An economic study of the cattle feeding enterprise in Iowa

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AN ECONOMIC STUDY OF THE CATTLE FEEDING ENTERPRISE IN IOWA

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS

C. F. CURTISS, Director

AGRICULTURAL ECONOMICS SECTION

AMES, IOWA

Published by Iowa State University Digital Repository, 1927
An Economic Study of the Cattle Feeding Enterprise in Iowa

BY JOHN A. HOPKINS, JR.*

This bulletin is a part of a larger and broader study which attempts to explain the economic forces and conditions which have caused the development of the present types of farming in Iowa, and their location under the particular conditions where they are found. A study of this sort is not intended to be, and should not be, purely analytical. It should trace the development of the present forms of farm organization, and should proceed to point out lessons to be drawn from their development for the guidance of the practical farmer.

Such a study cannot stop at an examination of the present system alone. Our present economic institutions are rooted deeply in the past. Our present economic environment would not be what it is had it not passed thru the specific course of development that has gone before. For this reason a brief historical sketch of the development of the beef cattle industry is presented.

The particular questions of the beef cattle enterprise to be considered in this bulletin have to do with reasons for the inclusion of this enterprise in the farm organization which is typical of most parts of Iowa. We need to examine the forces which make the raising or the fattening of beef cattle profitable under some conditions and unprofitable under others. The farmer needs to know this in planning the organization of his business, and he also needs to know the most advantageous form for the enterprise to take in that business. In the management of his farm he will want some basis upon which to judge the relative efficiency of his beef enterprise as compared to the same enterprise on other farms. This publication attempts to furnish some criteria of this sort from records which have been obtained on cattle feeding enterprises. Little

*The writer wishes to acknowledge the assistance received from the many farmers and others who have contributed the historical and statistical information on which this bulletin is based. He wishes to acknowledge particularly the direction and helpful criticism of Prof. C. L. Holmes, chief of the section of Agricultural Economics, under whom the study was made and the manuscript prepared, the assistance of Prof. Knute Bjorka, on the statistical methods used, and the valuable advice of Prof. John M. Evvard, of the Animal Husbandry Section, in the interpretation of the records on the fattening of cattle referred to in Section III. Acknowledgment is made to Prof. T. N. Carver, of Harvard University, under whose direction a thesis was prepared by the present writer on the Economic History of the Production of Beef Cattle in Iowa, which has been drawn upon in the historical section of the present study.
information has been available, up to this time, on the physical and financial costs incident to raising cattle in Iowa.

Because of the great variety of conditions under which one form or another of the beef enterprise is found, and because it takes both time and expense to obtain such data, both of which are much limited in this study, we are forced to stop with doing the best we can with the information at hand, much of it admittedly inadequate and much of it ill suited to throwing light on the questions which it was hoped to answer. Indeed, it is not intended to attempt to answer all of the practical questions involved but to provide the practical man with data which he may use with the aid of his good judgment in answering the specific questions which arise under his particular conditions.

Certain forces outside of the farm organization profoundly influence the internal organization of the farm itself and the products which it is most advantageous for the farmer to produce. Thus, altho the skill with which the farm is organized and the efficiency with which it is managed determine the costs of the products under a given price situation, if that price situation changes, and with it the prices of some of the cost elements, the relative advantages of various crops may change greatly. Also, the advantage or profitability of production depends as much on the prices received for the products as upon their costs. In deciding how he may use his resources most advantageously, the farmer must give as much consideration to the probable prices of the various alternative crops which he might produce as to the costs of producing them.

An attempt is made in the following pages to discover the principal forces which determine the prices of beef cattle in relation to the prices of other farm products which can be grown in the same sections or under the same conditions. But because of the limitation of space, the more comprehensive discussion of cattle price relationships must be reserved for later consideration.

DEVELOPMENT OF THE ENTERPRISE

CHANGING PLACE OF CATTLE IN IOWA FARMING

In the agriculture of early Iowa the production of beef cattle was the principal enterprise in each frontier or semi-frontier community. Altho it is still very important, the value of the cattle shipped out of the state each year is much less than that of hogs, and instead of standing almost alone as in the earlier years the enterprise is now tied up in mutual dependence with the other enterprises of the farm. The
history of this change is in itself an interesting story, and it helps us to understand the present function of the cattle in the farm organization.

The object of the farmer is to get the greatest possible return from the resources which are available to him. In the period of settlement land was the most plentiful and the cheapest factor of production. Capital was scarce and high in price. Labor was scarce and also high in proportion to the cost of the use of land. Under these conditions the most economical productive combination was one which used the largest possible amount of land in proportion to the available labor and capital. The raising of cattle on the cheap pasture of the prairies was pre-eminently an enterprise of this type, and the settlers turned to it as soon as they were able.

The settlement of Iowa began in the eastern and southern parts and moved to the west and north. Approximately the period from 1840 to 1880 was required for the migration of the frontier of cultivation across the state to its northwestern corner. During this period a vanguard of cattle preceded the plow, and after them came first the crops which used relatively large amounts of land per man. At first the acreage of corn was small and that of wheat relatively large. Later the acreage of wheat usually began to decline and that of corn to increase. This change came because climatic and soil conditions favored corn rather than wheat, and partly because the corn contributed to the farm income indirectly as well as directly thru the value of grain fed or sold. The growing of wheat utilized labor available on the farm only during a small part of the year. Corn provided a use for this labor over a longer period and in addition provided feed for livestock which used labor in the winter even more than during the crop growing season. This more efficient farm organization, therefore, had an advantage over the growing of wheat as well as over the grazing of cattle.

As concerned the cattle enterprise the change was also significant in that the cattle no longer formed the only or the predominant enterprise but now became an integral part of a more complex economic organization in which they were kept both to fill certain limited functions and also to add to the effectiveness of the general plan.

In this second stage the cattle served not only to harvest the prairie grass and convert it into a marketable product on the frontier, but also provided a means of transporting corn and other bulky crops to market. Particularly in the

1 The historical sketch is based on information collected by the writer in preparation of a study on "The Economic History of the Production of Beef Cattle in Iowa."
sections distant from railroads, it was not economically possible to haul or ship such crops to market. But when fed to cattle or hogs, these grains could be sent to market in the form of beef or pork, at a large saving in transportation cost.

Other crops were being added to the agriculture of the state and the cattle were therefore decreasing in relative importance. Nevertheless the absolute number of cattle was increasing because of the greater area of land being used and because of the greater product per acre. This is shown in table I, from which it may be seen that the number of cattle in Iowa trebled each decade up to 1860 and then doubled each decade up to 1890. There was an additional increase to nearly 4 million head in 1900 (as reported by the census of June 1, 1900) and thereafter only minor fluctuations to the present time.

With the growth of population and capital, and the settling of the farm into something like a permanent organization there came a third stage in the history of the beef cattle enterprise. The free prairie grass was gone. The greater part of the tillable land of the state was in some sort of a cropping system before 1890 and this system was becoming pretty stable by 1900. Larger acreages were being put into crops and the earlier and lower yielding crops were being replaced. The proportion of corn was constantly increasing. Here cattle were at a disadvantage as compared to hogs, for the latter were worth nearly as much per hundred pounds as cattle but could produce considerably more meat per bushel of corn. Still the ordinary farmer could not handle enough hogs to consume his whole crop of corn. Also there were roughages produced incidentally to the other crops which cattle could consume but hogs could not, and there were areas of rough land in farms which it was most convenient to keep in pasturage.

The cattle were still of use in saving freight, but there had been an increase in their function in converting low grade feeds into marketable products, utilizing rough land, utilizing labor during the winter, and otherwise preventing waste. From about 1890 to about 1907 there was a series of improvements in the technique of beef production

<table>
<thead>
<tr>
<th>Year</th>
<th>No. beef (other than milk) cattle in Iowa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1840</td>
<td>19,000</td>
</tr>
<tr>
<td>1850</td>
<td>69,025</td>
</tr>
<tr>
<td>1860</td>
<td>293,322</td>
</tr>
<tr>
<td>1870</td>
<td>614,386</td>
</tr>
<tr>
<td>1880</td>
<td>1,755,343</td>
</tr>
<tr>
<td>1890</td>
<td>3,394,736</td>
</tr>
<tr>
<td>1900</td>
<td>3,943,982</td>
</tr>
<tr>
<td>1910</td>
<td>3,041,214</td>
</tr>
<tr>
<td>1920</td>
<td>3,038,198</td>
</tr>
<tr>
<td>1925</td>
<td>3,287,477</td>
</tr>
</tbody>
</table>

a. Approximately.
b. Prior to 1920 cattle were classified into milk cows and "other cattle." In 1920 they were classified as Dairy Cattle and Beef Cattle. The censuses of 1900 and of preceding decades were taken as of June 1. The Census of 1910 was as of April 16. Those of 1920 and 1925 were of January 1.
which tended to reduce the production costs and to stay the declining importance of the cattle enterprise. The first of these was in the reduction of the usual age at which the cattle were marketed. In the eighties three years was a common age at time of sale and four years was by no means rare. Regarding the earlier maturity of the Shorthorn, C. E. Leonard, president of the American Shorthorn Association, said in 1900: “Such progress has been made in this respect that up to date Shorthorns are as well matured at two years as formerly at three.” The process of development towards “baby beef” was by no means at an end. The second improvement was in the adoption of nitrogenous supplements, which will be discussed more later.

The third outstanding improvement was the one which had been in progress to a greater or lesser degree since the settlement of each community. This was in the adoption of heavier yielding crops. The first step was in the displacement of prairie grass by timothy as a forage crop and by bluegrass for pasture. Within five to ten years after the introduction of timothy, that crop began to be displaced by clover which provided a much superior feed. The adoption of clover, like the process of settlement, moved across the state to the northwest. It was being grown in all parts of the state by 1900. About 1903 alfalfa began to displace clover to a small degree in some of the western sections. Its use increased slowly but it had become an important crop in western Iowa by 1913 or 1914. During the same period, from about 1903 to 1914, the silo came into wide use, especially in the eastern cattle areas where alfalfa was not widely grown. All of these developments tended to reduce the difference in the amounts of feed and the value of crops per acre as between corn and the forage crops. Since it is necessary to provide forage crops for the production of cattle, these improvements in the forages had the same effect in the competition as an improvement in the efficiency of producing beef cattle, and retarded the displacement of the cattle enterprise by crops. Further improvements in the forages or pasture crops, such for instance as the adoption of sweet clover as a pasture, may be expected to have similar effects.

By 1900 or 1905 the farm organization of Iowa had become quite delicately adjusted in such a way as to yield the maximum return to the farmer’s resources when considered as a whole. As a result more and more importance was coming to attach to the relationships between the prices of the different farm products to which the farmer could turn his effort.

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2 Iowa Homestead, Jan 3, 1901. address before American Shorthorn Association, in Chicago, Dec. 5, 1900.
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and the organization was becoming more sensitive to price changes. From being the principal enterprise in the agriculture of the frontier, the production of beef had, in some parts of the state, become largely a minor enterprise in a relatively intensive agriculture and a means of salvaging low grade by-products of other crops, while in other parts the intensive feeding of beef cattle had become a major livestock enterprise, second only to hog production.

EVOLUTION OF METHODS OF RAISING BEEF CATTLE

The same forces and conditions which determined the place in the farm organization filled by cattle were also the chief factors in determining the methods in raising and caring for them. In the early Iowa community the same shortage of labor and capital which made cattle the principal enterprise also prescribed for their care the methods which involved a minimum of labor and capital.

In each new community the small farm herds were usually permitted to run at large on the prairie until settlement became thicker and neighbors began to complain of damage to crops. Frequently the settler's children tended his cattle. This insured him against damage to crops and postponed the need for fencing. As described in the Report of the Iowa Agricultural Society for 1866 the cattle were usually given the range of the prairie in summer, and were given salt once a week. In winter when the ground was frozen, they were given the range of the corn fields. When it was not frozen, they were kept in the barnyard and fed mostly on prairie hay. For shelter strawstacks, groves, and straw sheds usually sufficed.

As the settlement thickened herds of young and dry stock were often gotten up and put out under a herdsman for the pasture season at a cost of from one to two dollars per head per season.

The scant shelter or the lack of shelter for the early cattle is also to be explained by the economic situation existing on these farms. Capital was very scarce among the settlers and hence the tendency was to put it to the uses which promised the greatest returns. During the earlier period it was cheaper to give the cattle very little shelter and maintain their bodily heat by feeding them the cheap corn or roughage than it was to provide good shelter and thereby save on feed. As the price of corn and roughage rose and capital became more plentiful it became more profitable to provide better shelter and the straw sheds and stacks began to give way to better sheds and barns. In the older parts of Iowa a few barns
were built as early as the fifties, but not until a much later date in most parts. In many sections they were by no means common even in the nineties. The building of better shelter for cattle appears to have proceeded more rapidly during the period from 1895 to 1900 or 1902 than in any earlier period. As the population grew and the amount of labor available per acre of land increased it became profitable to use proportionately less land and more labor, so that more care came to be given to the cattle. And since the cost of feeds was rising, economy in production became more and more imperative. Methods were therefore sought whereby the cattle could be matured at earlier ages, by which greater gains could be gotten per unit of feed, or by which lower grades of feed could be used.

By 1905 to 1907 the beef industry of Iowa had assumed a rather stable character and there had evolved two principal forms of the beef enterprise. In most sections of the state and especially where there was rough land best usable for pasture, small farm herds of cattle were kept to use this land and to use the roughage which was grown partly as by-products of other crops. The calves of these herds were hurried in their growth by careful and heavy feeding on high grade feeds and were sold at relatively early ages. In the period about 1905 two years seemed to be about the usual age. Later many of them were sold at 12 to 16 months as "baby beef," thus obtaining their gains in weight during the growing period of their life when the gains could be made at a smaller feed cost. This also permitted the sale of the heifers on a better basis as compared with the steers than would be possible at a greater age, and produced a higher grade of beef which sold at a premium.

The other type of beef producing enterprise was that in which cattle that had been grown in the western range sections were kept on Iowa farms two to six months for fattening on corn after they had gotten some gain on the unsalable roughages such as corn stalks. The development of the methods of this latter business will be discussed in more detail later. This type of enterprise represents a specialization of function in the production of beef, whereby the corn producing Iowa farms perform only the function of fattening the cattle, while the ranges which are unable to produce the necessary grain for fattening, confine their effort to raising cattle to the feeder state.
DEVELOPMENT OF METHODS OF FINISHING CATTLE

The consumer of discriminating taste finds the meat of well-fattened cattle so much more palatable than that of the same type of cattle which have not been fattened that he is willing to pay an increase in price for this beef which usually at least equals the added cost. Relative limitations to the number of people who insist on the finest finish, and on their buying power, however, is shown by the small proportion of cattle which are ordinarily finished in prime condition.

Here enters the opportunity for the farmer to make a profit by the fattening of cattle. It is not his function to increase the amount of beef so much as it is to improve its quality. The two functions may be combined to a greater or lesser degree as in the case of the production of baby beef, but it is possible to produce the greater part of the weight of a steer on relatively low grade, cheap feeds, while the fattening process requires more concentrates which are more valuable. Therefore, the farmer who has corn and other feeding stuffs of higher grade and greater value can ordinarily use it to better advantage in the production of the last one or two hundred pounds of weight which adds the greatest value to the carcass of the steer.

Development of Method of Fattening in Iowa.—The earliest reported fattening of cattle in Iowa, in the fifties, appears to have followed closely the methods used earlier in the older cattle feeding sections farther east. The feeding methods changed but little as the feeding industry moved westward behind the frontier. The difference in method was greater between different stages of agricultural development in the same locality than under similar conditions at different times. In 1851 some few cattle were being corn fed in Henry County, Iowa, which had then progressed far enough past the grazing stage to be raising a surplus of corn. The corn was fed in the fodder which was usually thrown on the ground, although racks were occasionally used. After a few years the settlers here, most of whom had come from the east and were therefore used to cutting and shocking corn, began to discover that much labor could be saved by snapping the ears or the ears and husk from the stalks in the field. Within a decade the practice of cutting and shocking corn had declined very materially here as well as in other parts of Iowa.

Corn in the fodder was therefore partially displaced in the feed lots by snapped corn or broken ear corn thrown on the ground. When the ground was muddy the loss of feed by this method was of course very great, and as transportation systems

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3 From the historical study mentioned above.
developed between Iowa and the markets, increasing the price of corn, more attention was given to methods of reducing this wastage. Feed bunks began to be used by some of the cattle feeders about 1870. Still corn was cheap and many who fed cattle at that time report having fattened cattle on nothing but snapped corn, using no other concentrates and no roughage in addition to the corn in its husk.

During the seventies and eighties the cattle were commonly put on feed at an age of three or three and a half years, and since corn was cheap, were fed for relatively long periods of six to eight months, being finished at what would now be considered very heavy weights. The cattle were usually started on corn in the fodder, sometimes while the corn was still green, then were changed to snapped corn which was continued for the greater part of the feeding period and then supplanted by ear corn and sometimes by shelled corn. For roughage prairie hay was ordinarily used. Later timothy and then clover hay came into use. From the frontier sections most of the cattle were sold without having been fed any grain, and it should be remembered that the total volume of feeding in Iowa prior to 1890 was small. Most of the feeders were handled in relatively large herds, but fewer men were feeding than 10 or 15 years later.

During the nineties the tendency to fatten cattle at younger ages, referred to previously, was under way and was being hastened by the work of the agricultural experiment stations. About the same time the market demand began to change so that the well finished animals of lighter weight were no longer discriminated against as consumers came to recognize that it was possible for cuts from these animals to be as well finished as cuts from the older and larger types of beeves to which they had been accustomed.

During the nineties a few feeders began to use nitrogenous supplements with the corn ration. The experiment stations were showing that the cattle needed a larger proportion of protein than was furnished by the prevailing ration, which consisted very largely of corn. Adding small amounts of protein-rich feeds to the ration materially increased the gains from a given amount of corn. The by-products of corn starch manufacture, called gluten meal or gluten feed, then oilmeal, and cottonseed meal began to be available about this time and were taken up by the feeders, who at first used them quite sparingly, sometimes sprinkling them lightly over the corn as a sort of appetizer. By 1904 or 1905, however, the supplements were being used more heavily and by more of the feeders.

As noted, the development of the cattle fattening industry
in Iowa involved the fattening of cattle at younger ages, the shortening of the fattening period, greater care for the cattle as the available labor increased, greater economy in the use of feeds, the use of more roughage and of higher grade roughage in fattening, and the supplementing of the corn ration with nitrogenous feeds. It should be remembered that all of these developments were consequences of changes in the economic environment and the continued operation of the same economic laws that had brought into existence the methods of beef production first found in the state. Thus, nitrogenous supplements were not generally resorted to because the beef producers had become more intelligent than they were in the earlier years but because the increased prices of corn made it profitable to feed it more carefully and to get a greater return by using supplements to make up its deficiency in protein. It was the increasing opportunity for the use of these feeding stuffs that stimulated their development and adoption.

Similarly, farmers did not begin fattening cattle at younger ages merely because they had suddenly seen the light and had been ignorant of the better method before. Instead, the change came because the increased value of the use of land for crops as compared to pasture now made the gain in weight of a steer between the time he was two and three years old cost more than it was worth, whereas before, with cheap pasture, it had been profitable to keep him the additional year for the price of this gain.

**MARKET CONTACTS**

The contacts which any group of producers have with others is an important consideration. This bulletin will not attempt to discuss all of these broader questions but will try to show the relative importance of Iowa in the beef producing industry of the United States and to give an idea of the way it keeps in contact with other parts of the cattle industry on the one hand, and indirectly with the consumers of beef on the other.

**SOURCES OF FEEDER CATTLE**

The specialization of function in beef production by which Iowa farmers fatten a large number of cattle that have been grown in the range section calls for a marketing mechanism so that the range cattle can be transferred to the feed lots. This function is performed for Iowa chiefly by the livestock markets along the Missouri River.

The yearly output of Iowa raised cattle since 1920 has been from one million to one million and a quarter. The annual
number of feeders shipped in thru the central livestock markets, has varied from 468,000 in 1921 to 844,000 in 1922. In addition to this some cattle are shipped in without passing thru these markets. But when it is remembered that this is only about one-third of the number of cattle shipped out of the state and that about one-third of the final weight of the fed cattle was put on in Iowa, it will be seen that the relative importance of the cattle shipped into Iowa is small as compared to that of the home raised ones. Nevertheless, the beef produced by feeding the range cattle does constitute an important part of the supply. Also, the feeding process involves an improvement in quality as well as an increase in the weight of the cattle, and is therefore, more important than the quantity of its output alone would indicate.

In 1924 and 1925 about one-sixth of the feeder cattle passing thru the public stockyards of the country were shipped into Iowa. This probably gives the best idea of the relative importance of the state in the business of fattening and finishing beef cattle. The figures for the shipments of cattle to Iowa and the other principal feeding states are given in table II.

The yearly variation in the volume of feeder shipments for the country as a whole since 1916 has been from about 78 percent to about 118 percent of the average for that period. For Iowa from 1919 to 1924 the variation was somewhat greater, ranging from approximately 74 percent of the average for the five year period in 1921 to 133 percent in 1922. Table III shows the year to year variation in the shipments of cattle to farms for further finishing.

Within the state, more than a third of the feeders in 1923 were distributed over an area about 50 miles wide extending from Sioux County south along the Missouri River to the southern boundary of the state and including 15 counties. This is shown in fig 1. In the eastern part of the state there is another feeding area covering parts of 16 counties. This section extends east from Marshall and Jasper Counties to Jackson County on the Northeast and Louisa County on the southeast.

| TABLE II. SHIPMENTS OF FEEDER CATTLE TO PRINCIPAL FEEDING STATES* |
|---------------------------------|----------------|----------------|
| State of Destination         | 1924  | 1925   |
| Iowa                          | 570,040| 487,334|
| Nebraska                      | 565,373| 426,470|
| Kansas                        | 478,431| 467,713|
| Illinois                      | 438,817| 437,349|
| Missouri                      | 285,497| 276,136|
| All other                     | 942,509| 1,002,346|

### TABLE III. ANNUAL SHIPMENTS OF FEEDER CATTLE FROM STOCKYARDS

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Feeder Cattle Shipped to Iowa</th>
<th>Percentage shipped to Iowa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1916</td>
<td>3,847,000*</td>
<td></td>
</tr>
<tr>
<td>1917</td>
<td>4,003,300*</td>
<td></td>
</tr>
<tr>
<td>1918</td>
<td>5,018,000*</td>
<td></td>
</tr>
<tr>
<td>1919</td>
<td>5,286,000*</td>
<td>13</td>
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<tr>
<td>1920</td>
<td>4,102,000*</td>
<td>11</td>
</tr>
<tr>
<td>1921</td>
<td>3,504,000*</td>
<td>13</td>
</tr>
<tr>
<td>1922</td>
<td>4,864,000*</td>
<td>17</td>
</tr>
<tr>
<td>1923</td>
<td>4,553,000*</td>
<td>16</td>
</tr>
<tr>
<td>1924</td>
<td>3,966,000*</td>
<td>14</td>
</tr>
<tr>
<td>1925</td>
<td>3,095,042*</td>
<td>16</td>
</tr>
</tbody>
</table>

*Partly estimated.

**Hopkins: An economic study of the cattle feeding enterprise in Iowa**

It received about one-fifth of the feeders shipped into the state. Nearly 60 percent of the commercial cattle feeding in Iowa, therefore, was done in about 30 of its 99 counties.

The number of cattle coming from each state or section of the range country to Iowa cannot be given, because at the stock-yards thru which they pass no records are kept that follow each shipment of cattle from their origin thru the markets to the feeding area or shambles. The bulk of the cattle fed in Iowa come from the section directly to the west, Nebraska, Kansas, the Dakotas, Wyoming and Colorado. But there are also shipments from the southwestern range section and from Canada.

The principal gateways thru which the feeders enter Iowa from other states are the livestock markets along the Missouri River. These markets serve as stopping places for the greater part of the cattle from the ranges, and particularly for cattle of the feeder type. In these markets the cattle that are in fit condition for killing are slaughtered and the carcasses are shipped to the eastern consuming centers without the weight of the offal. The cattle which are in need of further finishing are sold to feeders and in this way are distributed over the western part of the corn belt to be fattened on corn.

The distribution of cattle into Iowa from the Missouri River markets rather than from markets farther east is dictated by economic reasons. Since the cattle are moving toward consuming centers in the eastern part of the country, the minimum of freight expenses is involved in moving the cattle always eastward avoiding the double freight that would be encountered in any movement of cattle to the westward.
Omaha is the most important market thru which feeder cattle enter Iowa. After Omaha comes Sioux City, Kansas City and St. Paul. The number of feeders shipped in thru each of the principal markets during 1924 and 1925 is given in table IV.

A few large cattle feeders buy directly from the ranches so that some of the cattle do not pass thru the stockyards at all. This number seems to be on the increase, but no data are available to indicate its exact size. A small proportion is shipped in by cattle dealers and sold by them to the farmers either at auction or at private sale. But by far the greater number pass thru the established markets which give the farmer the advantage of a large number out of which to select the particular kind of cattle he wants. The markets also make available to the seller and buyer such facilities as a credit mechanism and a market information service.

Within the state feeder cattle move from section to section since feeder cattle are raised in a few localities in which not enough corn is grown to finish them. There is but little definite information regarding the volume of this movement. Most of the Iowa grown cattle are fattened in the communities in which they are raised and a considerable number on the farms on which they are raised, many of them in lots of less than a carload. Others are bought from the raisers by other farmers who make more of a specialty of feeding.

The principal localities which raise feeders are in the north eastern corner of Iowa and in the southern tier of counties where there is rough land on which but little corn is grown, and where accordingly, cattle are raised largely on pasture but where only a part of them are fattened. These cattle are ordinarily bought and “bunched” by cattle dealers and driven into adjoining localities or counties where they are sold to feeders. The greater part of the movement of feeders within the state, however, is between adjoining or nearby farms, and

| TABLE IV. FEEDERS SHIPPED INTO IOWA FROM PRINCIPAL STOCKYARDS IN 1924 |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Market          | Number feeders  | Percent         | 1924            | 1925            |
|                 | 1924            | 1925            | 1924            | 1925            |
| Omaha           | 208,161         | 170,736         | 37              | 25              |
| Sioux City      | 138,878         | 144,488         | 24              | 22              |
| Kansas City     | 125,508         | 95,426          | 22              | 20              |
| St. Paul        | 65,369          | 49,767          | 12              | 10              |
| Chicago         | 8,726           | 8,530           | 1               | 2               |
| St. Joseph      | 7,899           | 5,973           | 1               | 19              |
| Others          | 14,509          | 12,474          | 3               | 2               |
| **Total**       | **570,050**     | **487,334**     | **100**         | **100**         |

1 Data from the files of the Des Moines office of the Bureau of Agricultural Economics, of the U. S. Dept. of Agriculture.
CARLOADS OF CATTLE SHIPPED INTO IOWA - 1923

One Dot = 50 Carloads

Fig. 1. Location of Iowa feeding areas as shown by destinations of cattle shipped into the state.

The number moving from county to county seems to be relatively quite small.

Figure 2 shows the number of feeder cattle shipped into Iowa by months for the average of the five year period from 1921 to 1925 as compared to the feeder movement for the entire United States. It will be observed that the feeder movement for Iowa conforms to the movement of cattle from the ranges and to the Iowa farm year. That is, about 62 percent of the total yearly movement occurs during the four months from August to November, so that advantage may be taken of the fall pasturage, the stalk pasturage, and the available supply of farm labor during the winter.

The heaviest monthly feeder movement during this period occurred in October, with 238 percent of the average monthly shipments. The lightest occurred in June when the farmers were busy with work on crops, and just before the summer period of short pasturage. The June shipments were 39 percent of the average.

The Iowa movement in the spring months is somewhat smaller in proportion than that for the entire country. The shipments of feeders to Iowa increase at a slightly greater rate during August and September than that for the rest of the country, does not increase as much in October, and falls off more rapidly in November.
DISPOSITION OF IOWA CATTLE

About three-fourths of the cattle produced or fattened in Iowa are ordinarily marketed in Chicago. About one-eighth go to Omaha, and about one-twelfth to Sioux City. The remainder is divided in small numbers among several other markets. The receipts of cattle from Iowa as compared to the total receipts at each market for 1925 are as shown in table V.

The annual variation in the number of cattle shipped out of Iowa is considerably less than the variation in the number shipped in. In other words the number raised annually is much more uniform than is the number of western cattle fattened.

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Fig. 2. Monthly movement of feeder cattle. (Data for Iowa from January 1925, Iowa Monthly Crop Report, for U. S. from 1924 Yearbook of U. S. Dept. of Agri. p. 545, and Crops and Markets, Monthly Supplements for 1925.)
A comparison of the annual outputs of the state since 1920, together with an index of the number shipped out since 1912 is given in table VI.

The accompanying map (Fig. 3) will give an idea of the relative cattle output of the various sections of the state in 1924. It shows an area of dense cattle production in the western part of the state extending southward from Sioux County over a strip about three counties wide to the southern boundary. In the central western part of the state it extends eastward as far as Dallas County. This section is particularly well adapted to the cattle enterprise. Its soil is of the Missouri loess type which produces relatively high yields of corn but the fertility of which needs to be maintained by the growing of legumes and the use of manure. Both of these factors make for the keeping of a considerable number of livestock, and beef cattle fit in admirably with the cropping system necessitated by the type of soil and the presence of considerable rough land which it is advisable to keep in pastures. Also, the roughage provided by this crop-
ping system finds a convenient outlet in the cattle enterprise which is able to use both the corn stalks which would otherwise largely go to waste and the better grades of roughage such as alfalfa and clover hay.

In eastern Iowa there is another area in which the output of beef cattle is decidedly greater than the average. This is the irregular shaped, hilly area about two counties wide which extends from Jasper and Tama Counties eastward and southward to the Mississippi River.

In the southern part of the state east of Wayne County, cattle which are raised mostly on pasture, comprise one of the principal products; but the land has not as great a carrying capacity as the western cattle producing area and consequently the output per square mile is considerably lower. In the north central section the high percentage of smooth, rich land, most profitably used in the production of corn, and the consequent shortage of pasture, prevents a large production of beef. In the northeastern part of the state dairying is the principal cattle industry rather than the production of beef.

Figure 4 shows the marked difference found between the seasonal distribution of the cattle output of Iowa and that of the entire country. For the country the heaviest shipments occur from August to November, ordinarily reaching a peak in October. This corresponds largely to the shipment of cattle from the ranges. A large part of the range movement, however, is deflected to the feed yards for further finishing and
returns to market from three to six months later, so that the variation in the net receipts is not nearly so great as in the gross receipts.

For Iowa the heaviest movement to market occurs in December and January. The shipments from Iowa remain large until the early part of the summer, when they decline and remain at a low level until in November. This contrast with the cattle movement for the whole country is largely to be explained by the feeding of the range cattle for three to six months, as mentioned above, and by the finishing of Iowa cattle at seasons when feed and labor are most available, as contrasted with the sale of the range cattle at the end of the pasture season.

FACTORS DETERMINING THE EFFICIENCY AND PROFITABILITY OF FATTENING CATTLE

THE CATTLE FEEDER'S PROBLEM

The central problem of the cattle feeder is to operate his feeding enterprise so that it will add the maximum to his net farm income. From a cost accounting viewpoint the feeding enterprise should show the maximum of profit if all of the feeds, labor, and other contributions of the farm have been charged to it at rates which represent true opportunity costs; that is, rates which represent the contributions which would have been made to the farm income if these things had been put to the next most advantageous use.

In order to make the largest net profit on the feeding enterprise, the feeder will need to make an optimum or most favorable rate of gain on his cattle. This will usually be a fairly rapid rate of gain, but not necessarily the most rapid that could be obtained, for reasons which will be explained later. He will need to use a combination of feeds and a method of caring for the cattle which will obtain this gain at an optimum cost. This will usually mean a low cost but not necessarily the lowest possible cost per pound of gain. In addition to obtaining a favorable gain in weight at a low cost per pound, the feeder will attempt to buy and to sell the cattle which he is finishing at such times, under such conditions of the market, and in such flesh as to get the greatest possible increase or margin in the price per pound, without keeping the cattle too long or feeding them during a part of the farm year when there are other and more profitable alternative uses to which he could put his time and other resources.

The problem thus stated becomes amazingly complex when followed into its various ramifications of seasonal prices of thin and fat cattle, seasonal costs of gains when alternatives
in the use of labor and other resources are considered, relative costs of various degrees of finish, different rates of gain, and the many possible feed and cost combinations. The change in costs and profits when amounts and proportions of some of the more important factors in the problem are varied will be pointed out later. But it will not be possible to answer the question of the most advantageous methods and combinations under all possible conditions.

The following statements are based partly on actual records and partly on estimates obtained an cooperation with the Bureau of Agricultural Economics of the United States Department of Agriculture on the physical and financial costs of gains, profits, and similar factors, on about 550 lots of feeding cattle fattened in Pottawattamie County, Iowa, during the five year period, 1918 to 1923.4

GRADE OF FEEDER CATTLE AS AN INFLUENCE ON PROFITS

One of the most important factors influencing the profitability of the feeding operation is the type and grade of the cattle on feed. The question of the proper kind of feeders is probably outstanding in the minds of prospective feeders when they go to the stock yards to buy cattle. This factor will influence both the rate and the cost of gains in weight. It will also be one of the principal things determining the grade of the fattened cattle, and the margin received and the profit of the feeding enterprise.

4 The methods of analysis are described in Appendix A.
From the nature of the investigation on which this portion of the bulletin is based, it was practically impossible to get direct quantitative measurements of the grade of the cattle. It was thought that perhaps the relative price paid for feeder cattle might be an index of the grade and statistical analysis showed that there was actually a slight correlation in the direction of more rapid and cheaper gains with the higher prices paid for feeders. It was found that on the farms studied a 10 percent greater price paid for feeders, which presumably reflected a somewhat proportionate increase in the desirability of the cattle as feeders, was ordinarily associated with a greater rate of gain of about four one-hundredths of a pound per day and at an average cost of gain of one-fifth of a cent less than on cattle of the average cost. This was itself but a small difference as compared to the average cost per pound of gain of 16.8 cents for all of the herds studied. The final result, as measured in terms of profits on these farms, was that the feeders of 10 percent higher price yielded a greater profit of about $1.14 per head.

However, these relations were slight and one realizes that the wide variation in the time of the month in which feeders are purchased with the consequent range of the prices paid, as well as the fact that different purchasers may strike markedly different bargains on any market day, makes the price measure of the quality decidedly unsatisfactory. The question of the proper kind of feeders, however, should be constantly kept in mind. It has long been recognized that the man who can select the proper kind of feeders and buy them at a satisfactory price has a distinct advantage.

FINISH OF CATTLE AT SALE AS AN INFLUENCE ON PROFITS

Once the feeders are purchased and the fattening process is begun, and particularly as it nears completion, the farmer needs to consider the degree of finish in which they are to be sold. He will have to consider the advantages and disadvantages of various degrees of finish and the comparative profits under these conditions of selling the cattle in a high or low market grade. Here again relative prices were used as a measure of grade. In the case of finished cattle this measure should be somewhat more satisfactory inasmuch as the finish is very largely a matter of control with the feeders and in all probability finished cattle are bought by the representatives of the packers on a somewhat closer adherence to grade than is true of farmers buying feeder cattle.

Here again, statistical analysis showed some degree of correlation. The cattle sold in the higher relative price classes
made a slightly greater rate of gain per day, probably because the more desirable feeders were the ones usually finished to a higher degree. The difference in the cost of the gains was more pronounced than in the case of feeders of various relative prices. It was found that in order to get, for instance, 10 per cent more than the average price per hundred weight it was necessary to go to a greater expense of about one-half cent per pound of gain. When other conditions that accompanied a higher degree of finish were considered, practically no difference occurred in the profitableness of the feeding operation under a given market situation. The difference in profitableness of high or low finish at time of sale varied, however, from year to year with the price of corn and the spread between the prices of feeders and the price of fat cattle. The greater spread in price in 1919 and in 1920 than in 1921 and 1922 offered a greater opportunity for the skillful feeder to profit by putting his cattle in choice condition in these earlier years. At the same time the higher proportionate price of corn also made a greater loss probable to the unskillful feeder.

QUANTITY OF FEED PER DAY

One of the most important questions to the cattle feeder is the amount which he should feed. Should he use a moderate ration per day and count on a moderately long feeding period, or should he attempt to get the cattle on full feed as quickly as possible and continue to feed as much as he can get them to eat throughout the period?

To simplify this part of the analysis all feeds were reduced to terms of the two chief constituents which are common to all feeding stuffs, that is, to terms of crude carbohydrate equivalent, and crude protein. The average ration of those studied, when converted into terms of corn and clover hay would be equivalent to about 20 pounds of corn and 8½ pounds of clover hay per day. Large quantities of low grade roughages were included in the rations, however, and these were converted into the same terms as the more digestible concentrates, in terms of the crude and not of the digestible feed constituents. An assumed digestible content was not computed because there seemed to be considerable question as to the validity of the coefficients of digestibility under such varying conditions.

Again it should be emphasized that this study is a report of the amounts of feeds used and of the relationship between these amounts and other factors. These data do not afford directly any basis for prescribing rations, altho they do give evidence as to the general results obtained on the farms studied.
The figures obtained by the multiple correlation methods would show that the farms using more feed than the average obtain but a small increase in the rate of gain. For instance the feed equivalent of an additional five pounds of corn per day when added to the average ration was associated with gains in weight of cattle only one-seventh of a pound per day greater than the average gain. In the average ration gain was produced at over twice this rate per pound of corn. It should be remembered, however, that the feed equivalent of five pounds of corn does not mean exactly five pounds of corn. The rations found included considerable amounts of such low grade roughages as corn stalks. It would have been more representative of the rations found if instead of an increase of feed equivalent to five pounds of corn, we had said between two and three pounds of corn plus the equivalent of the rest in corn stalks and mixed hay.

Another consideration to observe in interpreting these data is that where a large quantity of feed is used it is not always used efficiently. Much of the increased amount of feed often represents a waste rather than an additional amount of nutrients converted into beef. We may conclude from this section of the study that the bulk of the farms which used feeds more heavily than the average got but a small additional gain in weight for it. The effects of variations in the ration can be gotten more dependably from the experimental feed lots where all the different rations are fed under essentially the same conditions than from a comparison of results on a large number of farms where different conditions as to efficiency and methods prevail on each farm.

Even on the farms which use feeds with equal efficiency the additional gains in weight are likely to be gotten at a higher cost per pound than where an average amount of feed is used and an average rate of gain obtained. In the first place the farms using the larger amounts of feed often use it more wastefully, as stated above. In the second place, it is necessary to feed a larger proportion of the more expensive concentrates and a smaller proportion of roughages in order to get the cattle to consume a greater quantity per day. This fact alone would cause some increase in the cost per pound of gain under heavy feeding. At the same time greater gains may be expected on the hogs following the steers.

In the present study it was found that an increase in the ration equivalent to five pounds of corn per day above the average resulted in an increase in the average cost of gain of approximately one-half cent per pound. But because the cattle fed a heavier ration were usually fed to a higher degree
of finish and therefore sold for a higher price, there was in
general practically no difference in the profitableness of the
heavier as compared to the moderate ration. But during the
periods when corn was cheap compared to cattle a heavier
ration was more profitable than when corn was high priced.

It is believed that large quantities of crude fibre—the un-
digestible woody part of feeds and particularly of roughages—
tend to reduce the rate of gains. The records studied gave some
evidence of this. It was suggested by these records that an
additional pound of crude fibre which is contained in approxi-
mately three and a half pounds of corn stover or timothy hay
inhibited or prevented about one-thirtieth of a pound of gain
per day which would have been made by the same amount of
feed if the woody and undigestible matter in excess of the
average had not been present.

**LENGTH OF FEEDING PERIOD**

In planning for the feeding operations the farmer needs to
consider that it is more difficult to obtain additional gains as
the steer becomes heavier and fatter, and that in a long feed-
ing period he will have to be content with a smaller gain in
weight per day than in a shorter one. Considering this the
feeder usually keeps the heavier and older steers in his feed
lot for a shorter time and tries to get as rapid a gain as
possible during this period. If younger and lighter cattle are
to be fed he will usually plan on a longer feeding period with
more gradual fattening.

It was impossible to ascertain the ages of the cattle on which
records were gotten but it was assumed in general that the
average weights of the cattle corresponded roughly to the
ages. A decided tendency was found to feed the heavier
cattle for shorter periods.

Among cattle of the same weights the average daily gains

**TABLE VII. AMOUNT OF FEED PER DAY—ASSOCIATED WITH
RATe OF GRAIN AND COSTS**

<table>
<thead>
<tr>
<th>Lbs. crude carbohydrate per day</th>
<th>No. herds</th>
<th>Lbs. crude protein per day</th>
<th>Gain per day, lbs.</th>
<th>Cost per lb. of gain</th>
<th>Average weight of cattle</th>
<th>Length of feeding period, days</th>
<th>Profit or loss per head</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-12</td>
<td>20</td>
<td>1.9</td>
<td>1.76</td>
<td>$1.42</td>
<td>682</td>
<td>183</td>
<td>-4.75</td>
</tr>
<tr>
<td>13-16</td>
<td>128</td>
<td>2.3</td>
<td>1.74</td>
<td>.160</td>
<td>852</td>
<td>212</td>
<td>1.15</td>
</tr>
<tr>
<td>17-20</td>
<td>204</td>
<td>2.9</td>
<td>1.95</td>
<td>.155</td>
<td>956</td>
<td>173</td>
<td>-2.85</td>
</tr>
<tr>
<td>21-24</td>
<td>115</td>
<td>3.4</td>
<td>2.13</td>
<td>.131</td>
<td>1054</td>
<td>152</td>
<td>-6.60</td>
</tr>
<tr>
<td>25-28</td>
<td>49</td>
<td>4.0</td>
<td>2.41</td>
<td>.153</td>
<td>1086</td>
<td>182</td>
<td>-2.30</td>
</tr>
<tr>
<td>29-32</td>
<td>15</td>
<td>4.6</td>
<td>2.23</td>
<td>.215</td>
<td>1030</td>
<td>141</td>
<td>-9.65</td>
</tr>
<tr>
<td>33-36</td>
<td>7</td>
<td>5.3</td>
<td>2.63</td>
<td>.129</td>
<td>1107</td>
<td>129</td>
<td>2.15</td>
</tr>
<tr>
<td>37-40</td>
<td>3</td>
<td>6.3</td>
<td>2.17</td>
<td>.208</td>
<td>1133</td>
<td>180</td>
<td>-26.70</td>
</tr>
<tr>
<td>41-44</td>
<td>1</td>
<td>6.0</td>
<td>3.40</td>
<td>.200</td>
<td>900</td>
<td>160</td>
<td>-10.90</td>
</tr>
</tbody>
</table>

3. A bushel of shelled corn contains about 42½ lbs. of crude carbohydrates, and 5⅔ lbs. of crude protein.
TABLE VIII. ILLUSTRATION OF RELATIONSHIP BETWEEN LENGTH OF FEEDING PERIOD AND RATE AND COST OF GAIN

<table>
<thead>
<tr>
<th>Length of Feeding Period. Months</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average pounds daily gain for period</td>
<td>2.3</td>
<td>2.2</td>
<td>2.1</td>
<td>2.0</td>
<td>1.9</td>
<td>1.8</td>
</tr>
<tr>
<td>Average cost of gain in cents</td>
<td>16.9</td>
<td>16.2</td>
<td>16.5</td>
<td>16.8</td>
<td>17.1</td>
<td>17.4</td>
</tr>
<tr>
<td>Average pounds daily gain for the added month</td>
<td>2.1</td>
<td>1.9</td>
<td>1.7</td>
<td>1.5</td>
<td>1.3</td>
<td>1.1</td>
</tr>
<tr>
<td>Average cost per pound of gain during month</td>
<td>16.5</td>
<td>17.1</td>
<td>17.7</td>
<td>18.3</td>
<td>18.9</td>
<td>19.5</td>
</tr>
</tbody>
</table>

for the whole period became smaller by about one-tenth of a pound for each additional month they were kept. Thus the average rate of gain for a five months feeding period was about 2.1 pounds per day, for a six months period it was about 2.0 pounds, and for a seven months period it was about 1.9 pounds per day. Of course this change in the rate of gain applies to moderate variations from the average length of feeding period which was 174 days for the farms studied. For extremely long or unusually short periods the change in the rate of gain will probably be different. If the average daily gains over the whole period diminish at this rate, the gains in each additional month must fall off at a rate of about two-tenths of a pound per day for each month added, as is illustrated in table VIII.

When we examine the relationship between the rates of gains and the costs of the gains, we find that, with an average cost of 16.8 cents per pound, the gains obtained in the third month cost about three cents per pound less than those in the eighth, and about one and three-fourths cents per pound less than the gains in the sixth month.

This means that within reasonable limits as the feeding period was lengthened the average cost per pound of gain over the entire period increased three-tenths of a cent for each month that was added. When we consider the costs of gains in each month separately, we find that the cost is about six-tenths of a cent greater each month than it was in the month before. Thus, the gains put on in the third month of the feeding periods cost on an average about 16.5 cents per pound, while the gains put on in the fourth month cost 17.1 cents, and those of the fifth month cost 17.7 cents. It should be remembered, however, that this represents the deviations found on a large number of farms and is not the experience of any one specific feeder.

SIZE OF HERD AND LABOR REQUIREMENT

If the prospective cattle feeder has a sufficient supply of feed to fatten two or more car loads of cattle he will need to
consider the relative advantages of feeding the two cars of cattle together or feeding one lot at a time.

On the farms studied it was found that increasing the number of feeders in the lot decreased the labor requirement at such a rate that a two car lot required on an average only about 66 hours of labor per month, while a one car lot required about 37 hours. In other words, the second car of cattle added only about 29 hours of labor per month to the 37 hours for the first.

It is commonly said that it is possible to get larger gains on cattle fed in smaller lots and that the smaller feeder has the advantage here. The records examined would indicate, as illustrated in table IX, that there is some truth in this. The data would indicate a greater rate of gain on these farms of about one-tenth of a pound per head per day in lots of one as compared to two car loads of feeders.

There was a greater difference in the costs of gains than in the rates of gains. With an average cost per pound of gain of 16.8 cents, it was found that the gain cost about six-tenths of a cent per pound more in two car lots than in one car lots fed under the same conditions. We find that the difference in the cost of feed accounts for only about one-half of this difference in cost, and therefore conclude that other influences likewise tend to increase the cost of gains as the size of the herd is increased. It is seldom possible to give such close attention to the individual steer in the large as in the small lot of feeders.

The difference in labor requirements between large and small lots of feeders has already been referred to. It is interesting to notice, however, that once moderately good care is taken of the cattle, it becomes very difficult to increase the rates of gains by using additional hours of labor. The cost

<table>
<thead>
<tr>
<th>Size of herd</th>
<th>No. herds</th>
<th>Gain per head per day</th>
<th>Cost per lb. gain</th>
<th>Labor per head per mo., hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 25</td>
<td>163</td>
<td>2.2</td>
<td>$.161</td>
<td>2.1</td>
</tr>
<tr>
<td>25-44</td>
<td>201</td>
<td>2.0</td>
<td>.160</td>
<td>1.6</td>
</tr>
<tr>
<td>45-64</td>
<td>103</td>
<td>1.9</td>
<td>.193</td>
<td>1.4</td>
</tr>
<tr>
<td>55-84</td>
<td>47</td>
<td>1.8</td>
<td>.154</td>
<td>1.9</td>
</tr>
<tr>
<td>85-104</td>
<td>14</td>
<td>1.9</td>
<td>.172</td>
<td>1.3</td>
</tr>
<tr>
<td>105-124</td>
<td>6</td>
<td>1.7</td>
<td>.112</td>
<td>1.8</td>
</tr>
<tr>
<td>125-144</td>
<td>5</td>
<td>1.7</td>
<td>.230</td>
<td>1.5</td>
</tr>
<tr>
<td>145-164</td>
<td>2</td>
<td>1.6</td>
<td>.338</td>
<td>2.8</td>
</tr>
<tr>
<td>165-184</td>
<td>2</td>
<td>1.5</td>
<td>.212</td>
<td>1.2</td>
</tr>
<tr>
<td>185-204</td>
<td>2</td>
<td>1.5</td>
<td>.125</td>
<td>0.05</td>
</tr>
</tbody>
</table>

* It should be remembered that this table summarizes the records of five years. A larger number of very large herds were fed during the years of high corn prices, thus accounting for the erratic changes in costs of gains in the largest sized groups.
of gains increased much more rapidly than the amount of gain. The addition of an hour a day in looking after a lot of 20 feeders, after they received the average amount of care, would be expected, from the records studied, to add a negligible amount of the average daily gain but if the labor cost 20 cents an hour, it would add about a half cent a pound to the cost of the gain.

INFLUENCE OF CORN PRICE ON THE COST OF GAIN

The price of corn was found to be the largest single influence on the cost per pound of gain. This is what we would expect, considering the important role played by corn in the fattening of cattle and the large proportion of the expense of fattening which goes for corn. The effect of variations in the price of corn on the cost of gain is illustrated in table X.

Thus, it was found that when corn cost 80 cents per bushel and gain in weight of cattle cost an average of 16.8 cents per pound, if corn were increased in price to $1.00 per bushel and other factors of production remained unchanged the costs of gain might be expected to increase by nearly three cents per pound.

The profitableness of the feeding enterprise in contrast to the cost of gain will not depend on the price of corn, so much as on the ratio between the price of corn and the price of cattle. On the farms studied over a period of five years it was found that the average ratio of the farm prices of corn to the prices received for the cattle was 100 pounds of beef to 15.06 bushels of corn. In other words the average price ratio of cattle to corn was about 1:15. When the price of beef in terms of corn rose, for instance when the ratio became 1:16 it became more profitable to convert corn into beef. When the ratio became narrower the profit was reduced.

It was found that when the ratio between the price of cattle and the farm price of corn changed from 1:15 to 1:14, that is when 100 pounds of beef would buy only 14 instead of 15 bushels of corn, the profit from the feeding operation was re-
duced by about $2.40 per head. This occurred in spite of the displacement of some of the corn from the ration and the substitution of other feeds for it. It was also noticeable that feeders in a more nearly finished condition were bought, and that cattle were fed to a higher degree of finish as the ratio between the prices of cattle and corn became wider.

MARGIN RECEIVED AND PROFIT

One of the most important influences on the profit made by cattle feeding is the margin, or increase in price received for the fattened steer over the price paid for the feeder. It might be thought that the profit would be increased by exactly the same amount as the margin. Thus on a steer bought at a weight of 700 pounds an added margin of one dollar per hundred pounds might be expected to add $7.00 to the profits. This is of course true in so far as the steer of the same finish may sometimes be bought for less or sold for more than at other times by taking advantage of market price movements. But this is only one cause for variations in the margin.

Generally the margin depends largely on the improvement in grade made on the steer during the feeding period. As stated above in the section on the finish of the cattle at time of sale, the higher the degree of finish obtained the higher the cost per pound of the gains in weight. Part of the wider margin, therefore, will usually be absorbed in the added expense in getting the steer into a better condition so that he will sell for the higher price.

The present study would indicate that an added cost of about two cents per pound of gain was associated with a margin one dollar greater than the average. This difference in cost may be due to differences in the cost of feeding cattle at different times of the year associated with seasonal differences in the margin, or it may be due to differences in the costs of obtaining different degrees of finish. It has not been possible to separate the influences of these two factors.

The average weight of the feeders on which records were obtained was about 775 pounds when bought. A margin of a dollar on these cattle was therefore about $7.75. The average gain in weight was about 325 pounds, and in getting the added margin of a dollar referred to, the increase in cost of two cents per pound on the 325 pounds is equal to $6.50. When we deduct this added cost from the $7.75 margin we have left a net gain of only about $1.25 per head. Taking together the two types of variation in cost just mentioned the obtaining of the wider margins seems to be profitable but the profit is only equal to about one-sixth of the added
margin. A different proportion might, however, be expected if there were a large change in the cost elements, for instance in the ratio between cattle and corn prices, or if the seasonal influence were eliminated.

RATE OF GAIN PER DAY AND PROFITS

Usually the greater the daily gain that can be obtained without using unusually expensive rations, the lower will be its cost per pound, because some feed is necessary to maintain the steer even if he is putting on no weight. The more rapid the gain in weight, therefore, the smaller the proportion of the daily expense of maintenance that is chargeable to each pound of gain. Thus it was found that on the farms studied an increase in the rate of gain of a half pound per day resulted in a reduction in the cost of gains of about 2.3 cents per pound when the average cost of gains was 16.8 cents and the average rate of gains 2 pounds per day.

Translated into terms of profit per head, an increase in the average rate of gain of a half pound per day meant an increase in the profit per head of $4.50. It would have been expected to add more than this to the profit, and in all probability would have done so had the cattle making the smaller and the larger rates of gains been fed the same lengths of time, and been handled otherwise in exactly the same manner. Actually, the cattle which gained in weight most rapidly were fed for shorter periods than the average and less weight per head was put on them. The first gains in weight on cattle bought in thin condition are obtained at a much lower cost than the later gains.

When we consider the relationship between the finish in which cattle are sold and the cost per pound of gain, we find that the margin received must also be considered. The cattle on which the cheapest gains were made were usually those which were fed for short periods or sold in poor finish. The saving in the cost of gains was usually partly offset by the loss in margin received. That is, where 300 pounds of gain were put on a steer at a cost of one cent per pound less than the average, it would not ordinarily increase the profit by $3.00 but only by about $1.50 because the cheaper gains in these records were usually associated with a poorer finish and therefore a lower price and smaller margin.

THE MOST PROFITABLE COMBINATION

It was said at the beginning of the discussion of the costs of fattening cattle that the problem of the farmer is to operate his feeding enterprise so that it will add the greatest possible
amount to the net income of the farm. The problem is not a simple one and an attempt to make it appear easy would be much more likely to lead to difficulty and confusion than to a greater understanding.

It will be observed that the factors discussed above cannot be considered singly and apart from each other. A variation in any one of them is found to be associated with variations in most of the others. The problem of the cattle feeder, as with any other farmer or business man, is not to increase some of these influences and to decrease others by the greatest possible amount, but to obtain the most favorable balance or equilibrium of the entire group, each factor being adjusted simultaneously in all of the manifold relationships in which it stands to each of the others.

The higher grade of feeders is thus associated with more rapid rates of gains, and cheaper gains, and also with the grade of the cattle when finished. The finish of the cattle when sold was also related to the cost of the gains, and of course to the price received. To get a degree of finish which would bring a higher price it was necessary to feed the cattle longer and on a more expensive ration, adding to the cost of the operation about as much as to the price of the cattle. Therefore, the question of the availability of grains and of the relative prices of grain, supplementary feeds, and of thin and fat cattle will determine the desirable degree of finish in each case. Table XI illustrates that in each year in which records were obtained the profitableness of the feeding enterprise was determined by a combination of factors rather than by the variation of any one factor alone.

We have seen that the amount of feed per day is related to the rate of gains per day, to the cost and nature of the feeds used and to the costs of the gains. Under farm conditions the amount of feed also is often related to the efficiency with which the feed is used. The length of the feeding period is inversely related to the rate of gain, and directly to the finish at time of sale. The size of the feeding herd is inversely related to the labor requirements per head.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cattle corn ratio 1:1</th>
<th>Margin received</th>
<th>Lbs. crude carb. per head per day</th>
<th>Crude ratio (lbs. carb. per lb. protein)</th>
<th>Length of feeding period days</th>
<th>Profit or loss per head</th>
</tr>
</thead>
<tbody>
<tr>
<td>1919</td>
<td>9.5</td>
<td>$ 4.25</td>
<td>18.2</td>
<td>6.28</td>
<td>151</td>
<td>$ -12.05</td>
</tr>
<tr>
<td>1920</td>
<td>9.9</td>
<td>2.98</td>
<td>19.1</td>
<td>6.30</td>
<td>173</td>
<td>- 8.25</td>
</tr>
<tr>
<td>1921</td>
<td>18.4</td>
<td>-0.6</td>
<td>18.6</td>
<td>6.20</td>
<td>191</td>
<td>-16.50</td>
</tr>
<tr>
<td>1922</td>
<td>28.4</td>
<td>1.79</td>
<td>18.6</td>
<td>6.20</td>
<td>187</td>
<td>12.95</td>
</tr>
<tr>
<td>1923</td>
<td>14.8</td>
<td>2.50</td>
<td>19.6</td>
<td>6.32</td>
<td>176</td>
<td>8.00</td>
</tr>
</tbody>
</table>
Since the feeder depends primarily on the use of corn for the making of additional weight in the finishing process, and since the corn is the largest cost item in the feeding business, it is to be expected that the price of corn is the largest element determining the costs of the gain in weight. For the same reason the ratio between the prices of corn and of cattle as between different years is the largest influence on the profit of the enterprise.

Following closely in importance after the price of corn, is the margin received in the price of the fattened cattle over that paid for the feeders. As between different years the margin will be determined by the market forces which set the relative prices of thin and fat cattle. These are beyond the control of the individual farmer. But the margin varies considerably and is partly under the feeders control. It is possible for him to make a good or a poor bargain in buying or selling the cattle. Also, in a particular year and under a given price situation, a greater margin may be obtained by putting the cattle into a higher finish. But the highest improvements in finish are obtained at an increasing rate of cost which consumes the greater part, tho usually not all, of the margin.

In summing up, as far as we can, it may be observed that on these farms profits were ordinarily increased by feeding cattle of somewhat above the average grade; by obtaining more than the average rate of gain per day, where it was done without using excessively expensive feeding stuffs; by feeding the cattle to such finish or by selling at such times as to obtain a wider margin than the average. Thus cattle bought at a price 10 percent above the average feeder prices (provided that the additional price actually represents increased ability to put on gains), which were fed heavily enough to gain a half pound a day more than the average, and were finished in such condition as to obtain a cent a pound more than the average margin, might be expected to return a profit of about seven dollars per head more than the average.5

CATTLE PRICES AND THE DEMAND FOR BEEF

UNDERLYING TRENDS OF CATTLE PRICES

In the production of beef, as in all other agricultural industries, the basic value making relationship is found in the ratio between the number of beef consuming people and the resources available for beef production under a given type of production practice. The population which desires beef for

5 For those readers who may be statistically inclined, the regression equations, on which most of the above discussion of costs and profits is based, are given in Appendix B.
consumption has been and is increasing all the time; altho in the United States this is at a decreasing rate. Of the economic factors of production, the growth of the necessary capital has at least kept pace with the increase in the number of mouths to feed. The growth of the number of laborers has been directly proportional to the growth of population. In addition to this the increase in education and improvements in methods have had the same effect as an additional growth in the labor supply. Only the supply of land has remained constant, and only the land area is likely to remain constant in the future.

The supply of land and the costs of increased production on it form the limiting factors in the problem of feeding a growing population. From the present stage of development, the use of more land necessitates the use of poorer land on which production becomes more and more difficult and expensive. At the same time unless new and improved methods are discovered, the production of more corn or more beef per acre involves not only a higher cost per acre but also a higher cost per unit of product.

Under any given system of production technique we find that the basic forces in the determination of beef prices consist in the growing demands of an increasing population for beef on the one hand, and on the other in the increasing costs of getting the larger amounts of produce desired from the relatively fixed area of land available. With a higher value of beef we find a tendency to a relatively smaller consumption, as illustrated in fig 5. And when the value of the beef has been reduced for a time we find the consumption again increasing, as is also illustrated in fig 5.

In any very long period, during which the population has been increasing continually, the number of cattle tend to de-
crease relatively to the population, even tho it may at the same time increase in absolute numbers. This may be stayed for a while by improvements in the methods of beef production but cannot by such means be stopped altogether. At the same time we are likely to find that the production of those crops better adapted to more intensive production, for instance the corn-hog enterprise, tend to increase as compared to the corn-cattle enterprise. The greater relative growth of the acreage of corn as compared to the number of cattle is illustrated in fig. 6.

These long time or secular movements do not occur rapidly, and yet the farmer in planning his longer time and more permanent plans can hardly afford to leave them out of consideration.

From the end of the Civil War to approximately 1890 the number of cattle received annually at stockyards increased at a greater rate than the population. The result of an increasing output of cattle was a declining price, which would probably have been even greater had it not been possible to remove some of the surplus by exporting it to European countries.

After 1890 the population continued to increase at nearly as great a rate as before but the land available for the extension of beef production had nearly all been put to use. Therefore, as may be observed from fig. 7, the beef supply now failed

![Fig. 6. Number of cattle in U. S. as compared with population, and corn acreage.](image-url)
to keep up to the growth of population and prices of beef rose correspondingly. This continued until 1903 when improvements in the methods of cattle raising and feeding began to result in greater production. The business depression of 1903 brought the influence of the increased output to a head and prices fell sharply. After 1903 the trend toward higher prices was resumed and continued to the outbreak of the World War in 1914.

From 1896 to 1914 the trend of prices for 1,200 to 1,500 pound steers was upwards at the rate of about 23 1/2 cents per hundred pounds per year. During the war period the price was carried far above the figures which would have been expected from the earlier trend, and at the end of the war fell much below the prices which might have been expected from the same trend. Incidentally it is interesting to note that had the 1896-1914 trend been projected thru the war period without including the war time prices in the computations, it would have led us to expect an average price of about $10.70 for the year 1924 and about $10.95 for 1925. Actually the average price for this class of cattle in 1924 was $9.77 and in 1925 was $10.87. But as compared to other prices cattle were much below their position of 1913, since the general price level had retained much more of its wartime increase than had the prices of cattle. Consequently the buying power of cattle in 1924 and 1925 was from 10 to 15 percent below that existing in the years 1909-1913.

CYCLICAL MOVEMENTS OF CATTLE PRICES

The movement of the prices and of the buying power of beef cattle has been described at various times as comprising cycles
of 14 or 15 years in length. If fig. 8 is examined it will be seen that the buying power of cattle has tended to move irregularly upwards at some times for periods of 10 or 12 years and then has fallen sharply from 1 to 4 years. However, there seem to have been sufficient reasons in the form of special conditions which are not expected to recur at any regular intervals, to furnish adequate explanations of these movements. Further, there do not seem to be forces of a cyclical nature and sufficient influence within the industry for us to expect them to recur at any regular intervals. The increase in the value of cattle in the early 1880’s may be attributed to the demand for cattle to stock up the western ranges and the temporary reduction in the output of cattle for consumption from this cause. The decline in value which followed in the late eighties may be attributed to the completion of the stocking of the ranges and the increase in the output of range cattle.

The increase in value from 1890 to 1902 may be explained by the end of the expansion of the range area on the one hand, and the continued growth of the beef demanding population on the other. About 1900-1903 improvements in the methods of producing beef, and especially improvements in the methods of fattening, such as the use of nitrogenous supplements and leguminous forages, began to be adopted more generally. This led to an increase in the feeding of cattle in the corn belt. Consequently we find the value declining to adjust itself to the new production conditions in 1903.

The reduction of the area available for the production of cattle and the continued growth of the demand for beef con-
continued under the new production methods as it had under the old ones and consequently the value of the cattle recommenced its rise. This movement was terminated by unforeseen and unpredictable developments during the European War.

It has been claimed that the so-called cycles of cattle prices are merely reflections of the long period of time necessary to readjust the production of cattle after periods of over or under-production, and that a chronic tendency to over or under-produce is at the bottom of the whole matter of growth and decline of cattle value. This explanation hardly seems adequate in view of the forces previously mentioned which, operating on the industry from without, have caused major variations in the output of beef.

A more reasonable explanation would seem to be that external forces, usually of an unpredictable nature, have made readjustments within the cattle industry necessary thru modifying the cost or value of the cattle. These changes in value have been accentuated by the difficulty and the length of time required to bring about the adjustments of production to the new economic conditions. The existence of recurring cycles, of regular periodicity which arise wholly within the cattle industry may well be questioned. If such cycles exist they are evidently of less magnitude than the changes brought about by unpredictable forces from outside of the industry. There may be regularly recurring influences to greater or

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Fig. 9. Seasonal trends of fat cattle prices.
smaller production of cattle from the general business cycle by modifying both production costs and the demand for beef, but the business cycle is itself but poorly explained as yet. There may be influences from cycles of good and poor seasons, which are likewise open to much debate. But the influence on the cattle industry from these sources is very uncertain and would scarcely seem to afford sufficient grounds for predicting definite cyclical movements of cattle values in the future.

SEASONAL MOVEMENTS OF CATTLE PRICES

An examination of the month to month movement of the prices of 1,200 to 1,500 pound steers is shown by fig. 9, and reveals a marked and a recurring seasonal variation. A low point is usually reached in February. This is normally followed by rising prices until August and September, when in September, a high point is reached and a downward trend is begun until the following February. The rate of seasonal change varies somewhat from year to year. During the period from 1896 to the beginning of the European War the average February price for 1,200-1,500 pound steers was about 95.6 percent of the yearly average.

During the period from 1920 to 1924 the same typical seasonal trend was continued but the magnitude of the month to month change was greater. The February price in the latter period was 94 percent of the yearly average and the September price was 109 percent.

The principal reasons for the seasonal trends of prices just described seem to be both in the number and in the quality of the cattle marketed. The February receipts usually include a large proportion of common cattle and follow heavy receipts of better stock in December and January. In March and April the better grades of cattle, the corn fed output of the corn belt states, begin to come on the market and in accordance with the improvement in quality the average prices rise.

The August and September peak in cattle prices is to be explained both by small receipts and the moderately high proportion of cattle of good finish. After September the receipts are increased particularly by the number of grass fat cattle from the ranges.

The prices of feeder cattle show a seasonal trend as in fig. 10 similar to that of fat cattle, but reaching high and low points at different times and with a greater variation from low to high. The late fall and early winter months usually mark the low points in the prices of feeder cattle. During the period from 1896 to 1916 December was the lowest month with the prices at about 92 percent of the yearly average. During the
period from 1920 to 1924 the November prices were slightly lower than the December ones, being about 90 percent of the yearly averages. The occurrence of low prices for feeders from October to December is to be explained by the heavy runs of range cattle during this season and the low prices prevailing in the whole cattle market. Altho this is the season when the largest numbers of feeders are bought by the corn belt farmers the low prices on the partly fat range stock which may either be killed or fed further, brings down the level of prices of the thin cattle as well.

The seasonal high point in feeder prices was reached, both in the earlier and the later periods referred to above in May. This is a period when few feeders are available and marks the opening of the pasture season. The high mark was reached at about 109 percent of the seasonal average in the period prior to the European War and at about 112 percent in the post war period.
MARGINS BETWEEN FEEDER AND FAT CATTLE PRICES

It has been said previously that the margin between the prices paid for the feeders and that received for the fattened cattle is one of the most important influences on the profit of the feeding enterprise. From 1890 to 1924 the average margin between the price paid for feeders in Chicago and the price of fat cattle six months later has varied from 20 percent in 1914 to 76 percent in 1909, when expressed in terms of percentages of the prices of feeders.

During the period named the margin as measured in dollars and cents has increased as the price of feeders has risen. But in proportion to the prices of feeders it would be very difficult to establish any definite tendency of the margin to become either greater or smaller. Wide and narrow percentage margins have alternated from year to year. As a usual thing the wider margins occurred during periods when the price of corn was high in relation to that of cattle, and the low margins have occurred when corn was low in price and consequently profitable to feed, as shown in fig. 11. The width of the margin therefore may be said to reflect either the profitableness of feeding on the one hand or to reflect the expenses of feeding on the other.
As has been said on a preceding page, the longer that cattle are kept on feed and the higher the degree of finish put on them the higher becomes the cost per pound of gain. Therefore the higher the price of corn in relation to the price of cattle the sooner the farmer comes to the place where additional gains and improvements in finish of the steers will cost as much or more than they will sell for. Therefore if the demand for cattle remains the same, the higher the relative price of corn the lower will be the finish to which it will be profitable to bring the cattle. And the lower the finish the lower the price that will be received for them, and therefore the smaller the margin. Thus, the relative price of corn is itself, often, the factor which will determine the margin to be received, by determining the extent to which it will pay to raise the finish of the cattle.

But the cost factors are not the only ones influencing the margin received. The demand of the consumers of beef is also important. The demand for the higher grades of beef varies with the income of the consumers and the ebb and flow of the business cycle. This furnishes another variable influence and causes the difference in price between thin and fat cattle to be now greater and now smaller than normal.

The margin that will be received on any particular lot of feeders is largely unknown to the farmer at the time he buys his cattle. Judging from past experience, observing the present spread between feeder and fat cattle prices, and making some rough guesses at the probable movement of cattle prices during the next few months, he plans his feeding operations accordingly. But the actual movement that occurs in prices is likely to be very different from that which he expected. If cattle rise the feeder makes a larger profit and if they fall he makes a smaller profit than expected or incurs a loss. The uncertainty of the margin thus introduces the largest element of risk into the feeding business. It seems impossible to eliminate this risk, but it is not improbable that it may be reduced by more careful observation and more accurate prediction of future movements of cattle prices.

Seasonal Variations in Feeder Margins. An examination of the feeder cattle margin by months as shown in fig. 12, displays a wide variation from season to season. During the period from 1896 to 1914 the average margin obtained after a six months feeding period, on cattle bought at the average prices for feeders and sold in the 1,200 to 1,500 pound steer class, was 48.5 percent. But the margins obtained on cattle bought in different months varied from 34 percent on cattle bought in May to 66 percent on cattle bought in December. The percentage margin increases gradually from May to December,
except that a slightly higher margin was obtained on an average on cattle bought in July than in August. After December the margin fell off gradually to the following May.

In terms of absolute prices only a slight difference is found from the seasonal variation in the percentage margin just mentioned.

In terms of dollars and cents, that is, the lowest margin was obtained on cattle bought in May, and the highest on cattle bought in December. The greatest seasonal difference in terms of dollars per hundred weight occurred between November and January. With the average seasonal price at $6.00, an increase of 40 cents per hundred weight in the margin might be expected on cattle bought in January over those bought in December, because the price of feeders ordinarily increases more from December to January than do fat cattle.
from June to July. It might appear, therefore, that December is usually the most advantageous month to buy feeder cattle. But this is doubtful. It is likely that the farmer who buys his feeders in October or November has the advantage over the one who buys in December, as the former can get a fuller use of his stalk fields and therefore save in the cost of the weight he adds to the cattle more than the man who fills his feed lot in December can gain in the wider margin. It is likely, too, that the low margin obtained on cattle bought in May is usually more than counterbalanced by the cheapness of gains made on pasture during the early fall. Each feeder needs to consider the relative costs of finishing during the different seasons of the year as well as the relative margins to be obtained.
SUMMARY

General Development of the Beef Enterprise.—In the early days of settlement, the beef enterprise was the major one for a time because it was preeminently adapted to extensive methods. It used much of the free or cheap land, required but little labor or capital, and helped transport bulky crops to market with a saving of freight.

As the agriculture developed the cattle provided a remunerative use for the roughages which were produced partly as byproducts of the other crops. They used as pasture the land which was too rough to raise advantageously such crops as corn, saved on the shipment of crops in the concentrated form of beef, helped conserve soil fertility, and provided a use for labor during the winter when it could not otherwise be used profitably.

Place of Iowa in the Beef Production of the Country.—About one-sixth of the feeder cattle in 1924 and 1925 were shipped into Iowa, as study of the movements thru the stockyards showed and about one-twelfth of the gross receipts and one-seventh of the net receipts came from Iowa.

One-fourth to one-third of the 2 million cattle usually shipped out of Iowa are those which have been stopped in the state for fattening on their way from the ranges to the eastern consuming centers.

Of the feeders shipped into the state from central markets, the usual percentages from the various markets follow: Omaha, 40; Sioux City, 20; and Kansas City, 20. Nearly two-thirds of these feeders go to the feeding area just east of the Missouri River and to the feeding area in east-central Iowa, these two areas comprising approximately 30 of Iowa’s 99 counties.

The shipments in the four months from August to November are approximately 60 percent of the total for the year, and correspond both to the movement of cattle from the range and to the convenience of the Iowa farmers. At this season, fall pastures and stalk fields are available, corn is most plentiful and it is just before winter when labor will be plentiful.

Both the output of cattle and the amount of feeding per square mile varies over the state, but the former varies least. The areas of greatest cattle output correspond to the cattle feeding areas mentioned above. The number of cattle kept was shown to be related to the type of farming, which depends mostly on the soil and topography. It varies inversely with the suitability of the land to more intensive enterprises as the corn-hog combination of the north-central section, the carrying capacity of the pastures, and the availability of corn above the needs of the hog enterprise.

Some Factors Determining Success of the Feeding Enterprise.—In a study of records obtained on about 550 lots of cattle fed in the Pottawattamie County feeding area from 1918 to 1923, herds receiving the heavier daily rations showed only small increases in the rate of gains and this was accompanied by a higher cost per pound. Because higher finishes were usually gotten on the cattle fed the heavier rations the profits differed little. This must be interpreted with caution, however, because it was impossible to separate the heavy efficient rations from the inefficient ones.

An additional pound of crude fibre per day (the amount contained
in approximately three and a half pounds of corn stover or timothy hay) was found to decrease slightly the rate of gain (about one-thirtieth of a pound per day) which might have been expected if the woody and undigestible matter had not been present, in excess of the average.

Increasing the size of the herd, from one to two carloads, for instance, saved about eight hours of labor per car per month, decreased the rate of gain about one-tenth pound per day, and increased the cost of gain about six-tenths of a cent per pound.

The price of corn was found to influence the cost of gains most. An increase of 20 cents per bushel increased the cost nearly 3 cents per pound when the average cost was 16.8 cents per pound.

The profitability of the feeding enterprise as between years was influenced most by the ratio between the price of corn and the price of cattle. In the records studied the average farm value ratio was 100 pounds of fat cattle to 15.06 bushels of corn. The wider the ratio the more profitable the feeding operation, so that an increase to 1:16 increased the profit by about $2.40 per head. This ratio also determined largely the most profitable degree of finish.

The margin received also greatly influenced the profit. An added margin of $1.00 per hundred pounds was associated, in the records studied, with a greater profit of about $1.25 per head, on cattle weighing 775 pounds each when bought.

Larger rates of gain per day than usual were found associated with lower costs per pound and higher profits.

**Prices of Cattle.**—Due to the continued growth of population cattle values, as well as those of other food products, rose continually during the period studied. From 1896 to 1914 this increase was approximately 23 cents per hundred pounds per year.

Both feeder and fat cattle prices have pronounced seasonal movements, which normally recur each year. Fat cattle prices varied from the seasonal peak in August or September, to the seasonal trough in February about 10 percent of the average price in the pre-war and about 15 percent in the post-war period.

Feeder prices are ordinarily highest in the late spring, usually in May, and lowest in November or December, usually varying about 18 or 20 percent of the yearly average.

A seasonal variation in the margins usually received occurs, depending on the seasonal movements of thin and fat cattle prices. In the pre-war period the margins on cattle bought in May and fed for six months were usually about 34 percent of the feeder price, and those on cattle bought in December averaged about 68 percent.

The margin varies widely from year to year and even from month to month. It is influenced by the price of corn and by the rate of business activity, which affects the demand for beef. The margin received on any lot of feeders depends as much on fat cattle prices after the feeders are bought as on the price paid for the feeders. The success of the feeder, therefore, depends to a large degree on his ability to anticipate the probable movements of the fat cattle prices.
APPENDIX A

The method used in the analysis of the 550 records on which the discussion in this section is based was one of multiple correlation. The simple averaging of factors by classes was unsatisfactory and was not used except in some of the earlier stages of the work. The objection to these more simple methods becomes obvious when it is remembered that, for instance, the average difference in the amounts of feed per day fed to different classes of cattle cannot alone explain the differences in the results in gains or profits on those different classes. Along with variations in the amount of feed we find associated variations in the quality of the cattle differences in their age, differences in the methods of feeding and the amount of labor used, differences in the nature of the feeds used, etc. In order to ascertain the difference in cost of gains or profits resulting from variations in the amount per day of feed of a certain type alone it would be necessary to hold all of the other factors constant, or else to make corrections for them. In order to ascertain the effects of variations in each of the factors concerned in this study if the other factors were held constant it was necessary to resort to the use of the methods of multiple correlation.

For the reader who wishes a full discussion of the method of correlation reference is given to the bulletin by H. A. Wallace and G. W. Snedecor on "Correlation and Machine Calculation," issued by the Department of Mathematics of the Iowa State College, January, 1925. An interesting application and an explanation of the method may be found in U. S. Department of Agriculture, Department Bulletin No. 1300, January, 1925, by Sewall Wright, on Corn and Hog Correlations.

The regression formula used in this study was:

\[ X = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n \]

where \( X \) is the dependent variable (for instance the cost per hundred pounds of gain where that is being studied), the \( M \)'s indicate the arithmetic averages, the \( \sigma \)'s indicate the standard deviations of the factors concerned, the \( \beta \)'s the partial regression coefficients, and \( A, B, \ldots \), etc., represent the independent factors concerned.

The influence of variations in the independent factors on the dependent one may be found by substituting various values for instance of \( A \) in the formula.

APPENDIX B

The regression equations were as follows:

I. Rate of gain per head per day:

\[ A = 1.9971 + 0.0028(C-105.59) + 0.0031(D-92.64) + 0.0252(E-18.85) - 0.0593(F-3.00) - 0.0340(G-3.73) - 0.0033(H-173.60) + 0.0037(J-1.62) - 0.0028(K-42.61). \]

II. Cost per pound of gain:

\[ B = 16.3327 + 0.0202(C-105.59) + 0.0498(D-92.64) + 0.1313(E-18.87) + 0.0919(F-3.73) + 0.0099(G-173.60) + 1.6380(H-1.62) + 0.0301(K-42.61) + 1.544(L-79.62). \]

III. Profits per head:

\[ P = 4.0010(A-2.00) - 1.5972(B-16.83) + 1.1657(C-105.59) - 1.705(D-92.64) + 0.6118(M-15.06) + 7.7624(N-2.08) - 4.07. \]
Of course the above regression equations apply strictly only to the group of farms studied, but, nevertheless they are highly suggestive under other similar conditions. It is likely that the first equation, that dealing with the rate of gain per day, will need more qualification and would vary more in its reliability from farm to farm than will either of the other two. This is because of the wide divergence in the effectiveness in the use of feeding stuffs from farm to farm, and because of the unreal simplicity of the expression of feedstuffs in only two common factors, the content of crude carbohydrate equivalent and the content of crude protein.

The factors included in the formulae were as follows:

A, The rate of gain per head per day in pounds.
B, Cost per pound of gain in cents.
C, Grade as expressed as the percentage which the price paid for the feeders was of the general average feeder price in Chicago.
D, Finish at sale, the price received expressed as a percentage of the prevailing price of 1,200-1,500 pound steers in Chicago.
E, Pounds crude carbohydrate equivalent in the ration per day.
F, Pounds crude protein per day.
G, Pounds fiber in the ration per day.
H, Length of feeding period in days.
I, Hours labor per head per month.
J, Number cattle in the herd.
K, Price of corn in cents per bushel.
L, Ratio of price of cattle to price of corn.
M, Margin received in dollars per hundred pounds.
N, Profit per head in dollars.