the country over periods of several months. It is highly improbable that all farmers would be willing to wait until an elaborate accounting process could be carried to completion before selling any of their crops and such a process would be necessary to ascertain what “costs” or expenses they had actually incurred on a particular crop.
COST OF PRODUCTION FIGURES IN TARIFF RATE MAKING

From time to time considerable attention has been given, at least in political campaigns, to the possible use of cost of production figures as a basis for the determination of tariff rates. At first thought the argument that the tariff rates should “equalize cost of production at home and abroad” has an appealing sound. It would seem to promise that domestic producers could compete with foreign producers without being placed under any handicap from greater natural advantages or from low rates of wages abroad.

The first objection to the policy of using “cost” as a basis of tariff rates is, of course, that such “costs” are in fact indeterminate both at home and abroad. The mechanics of computation of purported “costs” involve many arbitrary decisions as to valuations, allocation of joint costs, etc. The methods which may seem most reasonable at home may give quite misleading results when applied in the same manner in a foreign country where economic conditions are different.

A second question is: How can “costs” determined abroad under one set of conditions and under one monetary system be converted into terms comparable to similar figures in this country? Bennett states that the Tariff Commission, in its investigation of costs of production of butter in Denmark, found Danish costs to be lower than American costs by from 10.58 to 14.95 cents per pound, depending on the method of calculation and the method of converting from Danish to American currency. In periods such as the recent past, when currencies undergo rapid change this difficulty would be even greater.

A third difficulty is that American cost finders could obtain accurate information in a foreign country only if that country cared to cooperate.

In practice but little use seems to have been made of the “cost” findings of the Commission. In contrast to the half dozen or so items whose costs have been investigated by the Tariff Commission, hundreds of items in the tariff schedules have not. Tariff making continues to be dominated primarily by political rather than economic considerations, even after the advocacy of “cost equalizing” tariffs by politicians for over a quarter of a century.

USE OF COST FIGURES IN RAILROAD RATE HEARINGS

A third use made of “cost” figures has been in railroad rate case hearings. In the report on the Marshall County cost accounting study which was published in the Iowa Farm Bureau Messenger of November, 1921, it was said:

“. . . The most outstanding practical application of the work occurred in August when figures on the cost of producing corn and oats as secured on this Marshall County route were introduced as evidence in the Interstate Commerce Commission hearing on the Western Grain
and Hog Rate Case. These figures made a decided impression with the Commission, and the fact that they were based on actual daily accounts kept on farms in the producing territory and that these books were presented for the commission's examination and verification lent great weight to the testimony."

Of course, it is not possible to tell just what interpretation the Interstate Commerce Commission placed on these "cost" figures or on others of similar type. They were intended to reinforce the claim of the farm organization that the agricultural industry was not able to stand a heavier burden either of freight rates or of other expenses. It seems likely that the same inference could have been drawn more directly from a comparison of farm incomes and farm expenditures. In fact, figures on this subject were generally presented at the same hearings.

USE OF FARM COST FIGURES TO AROUSE FARMERS' INTEREST

Farm cost figures have frequently been used as a means of arousing the interest of farmer groups for one purpose or another. Sometimes this has been partly to impress members or prospective members with the investigational services of an organization. Sometimes such figures have been used to impress farmers with the need for increasing their efficiency and consequently reducing these "costs." In other cases comparisons have been made between "costs" and prices to drive home the idea that farm returns were not as large as they should be.

Few people except experienced investigators realize the practical difficulties involved in collection of farm "costs," or the logical inconsistencies underlying most figures of this type. "Cost of production" is simply something which price should equal. If he can show the farmer some figures which he calls "cost of production," a speaker can usually count on gaining the immediate attention of a large part of an audience.

The fact, however, that farmers are seldom familiar with the implications of "costs" figures suggests that, in discussing the returns from farming, it would be better to use figures on income or expense for the entire farm rather than "cost" per unit of product. Whatever true relationships exist between farm outlays and returns can be brought out quite as effectively by farm income statements as by farm "cost" figures. It would seem a reasonable requirement of persons speaking before farm audiences that they use data with which the farmers are as well acquainted as possible.

THE USES OF "COSTS" AS EFFICIENCY FACTORS

One of the least questionable uses of "costs" per unit of product seems to be for the purpose of comparing efficiency in production between different farms. That is, such figures may be used as efficiency "factors" or measures.
It is often desired to obtain a measure of the economic efficiency with which a farmer operates a single division of the farm such as the corn crop or the hog enterprise. On the corn crop, labor is ordinarily the largest single cost element. Therefore, the number of hours of labor used per acre in raising the crop is often used as a measure of relative efficiency between farmers. But labor is not the only cost element. Also labor may be saved by using more horses or larger machinery.

In such a case it is possible to apply the prices prevailing in the neighborhood for the use of labor, horse hire, use of equipment, land, etc., and so obtain a composite measurement or index of the combined cost factors.

On the hog enterprise, it is possible to save corn by feeding more tankage or to get better gains by giving the hogs closer attention. Here again the question arises whether the saving in one direction is more than offset by greater expenses elsewhere. Where each farmer uses a different ration or somewhat different methods, the advantage of such an index for purposes of comparison is clear.

For the purpose of these cost indexes, market prices of the factors of production should be used as the basis of valuation rather than the original investments. The farmer’s problem is to make the best possible use of his resources under the market situation existing or in prospect. His economic efficiency can therefore be measured approximately by the extent to which he is able to work out the most economical combination of available feed stuffs, or fertilizers, etc. Needless to say such indexes do not indicate necessary price.

The principal drawback of these indexes of cost is the high expense of obtaining them. Other data can also be used for this purpose, and some of these cost much less to obtain than the cost indexes.

SOME STATISTICAL CHARACTERISTICS OF COST OF PRODUCTION FIGURES

It is a matter of common observation that costs vary widely from farm to farm. Also there tend to be more farms on which costs are extremely high than where they are extremely low. This differs from the normal type of frequency distribution. The normal type is found in such figures as yields of corn per acre or gains per pig per day. This type of distribution is illustrated by fig. 1. It will be observed that, except for an occasional extreme or erratic case, the distributions tend to be symmetrical. That is, there are about equal numbers of cases on either side of the average, and if either of these graphs were folded in the middle, the right and left halves would approximately coincide.

When we plot cost figures in the same manner, however, we
get a definitely different form of distribution. This is illustrated by fig. 2, which shows the cost indexes per bushel of corn and per hundred pounds of hogs. When plotted on a natural or arithmetic scale, the tails of the graphs extend much farther to the right (toward high values) than they do toward the left. The lowest costs in each case are between 40 and 50 percent of the average for farms in the same county and the same year. The highest costs are from 180 to 220 percent of the averages. To look at it in a slightly different way, the average is about twice as high as the lowest figure; and the highest figures are about twice as high as the average.

When the same data shown in fig. 2 are plotted on a horizontal ratio scale we find that the distributions become symmetrical. This is shown in fig. 3. A ratio scale is one on which the same number of inches on any part of the scale represent equal percentages rather than equal absolute amounts. Thus, the distance is the same from 40 to 80 as from 50 to 100 or from 100 to 200.

In brief, indexes of cost tend to vary by proportionate rather than absolute amounts. This is typical of figures of this type and has been noticed in other crops (potatoes, winter wheat, cotton, etc.), and in other areas besides Iowa. The widespread appearance of this definite pattern in cost figures is highly signifi-
Fig. 3. Distributions of cost figures become symmetrical when plotted on a proportional horizontal scale.

cant. It indicates here that costs and their variation are subject to certain definite types of influence.¹⁸

A possible explanation of this type of behavior is that it is easier to become lax and permit costs to rise by a certain number of cents per bushel than to increase efficiency enough to lower costs by the same number of cents. In farm production one’s efforts are opposed by certain natural resistances. The more efficiency is increased (that is the lower the cost) the harder it is to overcome these resistances further.

Suppose a farmer had been producing corn at a cost of 60 cents per bushel. Now suppose he puts forth enough added effort in the way of increased efficiency to lower the cost by 6 cents per bushel (10 percent of the old cost). The next year he increases his effort towards efficiency by an added equal amount. From the way these cost figures have behaved in the cases studied, we would expect the cost to decline another 10 percent of the remaining cost, that is by 5.4 cents per bushel and not by another 6 cents.

The first attempt to increase efficiency and reduce costs succeeded in removing certain causes for wastage. When it came to increasing efficiency still further, there were fewer causes of wastage left and these were harder to find and to overcome.

This principle that costs tend to vary by proportionate rather than by absolute amounts is an important one in deciding on business policy. It suggests that it would not be profitable to stop absolutely every possible cause of loss or inefficiency. It is commonly recognized that a larger output, even at a slightly higher cost per unit, is usually more profitable than the small output that could be produced by a farmer at the lowest possible cost per unit.

VARIATION IN COST BETWEEN YEARS

Do farms tend to hold about the same relative position with regard to cost from year to year, or is the low cost farm

one year just as likely to have high costs the next? To get an answer to this question, it is necessary to have continuous records on a group of farms for 2 or more years. Careful statistical tests have been applied to such cost data as are available at the Iowa Agricultural Experiment Station in order to throw some light on the question. Unfortunately the amount of data available in any one sample is not very large. The ordinary cost accounting group amounts to only 20 or 25 farms. Also there is likely to be 10 to 20 percent turnover of members from one year to the next. When it comes to finding groups of farms which have kept cost records for 3 or 4 consecutive years, the samples are likely to be pretty small.

In a small group it is possible for some farms to occupy approximately similar positions in successive years purely from chance. As the number of cases increases the danger of being misled in this manner becomes smaller. There are certain well developed mathematical tests for testing this probability. These have been applied to 14 samples of cost data which were available and suitable for the purpose. The results show that in 5 of these cases there was a strongly significant tendency for the high cost farms to remain high and the low cost farms to remain low throughout the periods studied. Three of the nine remaining groups showed this tendency definitely but not to a strongly significant degree. Two might be considered as on the border line of significance. In the other four cases the farms showed no significant tendency to occupy the same position from year to year. But there was no case in which there was any noticeable tendency for high cost farms of one year to be low cost farms the next. In a small group it is possible for some farms to occupy

The conclusion to this section is that these "cost" figures, however doubtful their significance with regard to necessary price and however questionable their exactness, showed certain well defined statistical characteristics. In the first place the cost indexes for a group of farms assume a well defined pattern which suggests that the process of lowering cost becomes increasingly difficult the greater the efficiency that has already been attained. In the second place, there was a well defined tendency for the high or low cost farms of one year to be found in the same position the next year.

These generalizations are intended to apply only to farms following similar methods and operating under similar conditions. The tests were not met perfectly in all cases. But it should be remembered that homogeneous conditions did not exist on every one of the farms that had been studied. Thus, floods in one or two sections drowned out part of the corn in lowland fields but did not affect the well drained upland fields. Outbreaks of hog cholera occurred on a few farms, as did other unusual conditions. At this time it is not possible to determine the causes of unusually high costs in all cases. Had there been

19 See Appendix B.
hundreds or thousands of farms to study instead of a dozen or so, it is likely that some of these unusual causes for variation would have occurred with sufficient regularity to make the evidence much more conclusive.

THE RELATIONSHIP OF COST TO PRICE

If the ordinary person were asked what relationship exists between cost of production and price, he would probably reply simply that, price should equal cost plus a "fair" profit. If he should be quizzed further as to just what he meant by cost, what elements it is composed of, whose cost he has in mind, and under what conditions of production, it would generally become evident that he had not given a great deal of thought to these questions. Or perhaps he had considered these to be simple questions which did not require much thought. If he should again be asked just what sort of a price he had in mind and during what sort of a period of business activity, whether he was considering periods of rising or declining prices, whether he had in mind costs expressed in gold or in debased currencies, again it would be evident that he had thought only in a vague sort of way about these underlying conditions.

Any complete discussion of the relationships between costs and prices would run into hundreds of pages rather than a short discussion. Nevertheless, it is necessary, even in such a brief discussion as this, to make some sort of a definite statement of the underlying principles and of some of the assumptions on which they rest.

PRICE CONTROL TO GUARANTEE A "FAIR RETURN"

In this bulletin we do not attempt to treat of all the various types of interference with the free competitive establishment of price. A clear understanding, however, should be established at this point regarding two types of price control. The first of these is control by monopolies or industries representing partial monopolies. The second is price control by or in connection with public utilities. It is a common belief among farmers that most industries other than agriculture are able to maintain prices at remunerative levels with little regard to the condition of business.

A true monopoly is able to name a price and maintain it. This can be done only by keeping a strict control over the volume of output and limiting it to the amount which purchasers are willing to take at the price named. In such a case the price set is not "cost of production" but whatever figure seems likely to yield the largest net income. Actual monopolies, however, are rare. The most common type is that granted through patents or copyrights for a limited period of time.

Partial or incomplete monopolies occur more often; when a small number of powerful producers arrive at a common under-
standing regarding production and price policies. This type of interference is sometimes rather widespread and may dominate important sections of the industrial field at least for a short time. Such artificial prices are relatively easy to maintain while demand for the product in question is expanding. But such control usually collapses as soon as demand contracts, and the producers begin to fight amongst themselves for what volume of business is left.20 Needless to say, agriculture has not yet been able to establish anything approaching monopoly control over its output.21

It is sometimes asked that government should guarantee prices to agriculture on the grounds that agriculture is a vital necessity to the nation. Therefore, it is said that it should receive as favorable treatment as railroads or other public utilities. Here again the analogy is incomplete and the idea that public utilities receive “favorable” treatment is erroneous except where the purposes of government have gone astray. Public utilities represent a special case of monopoly as where a corporation is providing light, gas, or water service to a town. From the nature of the service, competition in the usual sense is impossible. Therefore, a monopoly must be permitted but in the interest of the public (i.e. the consumers), it must be regulated so that the public is assured of unfailing performance of the essential service at a reasonable price.

Rates are examined and passed upon by the government body

20 There are two flaws in the idea that “Industry” sets a price and consequently makes a profit. In the first place few industries are actually able to maintain an arbitrary price level. Industries composed of a small number of powerful business firms, as in the automobile field, are often typified by sharp competition. In others, attempts to regulate price may succeed for a while and then break down. In the copper industry, at the beginning of the depression, there was a small number of producing units and some actual measure of price control. Here diverse interests of the individual producers and piling up of heavy unsold inventories tempted the price and the partial monopoly after 1 year of depression. Copper prices fell from 17.9 cents in 1929 to 4.9 cents per lb. in 1932, and the organization was unable to save the industry from heavy losses.

21 The efforts of the Agricultural Adjustment Administration represent the nearest approach to such control over a limited list of agricultural products. But vagaries of the weather make the actual volume of production very uncertain even after some measure of control over acreage of crops or numbers of livestock has been obtained.

On the other hand, the possibility of increasing gross income (not necessarily net income) by such arbitrary reduction of output is greater with food products than most others. Since there is a relatively inelastic demand for food, an artificial scarcity is capable of raising the gross income to producers.

There are two serious difficulties in the way of profiting by such an artificial shortage in agriculture. In the first place the number of farmers and their wide geographic distribution make successful cooperation in such a venture extremely difficult. In the second place consumers can substitute one food article for another so that successful control would have to cover the entire industry rather than individual sections of it. Consumers also have other means of defense and of retaliation which producers seldom suspect until they arouse consumers’ antagonism.
concerned, not to guarantee an income to the corporation, but rather to make sure that they are not excessive. They usually serve more as maximum than as minimum rates. Of course, this does not mean that excessive rates have not at times been approved. But it should be understood clearly that governmental activity regarding public utilities is not at the behest of the industries regulated. The growth of public regulation has been opposed, often bitterly, by the industries concerned. It is merely recognized that, in return for their services, the corporations concerned are entitled to "reasonable returns" (a vague and changeable concept) on their "investment" (which is also subject to variable interpretation). There is practically never any guarantee of such return. In the case of the railroads an effort was made to recapture for the government half of any earnings, by individual companies, in excess of 6 percent. This recapture clause was abandoned because it was found impracticable of enforcement.

Rates in themselves are no assurance of satisfactory income. Railroad rates remained virtually unchanged from 1929 to 1932 but there was a great loss in volume of traffic. Consequently table 1 shows that net earnings of 150 railroads declined from $897,000,000 to a loss of $151,000,000. The 70 power companies reported in table 1 were still in an expanding stage of their development. Also they produce services which are demanded in relatively constant amounts. Nevertheless their net earnings fell from over $400,000,000 to $292,000,000 in 1933. Neither of these industries had either a guarantee of income from governing bodies or the ability to extort a "reasonable return" during a severe depression.

### TABLE I. NET EARNINGS OF 1099 CORPORATIONS, BY GROUPS: 1926-1933, FROM MOODY'S MANUAL OF INDUSTRIALS FOR 1934.

<table>
<thead>
<tr>
<th>Industry</th>
<th>No. of companies</th>
<th>Net earnings available for dividends in millions of dollars</th>
<th>1933</th>
<th>1932</th>
<th>1931</th>
<th>1930</th>
<th>1929</th>
<th>1928</th>
<th>1927</th>
<th>1926</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural implements</td>
<td>9</td>
<td></td>
<td>*17</td>
<td>*30</td>
<td>*9</td>
<td>40</td>
<td>77</td>
<td>81</td>
<td>48</td>
<td>43</td>
</tr>
<tr>
<td>Automobiles</td>
<td>22</td>
<td></td>
<td>68</td>
<td>*63</td>
<td>77</td>
<td>165</td>
<td>362</td>
<td>393</td>
<td>331</td>
<td>280</td>
</tr>
<tr>
<td>Building</td>
<td>43</td>
<td></td>
<td>4</td>
<td>*27</td>
<td>6</td>
<td>57</td>
<td>104</td>
<td>91</td>
<td>86</td>
<td>90</td>
</tr>
<tr>
<td>Chemicals</td>
<td>16</td>
<td></td>
<td>81</td>
<td>48</td>
<td>82</td>
<td>111</td>
<td>154</td>
<td>140</td>
<td>100</td>
<td>94</td>
</tr>
<tr>
<td>Copper mining</td>
<td>19</td>
<td></td>
<td>*1</td>
<td>*50</td>
<td>*6</td>
<td>54</td>
<td>228</td>
<td>146</td>
<td>56</td>
<td>63</td>
</tr>
<tr>
<td>Electrical equipment</td>
<td>22</td>
<td></td>
<td>2</td>
<td>*5</td>
<td>38</td>
<td>83</td>
<td>125</td>
<td>96</td>
<td>79</td>
<td>84</td>
</tr>
<tr>
<td>Machinery and tools</td>
<td>69</td>
<td></td>
<td>*13</td>
<td>*35</td>
<td>*17</td>
<td>*48</td>
<td>98</td>
<td>75</td>
<td>61</td>
<td>72</td>
</tr>
<tr>
<td>Petroleum</td>
<td>41</td>
<td></td>
<td>87</td>
<td>57</td>
<td>*51</td>
<td>263</td>
<td>597</td>
<td>521</td>
<td>262</td>
<td>551</td>
</tr>
<tr>
<td>Steel</td>
<td>46</td>
<td></td>
<td>*67</td>
<td>*160</td>
<td>*4</td>
<td>129</td>
<td>411</td>
<td>249</td>
<td>192</td>
<td>243</td>
</tr>
<tr>
<td>Tobacco-cigarettes</td>
<td>6</td>
<td></td>
<td>59</td>
<td>106</td>
<td>111</td>
<td>106</td>
<td>86</td>
<td>77</td>
<td>74</td>
<td>71</td>
</tr>
<tr>
<td>Total industrial</td>
<td>854</td>
<td></td>
<td>702</td>
<td>*98</td>
<td>670</td>
<td>1,923</td>
<td>3,611</td>
<td>3,062</td>
<td>2,393</td>
<td>2,641</td>
</tr>
<tr>
<td>Railroad</td>
<td>150</td>
<td></td>
<td>14</td>
<td>*151</td>
<td>135</td>
<td>524</td>
<td>807</td>
<td>787</td>
<td>673</td>
<td>809</td>
</tr>
<tr>
<td>Utilities—electric, gas telephone</td>
<td>70</td>
<td></td>
<td>292</td>
<td>343</td>
<td>413</td>
<td>423</td>
<td>414</td>
<td>366</td>
<td>315</td>
<td>275</td>
</tr>
<tr>
<td>All companies</td>
<td>1,099</td>
<td></td>
<td>1,110</td>
<td>234</td>
<td>1,411</td>
<td>3,072</td>
<td>5,141</td>
<td>4,466</td>
<td>3,547</td>
<td>3,879</td>
</tr>
</tbody>
</table>

*Deficit
Further, in the interest of consumers a governing body may actually compel a public utility to continue to perform a service agreed in its franchise, even though it may be at a loss. Many branch railroads in this country would soon be abandoned except that the Interstate Commerce Commission refuses to grant permission to suspend services which shippers or passengers still demand.

Before asking that agriculture be declared a public utility, farmers would do well to consider what public utility implies. They should also consider the history of other public utilities, as well as the lack of analogy between agriculture and the railroads or the electric power industry. With the public utilities the problem was to protect the public from small groups of powerful corporations. In the case of agriculture the problem is how to raise the standard of living of a large group of producers who are widely scattered, virtually unorganized and in sharp competition with each other.

PRICE DURING SHORT PERIODS OF TIME

First a distinction should be made between factors determining prices during short and long periods. During the short, or market period, there is no necessary relationship between cost and price. Suppose we consider the price of hogs in Chicago on a given day. The number of hogs likely to be offered for sale during the next few weeks is rather definitely fixed. There is no possibility of raising more hogs within a period of a few days or weeks. Neither is there any possibility of withholding from market a very large percentage of the hogs already raised and ready for sale. In this case, therefore, price depends on the size of the supply currently offered and on how intensely potential buyers want that particular number.

There are two assumptions underlying this statement. The first assumption is that the hogs are being offered for sale by freely competing sellers and are being purchased by freely competing buyers. The second is that there is not a single price which buyers are willing to pay regardless of the number offered. Instead there is a long list of various prices which they would be willing to pay under the existing demand conditions. If 15,000 hogs are offered it will be possible to get buyers to pay a certain price. If the number offered should rise to 16,000, it would be necessary to accept a somewhat lower price. With the demands for the first 15,000 hogs already in a way to be

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22 It is not impossible that some agricultural enterprises may be brought under control as public utilities. There is considerable talk of this concerning the production of fluid milk. In eastern sections of the country, where the drift in that direction has gone farthest, there is already rigid veterinary inspection of milk cows and condemnation in case of certain diseases. There is, further, rigorous regulation of the design of cow stables as to space per cow, light, ventilation, sanitation and as to the conditions under which milk is stored or transported.
filled, the additional 1,000 head can be disposed of only to people, or for purposes, which do not involve so strong a demand for hogs. If only 14,000 hogs should come to market the next day, the price would be pretty certain to rise because the demand is more intense for the fourteenth thousand than for the fifteenth.

It should be remembered that there is a schedule of selling prices as well as of buying prices. That is, if prices should fall very sharply some sellers would tend to hold back their hogs, at least for a few days. This influence is more important, however, with non-perishable products such as wheat and cotton than with fat hogs, peaches, melons, etc.

**PRICE AND COST DURING LONGER PERIODS**

*During a long period normal price tends to equal marginal cost of production* since anyone continually producing at a cost higher than price is ultimately forced out of business. Having made this broad, general statement, it immediately becomes necessary to explain just what it means and to interpret the terms "normal price" and "marginal cost". Also it should be emphasized that the statement means just what it says; normal price tends to equal marginal cost. Marginal cost does not determine price. The influence of demand conditions are as important as those of supply. It would be better to say that, over a long period, price is determined by the mutual operation of supply and demand forces.

What is meant by "normal price?" This does not necessarily refer to any actual price recorded in the market. Nor does it refer to an average of prices over some particular period of time. It assumes, first, that buying and selling are proceeding in a free competitive manner (an assumption which is at least partially violated in many industries). It assumes, further, that no changes occur during the period under consideration either in the nature or volume of demand, or in methods or costs of production. It assumes also that the monetary medium is not being subjected to manipulation and that the price level is stable.

New methods of production, changes in demands—even for staple food products, fluctuations in the buying power of money, periods of active and depressed business are continually occurring. Each of these upsets price relationships previously existing. And before one set of disturbances is eliminated, it is likely that several other disturbances have begun to show their effects.

Yet it is only under this static and unreal set of conditions that current costs could ever be said to equal or (by courtesy) to determine current prices. The tendency for normal price to equal marginal cost should be interpreted strictly and only as applying to this hypothetical situation. As a statement of a
relationship which would tend to exist under a static and unchanging condition the principle is of theoretical use. As a statement of what does happen under the dynamic conditions of everyday life, it provides us with no practical guidance.

MARGINAL COST

Which cost is it that would tend to equal price under the hypothetical conditions we have just defined? Again the layman is apt to reply—average cost. A little thought will dispel this error. Suppose that 100 farmers are raising wheat and no other crop. Over a period of years the cost of a bushel is slightly different to each of these men. Suppose, now, that the price each year were made to equal the cost of the average or fiftieth (median) man in rank. It would not be long until we would find the less efficient men forced to drop out. Ultimately, only half of our farmers would be solvent. (In fact if the price were fixed strictly at the average level instead of the cost of the 50th man, the average would be lowered each time a high cost man dropped out and the process would continue indefinitely.)

The correct statement is that the normal price tends to equal marginal cost. We may define the marginal producer as the highest cost producer whom it is necessary to keep in business in order to supply a given demand. There is a different marginal producer for each different amount of the product demanded. That is, if only 50 millions of hogs were wanted per year for the next 15 or 20 years the marginal producer would be a relatively efficient manager operating under relatively favorable conditions. But if 60 million were wanted per year the marginal producer for that number would be a less efficient manager or would be operating under less favorable conditions. His costs (the marginal costs for 60 million hogs) would be higher than the corresponding figure for a supply of 50 million.

Marginal production is not confined to the production of relatively inefficient producers. Costs may be considered to vary on the same farm depending on how far a given line of production is pushed. If the value of corn is very high it becomes profitable to raise it on the rougher fields, to apply more fertilizer, cultivate more often, etc. The last bushels obtained by these methods, which cost as much as the value, may be called the marginal corn output of a particular farm under a given value. If the value of corn falls, the alert farmer will put some of his rougher land back into pasture and will buy less fertilizer. He will contract his production until his most expensive corn costs no more than the price. It may take several years to make the adjustment, but, when it is made, the farmer will have a new and lower marginal cost.

In this sense it will be seen that, value is capable of governing cost (marginal cost) quite as much as cost governs value. This is likely to be a startling thought to some persons, but it can
be verified by experience. When prices fall it is necessary either to cut costs to a corresponding level, or ultimately, to go out of business.

**COST AND THE TIME ELEMENT**

There is another sense, also, in which value governs cost. If value rises considerably it is likely to lead to an expansion of the productive plant. In manufacturing this generally means that new factories are built and the old ones expanded. In agriculture it usually means the plowing up of pastures or ranges in order to grow the wheat or corn which has gone up in value and (temporarily) in profitableness. It also means buying of more machinery and putting up new buildings.

After the new building has been erected the only thing to do is to use it in such a way as to get the largest possible return, even though this may be less than was originally expected. If the rise in value was temporary, the industry may be left with an overexpanded plant for a considerable period. This is an important characteristic of the economic process. It is described by saying that economic processes are irreversible. The subsequent decline in value does not remove the increased capacity which the rise in value created.

**VARIABLE AND FIXED COSTS**

As we puzzle over the effects of expanding productive capacity in the preceding paragraphs, we find that we have uncovered another important classification of costs. Costs which are incurred directly on the current output of product such as feed for fattening cattle, twine for small grains, threshing labor, etc., may be called the *variable costs*. There is no question but that these apply to the production of this year’s output. They would stop at once if it were decided not to operate the farm next year, and they vary in amount in direct proportion to the amount of the product.

A contrasting type of expenditure is that which continues from year to year regardless of the amount of product. These may be called the *fixed costs*. They include such items as taxes, upkeep of buildings and fences, interest on investment already made, depreciation on buildings and part of the depreciation on machinery. These items cannot be reduced quickly, even though the outlook for the immediate future may be unfavorable.

This classification of costs is an important one in helping the farmer plan his operations for the coming year. Let us suppose he knows from his records that his variable expenses for hired labor, seeds, feeds bought, twine, threshing bills, etc., amount to $1,500 per year. His fixed expenses including interest on the investment he has already made, interest on mortgage, taxes, depreciation on buildings and equipment, upkeep of
buildings, etc. amount to $2,000. The total costs of all kinds are, therefore, $3,500. Now let us assume that the outlook for the coming year is for a total income of only $2,500. This means a loss of $1,000.

Should the farmer let his farm stand idle in order to avoid this loss? If he were to let the farm stand idle he would lose the entire fixed cost of $2,000. If he were to operate it he would get back all of his variable expenses and $500 on the fixed expenses.

Of course under such conditions no new investments would be made in farming equipment or buildings and the sales price of land would decline rapidly. But as a guide to temporary business policy, it is important to realize that all costs do not have the same significance.

After the buildings have been erected, the machinery bought, the farm stocked with livestock, etc., the total expenditures or costs per unit of product no longer furnish a satisfactory guide. These investments made may either yield high or low rates of returns, depending on later developments. Now the problem to the individual is how to make the largest returns from whatever resources he may have, regardless of how much he originally put into them. His choice is whether it would pay better to operate his farm under prevailing prices and according to his original plans or to let it stand idle, or to operate it under some revision of plans. Insofar as guidance could be furnished by a comparison of receipts and costs under these conditions it will be the variable costs and not the total costs that will be of use.

JOINT COSTS

Joint costs have already been mentioned in connection with the problem of cost allocation. It will be remembered that these are the costs which apply to more than one product. As with mutton and wool, cotton and cottonseed, oats and straw, beef and hides, etc., the whole production process is the unit. The wool cannot be produced without the mutton, nor the oats without the straw.

How is price related to costs in such a case as this? It cannot be said, here, that some particular amount of cost tends to equal price of a specific product, even over the normal period of time. As in the simpler case, the cost-to-price relationship is effective only as it is applied in decisions made by the individual producer. Those farmers who decide their returns would be larger than their total costs will probably decide to raise the sheep. (For a short period the farmer will find it advantageous to raise the sheep if his total returns promise to exceed total variable costs.)

The significant sum of cost here has to be expressed per sheep rather than per pound of wool or mutton. In the case
of cotton it will be the sum of costs for a combined unit of cottonseed and lint, and for other products for whatever the natural unit of production may be. The marginal producer will be the one to whom it is a matter of indifference (as far as economic considerations are concerned) whether he raises the crop or not. A reduction in the price of either of the joint products would stop him from growing both of them.

OTHER COST—PRICE CONSIDERATIONS

This discussion of the theory of cost has already covered several pages, and yet it has necessarily been of a rather sketchy nature. Probably enough has been said to convince any thoughtful reader that there are different types of costs which have very different significance to the producer as well as to the market.

In deciding on the utilization of a given resource, the farmer or other business man is more concerned about various opportunities which are open to him than about what he originally put into the business. Again, business plans are forward looking, while cost determination is essentially backward looking. The cost which is capable of guiding the farm operator most profitably is not cost originally incurred, but rather opportunity cost.

What crop should be planted on a certain piece of land? The answer does not depend at all on what was originally paid for the land—whether it was $10 per acre or $100. It depends instead on what returns could be made from the various alternative crops which might be raised there. Let us suppose that the alternatives (leaving the desirability of crop rotation out of the picture for the moment) are to raise oats, corn, or wheat. Let us suppose that a farmer figures that, after deducting the current expenses for labor, power, twine, etc., he could expect a net return per acre of $4.00 from oats, $6.00 from wheat, or $8.00 from corn. If he raises corn he has to give up the opportunity of getting a return of $6.00 per acre from wheat and the opportunity for a return of $4.00 from oats. Naturally he will choose the corn, because this is the alternative which will yield more than any other opportunity. In the next section we will explain the method of budgeting which makes it possible to choose the most remunerative opportunity.
The budgeting method is ordinarily used by the farmer in planning his own farm organization. Farm management workers have lately undertaken to develop and systematize it. By this method the farmer undertakes to plan the use of his resources as a whole and adapts each individual line of production to the requirements of the rest of the farm.

How shall we decide, for instance, whether to feed a carload of cattle? Certainly not on the basis of costs per pound of gain. Rather let us prepare a list of the returns to be expected on the one hand, and on the other a list of the various expenses which would be added by the feeding enterprise to the rest of the farm outlay.

**BUDGET FOR FEEDING STEERS**

Expected returns: 20 steers, 800 pounds, @ $8.00  ____________ $1,280

Expected expenses:
- Purchase price of steers, 500 pounds each @ $5.50  __ $550
- Corn, 900 bushels @ .40  ____________ 360
- Oilmeal, 3 tons @ $35  ____________ 105
- Cornstalk pasture, 1 month, no extra cost  ____________ 150
- Hay, 15 tons @ $10  ____________ 150
- Labor, no extra cost  ____________
- Total added expenses  ____________ $1,165
- Net returns expected  ____________ $ 115

The decision to feed the steers cannot be made, however, without considering any available alternatives. The corn and hay have already been raised and are to be disposed of somehow. From this budget it appears that a higher return would be obtained from feeding them to steers than from selling them directly. But they might have been fed to sheep. Before we decide in favor of the steers we should also consider this other possible enterprise in the same manner. It would involve a different set of direct expenses and receipts and probably would involve different labor plans and different relationships to other enterprises.

**How would this method be applied to the entire farm?** Let us suppose that a farmer is moving onto a new farm. The first question will probably be as to his crop system. Corn is probably the crop of highest value per acre. Therefore he desires to raise as much corn as possible. But too large an acreage of corn would soon reduce yields. Thus it is necessary to adopt a diversified cropping system. Now the question arises: At what point can high acreages of corn most profitably be balanced against maintenance of soil fertility and high yields? Should a 3-, a 4- or a 5-year rotation be adopted?

If a 4-year rotation is adopted it will give us more corn and less roughage than a 3-year rotation. A smaller amount of roughage would mean that we could not raise so many cattle or
sheep. On the other hand, with corn 2 years out of 4, more grain would be available either for feeding or for sale. Alternative budgets for each layout would have to be compared in making a choice.

From the crop system we are naturally led into a consideration of the livestock enterprises which could be utilized to convert the feed crops into marketable products. The livestock plans, in turn, may call for some revision of the crop plans. If the price of hogs is high, it may increase the net income to feed more hogs; this would call for a reduction in the acreage of roughage. With lower hog prices or higher cattle prices it would be profitable to feed more cattle. This would require more roughage and a corresponding reduction in the grain acreage. In order that the different crops and livestock enterprises may fit together and operate smoothly, it would be desirable to work out, or at least to think out the budgetary plans before the shift in numbers of livestock is undertaken.

Next, it is necessary to consider the “service” enterprises which provide the labor, power, etc., for the operation of the farm. The most economical number of horses and whether a tractor is kept will depend on the acreages in crops. It will also depend on whether these particular crops result in heavy peak loads for labor in certain seasons. Similar consideration must be given to the demands for labor, for equipment and for some other factors.

More complete descriptions of the budgeting method are available elsewhere. The important thing here is that this method attempts to work out such a combination of enterprises as would yield the greatest returns from whatever resources the farmer may have available. It deals with the whole farm and not with a single enterprise at a time. It is the method which the thinking farmer already uses naturally, (usually without realizing it) but not often in a systematic way. Most farmers would profit by becoming more thoroughly acquainted with this method and figuring out the probable results of their plans before they are put into operation.

APPENDIX A

TEST OF DEPARTURE FROM NORMALITY

Once a frequency distribution is set up in graphic form it is possible to determine its prominent characteristics by observation; that is, whether the distribution is decidedly skewed, flat topped or high peaked in form. Although a marked departure from normality may be discovered through observation, it would be very risky to say departure was or was not significant, for the sample, until the data had been subjected to some form of accepted mathematical test. The frequency

\[23\] An example of the use of the budgeting method as applied to the question whether it would be profitable to adopt the Corn-Hog plan may be found in Iowa Agr. Exp. Sta. Bul. 312.
distributions included in this bulletin were tested for departure from normality by the Fisher test.\textsuperscript{24}

The quantity \( G_t \), which is used in the Fisher test, is essentially a measure of asymmetry. A positive \( g_t \) indicates that the distribution is skewed to the right (i.e., towards the higher values) and a negative \( g_t \) indicates skew to the left.

The quantity \( g_s \) tests the slope and height of the distribution. When the distribution has a high apex and wide spreading tails, the resulting \( g_s \) is positive. A flat-topped distribution, with short tails is indicated by a negative \( g_s \).

The significance of the \( g_t \) and \( g_s \) statistics is tested by computing their respective standard errors. They are considered significant only if they are at least twice their standard errors. Thus, if the term \( g_t > 2 \) for a given distribution is less than twice its standard error, it is to be considered that the distribution is symmetrical within the range of chance variation.

**ARITHMETIC DISTRIBUTIONS OF PHYSICAL YIELDS**

Table II shows frequency distributions of the yield per acre of corn and oats and of gain per day on pigs. At the bottom of the table is shown the measures of symmetry and of shape of distributions. It will be observed that both measures are well within the limit of twice their respective standard errors. The distributions are therefore to be considered to be of the normal form. This is illustrated by fig. 1.

**Table II. Arithmetic Distribution of Yields.**

Yields per acre on corn and oats, gains per day on hogs, expressed as percentages of averages of groups.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Class, midvalue of percentage of avg. county yield</td>
<td>No. farms</td>
<td>No. farms</td>
<td>No. farms</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>3</td>
<td>10</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>16</td>
<td>21</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>85</td>
<td>49</td>
<td>42</td>
<td>37</td>
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<td></td>
</tr>
<tr>
<td>100</td>
<td>75</td>
<td>47</td>
<td>41</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>115</td>
<td>45</td>
<td>40</td>
<td>36</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>130</td>
<td>23</td>
<td>22</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>145</td>
<td>4</td>
<td>9</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>160</td>
<td>-</td>
<td>5</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>175</td>
<td>-</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>190</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>218</td>
<td>202</td>
<td>157</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( g_t = -0.242 \pm 0.166 \) \( g_s = 0.181 \pm 0.332 \)

**LOGARITHMIC DISTRIBUTIONS OF OPERATING COSTS PER ACRE**

Table III shows distributions of the operating costs per acre on corn and oats. This includes estimates of all costs except for the use of land and buildings and corresponds roughly to the total variable costs. It

will be observed that $g_1$ for corn costs per acre is positive and significant, while $g_2$ for oats is insignificant.

### TABLE III. LOGARITHMIC DISTRIBUTIONS OF OPERATING COSTS PER ACRE IN IOWA

<table>
<thead>
<tr>
<th>Counties and Years</th>
<th>Corn</th>
<th>Oats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Marshall 1921-1924</td>
<td>Marshall 1921-1924</td>
</tr>
<tr>
<td></td>
<td>Shelby 1921-1924</td>
<td>Shelby 1921-1924</td>
</tr>
<tr>
<td></td>
<td>Iowa 1925-1927</td>
<td>Iowa 1925-1927</td>
</tr>
<tr>
<td>No. farms</td>
<td>No. farms</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Class -7</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>-6</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>-5</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>-4</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>-3</td>
<td>30</td>
<td>24</td>
</tr>
<tr>
<td>-2</td>
<td>53</td>
<td>33</td>
</tr>
<tr>
<td>-1</td>
<td>56</td>
<td>38</td>
</tr>
<tr>
<td>0</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>1</td>
<td>22</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>247</td>
<td>230</td>
</tr>
<tr>
<td>$g_1$</td>
<td>.421</td>
<td>± .136</td>
</tr>
<tr>
<td>$g_2$</td>
<td>.179</td>
<td>± .112</td>
</tr>
<tr>
<td>$g_1$</td>
<td>.425</td>
<td>± .161</td>
</tr>
<tr>
<td>$g_2$</td>
<td>.323</td>
<td>± .323</td>
</tr>
</tbody>
</table>

### LOGARITHMIC DISTRIBUTION OF COSTS PER UNIT

Table IV shows the variation in costs per bushel of corn and oats and costs of hogs per hundred pounds in several different studies. Each of these distributions is centered on its geometric mean. Classes are at intervals of 15 percent. That is, the upper limit of each class is a figure which is 15 percent greater than the lower limit of the same class. If the lower limit of a particular class were 50, the upper limit of the same class would be 57.5, and the upper limit of the next higher class would be 66.1. Logarithms were used in determination of the geometric mean and in computing class intervals.

The distributions of costs per unit of corn, oats and marketable hogs in the combined Marshall, Shelby and Iowa County studies are symmetrical and of the normal width and height within the permitted limit of twice the standard error. The arithmetic distribution of these figures is shown in fig. 2, and the geometric or logarithmic distribution is shown in fig. 3.

The costs of hogs in Humboldt County and of corn in six counties in 1927 show significant skewness to the right, although the $g_1$ value was not greatly in excess of the two standard errors. The same is true of the $g_2$ measure of width and height. This is explained by the fact that some of the farms were operating under conditions widely different from the others in the same county and year. Serious injury to the corn on a single farm of a group from hail or flood or other unique causes, or an outbreak of cholera in a herd of hogs would disturb this relationship. In the case of the hog costs, one farm suffered heavy loss from disease. With corn, one farm had very high operating costs but extremely low yields, although the reason is not recorded. If these two cases be omitted, all five of these distributions become normal in form within the permitted limits.
TABLE IV. LOGARITHMIC DISTRIBUTIONS OF PER UNIT COSTS, CORN, OATS AND MARKETABLE HOGS.

<table>
<thead>
<tr>
<th>County &amp; year</th>
<th>Corn</th>
<th>Corn</th>
<th>Oats</th>
<th>Marketable hogs</th>
<th>Marketable hogs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>No. farms</td>
<td>No. farms</td>
<td>No. farms</td>
<td>No. farms</td>
<td>No. farms</td>
</tr>
<tr>
<td>-6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-5</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>-4</td>
<td>3</td>
<td>5</td>
<td>11</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>-3</td>
<td>4</td>
<td>13</td>
<td>16</td>
<td>14</td>
<td>5</td>
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<tr>
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<td>14</td>
<td>28</td>
<td>31</td>
<td>25</td>
<td>23</td>
</tr>
<tr>
<td>-1</td>
<td>21</td>
<td>43</td>
<td>38</td>
<td>55</td>
<td>27</td>
</tr>
<tr>
<td>0</td>
<td>19</td>
<td>76</td>
<td>50</td>
<td>60</td>
<td>47</td>
</tr>
<tr>
<td>+1</td>
<td>11</td>
<td>57</td>
<td>45</td>
<td>30</td>
<td>30</td>
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<tr>
<td>+2</td>
<td>15</td>
<td>29</td>
<td>32</td>
<td>24</td>
<td>14</td>
</tr>
<tr>
<td>+3</td>
<td>3</td>
<td>11</td>
<td>15</td>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td>+4</td>
<td>11</td>
<td>6</td>
<td>9</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>+5</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>+6</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>+7</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>97</td>
<td>270</td>
<td>252</td>
<td>258</td>
<td>157</td>
</tr>
</tbody>
</table>

\[
g_1 = 0.656 \pm 0.249 - 0.020 \pm 0.149 - 0.174 \pm 0.154 - 0.279 \pm 0.132 \pm 0.587 \pm 0.196
\]

\[
g_2 = 1.076 \pm 0.497 - 0.231 \pm 0.296 - 0.057 \pm 0.309 - 0.274 \pm 0.305 \pm 1.538 \pm 0.391
\]

Omitting one case

\[
g_1 = 0.490 \pm 0.350
\]

\[
g_2 = 0.652 \pm 0.600
\]

APPENDIX B

TENDENCY OF FARMS TO MAINTAIN SAME RELATIVE COST RANK OVER A PERIOD OF YEARS

The first step in treating the data was the elimination of the price differential, since in this study we are not concerned with the change from year to year because of variations in the price level. This was accomplished by taking the total of per unit costs for each year as 100 and expressing the costs per individual farm as percentages of the combined costs for the group of farms.


"Insofar as it is possible to argue that changes in costs of production would be of the same nature as changes in labor income, it appears that the notion of consistently high-cost and consistently low-cost producers, with regard to periods of years, is erroneous. The data on costs per unit indicate a negative sort of consistency—a year to year reversal of position—quite as well as they indicate a tendency toward consistency. (Italics supplied.) The data on labor income, by analogy, indicate inconsistency in maintenance of position quite as well as they indicate consistency."

After reading this statement by Bennett it seemed desirable to examine certain cost data which had previously been collected in the state of Iowa. Bennett makes only a graphic presentation of the data, from which apparently he drew his conclusions. In the examination of the cost data for Iowa, it was thought desirable to make a more critical statistical analysis and actually to measure the tendency of per unit costs to vary from farm to farm the same year and from year to year on the same farm.

It is understood by the writers that the method used does not completely eliminate the price differential, but it is accurate enough for most practical purposes and materially facilitates further calculations.


"Insofar as it is possible to argue that changes in costs of production would be of the same nature as changes in labor income, it appears that the notion of consistently high-cost and consistently low-cost producers, with regard to periods of years, is erroneous. The data on costs per unit indicate a negative sort of consistency—a year to year reversal of position—quite as well as they indicate a tendency toward consistency. (Italics supplied.) The data on labor income, by analogy, indicate inconsistency in maintenance of position quite as well as they indicate consistency."

After reading this statement by Bennett it seemed desirable to examine certain cost data which had previously been collected in the state of Iowa. Bennett makes only a graphic presentation of the data, from which apparently he drew his conclusions. In the examination of the cost data for Iowa, it was thought desirable to make a more critical statistical analysis and actually to measure the tendency of per unit costs to vary from farm to farm the same year and from year to year on the same farm.

26 It is understood by the writers that the method used does not completely eliminate the price differential, but it is accurate enough for most practical purposes and materially facilitates further calculations.
After elimination of the price differential we still have variations in two directions: (1) variation between costs on different farms for the same year, and, (2) variation between the costs on the same farm for consecutive years. Hereafter these two shall be denoted as: (1) variations between farms, and (2) variations within farms. If the variation between farms is greater than the variations within farms the data are said to show a positive consistency. That is, the costs per farm show a tendency to remain at or near the same relative level from year to year. The greater the variation between farms compared with the variation within farms the greater the tendency for the costs on the same farm to remain the same over a period of years.

On the other hand, the per unit cost of production figures are said to show a negative consistency if variation within farms is greater than variation between farms. The greater the difference the larger is the negative consistency. A negative consistency would indicate that a farm with low per unit costs one year would tend to have high per unit costs the next. In this study, sets of data comparing per unit costs were examined for corn, oats and hogs in pairs of years, and for 4-year periods.

ILLUSTRATION OF METHOD

Examples of the cost figures studied are given in table V. As a first step in the analysis it is necessary to eliminate the price differential between years. This was done by taking the total for the 13 farms in table V as 100 and expressing the cost per unit for each farm as a percentage of the total. These percentages are shown in table VI by years, vertically for the group of farms; and for the same farm, by years, horizontally.

Next, the analysis of variance is carried through as illustrated in table VII. With the influence of the price level removed from the cost of production figures on corn costs in Marshall County in the years 1920-1923, it was found that the statistic $F$ equals 2.18, which is slightly larger than the tabular $F=2.01$. In other words, the cost varied less from year to year on the same farm than it did from farm to farm in the same year. In this case there can be no doubt that the farms showed

For full details of the analysis of variance the reader is referred to Snedecor, G. W., "Calculation and Interpretation of Analysis of Variance and Covariance"; pages 3 to 12. Values of $(F)$ and $(t)$ are found on pages 88 to 91.
TABLE VI. COST PER BUSHEL OF PRODUCING CORN; YEARLY PRICE DIFFERENTIAL REMOVED, MARSHALL COUNTY, IOWA, 1920-23.

<table>
<thead>
<tr>
<th>Farm number</th>
<th>Costs as percentage of total for the group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1920</td>
</tr>
<tr>
<td>3</td>
<td>4.70</td>
</tr>
<tr>
<td>36</td>
<td>5.61</td>
</tr>
<tr>
<td>7</td>
<td>5.61</td>
</tr>
<tr>
<td>23</td>
<td>6.76</td>
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<tr>
<td>11</td>
<td>7.22</td>
</tr>
<tr>
<td>35</td>
<td>7.68</td>
</tr>
<tr>
<td>31</td>
<td>8.02</td>
</tr>
<tr>
<td>20</td>
<td>8.36</td>
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<tr>
<td>12</td>
<td>8.36</td>
</tr>
<tr>
<td>19</td>
<td>8.59</td>
</tr>
<tr>
<td>10</td>
<td>9.16</td>
</tr>
<tr>
<td>21</td>
<td>10.31</td>
</tr>
<tr>
<td>Sum</td>
<td>100.00</td>
</tr>
</tbody>
</table>

a positive consistency. That is, the individual farms tended to remain at or near the same level for the 4-year period instead of changing their position from year to year.

TABLE VII. ANALYSIS OF VARIANCE OF COST PER BUSHEL OF PRODUCING CORN*.

Marshall County, 1920 to 1923.

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Degrees of freedom</th>
<th>Sum of squares</th>
<th>Mean square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between farms</td>
<td>12</td>
<td>64.3763</td>
<td>5.3647</td>
</tr>
<tr>
<td>Within farms</td>
<td>39</td>
<td>95.9182</td>
<td>2.4594</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>160.2945</td>
<td>3.1430</td>
</tr>
</tbody>
</table>

\[
F = \frac{5.3647}{2.4594} = 2.18
\]

INTRA-CLASS CORRELATION

Intra-class correlation has been in use longer than the analysis of variance. Therefore, coefficients of intra-class correlation have been included for those persons who are acquainted with intra-class correlation but not with analysis of variance, (Table VIII.) It should be remarked that intra-class correlation is actually a form of analysis of variance, as pointed out by Fisher.

By using Fisher’s method of solving for intra-class correlation it is possible to solve for (r) directly from the mean square as found between and within farms. In the Marshall County corn cost problem discussed above, r = .23. This would automatically be considered significant since the value of F was found to be significant.

28 Harris, J. A. 1913. On calculation of intra-class coefficients of correlation from class movements when the number of possible combinations is large, page 471, Biometrica, IX, 446-472.

29 Fisher, R. A. Statistical Methods for Research Workers, Fourth edition, 1932, Chapter VII.
TABLE VIII. TENDENCY OF FARMS TO MAINTAIN THEIR RELATIVE COST POSITION OVER PERIODS OF TWO OR MORE YEARS.

Farms ranked on basis of cost per unit, measured by analysis of variance and intra-class correlation.

<table>
<thead>
<tr>
<th></th>
<th>Number of years included</th>
<th>Number of records</th>
<th>Value of $F$</th>
<th>Tabular value of $F$</th>
<th>Intra-class correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$P = .05$</td>
<td>$P = .01$</td>
</tr>
<tr>
<td>Cost per bushel of corn</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marshall county</td>
<td>4</td>
<td>13</td>
<td>2.18</td>
<td>2.01</td>
<td>2.68</td>
</tr>
<tr>
<td>Iowa county (1925-26)</td>
<td>2</td>
<td>18</td>
<td>1.92</td>
<td>2.24</td>
<td>3.22</td>
</tr>
<tr>
<td>Iowa county (1926-27)</td>
<td>2</td>
<td>17</td>
<td>3.82</td>
<td>2.32</td>
<td>3.32</td>
</tr>
<tr>
<td>Shelby county</td>
<td>2</td>
<td>16</td>
<td>2.73</td>
<td>2.38</td>
<td>3.46</td>
</tr>
<tr>
<td>Cost per bushel of producing oats</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marshall county</td>
<td>4</td>
<td>12</td>
<td>2.84</td>
<td>2.07</td>
<td>2.80</td>
</tr>
<tr>
<td>Iowa county (1925-26)</td>
<td>2</td>
<td>17</td>
<td>1.34</td>
<td>2.32</td>
<td>3.32</td>
</tr>
<tr>
<td>Iowa county (1926-27)</td>
<td>2</td>
<td>15</td>
<td>1.34</td>
<td>2.45</td>
<td>3.61</td>
</tr>
<tr>
<td>Shelby county</td>
<td>2</td>
<td>15</td>
<td>6.19</td>
<td>2.45</td>
<td>3.61</td>
</tr>
<tr>
<td>Cost per Cwt. of producing marketable pork</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marshall county</td>
<td>4</td>
<td>10</td>
<td>2.24</td>
<td>2.32</td>
<td>3.25</td>
</tr>
<tr>
<td>Humboldt county</td>
<td>3</td>
<td>27</td>
<td>1.27</td>
<td>1.42</td>
<td>1.64</td>
</tr>
<tr>
<td>Humboldt county (1922-23)</td>
<td>2</td>
<td>43</td>
<td>3.46</td>
<td>1.49</td>
<td>1.74</td>
</tr>
<tr>
<td>Humboldt county (1923-24)</td>
<td>2</td>
<td>30</td>
<td>1.56</td>
<td>1.62</td>
<td>2.01</td>
</tr>
<tr>
<td>Iowa county (1925-26)</td>
<td>2</td>
<td>17</td>
<td>3.91</td>
<td>2.32</td>
<td>3.32</td>
</tr>
<tr>
<td>Iowa county (1926-27)</td>
<td>2</td>
<td>15</td>
<td>3.21</td>
<td>2.45</td>
<td>3.61</td>
</tr>
</tbody>
</table>

RESULTS OF ANALYSIS

Results of the analysis of the several samples of cost of production data which were available are shown in table VIII. In these examples the value $F$ was used to measure the variation of costs on the same farm, for different years, as compared with the variations between farms in the same year. With the four samples of figures on cost of production of corn per bushel it was found that one $F$ is slightly below significance, two are well within the limit of significance and one shows strong significance. The cost data for oats result in a somewhat different distribution of $F$ values; two sets of data yield highly significant values, while the other two yield $F$ values which are definitely below significance. Of the six sets of cost data on producing pork, one was found to be below significance, while one value would be called significant and the other two strongly significant.

In an early part of this discussion the terms negative consistency and positive consistency are used. The question may be raised how it is known whether the consistency is negative or positive from the value $F$. Since the value $F$ is the result of dividing mean square between farms with mean square within farms, any value below one would indicate negative consistency, while a value of more than one would indicate a positive consistency. It will be noted that all $F$ values found in this study are greater than one and would be called positive.

Evidence was found in these data of a greater consistency in the cost figures on the same farm over a period of 2 or more years than exists between different farms for the same year. That is, the farms ranked according to their cost of production figures have a greater tendency to remain at or near the same level over a period of years than they have to change their rank significantly from year to year.