

THE UNIVERSITY OF MINNESOTA

GRADUATE SCHOOL

Report

of

Committee on Examination

This is to certify that we the undersigned, as a committee of the Graduate School, have given Warren Cleland Waite final oral examination for the degree of Master of Arts . We recommend that the degree of Master of Arts be conferred upon the candidate.

Minneapolis, Minnesota

June 31 1921

W. B. Clark
Chairman
C. H. Eckles
R. H. Blake
C. L. Holcomb
J. B. Garver

THE UNIVERSITY OF MINNESOTA

GRADUATE SCHOOL

Report
of
Committee on Thesis

The undersigned, acting as a Committee of the Graduate School, have read the accompanying thesis submitted by Warren Cleland Waite for the degree of Master of Arts.

They approve it as a thesis meeting the requirements of the Graduate School of the University of Minnesota, and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts.

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Chairman
Loy G. Blodgett
.....
C. H. Eccles
.....

.....1918

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COST INDICES
FOR
BUTTERFAT PRODUCTION

A THESIS
SUBMITTED TO THE GRADUATE FACULTY
OF THE
UNIVERSITY OF MINNESOTA

BY
WARREN C. WAITE

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
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CHAPTER I.

INTRODUCTION.

The purpose of this study is to investigate the practicability of index numbers as a means of showing changes in production costs. The analysis will also show how useful such indices will be to producers in regulating production, and to consumers in regulating their buying, and to all persons concerned with market prices. Butterfat has been taken as an example, and all detailed study of the problem will be in terms of this commodity. To have included several commodities in the study would have confused it needlessly.

Production cost is a much mooted question among economists and with the general public. It has attracted most attention in the marketing of certain agricultural products where bargaining plays an important role in the price determination. Notable examples of such products are sugar beets and market milk. Especially in the market milk industry, powerful producer and distributor organizations have been built up which are able to exert tremendous influence on prices through the strength of their bargaining power. As a result, increasing attention has been drawn to the problems of price and of price fixing, and in turn to production cost.

Following is the usual economic analysis of the relation between price and cost of production, which analysis

is the economic justification for the importance usually attached to a knowledge of production costs. All actual sales of course necessitate market prices. These market prices fluctuate, with a greater or lesser degree of violence, above and below the actual production costs. Back of these market prices, is what the economist terms a normal price, or a price tending always to prevail. Market prices seldom are the same as this normal price, yet they always tend to gravitate toward it.

If the producer believes that the present normal prices do not cover his normal production costs and will not do so in the future, he will stop producing as soon as possible. The prices which the producer thinks of are of course market prices, but in the sense that he is thinking of a long time or general continued market price, he is thinking of a normal price. There is, therefore, at any time a certain price which is necessary to draw out a certain volume of production. This price is now generally called "necessary price". To determine necessary price, one must know production costs. Any price fixing scheme must therefore sooner or later consider production costs.

Another reason for studying production costs is for the help they will be to the producer. If the producer knows that production costs are increasing or decreasing he will be able to judge more intelligently when to include, expand, or contract a particular enterprise in his farm business. When producers are so fortified, they will insure a steadier flow of goods to market with a consequent steadying of price. The

(1)
price should as Mr. Wallace believes, be concentrated more nearly about some constant point in the scale of production costs when the knowledge of what these costs are becomes the property of a great many people.

Goods of course come to market from two sources, either from new production or out of stock. Stock comes ultimately from new production. Production costs have no direct effect upon the price which must be paid to secure goods from stock, as the goods must be marketed during the intervals between production periods even if the price falls to a point that barely covers the marketing and harvesting costs. Production costs do however have an effect upon the price that must be paid to secure goods out of new production. The producer will refuse to produce unless he believes that the normal price he receives for his product will cover his normal production costs. The effect is not always immediate. Some production processes require a long time or capital goods that cannot be shifted easily to another use. In these cases production will be continued where the loss from the discarding of the production equipment would be greater than the loss which is incurred through its use. The degree to which maladjustments of price can take place before being reflected back and made apparent to the consumer through their effect

(1) Wallace, H.A. Agricultural Prices, Wallace Publishing Co.
p. 61.

upon new production, therefore depends upon the importance of the flow of goods to market from stock relative to the flow of goods to market from new production, and also the elasticity of the flow of goods out of new production.

Big differences exist between commodities in this respect. In some there is a very slow response as in the dairy industry. The volume of new production cannot well be changed for several seasons. In consequence the price maladjustments may be very great and there may be uneconomic expansions and contractions of considerable magnitude. A knowledge of production costs would show both the producer and consumer when unusual conditions existed in the industry more quickly than it becomes apparent under the existing system. Such maladjustments as take place at the present time could therefore be largely prevented.

Early Methods of Studying Costs.

The first attempts to arrive at the cost of milk production were by what is known as the field method. This method consists of obtaining cost data from groups of farms, tabulating this material and presenting it in forms of averages designed to show the so-called "cost of production". Three methods have been used for collecting the original data, known as the cooperating farm method, the survey method and the statistical route method.

The cooperating farm method has been used at some time by nearly every research agency. It has probably been

used most extensively by the United States Department of Agriculture. Ordinarily the original data are kept in the form of a farm diary by the farmer himself. Records are made of various receipts and expenditures of money and of the use of labor of men and teams. At the end of the year or at even shorter intervals this diary is sent to the central station to be tabulated and compared and combined with other diaries.

In the survey method an investigator is sent to each farm, and by questioning the farmer obtains the desired data regarding the farm business. The accuracy of this method depends upon the skill of the investigator and the ability of the farmer to remember the facts desired. It was one of the first methods used in obtaining material regarding the farm business, and is still extensively used.

In the statistical route method several farms cooperate with a central station where the mathematical computations and tabulations connected with the keeping of the records are carried on. A daily and hourly record of the various operations and expenditures are kept, and these records are checked daily for accuracy and completeness by a visit of the route man. This method is largely a development of the Minnesota Experiment Station but has lately been adopted rather extensively by the United States Department of Agriculture.

Whatever method was used, certain bases were chosen for the cost charges. These charges were added up and the enterprise declared profitable or unprofitable as the total of these cost charges was above or below the selling price of the

product. The results were presented usually in the form of arithmetical means of the cost data for all the farms. The results therefore show certain characteristics of the whole group of farms from which they were taken. They cannot be applied to other farms and farming conditions without a consideration of the characteristics of the group of farms from which the original data was obtained and the methods of making the particular cost charges. The results however unfortunately were often misinterpreted even by the authors of the studies themselves. Besides, the methods employed by the various workers have varied so widely that results are not always comparable. C. W. Larson of Columbia writes as follows on this point:

"In the many bulletins and reports extant on the cost of producing milk, no two of them follow the same plan; even different reports from the same experiment station have been worked out under systems that make comparisons impossible. The various writers are not agreed on the relative importance of the different factors involved and the methods of handling them."

The Rise of the Formula Method.

As early as 1916, a number of the agricultural cost accountants recognized the shortcomings of the methods then in vogue. One of the first departures was the search for certain constant units that would be applicable at all times. When

(2) Larson, C. W. Milk Production Cost Accounts, Preface.

these units were determined it was believed that they could be applied to current prices and the so called "cost of production" discovered. Pearson explains his formula as follows: (3)

"Owing to the fact that values are constantly changing, it seems necessary that results be expressed in terms of commodities whenever possible. The items of feed and man labor are most easily expressed in this way; man labor in terms of hours, and feed, except pasture in terms of pounds. Since feeds listed as miscellaneous form a relatively small portion of the total feed used, they may be disregarded in forming a simple, practicable, and comparatively accurate method for arriving at the approximate cost of milk production."

The essential difference between the formula method of obtaining production costs and the so called "cost of production" method lies in the number of cost charges that must be included. The cost of production as determined by the cost accounting method consists of a summation of all the cost charges entering into the production of a good. The formula or index method does not profess to be a summation of cost charges, it is rather a fixed number of units which applied to current prices will show the cost of production.

The war gave an impetus to developments in this direction. The government was called upon to fix the prices of war materials and the more important food products. A method had to be evolved as there was no data available regarding costs. One of the first problems that arose was that of fixing the price of milk. Mr Hoover as Food Administrator appointed a committee to investigate the production, distribution

and food value of milk. The committee consisted of Mr. C. L. King as chairman, Mrs. A. W. Smith, Mr. F. A. Pearson, Mr. J. W. Sullivan, Mr. Gifford Pinchot, and Mr. G. A. Warren. Of the members of the committee Professors Pearson and Warren were best acquainted with agricultural accounting and agricultural costs and to them therefore was assigned the task of reporting to the committee on production costs. These men compiled records of 976 cows on 490 farms in Minnesota, Michigan, Massachusetts, Connecticut, New York and New Jersey and computed the average quantities of feed and labor per hundred pounds of milk produced for the city market. The following are the

(4)
results:

2.88 hours of man labor
33.5 pounds of grain
45.3 pounds of hay
11.5 pounds of other dry forage
93.2 pounds of silage
9.4 pounds of other succulent feed.

Following the publication of this report by the committee, the formula method was adopted by several of the milk commissions appointed in the various large markets, notably Chicago and New York. The Chicago Milk Commission adopted a modified Pearson formula. Pearsons original researches had led him to believe that the requirements for producing one hundred pounds of market milk in the Chicago district was as follows:

(5)
44 pounds of grain
118 pounds of silage
50 pounds of hay
39 pounds of other dry forage
2.42 hours of man labor.

(4) King, C.L. The Price of Milk. John C. Winston Co. p 109.

(5) Univ. of Ill. Agri Exp. Stat. Bull. 216 p.364

The formula actually adopted by the Chicago Milk Commission was
(6)
as follows:

20 pounds of home grown grains
24 pounds of manufactured feeds
110 pounds of hay
3 hours of man labor.

The manner in which the Chicago Milk Commission worked
out the price to be set for milk is explained by Duncan as
(7)
follows:

"The price to the consumer is predicated on the following basis.

1. The average monthly price which the producer received for his product over an eight year period, representing the cost of production and a reasonable profit.

2. A ratio of the principal elements entering into production of milk based on their relative proportion to the total cost of production.

3. Application of the increase in the price of these elements for the month of November, 1917, to the average price for the eight-year period above mentioned to determine the increased cost of production and profit for November, 1917, over the eight year period.

4. The application of the same percentage increase as prevailed in November 1917, to the average price received in the eight year period for the months of December, January, February, March, April, May and June, fixing thereby the price to the producer for the months of November and December 1917, and January, February, March, April, May and June 1918, with the same increase over the eight-year period that prevailed for the month of November 1917."

As a base from which to determine the index an eight year period was selected, which was considered typical of healthy conditions in the milk business, a time when there was

(6) King, C.L. The Price of Milk. John.C.Winston Co. p.113

(7) Duncan-The Chicago Milk Inquiry. Journal of Political Science. Vol. 17 p. 340 April 1918.

a normal growth in the industry and the farmers apparently made a "necessary profit." The reason for choosing a so-called typical period as a base was the assumption that during such a period a monthly variation in price had been worked out that represented the seasonal change in production costs; in other words that price had become adjusted to production costs and would cover them and leave the producer a "reasonable profit." The years selected as a base were from 1908 to 1915.

From the various cost of production studies that had been made in the territory surrounding Chicago, the ratio of the principal cost charges to the total cost was determined for the eight year period selected as a base. The findings of the Committee as to the relative importance of these charges was;

- 19% home grown grains
- 19% mill feeds
- 35% hay
- 27% labor

These percentages were then used as weights. The percentage increase of each of these principal cost charges over the base period was determined. The total increase in cost was then determined by weighting these various charges by the percentages as determined above. The total of these increases of the various principal charges then indicated the percentage increase in the total cost of milk production.

To determine the point at which the price of milk should be set for a given month the following method was used. The

(8) Ibid. p 340

increase in production costs for November 1917, over the average of the production costs for the eight-year period was determined. This percentage increase was then applied to the price received for milk during the eight-year period, and the resulting price gave the producer the same percentage increase in price for his product that his production costs had increased. From this arbitrarily selected base of November 1917 the price for the other months was determined by applying to the price of that month the same percentage of variation that existed during the eight-year period from the month of November during that period.

As a basis for the charges of these various elements entering into the production costs, certain definite standards were selected. A ration that was considered standard for the territory was determined and the various feeds were weighted according to their importance in this standard ration. The farm-grown feeds were charged at the farm price as reported by the Bureau of Crop Estimates. The manufactured feeds were charged at the central market prices of the feeds entering into the standard ration. To this price was added a small margin for the dealer's profit, and a transportation charge supposedly representing the average cost of delivering the feed to the farm. Labor was charged at the estimated going rate in the district.

The formula as thus worked out was used for six months in the Chicago market. Apparently both the producers and distributors were satisfied with the results obtained, but when the Food Administration withdrew at the close of the war, the formula method was abandoned in favor of other methods. Since that time

the actual market prices have been below the prices as worked out by the formula method.

New York had a somewhat similar experience. The buyers and sellers, however, directed their attention to the Warren formula which had been worked out by Professor Warren of Cornell. The formula aimed to show the factors entering into the cost of producing milk for the New York market. The amounts per one hundred pounds of milk were as follows: (9)

33.79 pounds of grain
 43.3 pounds of hay
 10.8 pounds of other dry forage
 92.2 pounds of ensilage
 8.3 pounds of other succulent feed
 3.02 hours of man labor

The formula was used for a short time, and as at Chicago was abandoned when the Food Administration withdrew. A subsequent working out of the price by the formula method shows a lower price than the actual market prices that have existed since it was abandoned.

At the present time the formula method is not being used in any of our principal markets. New York, for example, is using a price based upon the prices of butter and cheese. However, there is a growing interest in the method. An instance of this is Mr. H. A. Wallace's recent book on "Agricultural Prices." The thesis of this work is stated in the following paragraph. (9)

"Nevertheless, there is a rough-and-ready method of determining cost of production or just price as distinguished from laissez faire or supply-and-demand price. We refer to the ratio method of price determination. Over a long series of years, cost of production plus a reasonable profit is roughly expressed by the relationship which exists between a raw product and the finished

(9) Wallace, H.A. Agricultural Prices, Wallace Pub. Co. p28.

product. In rough form it may be most easily grasped in the case of corn and hogs. Over any long period of years, hogs sell on the Chicago market at a price per hundredweight equal to the Chicago price of 11.5 bushels of corn. When hogs have sold for fourteen bushels of corn, they have sold for more than cost of production plus a reasonable profit, while, on the other hand when they have sold for nine bushels of corn, they have sold for less than the cost of production plus a reasonable profit. All this is not saying that certain producers may not have been able to make a profit when hogs have sold for nine bushels of corn. Neither is it saying that certain producers have not been selling at a loss when hogs have sold for as much as fourteen bushels of corn. It is simply saying that it has required the pulling power of a price for hogs which is equal to the price of 11.5 bushels of corn to keep enough men in the hog business year in and year out to supply the demand of this country for hog products during the past sixty years. This is what we mean by the ratio method of price determination. It is the only practical method of determining cost of production in such a business as farming, where there are millions of producers working under a variety of conditions."

Mr. Wallace does not confine this method to the corn and hog ratio alone, but advocates the application of the principles to other farm products:

(10)

"The fundamental idea of the ratio method is that the price of every product is determined in the long run by the price of some other product or products. The price of hogs is determined in the long run by the price of corn. The price of corn is determined in the long run by the price of land, labor, farm machinery and horse feed."

What Mr. Wallace is saying is that the physical units used in production remain constant and that a ratio may be established between the number of these units required to produce a given unit of the final product, and a unit of the final product. The application of market prices to these physical units will then tell us whether the farmer is making a profit from that enterprise or not. Such a ratio is essentially an index.

It is the purpose of this thesis to examine these formula or index methods of calculating cost to discover their advantages and disadvantages, and to determine their usefulness to producers in regulating production, to consumers in regulating their buying, and to all persons concerned with market prices.

CHAPTER II.

AN ANALYSIS OF THE DIFFERENCE BETWEEN THE ACCOUNTING METHOD OF DETERMINING COST OF PRODUCTION AND THE INDEX METHOD.

The first difference between the accounting method of determining the cost of production and the index method is in the number of cost charges included. The stark cost of production figure as determined by the accounting method consists in a summation of all the cost charges entering into the production of a given good. Unless the total figure includes all the cost charges entering into the production of the good, the resulting so called "cost of production" does not truly represent the claim made for it. The divergence of this so called "cost of production" from the true cost of production therefore depends upon the number and importance of the omitted charges.

In the index method all these cost charges are not included specifically. Provision is of course made for them. The index is either modified by a given percentage to represent the omitted charges, or the included charges are enlarged to such a degree as to cover the cost of the omitted charges. The index method is then not in reality a summation of all the cost charges entering into the production of a good, even though it does in other ways make allowance for these charges. It is rather a measure of the variation in price of the principal cost charges entering into the production cost of the good. The cost charges selected are those with whose sum it is believed the cost of production varies proportionally. Since only a measure of change is

desired and not a summation of cost charges, it is possible to construct such a figure without including all the cost charges.

The second essential difference between the cost of production figure as determined by the accounting method and the index method lies in the use which may be made of the figure for comparisons with market prices and for assistance in the determination of necessary price. The index method results in a single figure representing a variation in the change in price. This variation may or may not be measured from a base period, depending upon the method of constructing the index. Where the index is expressed as an aggregate of sums representing an actual cost, or is expressed in physical units no base period is necessary. When however the index is expressed in relatives a base period is essential. The accounting method, however shows a wide array of costs, few farms having the same cost of production. For purposes of comparisons between areas, a single figure must be extracted from the array which shows the characteristics of the group as a whole.

Difficulties Incident to the Determination of the Marginal Producer in an Array of Production Costs.

In the determination of necessary price the producer to whom the economist refers as the marginal producer is the one who must be considered. The marginal producer is usually considered as the producer who is just on the verge of leaving the business and would leave upon any drop in price, production costs remaining the same. The arithmetic mean, by which the characteristics of the array of production costs are usually expressed, does not enable us to locate the marginal producer, for one half the product-

ion is above this arithmetic mean and one half below it. Some other method is therefore necessary to determine the marginal producer.

In speaking of this marginal producer the economist may have one of two concepts in mind. The first concept may be of a single year and regard the marginal producer to be the producer whose returns from his sales just equal his expenses of production. The year considered is a normal one. The marginal producer therefore would not be the highest-cost producer, for even in normal times we should expect the highest-cost producer, to be producing at a loss, at least as far as any single year is concerned. To determine who the marginal producer is under this concept requires that price be known, for his location upon the curve of production costs depends upon the point at which the price is set.

The other and probably more usable concept assumes the marginal producer to remain the same over a series of years. In this sense he is defined as the producer who is just able to hold his own in the industry. Sometimes he produces at a small profit, again he may operate at a loss, but over the whole series of years his returns approximately equal his costs. It will, however, seldom be true that the marginal producer in the first concept is identical with the marginal producer in the second concept, as a high-cost producer of one year may become a relatively low-cost producer in the following year with little or no change in the demand and supply conditions.

Both of these concepts are much the same in that they assume the marginal producer to be the one whose costs approximate

his selling prices over a considerable period. In both cases the marginal producer can be located upon the array of production costs only when the price is known, the location of the marginal producer being dependent upon the point at which the price is set. These ideas assume that the highest costs do not necessarily represent the marginal producers. The marginal producers are, of course, producers who are on the verge of leaving the industry at any time and these highest cost producers are in this sense marginal, but they are held there either by the hope of future profits or the immobility of their capital investment. These highest costs are usually sporadic and represent only a small part of the production. It is assumed that those producing below the margin remain in the business because they hope to make a profit in the future. This is not, however, exactly true, for continuance of a low-cost producer in an industry depends not alone upon his profit in that particular industry but also upon his opportunity for profit in other industries. In general, however, we can assume that producers in one line certainly cannot be any more efficient in any other by virtue of the fact that they are in the particular industry in question.

The location of the marginal producer on this cost curve would therefore be somewhat below the highest-cost producers. In ordinary times he would not be expected to be below the modal or average costs. If such a thing occurred, many producers would leave the business because their costs were above the margin and in consequence the margin would be forced above the new modal or average cost. The marginal producer is therefore located some-

where in the broad expanse of the curve between the highest-cost producers and the modal or average-cost producers.

Exact statistical location of the marginal producer is as yet impossible, but Professor Taussig has introduced a device known as the "bulk line." It consists simply of drawing a line below the highest costs and just at the point where the bulk of production begins. Just where the sporadic costs leave off and the bulk of production begins is difficult to determine. It differs with times and enterprises. The present method is to arrange the production costs in an array and then arbitrarily draw the bulk line through a point that includes a given percentage of the production below it. Where these differences in cost rest largely upon physical differences, as in agriculture, Taussig believes that the long-time bulk line corresponds very closely to the marginal cost.

Averages and Bulk Lines in Reality Are Indices.

The production cost of an individual farm, as determined by the accounting method, a summation of all the cost charges entering into the production of a given good, is usually not an index. But when we compare a group of farms, we must extract from our array of production costs a single figure which is typical of the group. It does not represent any single production cost and therefore cannot truly be said to be a "cost of production" in the strict sense of the word. Strictly speaking, cost of production can refer to a single farm alone. These averages, whether they be the arithmetic mean or bulk line figures are then in reality indices. They represent a characteristic of the group

which compared with the averages and bulk line figures of the same group historically, or with other groups geographically or historically, show variations in production costs.

Purposes to be Served by the Index Number

The purposes to be served by the proposed index numbers has already been stated, but it may be well to repeat and amplify them slightly. The first purpose to be served would be in controlling the volume of production. This would be accomplished thru the assistance the index numbers would give to the farmer in his choice of enterprises. A comparison of the index number of production costs with an index of selling prices would enable the farmer to determine whether this particular enterprise was becoming relatively more profitable or relatively less profitable. A knowledge that an enterprise was becoming relatively more profitable or less profitable would furnish the producer with information that would enable him to more intelligently determine when to enter, contract or expand a particular enterprise of the farm business.

The index of production costs would also enable the producer to determine more accurately his most profitable production time. Dairying as contrasted with most other farm enterprises is one that may be conducted at any season of the year. A knowledge that production costs were increasing or decreasing relatively in a particular season of the year, when compared with the rest of the year would give the producer a more intelligent basis upon which to make his decision regarding the season in which to expand or contract this enterprise. In this way the index would aid in

directing the seasonal volume of production.

The index of production costs as pointed out before would be useful in assisting in the determination of necessary price. In an industry such as the production of butterfat, great maladjustments of price are possible and in consequence uneconomic expansions and contractions of considerable magnitude may take place. No statistical study has ever been made of their cost, but it is undoubtedly tremendous, not only to the producers, but also to the consumers.

These uneconomic expansions and contractions are possible because of the long period during which production must be continued at its existing volume regardless of the market price. To substantially increase butterfat production is a long process. When production is stimulated by a high price the volume of production is likely to be increased too much before the producers become aware of the fact thru the operation of market price.

This uneconomic expansion of butterfat production can then be rectified only by a lowered price which wrecks havoc upon the existing producers. The man who is producing butterfat cannot readily change to another farm enterprise. His equipment possesses comparatively little value in other uses. In consequence he must often continue butterfat production even when his time and investment would pay him more in some other enterprise if he could change, because if he discontinues production he loses almost the complete capital value of his equipment. He will therefore continue production until his present capital equipment is worn out, but will fail to replace this equipment.

A knowledge of necessary price would tend to prevent these losses. A knowledge of production costs, as shown for example by the indices, would assist in showing what this necessary price is.

CHAPTER III.

COST ITEMS ORDINARILY USED IN COST OF PRODUCTION STUDIES

Difficulties of Determining Agricultural Costs

The cost problem in agriculture is much more difficult than in ordinary industries. This is due to the differences in the fundamental natures of the businesses. The outstanding feature of our modern non-agricultural industries is large-scale production, with the consequent repetition of tasks and the resulting specialization of labor. Ordinarily, there is but one main product, the other products being simply by-products of the main production, and designed solely to utilize otherwise waste material.

The farm business, on the other hand, is made up of many different enterprises, none of which, except in rare instances may be called the main enterprise and none of which may be called by-product enterprises. Demands upon labor and equipment are intermittent and incessant when they do occur, and do not permit of any great degree of specialization of tasks. The demand of a particular enterprise for labor or equipment is usually seasonal, that is, it can be employed in a particular enterprise only at a particular time of the year and has no use in that enterprise at other times of the year. The various farm enterprises are therefore combined with a view of giving a constant utilization of labor and equipment throughout the year. The enterprises are selected so that one will use labor and equipment at one time and another will use the same labor and equipment at another time.

The reason for the intermittent character of the agricultural enterprises is their close dependence upon the season. Seeding, cultivation, haying and harvesting make demands for short periods that cannot be shifted without a change in the choice of enterprises. Each farm enterprise has therefore a close relationship with every other farm enterprise.

These relationships are expressed as, first competing, second supplementary, and finally complementary. The competitive enterprises demand the use of the same labor or equipment at the same time, either through the whole year or at various periods of the year. Supplementary enterprises are just the reverse of this, that is, one enterprise supplements the first enterprise. Complementary enterprises are those which contribute to one another in some way. Feed is grown on the land and fed to cattle and in return from the cattle enterprise manure is returned to the land for fertilizer. A correct combination and proportion of farm enterprises must therefore take all these factors into account. Hence, it is not alone the direct charges assignable to a particular enterprise that determine the value of that particular enterprise to the farm business as a whole, but also the effect which this enterprise has upon the costs of the other farm enterprises.

Most agricultural enterprises are highly seasonal in character and can be conducted at only one period of the year. Dairying, however, is an exception, for the farmer may so arrange this enterprise to conduct it at any period of the year. In consequence dairying may present almost any degree of the complementary, supplementary or competing aspects. Because of these many

aspects that each enterprise may possess with the other enterprises of the farm business, it is extremely difficult to determine the cost charges of any particular enterprise.

An analysis of the existing indices or a construction of a new index necessitates a knowledge of the cost charges entering into the production costs of milk. The cost accounting basis of these various charges must therefore be considered, and the possibility determined of representing them in an index. The importance of these various charges must be determined, and also the variation of these charges seasonally and over a long period of time.

The cost charges that enter into the cost of production of milk have been pretty well standardized in the so-called "cost of production" studies made in the past. Larson of Columbia, in his book, "Dairy Feeding and Management", classifies them as follows⁽¹⁰⁾

1. Labor
2. Feed
3. Indirect or overhead
 - a. Buildings
 - b. Cattle
 - c. Bedding
 - d. Sire
 - e. Miscellaneous

The credit items which should be deducted as special credits in order to determine the net cost of production are as follows:

1. Calves
2. Manure

This general division of charges is usually followed in other cost studies. It is, however, quite usual to find a further

(10) C.W.Larson and F.S.Putney, Dairy Cattle Feeding and Management, p. 361. (John Wiley and Sons).

subdivision of the overhead or indirect charges into a number of additional items. The feed and labor charges are also usually subdivided into several different divisions depending upon the grades and kinds used.

The classification that is followed in agricultural accounting is closely akin to that used in industrial accounting. Production costs in industrial accounting are classified into three principal divisions, known as elements of costs. These elements of costs are subdivided into direct and indirect elements. A classification would appear as follows:⁽¹¹⁾

1. Material (Direct
(Indirect)
2. Labor (Direct
(Indirect)
3. Expense (Direct
(Indirect)

A usual method involves the rearrangement of these items as follows:

1. Direct material
2. Direct labor
3. Expense (Direct
(Indirect
 - a. Material
 - b. Labor
 - c. Other

(11) J. Lee Nicholson, Cost Accounting, p. 24. (Ronald Press)

An example of the way in which this classification might be applied to butterfat production follows:

- A. Direct materials (Feed
(Bedding
- B. Direct labor (Milking
(Feeding
(Watering, etc.
- C. Expense (Insurance
(Taxes
 - 1. Direct (Veterinary fees
(Breeding fees
(Depreciation on livestock
(Interest on investment
(Rent, etc.
 - 2. Indirect

The extent to which the subdivision of the general classes of expenses is carried is shown in Table I, which lists the expense items used in five different so-called "cost of production" studies:

TABLE I.

ITEMS INCLUDED IN FIVE COST OF PRODUCTION STUDIES MADE IN

MINNESOTA, NORTH CAROLINA, ILLINOIS, CORNELL AND INDIANA

	<u>USDA 858</u>	<u>Illinois 216</u>	<u>Cornell 364</u>
FEED	Purchased concentrates	Grain	Grain, raised and fed
	Home grown grains		Grain, bought and fed
	Non-commercial roughage	Hay	Forage, raised and bought
	Carbohydrate hay		
	Legume hay	Other roughages	
	Silage and other succulent roughage	Succulent feeds	Silage
	Pasture	Pasture	Pasture
		Miscellaneous feeds	
LABOR	Human	Man	Man
			Woman and child
	Horse	Horse	Horse
OVER HEAD	Building	Building	Building
	Equipment	Equipment	Equipment
	Bull	Interest on value of livestock	Cost of cattle
	Bedding		Bedding
	Interest on cows	Miscellaneous	Cost of hauling milk
	Depreciation on cows	Insurance, taxes, grinding feeds, testing, coal, breeding fees, salt, etc.	Miscellaneous
	Appreciation on cows		
	Herd charges		
	Insurance, taxes, etc.		
	Grinding feeds		

TABLE I. ITEMS INCLUDED IN FIVE COST OF PRODUCTION STUDIES MADE IN
MINNESOTA, NORTH CAROLINA, ILLINOIS, CORNELL AND INDIANA

(Continued)

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	<u>North Carolina 266</u>	<u>Minnesota 173</u>
FEED	Purchased concentrates Home-grown grains Dry roughage Silage and other succulent feed Pasture	Grain roughage Silage Pasture
LABOR	Man Manager Hired man Woman Boy and girl Horse	Man Horse
OVERHEAD	Building Equipment Cost of keeping bull Bedding Depreciation on cows Herd charges Taxes, insurance, etc. Interest on cow investment	Building Equipment Sire Bedding Cow Depreciation, taxes, interest, insurance General expense Managerial supervision

(29)

TABLE II.

PROPORTION OF DIFFERENT CHARGES TO THE TOTAL COST OF MILK PRODUCTION
AS DETERMINED IN THIRTEEN DIFFERENT STUDIES

Cost	Wisconsin (1)	Michigan (1)	Pennsylvania (1)	North Carolina (1)	Connecticut (2)	Massachusetts (3)	New Hampshire (4)	Columbia (5)	New York (5)	New Jersey (5)	North Carolina 1915-6 (6)	North Carolina 1916-7 (6)	Washington (7)
Feed	48.5	57.2	52.1	53.2	56.7	54.9	49.4	52.7	67.8	63.3	53.9	55.8	56.4*
Labor	31.7	25.6	24.0	22.8	22.4	21.6	26.7	18.9	18.6	22.4	27.2	30.1	23.5
Buildings	6.6	3.2	6.4	5.0	2.6	4.6	6.1	5.7	4.4	2.6	-	-	-
Equipment	1.3	2.1	1.4	2.5	-	.7	.4	-	.4	-	-	-	-
Sire	1.9	2.3	1.4	2.8	2.0	2.5	2.6	2.5	-	1.0	-	-	-
Interest	2.7	2.6	2.0	4.5	2.5	3.2	3.1	-	-	-	-	-	-
Depreciation	-	.8	5.0	2.8	8.7	6.9	6.0	-	-	-	-	-	-
Taxes, cattle	-	-	-	-	-	-	-	6.5	2.0	7.8	-	-	2.5
Bedding	-	-	-	-	-	-	-	2.3	.8	2.7	-	-	-
Hauling milk	-	-	-	-	-	-	-	6.9	5.0	-	-	-	-
Miscellaneous	7.3	6.2	7.7	6.4	5.1	5.6	5.7	4.5	.9	-	18.9	14.1	17.6

*Includes bedding.

- (1) USDA Bul. 501, p. 4. A study of cost of Producing Milk on Four Dairy Farms Located in Wisconsin, Michigan, Pennsylvania, and North Carolina.
- (2) Rasmussen, Cost of Milk Production, N.H. College and Exp. Sta. Bul. #2.
- (3) Linsey, Cost of Milk Production, Mass. Exp. Sta. Bul. #145.
- (4) Truman, Record of Dairy Herd for Five Years, Conn. (Storrs) Exp. Sta. Bul. #73.
- (5) King, Cost of Milk, p. 122.
- (6) N.C. Dept. of Agriculture Bul. #266, p. 14. A Study of Factors Involved in Producing Milk in North Carolina.
- (7) USDA Bul. 919, Unit Requirements for Producing Milk in Western Washington, p. 15.

Relative Importance of the Various Charges

Table 2 represents the relative importance of the various expenses in the form of percentages of the total expense. The importance of feed is at once apparent, as it constitutes fully fifty per cent of the total cost in practically all cases. Next in importance comes the labor charge, which approximates fully twenty-five per cent of the total charge. The remaining percentage is distributed in smaller amounts over a wide group of overhead costs, none of which approximate feed and labor in importance.

The methods by which the physical units utilized in the production of milk are determined are much the same in all the studies. The units of physical measure are the same over the whole country and do not offer difficulties in comparison. The units of value are likewise uniform but the methods used in evaluating the cost charges differ materially in the several studies. In consequence comparisons between the studies are difficult and must only be made when the various bases upon which the cost charges in the individual studies are known.

Usual Basis of Valuation of Cost Charges

1. Feed Costs. As has been previously pointed out, feed constitutes by far the largest single cost charge in the production of butterfat. Feeds may be classified in several ways, first as to their source, i. e., farm-grown feeds and purchased feeds, and secondly as to their character, i. e., concentrates and roughages. Most studies of necessity adopt a double classification including both of the above. Bulletin 919, United States Department

of Agriculture, on "Unit Requirements for Producing Milk in Western Washington", uses the following: (12)

Concentrates is a term applied to grains and to their manufactured by-products which contain a large amount of nutritious substance in a relatively small bulk.

Home-grown grains refer to concentrates grown on the farm or in the locality where fed.

Dry Roughage includes various hays and other rough feeds, which are subdivided as follows:

Non-commercial dry roughage applies to coarse feeds, such as corn stover and velvet-grass hay, for which price quotations are not given in the trade papers.

Leguminous roughage includes alfalfa, clover, cowpea soy bean, and other commercial legume hays, when pure or when so slightly mixed with grasses as not materially to affect the protein content.

Commercial carbohydrate roughage refers to all commercial hays except those classified as leguminous roughage.

Succulent roughage consists of mangels, potatoes, silage and soiling crops.

The feeds in this study are also divided into those purchased and those that are home grown.

The basis for the charge made for the feed against the dairy enterprise differs among the various studies depending upon the character of the feed and whether it has been home grown or purchased. There are two methods advocated for the charging of the home grown grains in cost of production studies. They may be designated the accountant's method and the farm accountant's method. The former is used extensively in England and charges the feeds at the cost of production on the farm, while the latter, chiefly used

(12) USDA Bul. 919, Unit Requirements for Producing Milk in Western Washington, pp. 10-11.

in this country, charges the feed at the farm price. The farm price is in reality the market price, as it is supposedly the price at the nearest marketing point less the cost of transportation to that point. In actual practice, however, it is more often the price that the farmer has been offered for his product on his farm.

The following extracts indicate the general practice in this country:

"In this investigation all feeds consumed by cattle have been charged, at the farm price, not at the cost of production. The farm price of farm-grown feeds is the market price less the cost of transportation from the farm to the nearest regular market." (13)

"All feeds in the livestock records here presented are valued at what they are worth on the farm and not at what it cost the farmer to produce them. While the second method is a popular one, it is not business-like, nor is it good farm management." (14)

"Home-grown feeds that are readily marketable when they enter into the production of another farm product should be charged at the farm sale value; the farm sale value should ordinarily be based upon the average price during the feeding period." (15)

Feeds that are purchased off the farm are ordinarily charged at the actual purchase price plus whatever transportation expenses there are incident to getting them to the farm.

"Home-grown feeds were figured at market prices on the farm plus any expense connected with them, such as grinding, hauling, and baling. Oats and ear corn were hauled to the mill to be ground.....The purchased feeds were figured at their actual cost at the feed store or on the track, plus the cost of hauling them home." (16)

(13) Minn. Bul. #124, Cost of Minnesota Dairy Products.

(14) Mo. Bul. #125

(15) USDA Circular #132, Report of Committee Appointed by Secretary of Agriculture, p. 12

(16) USDA Bul. #858, Requirements and Cost of Producing Milk in Northwestern Indiana, p. 19.

"The purchased concentrates were charged at market prices when fed, plus cost of hauling. The home-grown grains and commercial roughage were charged at the market price on the farm. Non-commercial dry roughage and succulent roughages were given a fair value on the farm." (17)

".....the farm-raised feeds were charged to the dairy herd at prevailing farm values, while purchased feeds were charged at the purchase price. The labor of delivering these feeds to the farm appears under the items horse-labor and man-labor." (18)

"All grain and forage used by the cattle, whether raised or bought, was figured at its farm value, not at its cost of production." (19)

Non-commercial feeds also offer a difficult valuation problem. The only basis that is usable is the placing of an arbitrary figure upon their value.

"If the succulent roughage was salable, the farm price was used in determining the valuations per ton; however, if it was not salable, a price which was commensurate with its value as compared with the value of a marketable product was placed on it." (20)

"Non-commercial dry roughage and succulent roughages were given a fair value on the farm." (21)

"Home grown feeds that are readily marketable, when they enter into the production of another farm product, should be charged at the farm sale value; the farm sale value should ordinarily be based upon the average price during the period of feeding.

Crops grown solely for animal feed and having no market value should be charged at cost of production.

Either one or the other of the above principles, according to circumstances, should govern in determining the charge for silage." (22)

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- (17) N.C. Bul. #266, A Study of Factors Involved in Producing Milk in North Carolina, p. 6.
(18) Ill. Bul. #216, The Cost of Milk Production, p. 347.
(19) Cornell Bul. #364, Cost of Producing Milk on 174 Farms in Delaware County, New York, p. 123.
(20) USDA Bul. 919, Unit Requirements for Producing Milk in Western Washington, p. 11.
(21) N.C. Bul. #266, p. 6.
(22) USDA Circular #132, Office of the Secretary, Report of Committee Appointed by the Sec. of Agriculture, p. 12.

Another important source of feed and one upon which it is very difficult to place a value is the pasture. The importance of pasture in the economy of milk production can hardly be over-estimated. Professor Warren of Cornell says:⁽²³⁾

"Pastures furnish our cheapest feed. The pasture of one cow one day costs three to six cents; hay and silage, twelve to fifteen cents; grain, twelve to fifteen cents. A good pasture will replace all the hay and much of the grain. Pasture produces more milk than other feed at one-fifth to one-tenth the cost."

Cooper in Minnesota Experiment Station Bulletin No. 124 adopts a similar viewpoint:⁽²⁴⁾

"The importance of pasture in the economy of the farm is illustrated by the small quantity of grain or roughage fed during the pasture season,..... for practically five months out of each year the cattle are supported almost entirely from the grass crops."

The method that seems to be most generally used at the present time is to charge interest upon the estimated value of the land, and an additional charge for all expenses involving the upkeep of the pasture. The accuracy of the estimate of the land value is of course problematical, and the charge likewise varies with the rate of interest chosen. The following extracts show the variations of this method.

"Pasture used only for cows may be charged on the basis of six per cent of the acre valuation of the land and an estimate of the number of acres used per cow. On Minnesota farms it is found that two acres is a close estimate of the pasture required per cow for the season of approximately five and one-half months."⁽²⁵⁾

(23) Cornell Bul. #280, Pastures in New York, p. 355.

(24) Minn. Exp. Sta. Bul. #124, The Cost of Minnesota Dairy Products, p. 97.

(25) Minn. Exp. Sta. Bul. #173, Cost of Milk Production, p. 11.

"Pasture was charged to the cows at actual cost, no profit being made on the land in pasture.....Cost was figured in the following manner: Interest amounting to five per cent and taxes amounting to 0.5 per cent were charged on the actual value of the land in pasture. To this amount were added all other costs, such as making and repairing fences, manuring, fertilizing, reseeding, mowing and the like." (26)

"The cost of pasture was determined by adding to the interest on the investment in land the cost of maintaining fences, and incidentals, such as seeding, cutting weeds, etc. The investment in land was obtained by subtracting the value per acre of the improvements on the farm, as determined by prorating their value in accordance with the quality of the different classes of land on a farm, from the improved value per acre. In one or two instances where the land was rented at so much per acre for pasture purposes, this value was taken." (27)

"The pasture charge was determined by adding the interest on the value of the land, figured at six per cent, to the cost of keeping up fences, seeding, and other expenses incurred." (28)

"Land charge covers the value of the use of the land, including drains, fences, and irrigation systems. The charge is made up of interest on investment, taxes, upkeep of drains, etc.

In determining the interest item, both land value and interest rate are involved. Prevailing local prices of land, exclusive of buildings, should be taken as the land value, and the prevailing rate of interest at which money may be borrowed on well-secured farm loans as the interest rate. In localities where such influences as speculation or discovery of oil or use for town lots have affected the price of land the rental value may be taken into consideration in determining a fair charge for the use of the land. When dealing with the farm as a whole, this method applies to farms operated under any and all forms of tenure. In determining costs and returns to tenant and landlord, the actual terms of the contract should be kept so as to show separate statements for landlord and tenant and a combined statement for the entire farm." (29)

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- (26) Cornell Bul. #364, Cost of Producing Milk on 174 Farms in Delaware County, New York, p. 126.
(27) USDA Bul. #858, Requirements and Cost of Producing Milk in Northwestern Indiana, p. 20.
(28) N.C. Bul. #266, A Study of the Factors Involved in Producing Milk in North Carolina, p. 6.
(29) USDA Cir. 132, Office of the Secretary, p. 13.

2. Labor Charge. Next to feed, labor constitutes the largest item of cost in milk production. It is likewise one of the most difficult to handle. Labor used in milk production is of two kinds, human labor and horse labor. Human labor includes such tasks as driving cattle to and from the pasture, milking, caring for milk and dairy equipment, feeding cattle, cleaning stables, and various miscellaneous work connected with the dairy enterprise. Human labor is capable of several classifications, for example, on the basis of use, as, Productive or Direct Labor, and Unproductive or Indirect Labor. Or it may be classified according to the character of the units forming it, as, (1) the manager's own labor; (2) the hired man's labor; (3) the family labor. Family labor may be divided into (a) woman, and (b) child.

The usual unit of measurement for the labor on the farm is the man-hour of labor. The other labor, such as boy and woman labor, is reduced to the man-hour by some arbitrary basis.

It is extremely difficult to place a value upon labor. The method used by the United States Department of Agriculture is the one that seems to be the most prevalent at the present time. This method consists in placing a "going" value on the labor corresponding to the cost of similar labor on other farms. Unpaid family labor on the farm and the farmer's own labor are charged at what it would cost to replace them with hired labor paid at the prevailing rate in the vicinity. (30)

(30) USDA Circular 132, Office of the Secretary. Report of a Committee Appointed by the Secretary of Agriculture, p. 13.

The manner in which this is worked out in studies is shown by the following extracts regarding labor charges in various bulletins.

"The physical labor of the manager was valued at \$50 to \$55 per month. The rate for white hired men was based directly on the actual wages paid, plus board, house, garden or other concessions; and the entire wages ranged from \$30 to \$50 per month. Colored men received from \$17 to \$35 per month, including house, garden and other perquisites. Woman, boy and girl labor was figured at actual wages when determinable, and an estimated rate in other cases." (31)

"Cost accounts on farms in this state carried on by the Department of Farm Management at Cornell University in cooperation with the Office of Farm Management at Washington, D.C., show that the cost of man labor on the average farm is from 15 to 20 cents per hour, and the cost of horse labor is from 12 to 16 cents per hour. There is no reason to think that labor costs less in Delaware County than in the average county in the state. In order that labor charges might not be considered excessive, man labor was charged at 15 cents and horse labor at 12 cents. There were no cost records available to show how much woman and child labor costs. In this investigation, woman and child labor were valued at 10 cents per hour." (32)

"To figure the labor cost, a rate per hour for man labor and for horse labor must be used. For the years covered by this study, an average rate of 15 cents per hour for man labor and 11 cents for horse labor is a close approximation of the cost." (33)

"The rate per hour was computed each month for every farm on a basis of the number of hours available for work each month, and the wages paid by that farmer, and any other expenses connected with the hired help, such as board and room or having a horse kept. The number of hours was found by using the average length of the working day, with time out for meals, and hours of work performed on Sunday. Board for hired help was computed on the basis of local rates." (34)

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- (31) N.C. Bul. 266, A Study of the Factors Involved in Producing Milk in North Carolina, p. 9.
(32) Cornell Bul. 364, Cost of Producing Milk on 174 Farms in Delaware County, New York, p. 127.
(33) Minn. Bul. 173, The Cost of Milk Production, p. 21.
(34) USDA Bul. 858, Unit Requirements and Cost of Producing Milk in Northwestern Indiana, p. 20.

3. Building Charge. The building charge to be made against the dairy cow is extremely difficult of computation. This is for two reasons; first, the depreciation on a building can only be estimated, and secondly, in many cases the buildings which are used to house the dairy enterprise are also used for other enterprises on the farm, and therefore the annual cost of the building must be apportioned among these various enterprises. The building charge usually includes the following items:

1. Depreciation charge.
2. Repairs.
3. Interest on the capital invested.
4. Taxes.
5. Insurance.

The manner in which these computations have been made may be judged from the following extracts.

"The building charge includes insurance, depreciation, interest on capital invested, cash repairs, paint, rent for the water system, etc. The total charge for buildings usually constitutes from 8 to 10 per cent of the value of the buildings and 5 per cent of the net cost of milk production." (35)

"The charge for buildings included interest at 6 per cent on the present value of the buildings, together with depreciation, upkeep, and repairs, taxes, insurance where insurance was carried." (36)

"The annual charges that enter into the building cost are: interest on the depreciated average investment, depreciation, insurance, taxes, and repairs. Interest should be charged at 6 per cent. Depreciation may be figured at 3 per cent on frame buildings, and 2.5 per cent on cement structures. Silos have been depreciated at the rate of 3 per cent. Taxes have been estimated at 0.5 per cent on the depreciated value, and insurance at the value and rate used in the locality. The sum of these charges on the various buildings constitutes the annual building expense." (37)

(35) Ill. Bul. 216, The Cost of Milk Production, p. 352.

(36) N.C. Bul. 266, A Study of the Factors Involved in Producing Milk in North Carolina, p. 13.

(37) Minn. Bul. 173, The Cost of Milk Production, p. 22.

"Buildings, including silos, were inventoried at the beginning and end of the year and interest at 5 per cent was figured on the value of those used for the cows, as shown by the first inventory. The first inventory value, divided by the years it was estimated the buildings would remain in a usable condition constituted the depreciation charge. The cost of shingling, painting, and repairs was computed, and whenever possible exact cost was obtained and recorded. Dairies were charged with their share of actual taxes and insurance."(38)

The question of the proportioning of the charge among the various enterprises utilizing the buildings in question is difficult. Many studies do not attempt such a proportioning at all. One of the methods in use is explained as follows:

"The barn was considered as a unit and the annual charge was divided by the total number of animal units housed to obtain the cost per unit. One horse or one cow was considered as a unit, and two head of young cattle or two colts as a unit. The annual charge for the silo was divided by the cattle units and the charge for the milk house by the number of cows." (39)

4. Dairy Equipment. The items covered by the dairy equipment group consist of milk cans, pails, churns, separators, milking machines, scales, feed carts, etc., in fact, all equipment used in milk or butterfat production. Compared with the total cost, or with some of the other cost items, the equipment charge is of minor importance.

The charges entering into the cost of dairy equipment are much the same as those entering into the building costs. Those ordinarily included consist of interest, taxes, repairs, and increase or decrease in inventory value.

(38) USDA Bul. 858, Requirements and Cost of Producing Milk in Northwestern Indiana, p. 23.

(39) Minn. Bul. 173, Cost of Milk Production, p. 22.

"Interest, Depreciation, and repairs make up the annual cost of equipment." (40)

"The cost of equipment was figured in the same manner as the cost of buildings." (41)

"The dairy equipment was inventoried at the beginning and the end of the year. Interest at 6 per cent was charged on the first inventory value. The difference between the first inventory, plus equipment purchased, and the one taken at the end of the year, plus equipment sold, was recorded as depreciation. A list of all repairs on equipment and dairy supplies purchased was kept by the dairymen and recorded each month. Taxes on equipment as for cattle and buildings, were taken from the county records." (42)

5. Cow Costs. The charges that are made against the cow depend upon the basis upon which the study is made, that is whether the study is made upon a herd basis, or upon a cow basis.

"Briefly stated, the herd cost of milk production involves not only the cost of producing milk but also the cost of replacing the depleted cow stock. Usually the appreciation in the young stock raised more than counterbalances the depreciation of the milking herd." (43)

"The cow cost of milk production involves only the maintenance of the bulls and the milking stock; the cost of raising the young stock is not included. The milking herds are maintained by purchasing cows or by replacing depleted stock with heifers raised in the herd." (44)

Ordinary studies seem to be made upon the cow basis and include interest, taxes, insurance and depreciation. The methods of computing these charges differ widely, particularly the interest and depreciation charges.

(40) Minn. Bul. 173, The Cost of Milk Production.

(41) Cornell Bul. 364, Cost of Producing Milk on 174 Farms in Delaware County New York, p. 132.

(42) USDA Bul. 858, Requirements and Cost of Producing Milk in Northwestern Indiana, p. 23

See also N. Carolina Bul. 266, A Study of the Factors Involved in Producing Milk in North Carolina.

(43) Ill. Bul. 224, The Seasonal Cost of Milk Production, p. 4

(44) Idem

Regarding the depreciation charge, the following method is used at Minnesota:

"Depreciation should cover two factors of loss, death risk or loss and decreased value in production of milk. On the herds studied the death loss amounts to 1.5 per cent of the value of the cows in the herds. An average milking life of six years has been assumed, altho it is known that many cows do not remain in milking herds so long. After six years of milking, the cow is usually sold for beef and hence has a market value for the block. The formulas for determining depreciation would appear thus: Depreciation equals (1.5% of inventory value) plus $16 \frac{2}{3}$ of (inventory value minus block value)." (45)

E. W. Larson in "Milk Production Cost Accounts" states that the net cost of producing a two-year old heifer is approximately \$65.00. Upon this value he computes the interest charge at 5%, which makes an annual charge to the dairy industry of \$3.25 per cow. As a workable, tho not a scientifically accurate, method for arriving at the depreciation cost he uses the formula $\frac{x - y}{n}$, where x represents the cost of the cows, y the sale price of the cows at the end of their life in the herd and n the productive life of the cows in years. If then, the cost to produce the two-year old heifer is \$65 and its final block value is \$40 and its productive life is 5 years, the annual depreciation charge per cow is $\frac{\$65 - \$40}{5}$, or \$5.

Illinois bulletin 216 does not give the basis for charging depreciation, but gives the rate of interest charged at 5%. (46) North Carolina Bulletin 266 charges 6% instead of 5%. (47)

(45) Minn. 173, The Cost of Milk Production, p. 9

(46) Ill. Bul. 216, The Cost of Milk Production, p 361

(47) USDA Bul. 858, Unity Requirement of Producing Milk in Northwestern Indiana, p. 22

Cornell Bulletin 364 accounts for depreciation in the change in inventory. Interest is charged at 5%. (48) USDA 858 uses a similar method. (49)

6. Sire Cost. Ordinarily the cost of keeping the sire is kept separately from the rest of the herd and the cost then divided among the cows. The ordinary charges are the same as those made against the cows and probably approximate those costs. The amount of the individual charge made against the cows therefore depends largely upon the size of the herd. (50) Often, however, the manner in which the records are taken do not allow a separation of all these costs. (51)

The Credits To The Dairy Enterprise.

The major credit to the dairy herd is of course milk. There are, however, various other credits that are incidental to the main product.

These are generally -

1. Milk consumed by the household.
2. Manure.
3. Calves.

1. Methods of Crediting Calves. Whether or not calves constitute an item of credit depends upon the basis upon which the study is made. Where the study is made upon a herd basis, the increase of value of the young stock is set off

(48) Cornell Bul. 364, Cost of Producing Milk on 174 Farms in Delaware County New York, p 131.

(49) No. Carolina Bul. 266, A Study of the Factors involved in producing Milk in North Carolina. p. 24

(50) Minn. Bul. 173, Cost of Milk Production, p. 10

(51) No. Carolina Bul. 266, A Study of the Factors Involved in Producing Milk in North Carolina, p. 24-25

against the depreciation in value of the milking stock, and may be either an increase or a decrease.

This difference is pointed out in Illinois Bulletin 216 which says regarding the herd basis:

"In using the herd as the basis of calculation, it must be born in mind that the increase in the value of the young stock may be greater or less than the depreciation in value of the milking stock, according to the policy of the dairyman. If it proves to be greater, as was the case in this study, then the net increase in the aggregate value of all the stock appears as an item of income." (52)

Where the cow basis is used the cows are credited with the calves dropped and the young stock are figured separately from the milking herd. The estimated value of the calf when four days old is the usual credit.

"The value of a grade calf four days old has been estimated at various prices on the farms studied. Some male calves were killed at birth or soon after; others were sold at a dollar; and some were raised. At present prices a valuation of \$5 is warranted." (53)

North Carolina Bulletin 266 says,

"The credit for calves was based on the value at four days old. The sale price was used for those actually sold and the estimated sales value of those kept for raising." (54)

USDA 858 credits the cow with the value of the calf when four days old, at what it would be worth for fattening for veal. (55)

(52) Ill. Bul. 216, Cost of Milk Production, p. 353

(53) Minn. Bul. 173, Cost of Milk Production, p. 25

(54) No. Carolina Bul. 266, A Study of the Factors Involved in Producing Milk in North Carolina, p. 29

(55) USDA Bul. 858, Requirements and Cost of Producing Milk in Northwestern Indiana, p. 9

2. Methods of Crediting Manure. Manure is a very difficult item to determine the credit due to the cow. The amount and quality depends upon the size of the cow, quality and quantity of the feed, and the bedding.

The value of the manure is generally determined by one of two methods, first, an estimated of the chemical constituents multiplied by the market price, and secondly the value as determined by an increase in crop production. In practice, however, an arbitrary value is usually placed upon the manure and the cows credited upon this basis. No credit is ordinarily given for manure dropped in the pasture.

In the North Carolina Bulletin, the manure is credited at \$2 per two horse load. (56) The Cornell and Illinois Bulletins value the manure at \$1 per load. (57) Minnesota credits the cow with \$20 for the year. (58)

The Department of Agriculture recommends that-

"Manure should be charged at a value indicated by the farmer's experience as based on increased crop profits, or market values." (59)

Bulletin 858, United States Department of Agriculture, attempts a method of crediting by fertilizer constituents. The manner in which these were determined is as follows:

"When the total manurial constituents in the feed had been determined for each herd, they were credited to the cows in accordance with the scores which had

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- (56) No. Carolina Bul. 266, A Study of the Factors Involved in Producing Milk in North Carolina, p. 29
 (57) Cornell Bul. 364, p. 134 and Illinois Bul. 216, p. 354
 (58) Minnesota Bul. 173, Cost of Milk Production, p. 26
 (59) USDA Circular 132, Report of a Committee Appointed by the Secretary of Agriculture, p. 13

been given to the herds for the total manure saved. Each dairy was scored on its efficiency in saving manure, taking into account such factors as manure voided in the barn, quantity of liquid lost in the barn, and length of time and method of storing. The ingredients of the manure credited to each herd were then added to the nitrogen, phosphoric acid, and potash contained in the bedding. The amounts of these constituents thus obtained constituted the entire fertilizer credit the cows received.

"The composition of an average ton of manure produced by each herd in the winter period of each year was determined by dividing the fertilizer constituents it contained by the number of tons produced. It was possible to calculate the tons of manure produced for 100 pounds of live weight of cows by using an average of the results of three experiments conducted by the New York station, and one by the Ohio station, on the amount of manure produced by dairy cows. It was found by averaging these experiments that approximately 13 tons of manure were produced annually for 1000 pounds of live weight of cows. Our computations on tons of manure produced are based on this figure together with the weights of the cows on which records were kept. The bedding used was largely straw." (60)

Distribution of Costs.

1. Unit of Distribution. The yearly figure for the individual cost items having been determined, the distribution of this charge becomes necessary. The manner in which this distribution is made of course depends in a large measure upon the facts that the bulletin or study is endeavoring to show.

There are several bases upon which this distribution may be made. In the first place, it may be made upon the hundred-weight of milk produced. This is usually accomplished by dividing the total cost and the total individual costs per hundred-weight of milk.

Bulletin 216, Illinois, on "The Cost of Milk Production" is worked out entirely upon this basis. Most other bulletins also include this method among others.

Another basis that is used in distributing these charges is upon the cost per cow. In this case the total charges are divided by the number of cows and the resultant is the average cost per cow.

The cow basis is used entirely in Minnesota Bulletin 173 on the "Cost of Milk Production".

Most studies, however, use both of these bases and publish results upon the per cow basis as well as upon the hundred-weight basis. This is an excellent plan, as many figures possess a wider application upon one basis than upon another.

Among the many bulletins publishing figures upon both of these bases are Bulletin 858, United States Department of Agriculture, "Requirements and Cost of Producing Market Milk in Northwestern Indiana", North Carolina Bulletin 266, "A Study of The Factors Involved in Producing Milk in North Carolina", and Cornell Bulletin 364, "Cost of Producing Milk on 174 Farms in Delaware County".

2. Seasonal Distribution. Another problem in the distribution of costs is their seasonal distribution. This is a point that has not been considered as fully as it ought in the past in cost of production studies. There is, however, a great variation in the seasonal cost of milk production and it is of vital interest to the dairyman. The reason for this may be the

that the milk production studies are a later outgrowth of other cost studies. Most farm enterprises do not present these seasonal aspects. They can be conducted only in one season or period of the year. Dairying, however, is a marked exception, for it may be conducted at any period of the year that the dairyman desires. This renders the valuation of the costs of the dairy enterprise extremely complex, as the farmer may choose a season that will present very nearly any combination of competitive, supplementary, or complementary farm enterprises. On one farm the dairy enterprise is a summer enterprise and on another a winter, or it may shade into either of these in varying degrees.

A summary follows which shows the manner of pro-rating these charges in three bulletins which attempt to show seasonal variations in cost.

Feed other than pasture -In all three bulletins this is distributed on the basis of amount of feed used during the month.

Pasture In the Minnesota and North Carolina bulletins pasture cost is figured at 6 per cent on the value of the land, plus the cost of maintaining fences, cost of seeding, etc.

Minnesota. All pasture cost charged to summer.
 Illinois. No explanation of the basis of pro-rating charges. Pasture is charged at market rates for the year at least; possibly market rates were available for the months.
 N. Carolina Pro-rated according to number of animal units grazed each month.

Man and horse labor

Minnesota One half to each season.
 Illinois Charged on the basis of amount used, charge per hour being uniform throughout the year.
 N. Carolina Charged on basis of amount used.

Building charge

Minnesota	One half to each season.
Illinois	Pro-rated on basis of volume of milk produced each month.
N. Carolina	Approximately one half to each season; basis not stated.

Interest on investment in herd

Minnesota	One half to each season.
Illinois	Approximately one half to each season.
N. Carolina	Approximately one half to each season.

Depreciation Charged in same way as interest.

Manure credit

Minnesota	One half to each season.
Illinois	On basis of amount actually recovered.
N. Carolina	Basis not stated. Winter season is credited with more than summer season.

Calf credit

Minnesota	One half to each season.
Illinois	Credited to time sold.
N. Carolina	Credited to time sold.

Appreciation

Illinois	Not stated.
N. Carolina	Basis not stated; distribution unequal for the two seasons.

Pearson in Illinois Bulletin 216 recommends the application of the relative average variations in the prices paid for milk over a ten year period to the yearly figure to show the seasonal costs. His discussion follows, (61)

"A more or less satisfactory method of distributing the year cost over the various months is to use the relative percentage variations in the prices paid for milk during the different months of the year at the market to which the milk was delivered. The buyers of milk desire a constant supply throughout the year, and it may be assumed,

Minn. Bul. 173, Cost of Milk Production.

Ill. Bul. 224, Seasonal Cost of Milk Production.

No. Carolina Bul. 266, A Study of the Factors Involved in Producing Milk in North Carolina.

(61) Ill. Bul. 216, Seasonal Cost of Milk Production, p. 356.

therefore, that prices have been adjusted to stimulate the production of the desired amount each month of the year. The percentage variation by months of the average annual Chicago price of milk for the ten years 1907-1916 was as follows:

Month	Percentage Variation	Month	Percentage Variation
January	119.0	July	83.7
February	114.3	August	94.2
March	106.5	September	96.7
April	94.2	October	109.2
May	73.2	November	118.3
June	70.6	December	120.3"

Such a method, however, begs the whole question of costs, for by basing his percentage upon the average price of milk, Pearson brings in the demand and supply aspect of the problem.

CHAPTER IV.

TYPES OF INDICES USING FULL ACCOUNTING COSTS

In the preceding chapter has been presented a full list of the costs which must be included in any complete cost of milk production. These costs must all be summated whenever any single producer calculates his individual cost of production. Now it is possible to build up an index series in several different ways, using all the costs that are included in an individual cost accounting. It is also possible to build up series in which, for various reasons, some of the cost charges are omitted or represented in other items or otherwise modified. In this chapter will be presented the first type of indices, those using all the various cost charges. The other type will be presented in the chapter following. (62)

The essential thing about index numbers is that they constitute a chronological series and enable comparisons between different periods, or in some cases, a geographical series and enable comparisons between different regions. Sometimes these series are expressed in the form of the actual thing which they are trying to present, thus Dun's index number is expressed in the form of the actual cost of buying a year's supply of a list of 200 commodities. A cost of living index may thus express the actual

(62) The discussion in this chapter is based upon:
Secrist, An Introduction to Statistical Methods, pp.294-376
(Macmillan); Mitchell, W.C., Index Numbers of Wholesale Prices
in the United States and Foreign Countries, Bul. of U.S. Bureau
of Labor Statistics, Whole Number 173, July 1915.

cost of a year's supply of the commodities bought by families of the sort in question. Such indices may be called "absolute." More frequently the indices are in the form of percentages of a base year or a base period. Such indices are "relatives."

An absolute index is an aggregate of actual prices. This type of index may be constructed in several ways. First, it may consist of a sum of actual prices unweighted. That is, a number of commodities may be added together in a haphazard manner as their quotations may appear upon the market. The statistical absurdity of adding together a ton of steel rails, a pound of coffee, an ounce of silver, and the like, is at once apparent. Secondly, the absolute index may be weighted by one of two methods. This weighting may be accomplished by reducing all the commodities to a common physical basis. The prices of the commodities for this common physical unit are then added to determine the index. Such an index can of course hardly be said to be an absolute index, as it fails to express any absolute specific thing except the sum of the prices of one-pound amounts of various commodities. Bradstreet's index number is constructed in this manner. This index is the sum of the prices of 96 to 110 articles reduced to a per pound basis. Such an index is of course at fault in that it gives greater weight to the rare and costly articles which may be included, than to the cheaper and more widely used commodities. This tendency of more expensive and less important articles to carry too much weight in the final result can be corrected to a certain degree by the addition of more quotations for the more important articles. In fact, this is exactly what is done in the Bradstreet index.

It is, however, possible to weight this sum of actual prices by weighting the particular price quotations of the individual commodities by figures showing their relative importance in some particular use. The importance of the commodities in the family budget might be used in a food index, or the importance of the particular charges in a production index. As stated before, Dun's is an example of such an index. Here 200 commodities are weighted according to their importance in the year's purchase of goods by an individual.

When indices are expressed in the form of percentages of a base period, they are called "relatives." Relative index numbers may be constructed in many ways. The simplest method of construction is to average a series of unweighted relatives. In this method the individual price quotations in the base year are considered as 100, and the individual price quotations in the compared year are expressed as percentages of the quotations in the base period. These relatives are then added and the arithmetic mean of the relatives determined. The following illustrates the method.

Commodity	Price of Commodity in Base Period	Price in Compared Period	Relative Based upon Price in Base Considered as 100
Oats	50	60	120
Corn	90	120	133
Barley	100	150	<u>150</u>
			403

$$\text{Index} = 403 \div 3 = 134.$$

This is the method that is used by the Annalist in the preparation of their index. This index consists of the arithmetic mean of a sum of the unweighted relatives of 25 food products ordinarily found in the family budget.

An index of relatives may also be prepared which is an average of relatives weighted. The weighting may be accomplished in several ways. One method consists in increasing the number of quotations included of the more important commodities. This is the method that was used by the Bureau of Labor in their wholesale price index series prior to 1914. Or the relative may be weighted according to the importance of the commodities in some particular use. The weighting for particular purposes may be accomplished in two ways. First, the physical quantities used in the base period may be determined and used as weights. Or the relative percentages of the price of the physical quantities in the base period to the aggregate sum in the based period may be determined and these percentages applied as weights in the later periods. The first is the more common method. An example of the former method is the Bureau of Labor index showing changes in the cost of living among working men. This index consists of an average of relatives which has been weighted by the average amounts of commodities consumed by 2567 workingmen's families in a study made in 1901. The following illustrates the method.

Commodity	Relative Price	Relative Importance	Result
Corn	110	55.4	6094
Oats	120	33.8	4056
Barley	130	10.8	1404
TOTAL	155.54	100.0	11554

Another method of determining the final relative figure consists in the separation of the original relatives into groups, either by commodities or geographically. The relative for each group is then determined by taking the arithmetic mean of the sum of the relatives of the group. The relatives representing these various groups are then added and the arithmetic mean of the group relatives determined as the relative for the whole. This method is used geographically by the Bureau of Labor in their retail price indices. In this index relatives for each commodity for the various firms reporting in a city were added and the sum divided by the number of reporting firms to get the city relative. City relatives for each commodity within each of the geographical divisions chosen by the Bureau for presentation of data were added and the sum divided by the number of geographical divisions to get a divisional relative. The relative for the entire country was determined by finding the arithmetic mean of all the city relatives.

This same method could be used for commodities as well as for geographical use. For example, in a general index relatives might be determined for each group, farm products, mineral products, manufacturing products, etc. The relatives for these groups could then be added and their arithmetic mean taken as an index of the whole.

Another method of constructing relatives consists in an aggregate of the sums of the commodities included in the index. The aggregate sum of the base period is then taken as one hundred and the new aggregate expressed as a percentage of the base period.

This is the method used since 1914 by the Bureau of Labor in the preparation of their retail price series. The results obtained by this method differ from those obtained from an arithmetic mean of the relatives of the same prices. This is because the relatives computed from the aggregate of actual prices gives the same weight to equal actual changes in prices, while the method of taking an arithmetic mean of the relatives gives the same weight to equal percentage changes in price. An example showing this fact follows:

Commodity	Actual Price		Relative Price	
	Base	New	Base	New
Corn	90	120	100	133
Oats	50	60	100	120
Barley	100	150	100	150
Aggregate	240	330	300	403
Relative	100	137.5	100	132

The use of relatives of course requires the choice of a base period. There are two kinds of bases that may be used, either the fixed base or the chain base. The fixed base is a definite year or other period of time from which all relatives are computed. The chain base, on the contrary, moves forward from year to year, each year being taken as the base for the year immediately following it. The fixed base period was used by the Bureau of Labor in its retail price index prior to 1914. In that year a change was

made to the chain base method. It is a statistical fact that as the compared period grows further from the base period, the fixed base index less truly portrays actual conditions. The difference between the two methods may be seen from the following:

Commodity	M A Y		J U N E			J U L Y		
	Price (cents)	Rela- tive on May base	Price (cents)	Relative on		Price (cents)	Relative on	
				May base	June base		May base	June base
Corn	50	100	40	80	100	35	87½	70
Oats	20	100	30	150	100	20	100	67
Barley	60	100	80	133	100	80	133	100
TOTAL	130	300	150	363	300	135	320½	237

Relatives on
May base

100

121

107

Relatives on
chain base

100

121

79

The Average-Cost Index

The average-cost index is simply an average of the production costs of a given group of farms, as determined by the usual cost accounting method. This average may take any number of various forms. More commonly it is the arithmetic mean, but it may instead be expressed by the median or mode. The usual cost of production studies are expressed in averages, which averages purport to show the "cost of production" on the group of farms

from which they are taken. It is these averages that are referred to as average-cost indices.

There are many advantages connected with the use of average costs as indices. They are simple, being expressed as a single figure which is readily comprehended by the general public. Moreover, they are easily calculated by a simple arithmetic process, and are expressed as an absolute figure. Such a figure can be readily manipulated mathematically and can be easily compared with other similar figures.

The same objections apply to the average-cost index that apply to all indices that are constructed with full accounting costs. Such indices require the valuation of all items entering into the production of butterfat. For many of these items there are no price quotations available. There are many practical and theoretical difficulties incident to the valuing of these charges. Besides, there is much question as to what costs should be included. For example, accounting authorities hold widely diverged views as to whether interest should be considered as a cost or as a distribution of net income. Even when interest is included, there is the practical difficulty of the determination of the rate, which obviously differs with times, regions and types of capital goods. If the individual cost charges entering into the final total charge are incorrect, the total will be incorrect unless the errors should be compensating. There is therefore considerable question as to the accuracy of the average. These inaccuracies are further aggravated by the difficulty of obtaining local quotations for many of

the cost charges. The prices must often be estimated from the actual quotations in other places.

The average-cost index has a further disadvantage in that it is likely to be misleading. It is an average of the production costs on the group of farms from which it came, and nothing else. It does not represent the production cost on any particular farm of the group. Since it is expressed as an absolute figure, it is very often thought of as representing the true production cost on each of the farms in the group. It does not represent this, however, and no single figure can, for each of the farms has a different cost of production. Nor can it be said to represent the cost of production for the group; there can be no cost of production for a whole group, except in the sense of the marginal cost for a given supply.

Such a figure can be useful in regulating production only on the assumption that the production costs on the individual farm vary directly and proportionally with the average cost of the group. Such a condition will exist only when the proportion of enterprises, the combination of enterprises and accompanying conditions on the individual farms are the same as those disclosed by the averaging of all the farms of the group. The degree to which the production costs of the particular farms correspond with the average, depends upon the degree to which it approaches these average conditions.

These conditions make difficult the comparison of the average cost index of one area with conditions in another area.

Areas differ as to combinations and proportions of enterprises, and in addition, in the cost of the various elements entering into the production of butterfat. Only when the farmer knows the conditions prevailing upon the group of farms from which the average came, can he compare his combination and proportion of enterprises with it and estimate the change that would take place in the production costs on his farm. The accuracy of such an estimate is of course questionable.

The average-cost index of itself tells us nothing regarding necessary price. In this respect it is apt to be misleading, in that superficially it would seem that a price that covered this average cost of production would be a sufficiently high price to maintain the volume of production then taking place. Such, however, is not the case, as one-half the production is at a cost above this figure and one-half at a cost below. A price that just covered this average production cost would not be high enough to maintain the existing volume of production over any considerable period of time. The only way that this average cost could be used in determining necessary price would be under the assumption that necessary price fluctuated directly with the average cost index, and likewise the assumption that a certain period could be selected as a base in which price and production costs were in a correct relationship, so that the price in that period represented the price necessary to maintain the production then taking place. Even under these assumptions, when an endeavor is made to determine necessary price from it in another area, the average cost index is open to the same objections that were made against it for compari-

sons with other farms. The probable inaccuracies are very great.

Bulk-Line Cost Index

Another index which may be worked out using full accounting costs, is the bulk-line cost index. As has been pointed out before, the bulk-line cost is supposed to approximate the production cost of the marginal producer. The technique of the method usually consists in arranging the production costs of the individual farms in an array and drawing a line arbitrarily that includes a certain percentage of the production below it. In Bulletin 858, U. S. Department of Agriculture, "Requirements and Cost of Producing Milk in Northwestern Indiana",⁽⁶³⁾ the percentage selected was eighty. The exact location of the bulk-line is always a matter for discussion. It changes with different enterprises, areas and times. If it were constant, it could probably be located accurately by statistical studies in combination with the method of trial and error. Statistics alone are sufficient. And while a given bulk-line percentage is being tried out, conditions are changing so that the given cost, even though correct at the time, no longer fits. Obviously it is impossible constantly to be changing the percentage. Hence it is doubtful if a bulk-line index can be relied upon to show marginal cost accurately.

The bulk-line expresses cost in a single absolute figure, and as such may be compared easily with other areas and conditions.

(63) USDA Bul. 858, Requirements and Cost of Producing Milk in Northwestern Indiana, pp. 16-17.

An absolute figure is readily comprehensible by the public. The manner in which the figure is constructed is, however, not so well understood, and for this reason the figure may be used for purposes for which it is not fitted.

This method gives a different figure from the arithmetic mean for an index, almost always a higher one, and it may give very greatly different comparisons. The following taken from the table of costs in "The Cost of Producing Milk in Western Washington" shows this fact. (64)

	Average cost per hundred- weight	Bulk-line cost per hundred- weight	Spread
First winter	\$1.50	\$1.57	\$.07
Second winter	1.60	1.79	.19
Increase in cost	\$.10	\$.22	\$.12

	<u>Percentage Increase</u>	
	Average Cost	Bulk-line Cost
First winter	100	100
Second winter	106.6	114

It is likely that the bulk-line cost index will always be subject to larger variations than the average cost index. This is because it is drawn through a part of the frequency curve of costs where a slight change in the frequency ordinate requires a

 (64) USDA Bul. 919, Cost of Producing Milk in Western Washington,
 p. 16.

considerable change in the cost ordinate. The average-index will therefore more accurately represent the whole group. However, the bulk-line index, if it is anywhere near the marginal cost, will more accurately portray the significant part of the frequency curve and furnish a better basis for reasoning about necessary price and choice of enterprises.

The bulk-line should therefore enable us to locate the necessary price more accurately than the average cost because it conforms more closely to the theoretical idea of the marginal producer than the average cost. In fact, it represents an attempt to put into statistical practice the economic theory concerning marginal cost and price. Its accuracy as a measure of necessary price depends upon the correctness of the economic principles underlying the theory and the accurateness of the statistical measures.

The question also enters, as with all complete cost accounting indices, as to the accuracy of certain cost charges for which quotations can not be found. If these cost charges are inaccurate, the index itself is naturally inaccurate, depending upon the degree to which these errors are compensating.

The bulk-line cost index is open to the same objections as the average cost index for purposes of comparison with other farms and areas. In both instances the characteristics of the group from which the data were taken are necessary for correct interpretation of the meaning of the figure and its application to other conditions.

Weighted Average of Relatives Index

(Using full accounting costs)

Another method of constructing an index of production costs using full accounting costs, is by taking the percentages of the total cost of each individual charge as weights for the current price quotations. The price quotations are expressed as relatives usually of the base period in which the weights are calculated. The final figure is therefore a relative which expresses the relative change in production costs from the base to the compared period. An example follows which shows the principles underlying this method.

Charge	Per cent of total cost of each charge ⁽⁶⁵⁾	Index of base year	Index in compared year	Index x weights
Feed	49.4	100	210	10374
Pasture	8.2	100	140	1148
Labor	19.5	100	190	3705
Overhead and other costs	21.6	100	150	3240
Depreciation on cows	1.3	100	110	143
TOTAL	100.0	100		186.1

New Index = 186.1

(65) USDA Bul. 858, Producing Market Milk in Northwestern Indiana, p. 26.

The example is of course meager but the method can be refined to any desired extent by a subdivision of the charges.

A valuable feature of this index is the ease with which the weights may be compared with those in other similar indices. The chance for error in this comparison of course lies in the difference in the method of valuation of the charges and the differences in the quotations used in determining the index.

The weights that are applied in this method must differ constantly with times and areas. An idea of the extent of these variations may be gained from an examination of Table II in Chapter III. Even on the same group of farms in different years, the proportions of these costs differ. The figures from North Carolina for two different years on the same group of farms vary as much as 2.9 per cent in the labor charge. The character of the year selected as a base is therefore of the utmost importance, and must be considered in applying the index. The accuracy of the index in any particular year will depend upon how closely the actual percentage distribution of the cost charges in the compared period follows the percentage distribution of the cost charges in the base year. Similarly with areas, the accuracy of this index for purposes of comparison with another area depends upon the extent to which similarity exists in the percentage distribution of cost charges.

The index is also open to the objection raised before as to the reliability of certain cost charges for which quotations cannot be obtained. In this sort of an index, errors are in some respects cumulative. They not only affect the individual charge,

but are transmitted to all other charges when occurring in the base period. The percentage that any charge is of the total cost depends upon the amounts of the other charges; as these amounts are great or small they change the percentage of the total cost of any constant charge. Therefore, any mistake in any charge in the base period from which the weights are determined not only affects the accuracy of the particular charge in question, but also of every other charge. The amount of error, however, is probably small, and being spread over so many charges, does not greatly affect any one of them.

The individual farmer will experience difficulty in comparing the costs on his farm with those shown by the index. In few cases does he conceive of his costs upon a percentage basis from a value standpoint. To make such a calculation, he must know the physical units of the cost factors used in making the index, and the valuation given these units. He must know the same things for his own farm. The probable fault of the index will be that the farmer will fail to recognize its shortcomings and be too ready to assume the same percentage distribution of costs on his farm as in the index, and hence make a wrong application of it.

The percentage distribution is usually an average figure, based directly upon the value of production factors. It is therefore open to the objections raised against the average cost index. Also it does not represent production costs on any individual farms, except those farms possessing the same percentage distribution of costs.

In setting necessary price, such an index will be useful only under the assumption that the proportions of costs remain constant in the period under comparison, and that the cost of production in the base period was equal to necessary price for the volume of production required at that time. A further assumption must be made that the necessary price in the compared period bears the same relationship to the cost as in the base period. Only in so far as these assumptions are correct and conditions have not changed, can this index safely be used.

Indices of Physical Units at Current Prices

(Using full accounting costs)

The other method by which an index may be constructed using full cost accounting data, is by using physical units as weights, which are applied to current price quotations to determine the index. The physical units used as weights are the amounts of the various cost goods, (feed, labor, etc.) used in producing a given amount of milk (usually 100 pounds) under average conditions. The index is therefore the sum of the current costs of the required amounts of all the various cost items. Such an index is an absolute figure which can be readily understood.

This index possesses the advantage of easy comparison with other similar indices, the difference in the amounts of the physical units being at once apparent. The farmer can also make adjustments of the index readily to suit conditions upon his particular farm. He knows in a general way the physical units he requires for production, and can make allowances for the differences

between his farm conditions and the conditions expressed by the index.

Price quotations are of course unobtainable for some charges as in the other full accounting cost indices. The physical units are usually selected from a group of farms by means of an arithmetic mean. As such, therefore, they cannot be said to be representative of the cost of production, as an average cost of production can hardly be said to represent any particular cost of production at all. The average amount of labor or feed required to produce a hundred pounds of milk is just as truly an average as is an average of a lot of individual costs of production. The index does, however, represent the cost of production on the farms that have the same physical expenditures as are possessed by the weights used in the index. The farmer can therefore apply the index to his individual farm by modifying the index according to his particular conditions.

For the determination of necessary price this method has the disadvantage incident to the average cost index and percentage distribution of cost index, in that, usually being based upon the arithmetic average of the group, necessary price can only be determined by a relative comparison with the base period, in which comparison certain questionable assumptions must be made. If cost of production alone could give us necessary price, of course this comparison with a base period would not be necessary. To be sure, we might assume, under certain circumstances, that the cost of production in the base period was necessary price, and therefore it should be now; but this would require very unusual circumstances.

A milder assumption is that the new market price must bear the same relationship to the present production cost index as the necessary price in the base period bore to the production index in the base period.

To be sure, such an index could be constructed using physical units based not on the average amount of feed and labor required, but on the marginal amounts required. This would seem to give us necessary price direct, and not an index of it. But marginal units of feed and labor would fluctuate considerably more than the average amounts, and as with marginal costs, it would be difficult to determine them because conditions would change while we were trying them out.

Such an index has the disadvantage that it reads like a true cost of production, and is therefore bound to be misinterpreted. This difficulty might be obviated by reducing the cost indices to relatives, taking one year or period as a base.

CHAPTER V.

INDICES USING LESS THAN FULL
ACCOUNTING COSTS

The preceding chapter has discussed the methods of constructing indices using full accounting costs and some of the difficulties connected with their construction. This chapter analyzes the difficulties connected with the determination of some of these costs. Later the possibility of omitting some of these charges is discussed, as well as the possibility of representing them by other charges. Finally certain recommendations are made respecting the construction of such an index.

The following is the usual analysis of the principles underlying the value of producers' goods. Most economists recognize the fundamental importance of utility as a price determinant. The object of all economic processes is of course the satisfaction of human wants. Wants cannot be completely satisfied because of a lack of goods, which may be due either to the disutility incident to producing these goods or to their physical non-existence. Where goods exist in abundance with no disutility attached with their existence, they are free goods. Otherwise they possess value. This value is expressed in price. Consumers' goods are valued for their direct ability to satisfy human wants. Producers' goods are valued because of their ability to produce consumers' goods.

The process by which the value of goods is attained is very complex. Where there is a single producer's good entering

into a single final product and no other, the problem is comparatively simple. The relationship is direct and the value of the producer's good depends directly upon the value of the consumer's good. Ordinarily, however, the producer's good can be used in the production of several final goods. In such a case, the good will be used in such quantities in the various production processes that it has the same value in all of them. The distribution of the use may be illustrated by the following diagram:

Units of a cost good	Use A	Use B	Use C
1	20	18	16
2	18	16	14
3	16	14	
4	14		

A, B, and C represent three uses to which a given producer's good may be put. Thus, hay may be fed to horses, cattle or sheep. If hay is worth more in any one of these uses than in the others, then it will be given that use down to the point where it is worth no more than in the other uses. Producers' goods, therefore, will have the same value in all these different uses. If the demand rises for all these goods, it is likely that more will be produced and the margin will rise to 18 or above for all three. If demand falls, the reverse will be true. If the demand rises for any one use of the producer's good, more units of it will flow into that use and less for the others, but presently all will be equalized at a somewhat higher margin of value. If the supply falls, then only the 18's will be available. If supply increases, then the 14's become available.

The worth of this analysis of the value of producers' goods lies in the assumption that if we can determine the value of the good in one use, we may consider its value the same in another.

Usually, however, the analysis is not so simple as this. Instead, there are several producers' goods entering into several final products. Hay is only one of several feeds that are used for producing milk, and hay is used for producing other things than milk. This, however, does not seriously modify the analysis. The enterprisers, in anticipation of the demand for the final products, bid for the producers' goods and the bidding imparts to them their value. This bidding of the producers directs the goods into the uses yielding the largest value product; and gives them the same margin in all uses, for where a good will produce more in one use than in another, it will be bid away from the second into the first use. The price which any entrepreneur has to pay for a good depends upon its value as determined by his use and all the other uses to which it can be put. This constitutes the basis for using as costs in a cost of production study the value of the cost goods in other uses. The value of cost goods in competing uses is usually called their "alternative-use" value, or "opportunity cost" value. The former is the better term.

It will be apparent that alternative-use value is merely a measure or indication of value. Just as we read the height of a column of mercury to find the temperature of the air, so we may read the value of a cost good in its alternative uses to find its value in the use in question.

Alternative-use value is by no means an entirely satisfactory measure of the value of a cost good in any given use. If there were no such a thing as economic friction, if labor, capital and other cost goods passed instantaneously into new uses in response to changes in prices of final goods--then alternative-use value would be a perfect measure. Since there is a great deal of economic friction, it usually happens that cost goods at any one time are worth different amounts in different uses. Profits are to be made by buying these cost goods at what they are worth in less important uses and applying them to their more important uses. Losses will be experienced whenever cost goods are used in their less important uses. This supplies us with the reason for cost accounting. The purpose of cost accounting is to find out the relative profitableness of cost goods in different uses. The cost of production of a final product is merely the sum of the values of the particular set of cost goods entering into the product, the values of these cost goods being derived from alternative-uses. These sums of values when compared with market prices of the products, furnish us with an index of relative profitableness.

Since, however, because of economic friction, a given cost good is likely to have several alternative-use values, the question arises to which of these values should be used. To find the loss from a wrong use of any cost good, obviously its value in its most profitable alternative use must be used. Similarly, to find the profit from any use of a cost good, the same basis must be used. This means, of course, that if, for example, these uses

of a given cost good were being compared, A being the most profitable use, that the losses from B and C would be gauged with respect to A, and the profit from A with respect to B and C. The general rule can be laid down that the basis of valuation of all cost goods is cost accounting operations is the value of these cost goods in the most profitable alternative uses.

Very frequently this rule is easy to apply. The value of the cost good in its alternative uses is clearly indicated by a recognized market quotation. Many cost goods have a multitude of more or less competing uses. Out of this competition arises a market price. Thus arises the wages of labor, the price of coal or feed, the interest on capital, etc. The comparison of uses is between the use in question and the rest of the field. Whenever economic changes have put this particular use temporarily at an advantage or disadvantage, the economic friction not yet being overcome, then this particular use will show a profit or a loss.

It must be remembered that market prices of cost goods express the values of cost goods in their least important uses. We have already noted how units of a given cost flow into several uses until the same level of value is attained in all. They continue to flow into these several uses until an equilibrium is attained with supply. The last units flowing into these several uses, establish the value for all. These least important uses are likely to be associated with marginal entrepreneurs and marginal capital goods and marginal labor. The better-than-marginal entrepreneur will of course make any unit of cost good yield more

than the marginal use of it; but this extra yield is not value for the cost good, but a differential for the entrepreneur. The market value is the marginal use.

Difficulties In Valuing Cost Goods.

1. Many cost goods have no real market value. Farm accountants have resorted to all sorts of subterfuges to estimate their values. Most of these have ignored alternative-use as a basis of value; and they have ignored the marginal element in market price. The cost good in question is likely to be one which can have little use off the particular farm in which it is being used. Having no market, it can have no market price. An alternative-use value, even if it could be computed, would include differentials belonging to management and other factors. The most troublesome of these cost goods are family labor, silage, pasture, manure, rent and interest. The rent charge is not hard to establish wherever land is rented for cash; but not so in owner-operated farms.

2. No available market quotations. In many of the cost charges made in the usual cost of production studies there are no market quotations available to serve as a basis for the valuation of these charges. In certain areas market quotations can only with difficulty be determined even for commodities that have quite definite market quotations in other areas or in certain central markets. In such cases the prices for the area must be estimated from the known quotations in the other areas.

3. Question as to whether certain cost items are properly called costs. There are certain objections to considering some of these so-called cost charges as costs at all, sometimes from the standpoint of necessary price and sometimes from the standpoint of determining what to produce. What is satisfactory from one point of view may not be from another. Bran is a good example of this. Bran has other uses than as feed for dairy cows, but its other uses are relatively insignificant. It is utilized, of course, in all uses to the point where it pays the same in each use but the amount consumed for other uses than dairy feed hardly figured at all in the valuation. Bran therefore derives its value from the finished product of the dairy industry. If the use of bran were discontinued in the dairy industry its price would drop to almost nothing. When the prices of dairy products go up, the price of bran can be expected to rise and when the prices of dairy products fall the price of bran can be expected to fall.

For determining necessary price, therefore, in the first place, there is no need of including bran as a cost, and in the second place, there is positive evil in including it, for if a necessary price is once set too high, bran prices will presently reflect the new profits in dairying, and these new bran prices will become the bases for still higher costs of production.

The same analysis holds true of family labor, except that in the case of family labor there is often no alternative use at all, and its entire value is therefore derived from the dairy

enterprise. As the price of milk rises, family labor becomes more valuable, and as the price of milk falls family labor loses value. The only use frequently displaced by using family labor at the milking is recreation; there is frequently no other profit-bringing use for much of such labor. Where such is the case, the cost charge for such labor must therefore be very small or none at all. It may therefore be omitted from the cost charges, and it certainly may be omitted from an index of cost. In general land has several uses or combinations of uses open to it, and its rent reflects its value in those several uses. On at least part of the land which is used for a given product, enough to make a "zone of indifference", is open to several uses. (65) In many cases, however, economic friction keeps new areas from coming into new uses in response to rising prices, or keeps old areas from dropping out when prices fall. Rents may therefore for a considerable time reflect the prices of particular products unless costs are being studied. Thus cotton growers a year ago were demanding that the cost of producing cotton should be based on the rents following 40 cent cotton.

For the same reason there is an objection to considering rent as a cost in any case in which the rent can be seen to clearly be based upon the selling price of the product in question. In such cases the rent varies directly with the price of the final good and it should not be considered as a cost.

(65) J. B. Clark, Distribution of Wealth.

There is also a division among accountants as to whether interest should be considered as a cost. Interest, however, is essentially an element of cost if we want our cost figures to give us comparable statistics regarding capital investments for different enterprises, for different departments in the same enterprise, for different periods or for different methods in the same enterprise. The argument against the inclusion of interest are that it conceals the effect on profits of the amount of capital used and the time that it is employed. Moreover, the interest rate must be decided upon arbitrarily, for from the many existing rates we do not know which one to charge.

4. Joint costs. A large number of the cost goods entering into the production of butterfat enter jointly into the production of other farm products. On the ordinary farm butterfat production is but one of many enterprises. Corn, clover, hogs, cattle, horses, and numerous other enterprises may be conducted simultaneously. In the conduct of these enterprises many cases of joint costs arise. For example, the milk production enterprise, the hog enterprise and the veal calf enterprise have many joint costs - The use of the same pasture for cows, calves and horses is another such problem. Where two articles are produced as joint cost products the combined selling prices of both of them must tend in the long run to cover the combined necessary cost of both of them. But the distribution of these joint costs between the two enterprises is difficult and can only be estimated. No entirely satisfactory basis for the division of costs exists.

When one product is distinctly a by-product, or it is desired to show a profit upon one of the enterprises, the method of crediting the cost of one enterprise with the return of the other is used. In this manner the combined profit of both enterprises is thrown to the desired enterprise. The packing industries use this method in their accounting. It is likewise often used in farm management studies. For example, when clover is grown with oats as a nurse crop, the oats are often charged with the preparation of the seed bed. In consequence the oat crop shows a loss and the clover crop a large profit. Nevertheless farmers continue to grow oats in this way year after year.

A more logical basis would seem to be to charge, as the accountant puts it, what the traffic will bear. Let us suppose a manufacturing plant were to install a new department which the manager decided would introduce a combined saving from three departments that would more than cover the installation. There would be no way of directly determining the charge to be made against each department. The charge might be made according to the saving in each department, or according to what the traffic would bear. In other words there would be charged against each department as much as possible without that department showing a loss.

Since joint costs cannot be distributed except on arbitrary bases, and since agriculture has so many of them, the validity of all farm cost accounting is seriously impaired except upon some arbitrary basis. Neither economic theory or cost accounting offer much hope regarding the solution of this problem in the future.

5. The method used in the past in charging products of one enterprise which are further manufactured or refined in another enterprise to the latter enterprise at market prices is also criticised by some economists. The method is, however, widely used in this country, and has such strong advocates as the Department of Agriculture and most of the farm management departments of the country. The argument in support of this method is that each department of the farm business should be treated as though it were the sole enterprise of the business. Each enterprise will then show a profit or loss individually. The livestock enterprise, for example, is charged for the farm crops consumed by that enterprise at the market prices then prevailing. Thus the crop enterprises and the livestock enterprises are each made to show a profit or loss of their own.

The criticism of this method largely relates to the division of the farm business into the various enterprises. It is thought by many that the various "departments" should be determined by the final products sold, that is a farm producing dairy products, pork and eggs and poultry really has only three departments, and the crops and feed produced are parts of these three enterprises. The part of the corn crop which is fed to the cattle belongs to the dairy enterprise, and so on with all the other crops and enterprises. According to this analysis, costs are kept on all the crops, but no profits are computed for them. The crops are charged with the final products at their cost of production. The actual accounting under this analysis shows the crops as enter-

prises the same as the livestock. But the rule of industrial accounting for transfers between departments, namely, that all transfers between departments are made on the basis of cost of production, is applied in all cases.

A strong argument in favor of this analysis is that in only a few cases is there really a market price for farm products used in further production on the farm. These products are not grown for sale, but because they fit into his scheme of enterprises. The existing markets for some of these products can hardly be said to be producers' markets, because they could absorb only a small portion of the product were it actually sold. When there is a market price, however, it is simpler to use this than to compute cost of production.

Another argument in favor of the second analysis is that the market allows a competitive profit only upon a whole process of commodity production. The farmer cannot stop at any particular point in this process that he may desire. In consequence, in any consideration of market price questions, whether the problem is approached from the standpoint of the grower or the market the whole process must be considered.

6. There are seasonal variations in production cost based upon seasonal opportunities, which are often not considered in the usual cost of production studies. In case of labor, the customary method seems to be to charge a flat rate for the entire year based upon the total labor cost divided by the total number of hours work performed. Under such a plan, enterprises which

demand labor at periods when it has a high value in other uses are likely to be undercharged and show a considerable profit at the expense of those enterprises which utilize the labor that would otherwise have no use. Seasonal variation in labor cost is sometimes figured by dividing the labor cost of each month by the total hours of work in the month. This latter method more nearly approaches the truth than the farmer, provided that a range of years or seasonshands can be distributed properly between different months.

The only method which squares without alternative-use analysis is to place a value upon the labor according to the alternative opportunities for the use of the labor on the farm, at the time. The farmer in using the method would of necessity have to have before him at all times the next highest alternative value of the labor in the utilization on the farm. For example, a man digging potatoes when the next highest use is filling silos would charge the potato enterprise with the value of the labor in the silo-filling work. The difficulty of this plan lies in the fact that it is very difficult to determine the value of the labor in alternative uses.

Somewhat similar questions arise regarding the seasonal distribution of other charges, for example, the feed charge, and the building charge.

7. Another question which arises in the usual cost accounting studies is the manner of charging rent in a rotation. The ordinary method of making this charge is a flat rate per acre

regardless of the crop which is being grown. The returns from a rotation as a whole depend upon the interrelations of the whole system. Some crops are grown not for themselves alone, but because they also make definite contributions to following crops. Such crops should be credited with such returns in some way, perhaps, by lessening the rent charge against them and by raising the charge against the other crop. The only way of looking at the question is to consider the second crop as making use of some of the land in the preceding year, and therefore to require to stand some of the rent.

The figuring of complementary credits in a crop rotation, however, is extremely difficult.

Analysis of the Various Cost Charges.

It will be apparent from the foregoing that any cost index which is based on full accounting costs is fraught with very great difficulties. Following is an attempt to analyze the various cost charges to discover how they may be handled in making up an index using less than full accounting costs, which of them may be omitted, which may be represented by others, etc.

1. Purchased Feeds. The method used in this country in charging purchased feeds is to charge them at market prices. Wherever feeds are purchased off the farm there is naturally a definite price attached to them except in cases where trades are involved. Even in such cases it is probably safe to impute a market price to them.

To this market purchase price of the feeds is added usually the cost of the delivery of these feeds to the farm. This

cost of delivery may appear in the cost accounts of the farms in two ways, either as a direct charge to the grain of so much per bushel as the estimated or actual delivery expense, or it may be included in the labor account. In either case it is an actual expense connected directly with the cost of the purchased feeds.

Considerable difficulty, however, exists in the determination of the actual cost of this hauling. It is obvious that it is not uniform throughout the year. The cost of a forced trip for feed during a rush season would evidently be higher than a trip during the slack season. Moreover, most of the hauling is done on return trips when there would be no other use for the time. The determination of the value of such time is largely an estimate and cannot be determined accurately. The usual method seems to be to charge this time with the flat labor rate which is charged against the various other farm enterprises. It would seem that such a charge would be too high for if the labor were not used in this work it would have no use at all. The error when miscalculated will not be large, but nevertheless is important.

The question of using market quotations as indices of purchased feeds is complex. While actual purchases mean actual costs these sales prices are not tabulated for all sections as market quotations. Central market quotations can be readily determined, but in the outlying districts where we are endeavoring to determine costs, quotations are not available. In view of the fact that prices in these regions are dependent directly upon the central market the practice is often to use an index of the central

market quotation as representative of the price fluctuations over this area. Certain errors are incident to such an assumption. Prices in areas dependent upon the central market for their quotations vary for short periods from the central market more by definite margins than by percentages. An index of price quotations from the central market would therefore fluctuate more than the local price when expressed as percentages, as illustrated by the following:

Price of Corn Per Bushel					
Central Market			Outlying District		
	Bare Year	New Period	Bare Year	New Period	
Actual Price	\$1.00	\$1.10	\$1.10	\$1.20	
Index	1.00	1.10	1.00	1.09	

In the case of purchased feeds this is less likely to happen than in the case of feeds sold, for the seller may figure a percentage margin instead of a flat margin.

These errors in the case of purchased feed are, however, relatively small. In reality the quotations for purchased feeds represent the most reliable quotations of all milk production costs. They can be measured by actual expenditures.

In case physical quantities are used as weights for actual prices, rather than relatives this error would not exist, for then actual price margins could be added rather than percentage margins as in the case of relatives.

2. Marketable home-grown feeds. The usual practice in charging home-grown feeds which are readily marketable is to charge them to the enterprise utilizing them at market prices less the cost of transporting them to the market. Using a relative of market prices as an index of the cost of saleable home-grown feeds presents the same defects as in the case of purchased feeds, chiefly, that the farm price differs from the central market price, at least in short periods, by actual rather than percentage margins. This introduces an error similar to that in the case of purchased feeds. The error, however, is in the opposite direction from the error in the case of purchased feeds, and is in this respect compensating. Thus when purchased and home grown feeds are equal in amount, the effect may be entirely to eliminate this error. Or if it could be assumed that the margin remained constant in amount a percentage table could easily be worked out eradicating this error. The error, however, is no more serious than in the case of purchased feeds.

In the long run the value of feeds is based on the value of the final products into which they enter. Often when all adjustments are over, the different feeds will be so used that they yield the same return in each use. For short periods during which this readjustment is taking place feeds may yield more in one use than in another.

Prices of feed may be so high that livestock enterprises cannot be continued on this basis, but it may be cheaper to pay high for the feed and save the livestock than to let it starve.

Hence feed prices may at such times do as necessary costs for the time being, but not in the long run. Nor will they at such times serve as bases for choosing enterprises.

Here again enters the question of which prices to use for the index, whether to use market prices or to use the cost of production. If we use cost of production we are really going back to labor, capital and other prime costs. Our final index will then read so many hours of labor, so many units of capital, land, etc. But quotations for these prime costs are difficult to determine and are at best unsatisfactory.

Market price, however, includes a profit on the feed crop. If the profits on the feed crop were always constant, then market prices, even though including profits, would be used as an index. But this profit is not constant. Feed is sometimes produced at a large profit, sometimes at no profit, and sometimes at a loss.

3. Non-Commercial Feeds. A great many of the feeds used in the dairy enterprise, however, have no market and can be utilized only in some other enterprise. Straw, corn stalks, silage and root crops are typical of these sorts of crops. It is this type of feed for which the charge is most difficult to determine. The ordinary cost accounting method is to charge these feeds to the dairy enterprise at some arbitrary value. The other possible basis for the charge is at the cost of production. In fact, this method is ordinarily recommended for charging crops grown solely for animal feed and having no market price. Of

course it is difficult to determine these costs of production.

Alternative use offers another basis for charging certain of these feeds. For example, in the case of silage the alternative is letting the corn go as ear corn. The value of an acre of ear corn might therefore offer a basis for the determination of the value of an acre of silage. On a consideration of this value account would of necessity be taken of the difference in the cost of harvesting the corn as silage and as ear corn.

The value of displaced feeds might also be used, that is, the value of the feeds that would of necessity be fed in case silage was not fed. Such a basis might be largely a food value basis resting upon a comparison with other feeds when the cost of these elements of feed were known. This really amounts to having these non-commercial feeds represented by commercial feeds. Such a basis is not entirely satisfactory. It will do for silage; but the other non-commercial feeds may have little or no value except as utilized in the dairy enterprise. They have, therefore, no other alternative uses from which value might be attached to them. Their value depends upon the value of the final product into which they enter, namely, the products of the dairy enterprise. It would, therefore, seem possible to represent the fluctuations in value of these non-commercial feeds by the fluctuations in the price of butter, where butter was the product of the farm, or some other dairy product when that article was the product of the farm.

4. Pasture Cost. Pasture as pointed out in Chapter III is usually charged at a certain percentage of the capitalized value of the land. The farm mortgage rate is ordinarily used. This rate, however, is too high, as the true rate of land capitalization is low. Land values include not only the capitalization of the present rent returns, but also anticipated future increases. It is, obviously, illogical to include these future increases as a cost. Ultimately, we will be able to determine this rate of capitalization. At present, however, the only safe basis for the determination of the cost of pasture is the cash rent basis.

The possibility of representing certain of these charges by other quotations is extremely important from the standpoint of index number construction. Those feeds for which there are central market quotations, but no local quotations may be represented by these central market quotations with but relatively small error. This error, as pointed out before, lies in the fact that the difference in the variations in the price fluctuations between the centreal market and outlying districts are actual rather than percentage changes in short periods. These errors are relatively small, and as they are compensating to some degree in the case of home-grown commercial feeds and purchased feeds the error may probably be ignored.

For feeds such as bran, however, which derive their value solely from the dairy enterprise, market quotations are not essential. The value over long periods will correspond very closely to the value of the final products into which it enters. As this

final product is butter, the value of the bran will tend to follow the price of butter, certainly over long periods and to some degree over shorter periods. The cost of the bran in an index of butter production costs might therefore be represented by the fluctuations in the price of butter. A degree of error enters even under these assumptions as the value is determined by the general level of price of the dairy products, of which butter is only one contributing factor. Dairy products may temporarily get out of line with one another. Likewise bran may temporarily get out of line with other feeds. The value of displaced farm feeds sets a sort of upper but not a lower limit to this fluctuation.

The same plan may be used for measuring the fluctuations of the value of the non-commercial roughages. The same analysis holds as in the case of bran. This basis would seem better than the usually suggested method of representing these feeds by their cost of production. An arrangement which values a portion of the home-grown feed at market quotations and a portion at the cost of production is clearly illogical, because one includes profits and the other does not.

Hired Labor

In farm cost accounting several methods seem to be used for charging the labor upon an hour basis. First, the total wages for the contract period plus board and room and such other prerequisites as are given to the laborer, is divided by the total hours of work by that employee. This gives a man hour rate for

each man. This rate is applied to all enterprises. Secondly, the total wage cost on the farm (including extras) is divided by the total hours of work performed, giving a man hour rate per farm. The rate is applied to all enterprises alike. Extra labor is charged at the actual price paid and to the particular days. Finally, the actual wage in the community, including extras is divided by the average hours to get the community rate, which rate is applied to all farms and all enterprises. Often extra help is made an exception and charged at the actual rate paid.

The latter method is obviously wrong for individual cost accounting as it confuses the purpose of cost accounting. A farm with low labor cost should obviously be organized upon a different basis than one with high labor costs. The community rate is also likely to be for an average hired man, whereas any particular farmer may hire better or poorer than the average. The first method would also seem to be better than the second.

The determination of the seasonal value of this labor is extremely difficult. Ordinary cost of production studies do not attempt it. Nor do they try to determine the cost of labor to the various enterprises. Usually all enterprises are charged a flat rate for the entire season. The determination of this seasonal and enterprise cost of labor is rendered difficult by the nature of the wage contract. The following general systems are in use: First, the farmer may hire the man for the entire season and pay him by the month in equal monthly installments.

This yearly payment may also be graduated into different monthly payments. The year may be divided into the busy and slack seasons and the monthly wage be different in these two seasons. Or the payment may be made by means of a "wage scale" where the monthly wage depends upon the demand for labor.

The farmer may also hire the labor for periods of less than a year. For example, the extra labor may be needed only for a month or possibly only for a few days. For some farm enterprises it may even be possible to utilize piece work, as for example, in picking berries, hicking corn by the bushel, etc.

If all that is wanted, however, is quotations that may be used as bases for indices, the situation is somewhat different. The Bureau of Crop Estimates figures gives wages by states, with and without board, when men are hired by the month and when they are hired by the day at harvest time and other periods than harvest time. It seems probable that these figures represent in a general way the fluctuations in the labor cost on the various farms. They do not, however, represent seasonal variations. Nor costs to different enterprises. Moreover, the quotations are given by states as a whole, while what is needed are quotations by smaller districts such as counties.

Investigation upon this portion of the problem has been insufficient to give us a correct basis for our cost charges. The only possibility of adjusting regular hired labor to displacement costs is as follows: Charge the piece and extra day rate, to the various enterprises whenever competitive rates are available. The remainder may then be distributed to the remaining enterprises

at a flat rate or upon the basis of estimates. The rate for the whole month might be based upon the competitive rate whenever available, or by estimates. Such charges rest upon the assumption that labor is free to move from place to place day by day. Such of course is not the case, and in this respect our assumption is not square with the facts.

Family Labor.

Much of the labor on the farm, however, is not hired, but is family labor. Such family labor has usually no outside competitive rate, and the value must be based upon the most profitable alternative use. Where an outside alternative exists which is enough more profitable to make labor worth more than it is to the farm business, then this is the rate that should be charged. When no such rate as this exists, the displacement cost must be used. Often there is no alternative use for the labor and the displacement cost consists simply of the loss of recreation or pleasure. The general alternative of the whole family in some other line of business must, however, be considered in valuing the family labor. From the standpoint of farm organization there is no justification for charging family labor at hired labor rates. It would also seem that there would be no justification for believing that the value of family labor fluctuates with the value of hired labor. Such an assumption would only be true where family labor displaced hired labor. It is often maintained in certain so called "cost of production" studies that family labor must be represented by hired labor, because if the family labor were not used then hired labor

would of necessity be used. Such, however, is not the case for if family labor were not available the enterprise would not be carried on. The only reason for conducting the enterprise is that it is the only way in which family labor can be given a value and thus be made to contribute to the general profit of the farm. The value of the labor, therefore, depends upon the price of the products of the enterprise, and will fluctuate with these prices under our assumptions. We might, therefore, take as a measure of the changes of the value of family labor, the changes in the prices of the final product, as has been suggested for bran and certain non-commercial roughages.

The Farmers Own Labor.

The farmers own labor must also be valued. The general level of the farmers own labor cannot depart vary far from the value of hired labor; otherwise the farmer would become a hired man himself. If the farmer should become a hired man he would, however, have no sale for his management, which ordinarily can be sold only in conjunction with the labor. It is possible that the farmer might sell this labor cheaply in order to obtain something for his management. The valuation of management will be considered later. Considered from the point of view of index making, however, it is quite likely that the value of the farmers own labor must fluctuate nearly according to the value of hired labor. There will be periods, of course, when this is not true. In a period of agricultural depression, for example, farmers labor will be worth less than hired labor because hired labor can move.

Overhead Charges.

The so-called "overhead" charges of butterfat production are shelter, equipment, cow cost and sire cost. For most of these there are no market quotations, and the amount of the charge is extremely difficult to determine.

1. The Building Charge. The usual building charge consists of repairs, insurance, taxes, depreciation and interest on the investment in buildings. In an individual cost accounting study the charge for repairs, insurance and taxes is definite and can be determined accurately at the close of the year. The depreciation and interest on the investment are rather indefinite and are in reality usually estimates. For index purposes the taxes and insurance charge are rather constant from farm to farm depending upon the value of the buildings. Repairs are not, but depend largely upon the care of the individual farmer and the construction of the particular building in question. The item is small, however, and the error may be ignored without seriously effecting the index.

The charge for the depreciation of an individual building is an estimate. No one can fortell accurately the life of the building nor the scrap value at the end of its period of usefulness. The depreciation thru out the period must therefore be estimated. Straightline depreciation is ordinarily used, because of its simplicity, although it is probable that depreciation varies from year to year. For necessary price determination straight-line depreciation would be satisfactory and for the choice

of enterprises upon an individual farm over a period of years it would probably also be satisfactory.

Interest upon the average depreciated value of the investment in buildings is also charged. This value as pointed out above is an estimate, but is probably as accurate a figure as can be determined. The chief difficulty lies in the determination of the interest rate to be charged. The rate of interest varies temporarily with times. There is also a different rate for the various enterprises of the farm. For example, a farmer may be earning 12 per cent on the money he has invested in his farm business, he figures he can earn 10 per cent by borrowing money to purchase cattle, he can borrow this money at 8 per cent with the purchased cattle as security, or at 6 per cent with the entire farm business as the basis of the security. The question is what rate of interest should be charged to the investment in cattle, not only upon the purchased cattle, but also upon the cattle the farmer already owns. It will thus be seen that the rate of interest charged is largely an estimate. In consequence we cannot state definitely as yet what the rate of interest is for any particular enterprise on the farm.

After the total charge for shelter has been determined it must be distributed seasonally and prorated with the other enterprises using the same building. The methods pointed out in Chapter III are probably satisfactory.

2. Equipment Charge. The equipment charge is one of the minor charges made against the dairy enterprise. It is similar to the building charge in the character of the items making it up.

The depreciation and interest charges are largely a matter of estimate. Depreciation is more rapid in the case of equipment than in the case of buildings. Because of the small size of this charge it may probably be represented by the building charge without serious error in an index

3. Cow Costs. As pointed out in Chapter III, four charges are usually made against the cow, depreciation, interest on investment, taxes and veterinary and breeding fees.

Where the herd basis is used depreciation does not enter as a cost. Upon a cow basis it is, however, a cost. Straight-line depreciation is ordinarily used, although this is not entirely correct, for the cow appreciates in value in the early part of her life. In the case of interest upon the investment, taxes and depreciation, the amount of the cost charge depends in a large measure upon the value of the cow. The value of the cow in turn depends upon the value of the final product. We may, therefore, represent these costs in an index by the value of the final product.

There is, however, a certain degree of inaccuracy in this method in the case of cows. Her value depends upon the profit that can be made from her. A percentage rise in the price of a final product might be accompanied by more than a percentage rise in profits, in which case the value of the cow would rise proportionately more than the value of the final product.

For purposes of necessary price such a basis would seem satisfactory, and likewise for the comparison of enterprises

4. Management. The farmers labor income consists of three elements, namely, first, payment for the physical labor of

of the farmer and his family, secondly, payment for management, and finally, payment for risk taking and residual responsibility taking -- profits. The management function is usually defined as the direction and supervision of the production process. In commercial and industrial enterprises the functions of management are delegated to specific individuals and in consequence the cost can very readily be determined. In the farming business, however, the management function is combined with the physical labor of the farmer. In consequence, some method for estimating the charge for management must be made. The usual method is by means of a fixed percentage or by an estimate of the farmer himself.. This method does not provide for seasonal distribution nor for distribution between enterprises. Management has a definite value in alternative uses upon the farm, and for purposes of index making can undoubtedly be assumed to fluctuate very nearly with the value of the farmers labor, hence it might be expressed in some percentage of the farmers own labor.

Basis of the Proposed Index.

Table III summarizes certain conclusions regarding the cost charges included in an index of milk production costs. It will be seen that certain of these charges can be represented by the price fluctuations of the product itself. Those charges such as bran, family, labor, non-commercial feeds and the cows, derive their value almost solely from the one group of final products and therefore fluctuate with them in price.

The remaining elements could then be represented as follows:

TABLE III.

TABLE SHOWING CHARACTER OF THE VARIOUS COST CHARGES.

CHARGE	Measur- able Physic- al Qu- antiti- es	Prob- lem in joint costs with other farm enter- prises	Deter- minable Value	Defin- ite Market Quota- tions	Depend- ent Di- rectly on final dairy product for value	Repre- sented in in- dex by some other charge ?	Season- al cost directly determ- inable
Feed- Purchased Bran	Pounds Pounds	No No	Yes Yes	Yes Yes	No Yes	No Dairy Product	Yes ----
Saleable home-grown Non-commer- cial	Pounds Pounds	No No	Yes No	Yes No	No Yes	No Dairy Product	Yes ----
Pasture	Acres	Often	No	Yes	No	No	Parti- ally
Labor Hired Family	Hours Hours	Yes No	? ?	Yes No	No Yes	No Dairy Product	No ----
Farmer	Hours	Yes	?	Partially	No	No	No
Overhead Buildings Taxes & Insurance depreciati ion & Int- erest	\$ \$ \$	Yes	Yes Yes Yes	No ? H	No Parti- ally	No Build- ings.	No No
Equipment	\$	No	Yes	H	Parti- ally	Build- ings.	No
Cow Taxes & Insurance Depreciation & Interest	\$:\$: Yes	: Yes : No	: No : No	Largely Largely	Dairy Product :	--- :

Other purchased feeds by the market prices, plus cost of hauling. Home-grown readily saleable feeds, by market prices, less cost of hauling. Silage by its equivalent in corn, plus the difference in the cost of harvesting. Pasture, by current cash rents on pasture land or rates of hire for pasture. Hired labor, by the current rates. Farmer's labor, by hired labor. Management could be represented by the farmer's labor. Equipment could be represented by the building charge with but small error.

Construction of the Index.

The index may be constructed in one of two ways, either as a weighted index of relatives or by applying physical units to actual prices. The weighted index of relatives has the advantage of the easy inclusion of the butter relative as a representative of certain costs. Its disadvantages are those already raised in Chapter IV in the discussion of relative index numbers. The weights must be determined by reducing all charges to a common denominator which in this case is value. Values change constantly so that the weights are in reality changing constantly. As has been pointed out before, accuracy in weights is much more important in an index of few quotations than it is in one composed of many quotations. The lessening of the number of charges has, therefore, increased the importance of the weights.

The other method of constructing the index is by means of actual prices weighted by physical quantities. Both for purposes of determining necessary price and in the choice of enterprises this type of index would seem to be superior to the weighted index or relatives.

As has been already pointed out the arithmetic average is insufficient as a representation of the cost of a group of farms because there is no such thing as a single cost of a group of farms except in the sense of a marginal cost, or a cost which market price must cover in order to maintain a given supply. This marginal cost is composed of certain marginal cost items, which when determined might be expressed in an index. Since marginal cost is the thing in which we are interested, such an index would have more significance than one based upon average costs. It would be worth more in the determination of necessary price and be more useful to the farmer in making comparisons with his individual farm than the average cost index.

The difficulty with the marginal cost, however, is that it is difficult to determine. All that is needed, however, is an index that shows changes in marginal cost. It has been customary of late to use "bulk-line" as an index of marginal costs. Applied to physical units, the bulk line would work out as follows: Each cost charge will have its own units. Some of these will be bushels, others hours, others dollars. These cannot be combined into one array. Hence a separate array must be made for each one. This can be done only when the charges are in no sense supplementary. Where costs are from supplementary items, the items must be reduced to a common base and compared as totals rather than as individual items, for otherwise the index will be made unnecessarily high. For example, hired labor, family labor, and the farmer's own labor could not be compared upon this basis, as a farm with more of one kind would use less of another kind.

The farm using a large amount of hired labor will usually use a small amount of family labor, while a farm having a large amount of family labor will usually use a small amount of hired labor. An index of the bulk line of each of these three would therefore be illogical. The same would be true in the case of feeds. The farms on the bulk line as far as cost was concerned might consist either of farms using a large amount of purchased feed and a small amount of home-grown feed, or a large amount of home-grown feed and a small amount of purchased feed.

The method which it seems necessary to use under the circumstances is as follows: Reduce physical units to costs and combine them into a value array. Single out a group of farms clustered around the bulk-line, as many above as below. Average the cost items in terms of physical units for this group of farms. The results will show that the marginal group of farms are requiring some many pounds of feed, so many hours of labor, etc. to produce a hundred pounds of milk. The reason that a group of farms must be taken rather than one is that the particular farm that happens to be at the bulk-line may be erratic in its use of cost goods -- it may use an abnormal amount of some particular cost good.

The real reason for using the bulk-line rather than the average is that it is more sensitive to changes in conditions of production, and it comes nearer to reflecting conditions on the margin. This is on the assumption, of course, that the bulk-line is nearer to the margin than the average is. Whether this is true depends upon where the bulk line is located and where the

margin happens to be. It is ordinarily assumed, partly on theoretical grounds and partly as a result of investigations, that the margin for farm products is somewhere between the eighth and ninth deciles.

Such an index of physical quantities as weights applied to current prices would give us an absolute figure which would seem to give us necessary price at once; but such an assumption is hardly warranted as it presupposes that conditions are just right in the period in which the weights are chosen. A much safer assumption would be that the market price then prevailing was a necessary price to maintain the production then prevailing under the conditions as shown by the index. Using this period as a base, then, necessary price in the new period would be represented by the same percentage change from the price in the base period as was represented by the change in production costs shown by the index. In view of the fact that absolute indices of production costs are likely to be misleading, it would be best to reduce the index to a relative figure, using some period or year as a base.

Pearson's Formula

Pearson's formula consists of a group of physical quantities which when applied as weights to current prices are believed to yield the "cost of production" of milk. Pearson's formula as presented in Bulletin 216, Illinois Experiment Station, "The Cost of Milk Production", is open to certain objections. In the first place, the basis for the valuation of the various cost charges is not clear. A number of charges are not specifically included.

Upon the "cow basis", 25.6 per cent of the other charges are added to cover these additional costs. This assumes that these additional costs fluctuate with the cost of the included charges. In view of the fact that there is no relationship between these charges, this is not a proper assumption.

Upon the herd basis, Pearson adds no percentage at all, and it is not clear where these costs are included. Another criticism is the manner of determining seasonal costs. The formula is said to represent the year cost of milk production. The monthly cost is found by applying to this figure a monthly scale showing the same variation as the monthly Chicago milk prices over a series of years. Such a procedure bets the whole question of costs, as it drags in the supply and demand aspect of the problem. The formula is based upon averages and is consequently open to all the objections raised against the average cost indices. Pearson's formula undoubtedly has value in the Chicago milk area and points out the method for further work along this line.

Wallace in his "Agricultural Prices", uses Pearson's formula as a basis for the cost of milk production, and then applies these same principles to other commodities, using, however, in some cases, even fewer cost charges. For example, in showing the cost of producing hogs, he uses corn alone. Such a procedure cannot be justified. It will be apparent that corn obtains its value to a large extent from pork alone. The other costs entering into the production of these commodities must in some way be represented, and there must be some logical connection between the charges that

are omitted and the way in which they are represented.

Conclusion

It seems evident that an index can be constructed using less than full accounting costs which will possess certain advantages over the full accounting cost method. In the first place, the proposed index would be more accurate than the full accounting cost index, since it does not try to include many charges that cannot be satisfactorily ascertained upon full accounting bases. Instead, it represents them by costs that can be accurately determined. Secondly, such indices are much simpler to compute than full accounting cost indices. They also possess a more permanent value.

Indices of the cost of the various products might be computed for the various sections of the United States. The costs shown by these indices could be published from time to time in the various official bulletins of the government, in agricultural papers and elsewhere, as is done at the present time with the Bureau of Labor indices. The wide publication of such indices would show us more quickly when changes in production costs were occurring. The farmer would know sooner when he was producing at a profit and when at a loss. He would be able to forecast the trend of production more accurately and hence govern his own production to better advantage. This would prevent economic losses by securing a better adjustment between production and demand.

Such an index would also have value in throwing light upon necessary price, by showing changes upon the supply side of

the problem. Most agricultural products are increasing cost goods, and hence cost of production as well as demand must be taken into account in determining their necessary price. The indices would inform us as to the supply aspects of the problem.