# *COSTS of* procuring, manufacturing, and distributing MIXED FEEDS in the Midwest



*Case study of four types of organization*

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# PREFACE

This study of the costs of procuring, manufacturing, and distributing feeds in the Midwest was undertaken by the U. S. Department of Agriculture to analyze the factors influencing operating costs and to determine how these factors affect the total operating efficiency of various types of organization. The study uses data obtained from a detailed analysis of the accounting records of firms, and budgets costs to various model types of operation.

This procedure requires a considerable amount of time, but the basic comparisons and functional relationships between the various factors and costs do not change rapidly even though the actual level of costs and prices may change. Therefore, this report should be of value not only as an example of the use of this methodology in marketing-cost studies but also as a summarization of basic functional relationships in the formula feed industry.

The study was conducted by research workers at Iowa State College with contract funds supplied by the Department. Mrs. Theda Ballantyne, Dr. J. T. Scott, and Dr. S. M. A. Husain of this college materially assisted in conducting this research. The study is a part of the Department's broad program to increase marketing efficiency and thus increase the price that farmers receive for feed ingredients and to reduce the price to the farmer for purchased formula feeds.

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# COSTS OF PROCURING, MANUFACTURING, AND DISTRIBUTING MIXED FEEDS IN THE MIDWEST

Case Study of Four Types of Organization

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## SUMMARY

Costs were studied in four types of feed manufacturing and distributing systems: (1) premix operation with mixing done by dealers, (2) concentrate operation with grain added by dealers, (3) centralized complete-feed operation through dealers without mixing facilities, and (4) independent manufacturer-retailer operation.

Detailed quantity and cost data were obtained from 3 plants of each of the 4 types of manufacturers and from 20 retailers. To facilitate comparison, these data were used to prepare estimates of costs of making and distributing 40,000 tons of a hypothetical laying mash in each of the four systems. When all of the factors, except those directly related to the type of operation, were held constant, the relative efficiencies of the methods were estimated as they appear in table 1.

The retail-manufacturer system resulted in a slightly lower cost than the others. Because of the efficiencies or inefficiencies of specific functions which may characterize any given plant, operations of individual companies can be expected to deviate from the cost levels shown in the report. Some of these efficiencies may relate to such factors as managerial efficiency, capacity utilization, and return-haul arrangements, which are not included in the study.

Costs are less affected by the type of organization than by some other factors. For example, variations in costs of ingredients are affected primarily by the distance from which the ingredients must be shipped, the quantity of ingredients ordered at one time, and whether they are purchased in bulk or bagged form.

Plant production and handling costs are affected by the volume of feed output, the size and type of other activities integrated with the feed manufacturing operation, whether or not the feed is pelleted, and whether it is sold in bulk or in bags. Overhead costs are affected primarily by the volume of feed manufactured, the volume of feeds merchandised in addition to those manufactured, and the number and size of activities in the business in addition to the feed department. Selling, advertising, and research costs are determined by the policies of the company. Costs of transporting feeds depend primarily upon the distance which the feeds must be hauled to get them to the farm where used.

Table 1.--Cost per ton for specified factors of feed production and distribution expressed as a percentage of average cost for each factor, for 4 types of organization 1/

| Type of organization | Ingredients | Procurement | Production | Research | Selling | Overhead | Transportation | All factors |
|---|---|---|---|---|---|---|---|---|
| | Percent | Percent | Percent | Percent | Percent | Percent | Percent | Percent |
| Premix | 102 | 13 | 138 | 60 | 59 | 79 | 69 | 101 |
| Concentrate | 98 | 83 | 111 | 110 | 81 | 103 | 110 | 100 |
| Complete-feed | 99 | 152 | 80 | 200 | 117 | 134 | 151 | 102 |
| Retail-Manufacturer | 101 | 152 | 71 | 30 | 144 | 85 | 70 | 97 |
| Average, 4 systems | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars |
| Average, 4 systems | 63.96 | 0.23 | 13.06 | .50 | 5.77 | 5.01 | 3.28 | 91.81 |

1/ For poultry mash at 40,000 tons of output per year.

# INTRODUCTION

This study was designed to provide information concerning the relative efficiency of alternative methods of organization and operation in the feed milling and distribution industry. The industry has shown rapid growth and development in recent years, and many different methods and practices of manufacture and distribution have developed. Information concerning the relative efficiency of these different methods and practices has direct value to those charged with planning and directing the operations of feed companies and those of retail feed outlets. Because the farmer is both an important producer of raw materials for the industry and the direct user of nearly all of its final product, he has a double stake in the overall efficiency of the mixed feed industry and the resulting price margin between the producer and the consumer.

Valuable studies have been made in recent years relative to feed plant operations and to specific phases of the operations of these plants. But few of these studies have embraced the overall efficiency of firms in the feed industry all the way from the procurement of ingredients to the delivery of the manufactured feed to the farmer.

The present study attempts to deal with this subject by a case study of a number of firms selling feed in the State of Iowa through alternative procurement and merchandising methods. Many of these firms also merchandise feed in other Midwestern States.

Four distinct types of organization and operation were isolated for specific study:

1. Premix companies with retailer-manufacturers.
2. Concentrate companies with retailer-mixers.
3. Complete-feed companies with retailer-distributors.
4. Independent retailer-manufacturers.

In the premix organization, the feed companies formulate highly concentrated premixes of minerals, vitamins, and antibiotics which are used by their retailer-manufacturers to formulate the complete feed by adding vegetable and animal proteins, grains, and other ingredients to the premix. The premix companies furnish the retailer-manufacturers the formulas and formulating instructions for the complete feed. The mixed feed is retailed under the brand name of the premix company.

The retailer-manufacturers operating in a premix organization procure all ingredients except those contained in the premix and manufacture the complete feeds. Premixes of this type are retailed directly to farmers only when the farmer has adequate equipment and sufficient volume to warrant the formulation of his own livestock feed. This type of organization results in a highly decentralized system of feed manufacture but a highly centralized system of sales and advertising programs.

In the concentrate operation, the feed companies formulate high-protein concentrates to which the retailer-mixers add farm grains in order to obtain a complete feed. The concentrates contain vegetable and animal proteins and related

ingredients as well as minerals, vitamins, and antibiotics. The concentrate companies usually furnish their retailer-mixers with formulas for adding farm grains to make a complete feed, but the resulting complete feeds frequently are not tagged and merchandised under the brand name of the parent feed company. Instead, they are looked upon as custom-mixed feed for the farmer customer, but of course containing the brand X concentrate.

The concentrates frequently are sold to farmers by retailers in the same form as received from the concentrate company. In this case, the farmer either feeds the concentrate free-choice with farm grains, mixes the concentrate with farm grains as he feeds it, or makes a complete feed by mixing grains with the concentrate himself. But almost without exception, the high-volume retailers of concentrate companies are those with adequate milling and mixing equipment so that they can prepare the complete feed from the concentrate for the farmer.

In the complete-feed operation, the complete feed for the farm livestock is formulated by the parent company. It is merchandised to farmers by the retail outlets without mixing or adding ingredients. All ingredients, including grains, are procured by the parent company and added to the feed before it is distributed to the retail outlets. Many of the retail outlets of these companies are hatcheries and other types of feed stores which have no feed milling and mixing facilities whatsoever. This type of operation represents complete centralization of both the feed manufacture and the brand advertising of the feed in the form that it is used directly by the farmer.

The independent retailer-manufacturers formulate their own feeds and retail them directly to farmers. They represent a completely integrated operation in that they operate independently of any other feed manufacturing company or any other feed retailer. They mix their own brand of feed according to their own formulas, purchasing and adding all vitamins, minerals, and antibiotics as well as all other ingredients, in direct competition with the major feed companies. They also retail the complete feeds in direct competition with the retail outlets of these major feed companies.

The operations of many companies in the feed industry do not fall completely into one of these four categories. Some companies wholesale both premixes and concentrates and others wholesale both concentrates and complete feeds. Some even wholesale all three. Some companies sell feeds both wholesale to retailers and retail direct to farmers. Some retailers manufacture complete feeds from premixes and also add grains to concentrates. Some add grains to concentrates and also retail complete feeds. Some retailers do all three. Yet, each of the four is a characteristic type of operation and a great many companies fall predominantly if not exclusively into one of these four. All four types of operation are common in Iowa.

## METHODOLOGY

In order to study the entire operation from ingredient procurement to delivery of the complete feed to the farmer, it was necessary to study both the parent feed companies and the feed retailers for three of the four types of organization and operation. For the independent retailer-manufacturers, no

separate retailers were involved. In all cases it was necessary to study several distinct phases of the total operation and the class of costs associated with each of these phases:

1. Feed ingredient procurement, and the costs of ingredients delivered to the feed company.

2. Feed formulation and manufacture.

3. Feed merchandising including both direct selling and advertising.

4. Transportation patterns and distribution costs of the manufactured feeds.

5. Supervisory and overhead costs.

6. Research and formula development.

It was recognized that operating costs and economic efficiency in each of these phases of operations are likely to be affected by different factors, or to different degrees by comparable factors. It was further recognized that efficiency of the four types of operations may be affected differently by the same factors in any one of these six phases of total operations. Consequently, the study was designed to consider independently each of the six factors both for the parent companies and the retail outlets in the first three types of operation, and for the complete operation in the case of the retailer-manufacturer companies.

The research was conducted in four distinct steps:

1. Preliminary survey by personal interview of about 35 feed companies in order to select those for case study.

2. Detailed tabulation of cost and volume statistics and other information by personal visit to 12 feed companies (3 of each of the 4 types of operation) and to 20 retailers (2 or 3 for each of the 9 case-study companies having retailers).

3. Detailed summary and analysis of the information obtained from each company and retailer visited in order to discover quantitative relationships and provide the coefficients necessary for budgeting purposes.

4. Detailed budget analysis of each of the four types of operation (both manufacturer and retailer) as well as comparative budget analyses between them.

The preliminary survey was taken by personal interview in order to choose the companies for case study which exhibited the characteristics needed and which were willing to make records available and otherwise cooperate fully with the research workers. This information was summarized and used to select the 12 feed manufacturing plants for detailed study. Selection among those willing

to cooperate was made on the basis of characteristics representative of one of the four distinct types of operation and, within each type of operation, on the basis of varying characteristics among the plants selected for that type. Consideration was also given to the type of accounting records maintained and the availability of accurate information in the detail needed.

The information from the case-study plants required virtually a complete costing audit of each of the plants visited. Monthly ingredient purchases, sales, inventories, and costs were obtained for the entire operation during 1956.

The case-study retailers for a company were selected upon consultation with management of the parent company. They were selected as being representative of all the company's retailers, having adequate records, and being willing to cooperate. For each parent company, at least one retailer was selected at approximately the upper quartile and at least one at approximately the lower quartile in annual sales volume among all of the company's retailers. The information from the 20 retailers was also obtained by personal visit, and was comparable to that obtained for the parent companies. However, the information from retailers was obtained on an annual rather than a monthly basis.

The information obtained from each of the case-study companies and retailers was cross-checked and summarized. Ingredient purchases were classified by type of ingredients, and feed sales were classified by type of feed. Ingredient merchandising volume and costs were separated from the feed manufacturing operations. Monthly purchases of ingredients and sales of feed were reconciled with inventory changes. Expenses were classified by class of costs and the class totals were reconciled with total costs by month and for the year. Ingredient procurement and manufactured feed distribution patterns and transportation costs were summarized. Finally, master sheets were prepared for each of the six phases of operations by month in each of the case-study plants. These were assembled on a summary sheet to show monthly total volumes and costs for each plant.

Relationships such as those between costs and volume, transportation costs and distance, and costs and other relevant factors were plotted. For those factors indicating a pattern of relationship to costs, quantitative relationships both within and between plants were determined by graphic and least squares analyses.

The final step was to utilize the information and relationships obtained from the case studies and from other research studies to budget directly comparable costs for a hypothetical feed operation under each of the four types of organization. Budgeting these costs was performed by using the average relationship between costs and the factors affecting costs found to exist for all of the plants studied and applying these relationships to the specific conditions for each of the four types of operation. In the tables, costs are actual cost data unless designated "budgeted costs."

In order to do this an exactly identical formula for one feed -- a laying mash -- was projected for each of the four different types of operation. Under each type of operation, identical ingredients were purchased and an identical feed was delivered to the farmer customers. But the ingredients were not all

purchased at the same level, of course. Nor was the geographic pattern of procurement identical for all of them. Instead these patterns followed those actually exhibited by the plants in each of the four groups studied.

Further budgeting control was interjected by setting up identical sales volumes for the complete feed, the premix, the concentrate, and the retailer-manufacturer operations. This annual volume of 40,000 tons of complete feed is within the observed operating range for each group of plants analyzed. On this basis, the plant volume for the concentrate and the premix operations was dictated directly by the single feed formula projected for all four types of operation. The annual volume per independent retailer-mixer was set at 10,000 tons, as dictated by volume in the case-study plants in this group, so that four of these plants are required to make a direct comparison with each premix, concentrate, or complete-feed plant.

The annual volume pattern for the retailers of each of the three types of operations was also made identical in the budgeting process. In all cases, 60 percent of the annual volume was handled by retailers of 1,700 tons volume and 40 percent by retailers of 500 tons annual volume. But again this did not prevent substantial differences in costs of retailing among the three types of operation.

Additional direct comparability among the four types of operation was obtained by applying a uniform trucking-cost formula for the manufactured feed. The coefficients of this formula were determined statistically from the distribution pattern and transportation cost data from the plants studied, and applied to the distribution pattern for the four model operations.

On the basis of the comparable volume and characteristics of operation for the four types of model plants, complete cost budgets were made for each of the four different types of organization and operation. These four budgets provide the basis for the comparative analysis among the four different methods of manufacturing and distributing feed to farmers.

This methodology makes the results applicable over a broader range of operations than is true for a typical case-study because of the construction of functional relationships among costs and operation practices. However, all of these relationships have limits and should not be extended beyond the range of observations controlled by the case study plants in the analysis.

This methodology does not overcome the problem of differences in managerial efficiency but it does result in an averaging of these differences among different companies for each type of operation. In addition it should be noted that no extremes in managerial efficiency were noted among the 12 manufacturing plants and 20 retailers even though they were not chosen with this factor in mind.

Neither does this methodology overcome the problem of differences in the proportion of capacity utilized. However, the fact that (1) the operating range of each group of three companies closely approximates the model plant size of 40,000 tons of complete feed mixed and sold per year, and (2) the range of volume within each type of operation is small even though this factor was not

considered in selecting the case-study plants, indicates that the volume chosen represents a fairly efficient level of operation for each type and that linear relationships can be used. Only in the case of the complete-feed operation was the range of observation relatively wide. For this type of operation previous studies and industry opinions indicate that a volume of 40,000 tons per year is past the break in the cost curve and is in a volume area where a straight line regression is reasonable.

## COST OF INGREDIENTS

The different types of operation in feed manufacture and distribution were found to have little direct effect on the delivered prices of feed ingredients purchased. Instead, differences in the ingredient costs from one type of operation to another are explained largely by differences in the distance which the plants must reach out in order to obtain the ingredient, the number of tons of the ingredient that the plant is able to purchase at one time, and whether or not the ingredients can be purchased in bulk.

### Ingredient Costs in the Plants Studied

The average volume purchased and price paid for the various ingredients is shown in table 2 for the plants studied under each of the four types of operation. The averages for no one of the classes of plants were uniformly high nor uniformly low for all ingredients, either in terms of the volume or the prices paid for ingredients. These averages are lowest for one group of plants in the case of one ingredient and for another group in the case of another ingredient. 1/

The average total volume of all ingredients purchased ranged from 140,914 hundredweight for the premix plants to 648,686 hundredweight for the complete-feed plants. Some were sold as individual feed items. The average total hundredweight volume of all ingredients used in mixed feeds ranged from 46,265 for the premix plants to 608,969 for the complete-feed plants.

The average price paid for all ingredients purchased varied from $2.90 per hundredweight for the retailer-manufacturer plants to $5.44 per hundredweight for the premix plants. 2/ The average per hundredweight price paid for all ingredients used in mixed feeds varied from $3.18 for the retailer-manufacturer plants to $4.69 for the premix plants.

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1/ One of the premix plants was not used at all in computing the averages and ranges because it purchased its premix on a contract basis already manufactured to its specifications.

2/ These averages are weighted within each plant by the volume of each ingredient purchased, but are the simple averages of these weighted averages for each of the three plants in the group.

Table 2.--Volume purchased per plant, and delivered prices of selected ingredients used in mixed feeds, by type of organization, 1955

| Ingredient | Premix 1/ | | Concentrate | | Complete-feed | | Retail-manufacturing | |
|---|---|---|---|---|---|---|---|---|
| | Volume purchased | Price per cwt. | Volume purchased | Price per cwt. | Volume purchased | Price per cwt. | Volume purchased | Price per cwt. |
| | Cwt. | Dol. | Cwt. | Dol. | Cwt. | Dol. | Cwt. | Dol. |
| Whole corn | --- | --- | 40,224 | 2.71 | 53,338 | 2.55 | 4,387 | 2.62 |
| Processed oats | --- | --- | 12,085 | 3.99 | 29,683 | 3.79 | 13,030 | 3.46 |
| Soybean meal | 55,006 | 3.00 | 152,121 | 3.31 | 37,317 | 3.09 | 61,934 | 3.36 |
| Linseed meal | 5,405 | 3.53 | 57,832 | 3.44 | 6,333 | 3.67 | 16,633 | 3.35 |
| Cottonseed meal | 4,245 | 3.49 | 15,756 | 3.68 | 4,260 | 3.66 | 1,901 | 3.74 |
| Alfalfa meal | 5,900 | 1.94 | 36,548 | 2.39 | 38,477 | 2.43 | 13,536 | 2.10 |
| Bran | 100 | 2.43 | 9,698 | 2.28 | 103,147 | 2.28 | 2,653 | 2.20 |
| Shorts and midds | 1,157 | 2.50 | 34,280 | 2.45 | 12,132 | 2.36 | 10,481 | 2.42 |
| Meat scraps | 16,820 | 3.67 | 49,422 | 4.00 | 3,807 | 3.96 | 20,261 | 4.16 |
| Tankage | --- | --- | 31,274 | 4.24 | 40,770 | 4.00 | 4,823 | 3.74 |
| Fish meal | 3,462 | 7.64 | 170 | 8.02 | 4,209 | 8.75 | 87 | 8.12 |
| Dried whey | 1,258 | 5.72 | 4,485 | 5.98 | 1,003 | 6.02 | 18 | 6.77 |
| Salt | 2,890 | 1.32 | 4,081 | 1.17 | 3,177 | 1.26 | 5,346 | 1.01 |
| Calcium and limestone | 7,618 | .53 | 11,118 | .58 | 11,620 | .64 | 5,353 | .52 |
| Bone meal | 30 | 4.38 | 2,849 | 4.54 | 1,799 | 3.94 | 398 | 4.24 |
| Dicalcium phosphate | 7,073 | 4.09 | 2,052 | 4.14 | 673 | 4.12 | 1,507 | 4.14 |
| Bentonite | --- | --- | 1,437 | 1.41 | 232 | 1.63 | 1,275 | 1.47 |
| Colloidal clay | 8,320 | 1.09 | --- | --- | 2,320 | 1.12 | 4,793 | 1.19 |
| Sugar | 2,273 | 5.38 | 1,772 | 6.42 | 168 | 7.30 | 606 | 6.93 |
| Dextrose | 220 | 7.69 | 835 | 8.03 | 110 | 7.65 | 208 | 7.76 |
| Molasses | 4,386 | 1.53 | 32,626 | 1.57 | 8,561 | 1.53 | 22,452 | 1.59 |
| All ingredients purchased | 140,914 | 5.438 | 589,276 | 3.493 | 648,686 | 3.326 | 249,974 | 2.899 |
| All ingredients used in manufacturing | 46,265 | 4.694 | 505,478 | 3.427 | 608,969 | 3.324 | 158,560 | 3.180 |

1/ Only two plants used in the averages, since one plant purchased premixes ready mixed.

This variation among the four types of operation in both the average volume and the average prices of all ingredients is largely explained by the difference in the types of feed manufactured by the case-study plants among the four groups. The premix plants have a relatively small average volume and high average price of the total ingredients purchased and used for feed manufacture. The concentrate plants fall in between on both average volume and average price of the total ingredients purchased and used in feed manufacture. The complete-feed plants have a relatively large average volume and relatively low average price of the total ingredients purchased and used for feed manufacture. The retailer-manufacturer plants manufacture and sell feed directly to farmers, so that their average volume of ingredients purchased and used in feed manufacture is relatively small. And since they largely manufacture complete feeds, the average prices for the total ingredients purchased and used for feed manufacture is relatively low in these plants also.

Table 3 shows the average characteristics of the purchase of selected ingredients for all 12 of the manufacturing plants studied. This can be seen by reading across the table under the columns headed "mean" for a particular ingredient. For example, in the 12 manufacturing plants studied, the average delivered price for soybean meal was $3.19 per hundredweight. The soybean meal purchased by these plants was shipped an average distance of 83 miles, and was ordered in an average lot size of 36 tons. On the average, 79 percent of the soybean meal was purchased in bulk and 11 percent of it was delivered by truck.

Most of the differences in the delivered costs of the major ingredients among the individual plants studied were found to be associated with differences in the distance from which the ingredient was shipped, the number of tons of the ingredient that was purchased at one time, and whether the ingredient was purchased in bulk or in bags. The approximate relationship between each of these factors and the per unit costs of each ingredient were determined by graphic correlation analysis. 3/

The percentage received by truck was found to have no significant effects on the average cost of the ingredients purchased in these plants.

The relationship between each of the three factors and per unit ingredient costs as determined in this manner are shown in table 3 under the columns headed "approximate b value." The first such column shows the average increase in cents per hundredweight in the delivered price of the ingredient for every 1-mile increase over the average distance shipped. The coefficient in this column for alfalfa meal of +0.157 means that the delivered price of alfalfa meal was found to increase 0.157 cent per hundredweight over the average price of $2.22 for each additional 1 mile over the average 200 miles the alfalfa meal was shipped ($0.157 for each 100-mile increase in distance shipped). For most

3/ Costs per hundredweight were plotted against distance, these residuals were plotted against tons per order, and these second residuals were plotted against percentage purchased in bulk. Checks were made by plotting the final residuals back against distance. Adjustments for seasonal price variations were made before the plotting was done.

Table 3.--Characteristics of purchases of selected ingredients for all feed manufacturing plants studied

| Ingredient | Average price paid per cwt. | Distance shipped | | | Weight per order | | | Percentage bought in bulk | | | Percentage hauled by truck | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Range | Approx. b value | Mean | Range | Approx. b value | Mean | Range | Approx. b value | Mean | Range |
| | Dollars | Miles | Miles | Cents | Tons | Tons | Cents | Percent | Percent | Cents | Percent | Percent |
| Whole corn | 2.63 | 32 | 25-50 | +0.300 | 10 | 0.10-30 | --- | 100 | 100-100 | --- | 96 | 70-100 |
| Processed oats | 3.47 | 58 | 25-120 | + .220 | 13 | 5-30 | --- | 1 | 0-9 | --- | 78 | 2-100 |
| Soybean meal | 3.19 | 83 | 25-200 | + .250 | 36 | 20-50 | -0.400 | 79 | 6-100 | -0.300 | 11 | 0-60 |
| Linseed meal | 3.50 | 228 | 25-400 | + .079 | 22 | 6-30 | -1.400 | 22 | 0-99 | - .340 | 26 | 0-100 |
| Cottonseed meal | 3.64 | 520 | 25-1000 | + .042 | 16 | 1-30 | --- | 8 | 0-95 | --- | 76 | 0-100 |
| Alfalfa meal | 2.22 | 200 | 25-400 | + .157 | 25 | 10-30 | --- | 11 | 0-90 | --- | 36 | 0-100 |
| Bran | 2.30 | 112 | 25-300 | + .160 | 22 | 5-35 | - .310 | 8 | 0-90 | --- | 10 | 0-75 |
| Shorts and midds | 2.43 | 112 | 25-300 | + .035 | 26 | 20-35 | - .450 | 19 | 0-100 | --- | 3 | 0-20 |
| Meat scraps | 3.95 | 90 | 25-350 | + .204 | 11 | 2-20 | -3.500 | 13 | 0-60 | --- | 90 | 50-100 |
| Tankage | 3.99 | 64 | 25-150 | + .393 | 13 | 6-27 | --- | 8 | 0-75 | --- | 92 | 25-100 |
| Fish meal | 8.13 | 441 | 25-2000 | + .080 | 9 | .50-20 | -5.000 | 0 | 0-0 | --- | 78 | 0-100 |
| Dried whey | 6.12 | 225 | 50-300 | + .390 | 8 | 1-16 | -7.900 | 0 | 0-0 | --- | 78 | 10-100 |
| Salt | 1.19 | 325 | 25-500 | + .109 | 16 | .50-30 | -1.030 | 25 | 0-100 | - .450 | 51 | 0-100 |
| Calcium and limestone | .57 | 150 | 25-1000 | + .036 | 23 | 1.80-40 | - .240 | 0 | 0-0 | --- | 27 | 0-80 |
| Bone meal | 4.28 | 122 | 25-500 | + .090 | 6 | .05-15 | -4.500 | 0 | 0-0 | --- | 100 | 100-100 |
| Bentonite | 1.50 | 285 | 25-1000 | + .011 | 14 | 1-30 | -1.700 | 0 | 0-0 | --- | 57 | 0-100 |
| Colloidal clay | 1.13 | 635 | 25-1000 | 0 | 24 | 1.50-40 | - .140 | 0 | 0-0 | --- | 38 | 0-100 |
| Sugar | 6.51 | 567 | 25-1000 | 0 | 14 | .10-30 | -6.000 | 0 | 0-0 | --- | 61 | 0-100 |
| Molasses | 1.56 | 463 | 50-1000 | + .019 | 29 | 15-45 | - .600 | 100 | 100-100 | --- | 66 | 0-100 |

of these ingredients, the price differentials for the distance shipped indicated by the approximate b values are fully equal to prevailing freight rates. For some, these differentials are even greater than prevailing freight rates, apparently reflecting a "shopping" or "bargaining" advantage as well as a freight advantage of plants which are located relatively close to sources of the needed feed ingredients.

The column headed "approximate b value" under "average weight per order" in table 3 shows the decrease in cents per hundredweight in the cost of the ingredient for every 1-ton increase in the volume per order given for the ingredient. For example, the coefficient in this column for linseed meal of -1.40 shows that for every 1-ton increase in order size over 22 tons, the price of linseed meal was found to decrease 1.4 cents per hundredweight under the average cost of $3.50 ($1.40 per hundredweight decrease in this price per each 100-ton increase in size of order). The absence of an approximate b value under average tons per order in table 3 for certain ingredients shows that no relationship was found between size of order and cost per hundredweight for these ingredients.

Table 3 also shows the approximate b value or relationship between the delivered cost per hundredweight and the percentage purchased in bulk for those ingredients which were purchased in bulk by the plants studied in percentages which varied enough so that this relationship could be computed. These coefficients show the decrease in cents per hundredweight in the cost of the ingredient under the average price for each 1-percent increase in the percentage purchased in bulk over the average of this percentage. For example, the figure of -0.300 for soybean meal shows that the price per hundredweight of soybean meal was found to decrease 0.3 cent per hundredweight under $3.19 each time an additional 1 percent over 79 percent was purchased in bulk.

## Budgeted Ingredient Costs for the Four Types of Operation

In order to compare the delivered cost of ingredients under the four types of operations these costs were budgeted for each type of operation based on the average distance of haul, tons per order, and percentage delivered in bulk observed in the plants of each type which were studied. This was done by working from a base price for each of the selected ingredients. In most cases, these base prices are the simple overall averages of the actual prices paid by the 12 feed companies (first column of table 3). In two or three cases, however, adjustments were made in the overall average prices per hundredweight. For example, the actual overall average price for fish solubles was $7.18. But since this average includes highly concentrated solubles purchased by the premix plants, the average was adjusted downward to $6.25 per hundredweight in order to retain our assumption of comparable formulas. The base prices used are shown in table 4.

Table 4 shows the average distance of haul, the weight per order, and the percentage shipped in bulk for the selected ingredients used to budget the ingredient costs under the four types of operation. The adjustment made in the base price for each factor is also shown. These total adjustments are based

Table 4.--Factors used in budgeting feed ingredient costs, and adjustments in price per hundredweight, 4 types of organization

| Ingredient | Concentrate and complete-feed operations: Length of haul: Distance | Length of haul: Adjustment | Size of order: Wt. | Size of order: Adjustment | Bought in bulk: Percentage | Bought in bulk: Adjustment | Av. cost per cwt. | Independent retailer--mfgr. operation: Length of haul: Distance | Length of haul: Adjustment | Size of order: Wt. | Size of order: Adjustment | Bought in bulk: Percentage | Bought in bulk: Adjustment | Av. cost per cwt. | Retailer operation: Length of haul: Distance | Length of haul: Adjustment | Size of order: Wt. | Size of order: Adjustment | Bought in bulk: Percentage | Bought in bulk: Adjustment | Av. cost per cwt. | Base price per cwt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Miles | Dol. | Tons | Dol. | Pct. | Dol. | Dol. | Miles | Dol. | Tons | Dol. | Pct. | Dol. | Dol. | Miles | Dol. | Tons | Dol. | Pct. | Dol. | Dol. | Dol. |
| Whole corn | 35 | +0.01 | --- | --- | --- | --- | 2.64 | 25 | -0.02 | --- | --- | --- | --- | 2.61 | 10 | -0.07 | --- | --- | --- | --- | 2.56 | 2.63 |
| Whole oats | 35 | + .01 | --- | --- | --- | --- | 2.24 | 25 | - .02 | --- | --- | --- | --- | 2.21 | 10 | - .07 | --- | --- | --- | --- | 2.16 | 2.23 |
| Bran | 112 | 0 | 22 | 0 | 0 | 0 | 2.30 | 112 | 0 | 16 | +0.02 | 0 | 0 | 2.32 | 142 | + .05 | 5 | +0.05 | 0 | 0 | 2.40 | 2.30 |
| Shorts | 112 | 0 | 26 | 0 | 0 | 0 | 2.43 | 112 | 0 | 16 | + .05 | 0 | 0 | 2.48 | 142 | + .01 | 5 | + .09 | 0 | 0 | 2.53 | 2.43 |
| Meat scraps | 90 | 0 | 11 | 0 | 0 | 0 | 3.95 | 90 | 0 | 8 | + .10 | 0 | 0 | 4.05 | 90 | 0 | 5 | + .21 | 0 | 0 | 4.16 | 3.95 |
| Soybean meal | 83 | 0 | 36 | 0 | 100 | -0.06 | 3.13 | 83 | 0 | 30 | + .02 | 50 | +0.09 | 3.30 | 83 | 0 | 10 | + .10 | 0 | +0.24 | 3.53 | 3.19 |
| Alfalfa meal | 200 | 0 | 25 | 0 | 0 | 0 | 2.22 | 200 | 0 | 20 | 0 | 0 | 0 | 2.22 | 200 | 0 | 5 | 0 | 0 | 0 | 2.22 | 2.22 |
| Limestone | 150 | 0 | 23 | 0 | 0 | 0 | .81 | 150 | 0 | 20 | + .01 | 0 | 0 | .82 | 150 | 0 | 5 | + .04 | 0 | 0 | .85 | .81 |
| Bone meal | 122 | 0 | 6 | 0 | 0 | 0 | 4.28 | 122 | 0 | 3 | + .13 | 0 | 0 | 4.41 | 122 | 0 | 1 | + .22 | 0 | 0 | 4.50 | 4.28 |
| Salt | 325 | 0 | 16 | 0 | 100 | - .34 | .85 | 325 | 0 | 12 | + .04 | 100 | - .34 | .89 | 355 | + .03 | 5 | + .11 | 0 | + .11 | 1.44 | 1.19 |
| | | | | | | | | | | | | | | | Premix operation | | | | | | | |
| Fish solubles | 441 | 0 | 9 | 0 | --- | --- | 6.25 | 441 | 0 | 3 | + .30 | --- | --- | 6.55 | 441 | 0 | 13 | -0.20 | --- | --- | 6.05 | 6.25 |
| Distillers solubles | 150 | 0 | 10 | 0 | 0 | 0 | 3.93 | 150 | 0 | 5 | + .10 | 0 | 0 | 4.03 | 150 | 0 | 15 | - .10 | 0 | 0 | 3.83 | 3.93 |
| Dried milk | 100 | 0 | 5 | 0 | 0 | 0 | 10.26 | 100 | 0 | 1 | + .20 | 0 | 0 | 10.46 | 100 | 0 | 5 | 0 | 0 | 0 | 10.26 | 10.26 |
| Trace minerals | 500 | 0 | 1 | 0 | 0 | 0 | 15.00 | 500 | 0 | 1/2 | + .01 | 0 | 0 | 15.01 | 500 | 0 | 10 | - .18 | 0 | 0 | 14.82 | 15.00 |
| Fat | 150 | 0 | 1 | 0 | 0 | 0 | 8.16 | 150 | 0 | 1/2 | + .01 | 0 | 0 | 8.17 | 150 | 0 | 5 | - .08 | 0 | 0 | 8.08 | 8.16 |
| Epsom salts | 500 | 0 | 1 | 0 | 0 | 0 | 3.50 | 500 | 0 | 1/2 | + .01 | 0 | 0 | 3.51 | 500 | 0 | 5 | - .08 | 0 | 0 | 3.42 | 3.50 |
| Antibiotics | 250 | 0 | 1/2 | 0 | 0 | 0 | 63.77 | 250 | 0 | 1/4 | + .10 | 0 | 0 | 63.87 | 250 | 0 | 2 | - .30 | 0 | 0 | 63.47 | 63.79 |
| Vitamin A | 250 | 0 | 1/2 | 0 | 0 | 0 | 96.45 | 250 | 0 | 1/4 | + .10 | 0 | 0 | 96.55 | 250 | 0 | 2 | - .30 | 0 | 0 | 96.35 | 96.45 |
| Vitamin D | 250 | 0 | 1/2 | 0 | 0 | 0 | 76.95 | 250 | 0 | 1/4 | + .10 | 0 | 0 | 77.05 | 250 | 0 | 2 | - .30 | 0 | 0 | 76.65 | 76.95 |
| Vitamin B complex | 250 | 0 | 1/2 | 0 | 0 | 0 | 39.05 | 250 | 0 | 1/4 | + .10 | 0 | 0 | 39.15 | 250 | 0 | 2 | - .30 | 0 | 0 | 38.75 | 39.05 |

directly on the coefficients and the mean values for distance shipped, tons per order, and percentage in bulk for each of the ingredients shown in table 3.

The method of adjusting the base price to fit each of the different types of operation and obtain the average cost per hundredweight shown in table 4 can be illustrated by following the figures for soybean meal. For the concentrate and complete-feed operation, the average distance and tons per order assumed are the averages for the plants studied (see table 3), so no adjustments were made in the base price for these factors. But for these two types of operation, it was assumed that all of the soybean meal was purchased in bulk whereas the average percent purchased in bulk for the 12 plants was 79 percent. The coefficient for bulk purchases of soybean meal is 0.3 cent per hundredweight decrease in the cost of the ingredient for each 1-percent increase in the amount purchased in bulk. Twenty-one percent (100 percent minus 79 percent) multiplied by 0.3 cent equals 6.3 or the 6 cents negative adjustment shown in the percent bulk column for the concentrate and complete feed operations.

Following the soybean meal figures no adjustment was made for the independent operation on distance of shipment, since this distance was also budgeted at the average of 83 miles. But the average size of order was budgeted at 30 tons rather than 36 tons. The coefficient in this case is an increase of 0.4 cent per hundredweight in the ingredient cost for each 1-ton decrease in the average size of order of the ingredient. Thus, 6 tons (36 tons minus 30 tons) multiplied by 0.4 cent per hundredweight gives the 2-cent positive adjustment under the independent operation. Likewise the adjustment of +9 cents for the percentage bought in bulk is 29 percent (79 percent minus 50 percent) times 0.3 cent per hundredweight (8.7 cents rounded to 9 cents). The base price of $3.19 per hundredweight plus 2 cents for the percent bulk adjustment and plus the 9 cents for the tons per order adjustment gives the adjusted price per hundredweight for soybean meal of $3.30 for the independent operation. The adjusted price for soybean meal to retailers was computed in a similar fashion.

The nature of the adjustments and the effects of these adjustments on the total cost of ingredients for the four types of operation are apparent from table 4. Relatively little adjustment was made for the concentrate and complete-feed operations. The characteristics budgeted for these two closely paralleled the averages for the 12 plants studied. The cost of corn and oats is slightly less to the independent plants because they are closer to the supply of these ingredients and are able to purchase a part of their needs directly from farmers. However, the cost of other ingredients is slightly higher because their smaller volume of output makes it necessary to purchase in somewhat smaller lots. The retailers save still more on corn and oats since they purchase all of their needs directly from farmers in the immediately surrounding area. But their substantially smaller volume means small orders and higher costs for other ingredients. The premix companies enjoy larger purchases of the premix ingredients and, therefore, incur slightly lower per hundredweight costs for them. 4/

4/ The trace ingredients shown in table 4 are not shown in table 3. However, the method of making the adjustments in the budgeted costs for the different types of operation was the same as for the other ingredients.

In order to carry through a comparison of the ingredient costs for feed produced under the four types of operation, the quantity and quality of each ingredient purchased have been held constant. This has been accomplished by assuming that an identical feed formula is produced in each of the four operations. The feed selected for this purpose is a laying mash, the formula for which is shown in the first column of table 5.

The ingredients in the last group listed are presumed to be contained in the premix. The premix (consisting of fish solubles, distillers' solubles, dried milk, trace minerals, fat, epsom salts, antibiotics, and vitamins) makes up 150 pounds of the ton of complete feed. The concentrate consists of the premix plus the second group of ingredients (bran, shorts, meat scraps, soybean meal, alfalfa meal, limestone, steam bone meal, and salt). The concentrate makes up 1,100 pounds of the ton of complete laying mash.

Under the premix operation, the premix is by assumption formulated by the feed company while all of the rest of the ingredients are purchased by the retailer-mixer who makes the complete feed, using the premix. The cost of the ingredients for the premix is incurred by the feed company while the cost of all other ingredients is incurred by the company's mixer dealers.

Under the concentrate operation, all of the ingredients except corn and oats are purchased by the feed company. The concentrate is formulated by the feed company and transported to its retailers where the corn and oats are added to make the complete feed. Only the costs of the corn and oats ingredients are incurred by the retailer-mixer.

Under the complete feed operation, all of the ingredients are purchased by the feed company and added to the formula. Retailers incur none of the costs for ingredients contained in the final laying mash.

Since there are no separate retailers under the independent operation, all ingredient costs are incurred by the feed company.

Table 5 shows the 1955 total cost for each ingredient in the formula under each of the four types of operation. The last three lines show the total cost per ton of ingredients in the premix, the concentrate, and the complete feed. The total cost of ingredients for the completed feed varied from $62.80 per ton under the concentrate operation to $65.02 per ton under the premix operation. The ingredient cost per ton of the premix alone was lowest for the premix operation -- $174.93 -- and lowest -- $180.93 -- for the independent operation. The ingredient cost per ton for the concentrate alone was $73.02 for both the concentrate and complete operations, $75.27 for the independent operation, and $77.05 for the premix operation.

## INGREDIENT PROCUREMENT

The costs of procuring ingredients (excluding the costs of the ingredients themselves) represent a very small percentage of the total cost of manufacturing and distributing feed. Many of the feed manufacturing companies do not recognize ingredient procurement as a separate function at all in their accounting records.

Table 5.--Budgeted cost of ingredients in a ton of laying mash, and total cost of a ton of premix and concentrate, by type of organization

| Ingredient | Formula per ton | Ingredient cost by type of organization | | | |
|---|---|---|---|---|---|
| | | Premix | Concentrate | Complete | Independent |
| | Pounds | | | | |
| Whole corn | 800 | $ 20.48 | $ 20.48 | $ 21.12 | $ 20.88 |
| Whole oats | 100 | 2.16 | 2.16 | 2.24 | 2.21 |
| Bran | 100 | 2.40 | 2.30 | 2.30 | 2.32 |
| Shorts | 100 | 2.53 | 2.43 | 2.43 | 2.48 |
| Meat scraps | 100 | 4.16 | 3.95 | 3.95 | 4.05 |
| Soybean meal | 450 | 15.89 | 14.09 | 14.09 | 14.85 |
| Alfalfa meal | 100 | 2.22 | 2.22 | 2.22 | 2.22 |
| Limestone | 50 | .42 | .40 | .40 | .41 |
| Bone meal | 30 | 1.35 | 1.28 | 1.28 | 1.32 |
| Salt | 20 | .29 | .17 | .17 | .18 |
| Fish solubles | 50 | 3.02 | 3.12 | 3.12 | 3.28 |
| Distillers solubles | 50 | 1.92 | 1.97 | 1.97 | 2.01 |
| Dried milk | 19 | 1.95 | 1.95 | 1.95 | 1.99 |
| Trace minerals | 10 | 1.48 | 1.50 | 1.50 | 1.50 |
| Fat | 10 | .81 | .82 | .82 | .82 |
| Epsom salts | 5 | .17 | .17 | .17 | .17 |
| Antibiotics | 2 | 1.27 | 1.28 | 1.28 | 1.28 |
| Vitamin A | 1 | .96 | .96 | .96 | .97 |
| Vitamin D | 1 | .77 | .77 | .77 | .77 |
| Vitamin B complex | 2 | .77 | .78 | .78 | .78 |
| Total cost per ton: | | | | | |
| Premix | | 174.93 | 177.60 | 177.60 | 180.93 |
| Concentrate | | 77.05 | 73.02 | 73.02 | 75.27 |
| Complete-feed | | 65.02 | 62.80 | 63.52 | 64.49 |

Instead they include the costs of performing this function with the costs of production, handling, and storage and the total administrative, office, and overhead costs. Retailer-mixers almost universally fail to keep separate cost records for the function of ingredient procurement.

Because procurement costs are such a small percentage of total costs, and because of the difficulty of separating these costs in the accounting records of operating companies, the information regarding this class of costs obtained in the study is much more limited and tentative than that obtained for most of the other classes of costs.

## Procurement Costs in the Plants Studied

Complete cost allocations to the ingredient procurement function could be studied only for the three plants in the concentrate group. Average procurement costs per ton in 1955 by expense item and the ranges in these costs for the three plants are shown in table 6.

The total per ton procurement costs averaged 42 cents per ton for the three concentrate plants studied. Administrative salaries were the largest single procurement expense item in these plants, making up an average of 51 percent of the total. Office salaries were the next largest expense and made up another 17 percent of total procurement cost in the three concentrate plants.

The average total per ton procurement costs and the corresponding ranges in these costs for the case-study plants representing the other three types of operation are shown in the lower part of table 6. The higher costs for the concentrate plants are most likely due to differences in accounting methods.

Table 6.--Procurement costs per ton for the 4 types of feed manufacturing plants studied, 1955

| Item | Average | Range | Percentage distribution of average costs |
|---|---|---|---|
| | Dollars | Dollars | Percent |
| Concentrate plants: 1/ | | | |
| Administrative salaries | 0.2169 | 0.1965-0.2407 | 51 |
| Office salaries | .0710 | 0- .1955 | 17 |
| Bonuses | .0387 | .0209- .0628 | 9 |
| Office supplies | .0148 | .0038- .0306 | 3 |
| Telephone | .0322 | .0276- .0354 | 8 |
| Postage and mailing | .0037 | 0- .0069 | 1 |
| Depreciation | .0078 | 0- .0118 | 2 |
| Insurance and taxes | .0197 | .0033- .0317 | 5 |
| Printing | .0022 | 0- .0034 | 1 |
| All other | .0127 | .0018- .0240 | 3 |
| Total | .4197 | .3390- .5324 | 100 |
| Total for premix plants | .26 | .17- .35 | |
| Total for complete-feed plants | .12 | 0- .36 | |
| Total for retailer-manufacturer | .03 | .02- .05 | |

1/ Annual average volume handled in the concentrate plants was 25,044 tons; the range was between 16,439 and 33,426 tons.

## Causes of Variation in Procurement Costs

The impossibility of precisely separating total procurement costs from overhead and production costs from the accounting records of the case-study plants made it difficult to analyze the factors affecting the procurement costs to these plants. Differences in the accounting methods used in the case-study plants largely offset any real differences in these costs among the plants studied.

Data which were available, however, indicate that there appears to be no significant difference in procurement costs per ton of ingredients purchased that could be attributed to the type of operation. Such factors as the integration of soybean processing and rendering with the feed milling operation so that feed ingredients were available within the company are more important in determining procurement costs than whether the operation is one of premix, concentrate, complete feed, or retailer-manufacturer. But because total procurement costs are so small relative to total manufacturing and distribution costs, even the effects of such integration could not be assessed quantitatively in the study. An analysis of the monthly purchases indicate a definite negative relationship between the volume of ingredients purchased and the per ton procurement costs (see appendix).

## Budgeted Procurement Costs for the Four Types of Operation

The budgeted procurement costs for the hypothetical laying mash for the four types of operations are summarized in table 7. These costs apply at the manufacturer's level only. No separate ingredient procurement costs were budgeted at the retail level because of the complete lack of information in the records of the case-study retailers. There would be no procurement cost for the complete-feed retailers in any case, and the cost for procuring the grains used by the concentrate retailers would be negligible in terms of the percentage of total cost. The cost of procuring the ingredients used by the premix retailers if measured accurately might well be at least as much per ton of ingredients purchased as the cost per ton of ingredients used by the manufacturers themselves.

The budgeted costs and percentage of total procurement cost by class of expenses for each of the four types of operation are shown in the upper section of table 7. These total procurement expenses are estimated to be 35 cents per ton of feed manufactured for all four types of operation. Nothing in the organization of any of the four types of operation indicates that the manufacturing plants of one type would have procurement costs per ton substantially different from those for any of the others.

The breakdown of the budgeted total procurement costs by class of expenses is shown in the table for each of the four types of operation. This breakdown closely parallels that found to exist on the average for the case-study plants.

Table 7.--Budgeted procurement costs for the four types of organization (manufacturers only)

| Cost item | Premix | | Concentrate | | Complete feed | | Retail-manufacturing | |
|---|---|---|---|---|---|---|---|---|
| | Costs | Percentage of total | Costs | Percentage of total | Costs | Percentage of total | Costs | Percentage of total |
| | Dollars | Percent | Dollars | Percent | Dollars | Percent | Dollars | Percent |
| Supervision | 840 | 80 | 4,620 | 60 | 8,400 | 60 | 2,660 | 76 |
| Labor | | | 1,232 | 16 | 2,240 | 16 | | |
| Depreciation | | | 231 | 3 | 420 | 3 | | |
| Telephone | 105 | 10 | 770 | 10 | 1,400 | 10 | 525 | 15 |
| Postage and printing | | | 77 | 1 | 140 | 1 | | |
| Office supplies | 21 | 2 | 154 | 2 | 280 | 2 | 35 | 1 |
| Other | 84 | 8 | 616 | 8 | 1,120 | 8 | 280 | 8 |
| Total | 1,050 | 100 | 7,700 | 100 | 14,000 | 100 | 3,500 | 100 |
| Total per ton mixed | 0.35 | --- | 1/0.35 | --- | 1/0.35 | --- | 2/0.35 | --- |
| Total per ton complete feed | .03 | --- | .19 | --- | .35 | --- | .35 | --- |

1/ Actual cost records in the case-study plants ranged from 0.17 cent to 0.36 cent for those plants having relatively comparable cost records.

2/ No comparable cost records were available.

## PLANT MANUFACTURING, STORING, AND HANDLING COSTS

While the plant manufacturing and storage operations represent an important part of the total operation, they certainly do not represent all or even the major share of the total costs of manufacturing and distributing mixed feeds. 5/ Average production costs for the four types of operation represent only about 14 percent of the total costs to manufacturers and retailers for manufacturing and distributing livestock feeds when ingredient costs are included.

### Production Costs in the Plants Studied

The average total costs of production, handling, and storage for the case-study manufacturers representing each of the four types of operation were computed from the cost records of each of the plants studied. These costs, along with the average volumes of production are shown on the last two lines of table 8. The ranges among the plants studied also are shown.

The average production costs were highest for the three complete-feed companies--$13.03 per ton. However, this average was raised materially by the very high production cost of $19.92 for one of these companies. The average for the other two complete-feed plants was only $9.58 per ton. The average production cost per ton was $9.02 per ton for the premix plants, $8.89 per ton for the concentrate plants and $8.15 per ton for the retailer-manufacturer plants. The range in this cost was only $1.76 among the three concentrate plants, but about $3.00 or more among the plants of the other three types. Production costs represent a smaller proportion of the total costs in the premix plants and were relatively most important in the retailer-manufacturer plants.

The average production cost for each type of expense for the three manufacturing plants representing each of the four kinds of operation are also shown in table 8. The ranges in these costs among the plants studied also are shown. Labor represented the largest single production expense in all groups of plants. Mill supplies on the average were the next most important production expense. Supervision represented a more important production expense in the premix plants than in the other groups and was least important in the retailer-manufacturer plants. Depreciation was a fairly important production expense in all four types of plants.

The 1955 volume and production costs of the retailers studied are shown in table 9. Seven of these retailers were premix outlets, six were concentrate

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5/ Of the research directed toward operating efficiency in the mixed feeds industry, the emphasis predominantly has been on plant manufacturing, storing, and handling. This phase of the total function of manufacturing and distributing mixed feeds has received the attention of both engineering and economic research. The other phases of the total operation--ingredients, procurement, research and formula development, administrative, office and overhead, sales, and feed transportation--have received proportionately much less attention by research workers.

Table 8.--Production cost per ton of feed, by type of expense, for the 4 types of manufacturing plants, 1955

| Expense item | Premix | | Concentrate | | Complete feeds | | Retail-manufacturing | | Average, 4 types of plants |
|---|---|---|---|---|---|---|---|---|---|
| | Average | Range | Average | Range | Average | Range | Average | Range | |
| | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars |
| Supervision | 1.91 | 1.68- 2.19 | 0.63 | 0.07- 1.13 | 0.49 | 0.0 - 0.92 | 0.31 | 0 - 0.94 | 0.84 |
| Labor | 2.65 | .46- 5.36 | 4.23 | 3.34- 5.20 | 5.13 | 3.20- 8.12 | 3.21 | 0.59- 5.42 | 3.80 |
| Mill supplies | 1.71 | 0.00- 3.93 | 1.91 | .10- 3.64 | 3.00 | 1.55- 4.32 | 2.51 | 2.00- 3.04 | 2.29 |
| Depreciation | 1.39 | .44- 3.07 | .50 | .42- .65 | 1.58 | .21- 3.45 | .55 | 0 - 1.00 | 1.01 |
| Fuel and power | .63 | .19- 1.47 | .46 | .33- .56 | .90 | .34- 1.18 | .88 | .78- 1.01 | .72 |
| Repairs | .49 | .04- 1.36 | .45 | .08- .99 | .45 | .18- .67 | .43 | .18- .88 | .46 |
| All other | .23 | .22- .24 | .69 | .44- .90 | 1.48 | .61- 2.21 | .25 | 0 - .74 | .66 |
| Total cost per ton | 9.02 | 6.70-13.15 | 8.89 | 8.06- 9.82 | 13.03 | 7.33-19.92 | 8.15 | 6.22- 9.52 | 10.07 |
| | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons |
| Volume mixed | 2 | 2 - 3 | 25 | 16 - 35 | 30 | 5 - 78 | 8 | 5 - 10 | --- |



Table 9.--Volume handled and plant production and handling costs for retailers who mix and do not mix feeds, 1955

| Item | Number of retailers | Annual volume per retailer | | Production cost per ton | |
|---|---|---|---|---|---|
| | | Average | Range | Average | Range |
| | Number | Tons | Tons | Dollars | Dollars |
| Retailers who mix feeds: | | | | | |
| Premix | 7 | 1,504 | 140-3,052 | 13.51 | 6.04-27.16 |
| Concentrate | 4 | 913 | 285-1,567 | 16.97 | 10.26-31.35 |
| Complete-feed | 2 | 730 | 300-1,160 | 15.98 | 10.60-21.35 |
| Retailers who do not mix feeds: | | | | | |
| Concentrate | 2 | 771 | 500-1,042 | 2.82 | 2.33- 3.31 |
| Complete-feed | 5 | 818 | 70-1,650 | 2.52 | 1.16- 3.89 |

outlets, and seven were complete-feed outlets. Altogether, 13 of the retailers had mixing facilities and seven of them did not. The retailers who did mixing have substantially higher plant and production costs than those who only merchandise feed.

The total plant and production costs averaged $14.95 per ton for the 13 retailers who did feed mixing and only $2.61 per ton for the 7 retailers who only merchandised feed. Of those with mixing facilities, the average cost per ton was highest for the concentrate outlets and lowest for the premix outlets.

For retailers with mixing facilities production costs represented an average of 61.9 percent of the total costs for the premix dealers, 61.5 percent for the concentrate dealers, and 56.2 percent for the complete-feed dealers. Of the retailers without mixing facilities, the percentage of total costs represented by plant costs averaged 26.1 percent for the concentrate dealers and 21.4 percent for the complete-feed dealers.

## Causes of Variation in Production Costs

Feed manufacturers.--The total costs per ton of producing, handling, and storing mixed feed have been shown by other studies to be related quantitatively to such factors as the volume of feed manufactured and unused plant capacity. This study also indicates a definite relationship between the volume of feed output and total plant costs. Graphic correlation analysis was made of the total plant costs and related variables both for the manufacturing plants and the retail outlets as a part of the study. While the results are not conclusive because the number of observations was limited and the observations were not selected randomly, they are indicative of quantitative influences of several factors upon the total per ton plant costs incurred in feed manufacture and distribution.

The factors examined for possible relationships to total costs per plant of production, handling, and storage for the feed manufacturers include volume of feed manufactured, volume of other kinds of feed manufactured, volume of ingredients merchandised, the size of the total plant operation in addition to the feed department, the percentage of output in bulk, and the percentage of output pelleted. Table 10 shows the values for these factors and for plant costs per ton averaged for the three plants in each of the four groups.

The deviations from the budgeted total production costs per ton for the case-study manufacturing plants were found to be related to the changes in volume, the percentage of the total plant operation represented by mixed feeds, the percentage of the manufactured feed distributed in bulk, and the percentage of the total feed output pelleted. No apparent relationship was found between these deviations in production cost and the volume of other feeds manufactured or the volume of merchandising by the feed department.

Table 10.--Production costs and related variables for feed manufacturing companies, 4 types of organization, 1955 (excludes production costs at retail)

| Item | Premix | | Concentrate | | Complete-feeds | | Retail-manufacturing | |
|---|---|---|---|---|---|---|---|---|
| | Average | Range | Average | Range | Average | Range | Average | Range |
| | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars |
| Production cost per ton | 9.02 | 6.70- 13.16 | 8.89 | 8.06- 9.82 | 1/ 9.58 | 7.33- 11.83 | 8.15 | 6.22- 9.52 |
| Deviation from budgeted cost per ton | +1.02 | -1.30- 5.16 | + .39 | -.44- 1.32 | 1/+1.33 | -.92- 3.58 | -1.10 | -3.03- .27 |
| Budgeted production costs: | | | | | | | | |
| Per ton mixed | 8.00 | | 8.50 | | 8.25 | | 9.25 | |
| Per ton complete-feed 2/ | .60 | | 4.68 | | 8.25 | | 9.25 | |
| | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons |
| Volume mixed | 2 | 2 - 3 | 25 | 16 - 35 | 30 | 5 - 78 | 8 | 5 - 10 |
| Equivalent complete-feed | 26 | 21 - 33 | 46 | 29 - 63 | 30 | 5 - 78 | 32 | 18 - 39 |
| Manufactured volume of other feed | 16 | 0.5 - 35 | 1 | 2 - 3 | 0.9 | 1 - 2 | 0.02 | 0 - 0.07 |
| Volume merchandised | 2 | 0 - 5 | 5 | 1 - 7 | 3 | 0.1 - 9 | 2 | 0.9 - 4 |
| | Percent | Percent | Percent | Percent | Percent | Percent | Percent | Percent |
| Feed operations to total operation | 65 | 30 - 95 | 75 | 45 - 95 | 98 | 95 - 100 | 73 | 40 - 100 |
| Distributed in bulk | 0 | 0 - 0 | 8 | 3 - 14 | 1 | 3/ | 17 | 10 - 23 |
| Percent pelleted | 0 | 0 - 0 | 83 | 76 - 92 | 86 | 65 - 98 | 70 | 38 - 96 |

1/ The high-cost plant (19.92 per ton) is excluded in this average.
2/ Budgeted to 40,000 tons of feed retailed for all types of operations.
3/ Less than 0.5 percent.

The total plant production costs per ton were found to: 6/

1. Decrease $0.0336 with each 1,000-ton increase in feed manufactured.

2. Increase $0.03 with each 1-percent increase in the proportion of the total operation represented by the feed operation.

3. Decrease $0.30 with each 1-percent increase in feed sold in bulk.

4. Increase $0.008 with each 1-percent increase in feed pelleted.

These relationships are shown graphically in figure 1. The magnitude of the relationships (slopes of the lines) are identical for all four types of operation. However, since the four types of operation vary in volume manufactured, size of the feed department in relation to total plant operations, percent of feed pelleted, and percent of feed sold in bulk, the actual cost (the vertical location of the lines of relationship in figure 1) varies with each type of operation. The lines in figure 1 represent the average production cost for all four types of operation and are based on the average adjusted volume, the average percent pelleted, the average percent sold in bulk and the average size of the feed department in relation to the total business operation for all 12 of the plants studied. 7/

In the 12 plants studied, the direction of the relationship found between the percentage of the total plant operation represented by the feed department and feed production costs is certainly what one would expect. The smaller the percentages represented by the feed department the greater the total size of other kinds of activities (soybean processing, rendering, etc.) conducted at the plant. If the percentage were 100, the plant would consist of nothing but the feed department. Since the volume of the feed operation was fixed in this analysis, the smaller the percentage shown in the scale at the top of the chart the larger the total plant operations. As the total plant operations increase, total feed production costs per ton decrease somewhat, as indicated by the coefficient. However, the magnitude of this relationship seems a little large, and might not hold true for a larger universe of feed companies. At least it should be interpreted as tentative and subject to verification or modification by further research.

The direction of the relationship between the percentage of the operation in bulk and the total per ton production costs is what one would expect. The costs of bags, bagging, and bag handling are eliminated by a bulk operation so that production costs should be lower. But it seems doubtful that one would usually find that a bulk operation decreases total production costs as much as

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6/ These approximate relationships were computed by graphic regression analysis from the deviations from the budgeted per ton costs and the tonnage of complete feed manufactured, the percentage of the total operation represented by the feed department, the percentage of feed pelleted, and the percentage of feed handled and sold in bulk in each of the 12 manufacturing plants studied.

7/ The magnitude of the relationship found between per ton production costs and volume of feed manufactured is consistent with similar relationships brought out previously by other studies.

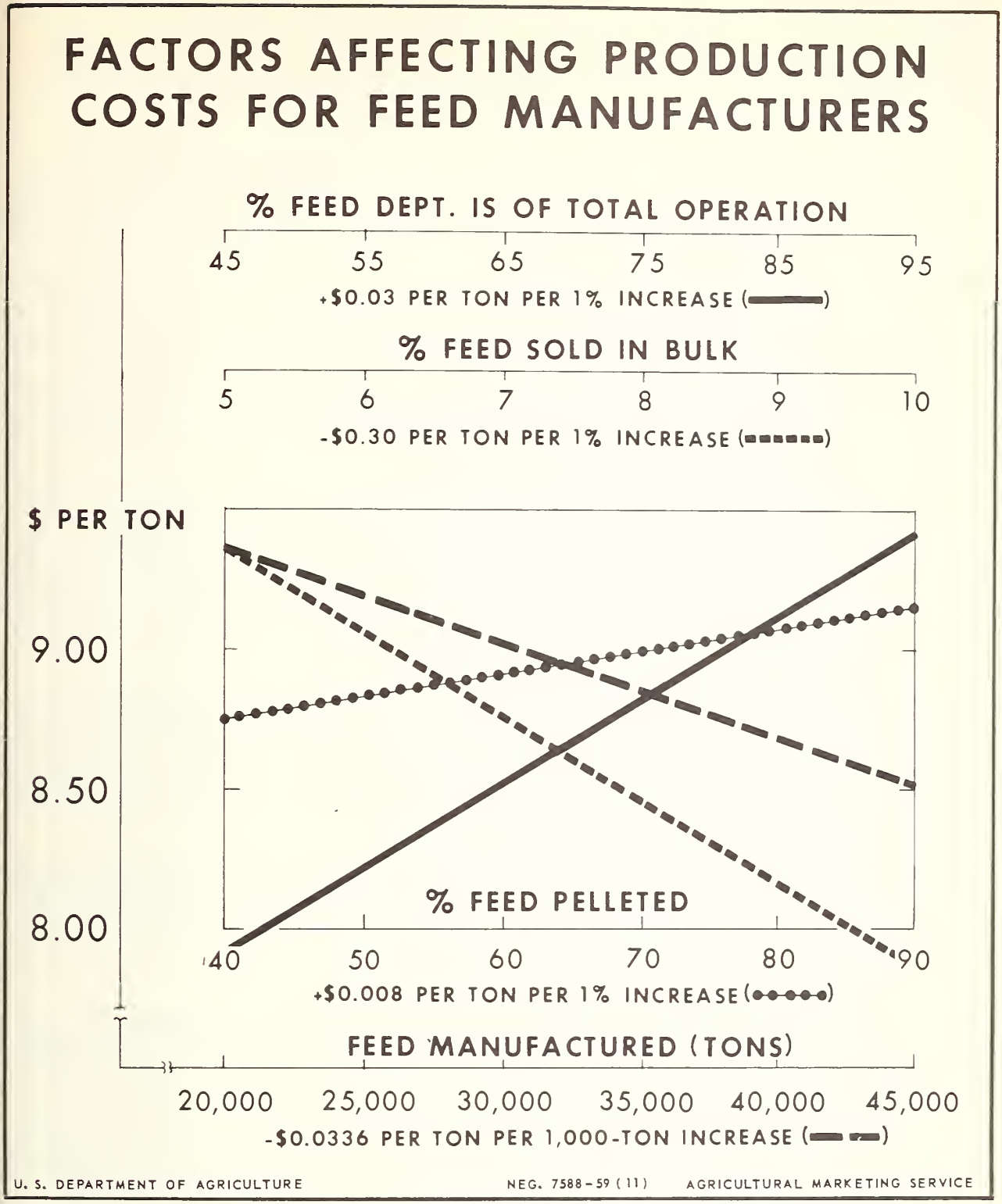
FACTORS AFFECTING PRODUCTION COSTS FOR FEED MANUFACTURERS
% FEED DEPT. IS OF TOTAL OPERATION
45
55
65
75
85
95
+$0.03 PER TON PER 1% INCREASE
% FEED SOLD IN BULK
5
6
7
8
9
10
-$0.30 PER TON PER 1% INCREASE
$ PER TON
9.00
8.50
8.00
% FEED PELLETED
40
50
60
70
80
90
+$0.008 PER TON PER 1% INCREASE
FEED MANUFACTURED (TONS)
20,000
25,000
30,000
35,000
40,000
45,000
-$0.0336 PER TON PER 1,000-TON INCREASE
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Figure 1

indicated by the coefficient found for the 12 case-study plants and shown in figure 1. It should certainly be interpreted with reservation unless and until verified by further research. It may have been caused in part by other efficiency factors in those plants using a bulk operation which were not isolated in the study.

Although also based on the limited information from only 12 case study plants, the net relationship between the percentage of feed pelleted and total per ton production costs seems quite reasonable in both direction and magnitude. It indicates that pellets cost 80 cents per ton more to produce than mash, considering all production expenses.

Production costs decreased approximately 18.7 cents with each 1-percent increase in monthly volume in the premix plants, 7.1 cents with each 1-percent volume increase for the concentrate plants, 6.2 cents with each 1-percent increase in volume for the complete-feed plants, 13.9 cents with each 1-percent increase in volume for the retailer-manufacturer plants, and 11.5 cents with each 1-percent increase in volume for all 12 plants taken together. (See appendix).

Feed retailers.--The major factor affecting total plant costs to feed retailers is whether feed is mixed or simply merchandised by the retailer. As shown in the last line of table 11, 13 of the 20 retailers mixed feed and 7 of them only merchandised feed. Total plant costs averaged $14.95 per ton for those that did feed mixing and only $2.60 per ton for those that did not mix feed.

The other important factor affecting total plant costs per ton of feed handled by retailers is the volume handled. Table 11 shows the average plant cost per ton for the retailers studied, by size of volume handled, both for those with mixing facilities and those without mixing facilities. While the correlation is not perfect, increases in volume certainly are associated with lower plant costs per ton, for both groups.

Graphic correlation was used to determine the relationship between annual volume and plant costs per ton for the two classes of retailers studied. For the retailers with mixing facilities, the relationship found is: 8/

$$(1)\quad Y = 26.00 - .007\ T,$$

where Y is the total plant cost in dollars per ton and T is the volume of feed output in tons per year. The relationship found for the retailers with mixing facilities is: 9/

$$(2)\quad Y = 4.00 - .0015\ T,$$

where again Y is the total plant cost in dollars per ton and T is the volume of

8/ This formula was used to budget costs at annual volumes of 500 and 1,700 tons per year. It should not be extended and used for predicting costs for an unlimited range of operating volumes.

9/ See footnote 8.

Table 11.--Production costs for feed retailers with and without mixing facilities, by size of annual volume, 1955

| Annual volume in tons | Retailers with mixing facilities | | Retailers without mixing facilities | |
|---|---|---|---|---|
| | Number | Average cost per ton | Number | Average cost per ton |
| | Number | Dollars | Number | Dollars |
| Less than 500 | 3 | 26.62 | 2 | 3.60 |
| 501 - 1,000 | 3 | 12.92 | 2 | 2.45 |
| 1,001 - 1,500 | 2 | 11.46 | 2 | 2.48 |
| 1,501 - 2,000 | 3 | 12.87 | 1 | 1.16 |
| Over 2,000 | 2 | 7.13 | --- | --- |
| Total or average | 13 | 14.95 | 7 | 2.60 |

feed handled in tons per year.

Equation (1) indicates that total plant and production costs for retailers who do feed mixing decrease 0.7 cent per ton for each additional ton of feed mixed. This formula would mean a cost for plant handling and mixing at the retail level of $20.75 per ton at a volume of 750 tons per year, and $15.50 at a volume of 1,500 tons per year.

Equation (2) indicates that total plant handling costs for retailers without a feed mixing operation decrease 0.15 cent for each additional ton handled. This means the per ton plant handling costs for such retailers would be $2.87 at a volume of 750 tons per year and $1.75 per ton at a volume of 1,500 tons per year.

These relationships are based on a small number of case-study plants and should not be generalized without caution. But they certainly indicate a very substantial reduction in plant costs per ton to retailers as their annual volume of feed sales is increased at least within the volume levels included in this analysis.

## Budgeted Production Costs for the Four Types of Operation

The budgeted total cost per ton to manufacturers for plant production, handling, and storage is $8.00 for the premix operation, $8.50 for the concentrate operation, $8.25 for the complete-feed operation and $9.25 for the retailer-manufacturer operation (table 12). These figures reflect differences in volume of output as well as differences in the nature of operations between the manufacturers of the four different types. The fact that the budgeted production cost is 25 cents per ton higher for the concentrate operation than for the complete-feed operation is explained by the difference of 18,000 tons in the annual output of the two types of manufacturers. The budgeted production cost for the retailer-manufacturer operation is 75 cents per ton higher than that for

Table 12.--Budgeted production costs per ton for feed manufacturers and retailers, 4 types of organization

| Type of organization | Manufacturers | | | | | | | | Retail total | Overall total | Retail as percentage of overall |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Supervision | Labor | Mill supplies | Depreciation | Fuel and power | Repairs | All other | Total | | | |
| | Dol. | Dol. | Dol. | Dol. | Dol. | Dol. | Dol. | Dol. | Dol. | Dol. | Pct. |
| Premix: | | | | | | | | | | | |
| Mix | 0.80 | 3.04 | 2.24 | 0.56 | 0.48 | 0.16 | 0.72 | 8.00 | | | |
| Equivalent complete-feed 1/ | .06 | .23 | .17 | .04 | .04 | .01 | .05 | .60 | 17.46 | 18.06 | 97 |
| Concentrate: | | | | | | | | | | | |
| Mix | .60 | 3.83 | 2.43 | .60 | .51 | .17 | .43 | 8.50 | | | |
| Equivalent complete-feed 1/ | .33 | 2.10 | 1.33 | .33 | .28 | .09 | .23 | 4.68 | 9.82 | 14.50 | 68 |
| Complete-feed 1/ | .58 | 3.71 | 2.31 | .58 | .50 | .17 | .41 | 8.25 | 2.17 | 10.42 | 21 |
| Retail-manufacturing 1/ | .65 | 3.98 | 2.50 | .93 | .93 | .19 | .09 | 9.25 | 0 | 9.25 | 0 |

1/ On 40,000-ton equivalent.

the complete-feed operation primarily because the annual volume is only one-fourth as large.

Volume of output does not explain why the budgeted production cost per ton to the manufacturer is actually lowest for the premix operation with an annual volume of only 3,000 tons. Rather this production cost in the premix plant is explained by the specialized nature of premix manufacture and the fact that grinding and other heavy machinery is not needed for the manufacture of this type of product.

Production costs for the case-study plants in all four groups ranged both above and below the budgeted costs, even though they did not exactly average budgeted costs for any one of the four types of operation.

The budgeted total plant costs incurred at the retail level are also given in table 12. These costs are based on 60 percent of the total volume handled by retailers doing an annual volume of 1,700 tons each and 40 percent of the total volume handled by retailers doing an annual volume of 500 tons each. This is true of the retailers under all three types of operation. The budgeted total plant costs for the retailers of these two annual volumes for each of the three types of operation are shown in table 13.

For both the small and the large retailers, the total plant costs are highest for the premix operation and lowest for the complete-feed operation. This difference arises directly from differences among the types of operation. The premix dealers add 1,850 pounds of ingredients to the premix to make each ton of feed, and consequently have relatively high plant production, handling, and storage costs. The concentrate dealers add only grains (900 pounds per ton) to the concentrate, and therefore have lower plant costs. The complete-feed dealers do no mixing so that they have no production nor ingredient handling and storage costs at all. The plant costs for them include only the mixed feed handling and storage costs, and are much lower than the retail plant costs for the other two types of operation.

Total plant costs for the case-study retailers who did feed mixing ranged from $6.04 per ton to $31.35 per ton (table 9). This variation was largely explained by differences in the volume of feed mixed and the number and kinds of different ingredients added in making the final feed. The annual volume ranged from 140 tons to 3,052 tons in these retail plants studied. The plant costs per ton ranged from $1.16 per ton to $3.89 per ton among the retailers studied who did not have mixing facilities. The annual volume for these plants ranged from 70 tons to 1,650 tons (see table 9). The differences in volume accounted for most of the differences in plant costs per ton among the retailers without mixing facilities. The budgeted plant costs for the retailers under all three types of operation are based on these costs which were found to exist among the retailers studied at different annual volumes and with and without mixing facilities.

The budgeted total plant costs per ton for all retailers (table 13) are simply the weighted averages of these costs for the retailers of the two different volumes for that type of operation.

Table 13.--Budgeted retail production costs per ton for the 3 types of organization

| Volume | Premix | Concentrate | Complete-feed |
|---|---|---|---|
| | Dollars | Dollars | Dollars |
| 1,700-ton dealers (24,000 tons) | 14.10 | 7.78 | 1.45 |
| 500-ton dealers (16,000 tons) | 22.50 | 12.88 | 3.25 |
| All dealers (40,000 tons) | 17.46 | 9.82 | 2.17 |

The total budgeted costs per ton for plant production, handling, and storage for both manufacturers and retailers are shown in table 12. This combined total plant cost was almost twice as much for the premix operation as for the retailer-manufacturer operation--$18.06 per ton compared to $9.25 per ton. It was $14.50 per ton for the total concentrate operation and $10.42 for the complete-feed operation.

The relative efficiency of total plant production, storage, and handling in the four types of operation is measured by these four figures. All four operations provide farmers with the same total quantity of the identical formula of the completed feed in bagged and mash form. For this particular class of costs, the retailer-manufacturer operation is the least costly (most efficient) followed in order by the complete-feed operation, the concentrate operation, and the premix operation.

While the premix manufacturing operation is the most efficient in terms of total plant costs, the relative inefficiency of their retailing plants, which are small by comparison to wholesale companies, far more than offsets this advantage. Note again that retailing plant costs make up 96.68 percent of the total combined plant costs under the premix operation. In contrast, the retailer-manufacturers have a higher total plant cost per ton than the wholesale feed manufacturing companies under any of the other three types of operation. But since there are no additional retail plant costs at all under this type of operation, the total cost of manufacture, storage, and handling the feed from raw ingredients to the farmer who uses it are less for this type of operation than for any of the other three.

## OVERHEAD COSTS

In any kind of business operation, overhead costs (administration, office maintenance, depreciation, and the like) must be borne by the total activities performed by the firm. These functions are just as necessary as the labor and machinery used in plant operations, and represent one of the major classes of

cost studied for both the manufacturers and the retailers under each of the four alternative types of operation.

## Overhead Costs in the Plants Studied

Manufacturing plants.--The average total overhead costs for the case-study manufacturers representing each of the four types of operation were computed from the cost figures for each of the plants studied. These costs along with the average volumes of production are shown on the two lower lines of table 14. The ranges in these figures among the plants studied also are shown.

The average overhead costs per ton were highest for the premix plants and lowest for the concentrate plants. Total overhead costs averaged $11.53 per ton for the premix plants and $2.41 per ton for the concentrate plants, $5.72 per ton for the complete-feed plants and $3.82 per ton for the retailer-manufacturer plants.

Overhead costs averaged 8 percent of the total cost in the premix plants, 3 percent in the concentrate plants, 6 percent in the complete-feed plants, and 5 percent in the retailer-manufacturer plants. The range in this percentage was greatest among the premix plants and rather uniform among the plants representing the other three types of operation.

The average cost for each type of expense for the three manufacturing plants representing each of the four kinds of operation are shown in table 14. The ranges in these costs among the plants studied also are shown. Overhead administration expenses were highest for the premix plants and lowest for the retailer-manufacturer plants, and averaged $2.14 per ton for all of the plants as a group. The range in this overhead cost was quite large among the plants in each of the four groups; it extended from 16 cents per ton to $6.73 per ton among all 12 of the plants studied.

The overhead cost represented by the salaries of office workers averaged highest for the complete-feed plants and lowest for the concentrate plants. The average overhead expense for depreciation of the office buildings and equipment was highest for the retailer-manufacturer plants and lowest for the concentrate plants. Overhead telephone expenses averaged highest for the complete-feed plants and lowest for the concentrate plants. The overhead costs for travel and entertainment averaged highest for the complete-feed plants and lowest for the concentrate plants. The per ton overhead cost for office supplies averaged highest for the premix plants and lowest for the concentrate plants. The average monthly overhead costs disclosed a strong tendency for the high costs to be associated with low volumes and the reverse (see appendix).

Retailers.--Although the average overhead costs per ton were fairly uniform among the different types of retailers, they were highest for the complete-feed retailers with mixing facilities and lowest for the concentrate retailers without mixing facilities (table 15). The range in these costs was greatest for the premix retailers and smallest for the complete-feed retailers with mixing facilities.

Table 14.--Overhead costs per ton, by type of expense, for the 4 types of feed manufacturing plants, 1955

| Expense item | Premix | | Concentrate | | Complete-feed | | Retail-manufacturing | | All groups |
|---|---|---|---|---|---|---|---|---|---|
| | Average | Range | Average | Range | Average | Range | Average | Range | Average |
| | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars |
| Administration | 5.36 | 3.57- 6.73 | 0.80 | 0.16-1.25 | 1.98 | 0.19-4.23 | 0.41 | 0-1.24 | 2.14 |
| Office workers | 1.69 | 0- 3.79 | .71 | 0-1.17 | 1.86 | 1.06-3.17 | .83 | .49-1.19 | 1.27 |
| Depreciation | .24 | .03- .58 | .02 | 0- .05 | .24 | .19- .33 | .74 | .01-1.83 | .31 |
| Telephone | .15 | .04- .33 | .03 | 0- .06 | .19 | .17- .21 | .17 | .02- .26 | .14 |
| Travel and expense | .10 | .01- .21 | .17 | .02- .14 | .20 | .12- .33 | .10 | 0- .30 | .12 |
| Office supplies | .69 | .06- 1.51 | .06 | 0- .13 | .27 | .11- .49 | .16 | .06- .27 | .30 |
| All other | 3.30 | .26- 9.03 | .64 | .09-1.07 | .96 | .74-1.17 | 1.41 | .58-2.19 | 1.26 |
| Total overhead expense | 11.53 | 8.05-17.75 | 2.41 | .31-3.55 | 5.72 | 4.38-7.24 | 3.82 | 2.05-6.85 | 5.87 |
| | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons |
| Volume | 2 | 2 - 3 | 25 | 16 - 35 | 30 | 5 - 78 | 8 | 5 - 10 | --- |



Table 15.--Volume handled and overhead costs for the classes of feed retailers studied, 1955

| Item | Plants | Annual volume | | Overhead cost per ton | |
|---|---|---|---|---|---|
| | | Average | Range | Average | Range |
| | Number | Tons | Tons | Dollars | Dollars |
| Retailers who mix: | | | | | |
| Premix | 7 | 1,504 | 140-3,052 | 3.08 | 0.78-6.12 |
| Concentrate | 4 | 913 | 285-1,567 | 3.93 | 2.01-5.54 |
| Complete-feed | 2 | 730 | 300-1,160 | 4.77 | 4.27-5.26 |
| Retailers who do not mix: | | | | | |
| Concentrate | 2 | 771 | 500-1,042 | 3.01 | 2.42-3.60 |
| Complete-feed | 5 | 818 | 70-1,650 | 3.33 | 1.92-5.01 |

Overhead cost averaged 28.2 percent of the total cost (excluding ingredients) to the 7 retailers without mixing facilities and only 14.5 percent of the total cost to the 13 retailers with mixing facilities. The differences in these percentages between the groups of retailers is explained by the higher total costs to the retailers who mixed feed rather than by differences in the average total overhead costs between the two groups. Overhead costs averaged about 14 percent of the total cost to the premix retailers and concentrate retailers with mixing facilities, and 17 percent of the total cost to the complete-feed retailers with mixing facilities. These overhead costs averaged 27.8 percent of the total cost to the concentrate dealers without mixing facilities and 28.3 percent of the total cost to the complete-feed dealers without mixing facilities. Fairly wide ranges were exhibited in these percentages among the retailers of all five classes.

## Causes of Variation in Overhead Costs

Many of the overhead expenses are a fixed cost which must be maintained at least at some minimum level even with little or no output. Because of this, one expects to find an inverse relationship between the volume of output and total per unit overhead costs. Such a relationship was found in this study for feed manufacture and distribution, both at the manufacturing level and at the retailing level. The manufacturer's overhead costs also were found to be inversely related to the volume of other departments conducted by the feed company. The exact magnitude of these relationships is not conclusive because the number of observations was limited and the observations were not selected randomly. But the relationships found are indicative of the quantitative influences of volume upon the total overhead cost per ton of manufacturing and distributing feed.

Manufacturers.--The factors examined for possible relationships to total per ton overhead costs to the feed manufacturers were the same factors examined for possible relationships to the direct production costs for these companies. They include the volume of feed manufactured, volume of other kinds of feed manufactured, volume of ingredients merchandised, the size of the total plant operation in addition to the feed department, the percentage of output in bulk, and the percent of output pelleted. The average value for these factors and for per ton overhead costs together with the ranges in these costs for the three plants in each of the four groups are shown in table 16. The deviations of the overhead costs per ton for each manufacturer from the per ton budgeted overhead costs for that type of operation were determined and used in the analysis in lieu of the actual per ton overhead costs. The averages and ranges of these deviations are shown on the second line of table 16. This procedure was followed in order to make the overhead costs more directly comparable from one type of operation to another.

The deviations from the budgeted total overhead costs per ton for the feed manufacturing plants studied were found to be related to the adjusted annual volume, the tons merchandised by the feed department, and the percentage of the total plant operation represented by the feed department. No apparent relationships were found between these deviations in overhead cost per ton and the

Table 16.--Overhead costs and related variables for the feed manufacturing companies, 4 types of organization, 1955

| Item | Premix | | Concentrate | | Complete-feeds | | Retail-manufacturing | |
|---|---|---|---|---|---|---|---|---|
| | Average | Range | Average | Range | Average | Range | Average | Range |
| | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars |
| Overhead cost per ton | 11.53 | 8.05- 17.75 | 2.41 | 0.31- 3.55 | 5.72 | 4.38- 7.24 | 3.82 | 2.05- 6.85 |
| Deviation from budgeted cost per ton | +2.90 | -.70- +9.37 | -0.99 | -3.09- 0.15 | +2.32 | +.98 +3.84 | -.43 | -1.69 +2.60 |
| Budgeted overhead costs: | | | | | | | | |
| Per ton mixed | 8.75 | | 3.40 | | 3.40 | | 4.25 | |
| Per ton complete-feed | .66 | | 1.87 | | 3.40 | | 4.25 | |
| | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons |
| Volume mixed | 2 | 2 - 3 | 25 | 16 - 35 | 30 | 5 - 78 | 8 | 5 - 10 |
| Equivalent in complete-feed | 26 | 21 - 33 | 46 | 29 - 63 | 30 | 5 - 78 | 32 | 18 - 39 |
| Volume of other feeds manufacturing | 16 | 0.5 - 35 | 1 | 2 - 3 | 0.9 | 1 - 2 | 0.02 | 0 -.07 |
| Volume merchandised | 2 | 0 - 5 | 5 | 1 - 7 | 3 | 0.1 - 8 | 2 | 0.9 - 4 |
| | Percent | Percent | Percent | Percent | Percent | Percent | Percent | Percent |
| Feed operation as percentage of total operation | 65 | 30 - 95 | 75 | 43 - 95 | 98 | 95 - 100 | 73 | 40 - 100 |
| Percentage sold in bulk | 0 | 0 | 8 | 3 - 14 | 1 | ½ - 2 | 17 | 10 - 23 |
| Percentage pelleted | 0 | 0 | 83 | 76 - 92 | 86 | 65 - 98 | 70 | 38 - 96 |

volume of other feed manufactured, the percent of the feed sold in bulk, or the percentage of the feed pelleted.

The total per ton overhead costs were found to: 10/

1. Decrease $0.042 with each 1,000-ton increase in the adjusted annual production.

2. Decrease $0.23 with each 1,000-ton increase in the volume of ingredients sold as is.

3. Increase $0.029 with each 1-percent increase in the proportion of the total operation represented by the feed department.

The net effects of each of these variables on the overhead costs per ton to the feed manufacturers as indicated by the three coefficients are shown in figure 2.

The lines in figure 2 represent the average overhead cost for all four types of operation. Their slopes (the magnitude of the relationships) are identical for all four types of operation, but the level of the lines would be different for each individual type of operation because of the differences among them in the average value of the variables found to affect per ton overhead costs. 11/

The monthly costs per ton of total overhead expenses for the feed manufacturing plants studied were considerably lower in months when total production was higher, as one would expect. The average overhead costs per ton varied from month to month for the manufacturing plants in all four groups (see appendix).

Retailers.--One important factor affecting total overhead costs per ton of feed handled by retailers is the annual volume handled. Table 17 shows the average overhead cost per ton for the retailers studied, by volume groups, both for those with mixing facilities and for those without mixing facilities. The last line of the table shows that there was only 35 cents difference between the averages of these costs for retailers with mixing facilities and those without them.

But a very definite relationship is evident in table 17 between annual volume for the retailers and their average overhead cost per ton. This cost averaged $4.38 per ton for the five retailers with volumes of 500 tons and under

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10/ The relationships were determined by graphic correlation analysis from the deviations from the budgeted per ton overhead costs, the tonnage of complete feed manufactured, the volume of feed ingredients merchandised by the feed department, and the percentage of the total company operation represented by the feed department.

11/ Both the direction and the magnitude of the relationships shown by the overhead cost lines in figure 2 seem reasonable. However, it must be remembered that they are based on a limited number of case-study plants and need to be tested by further research.

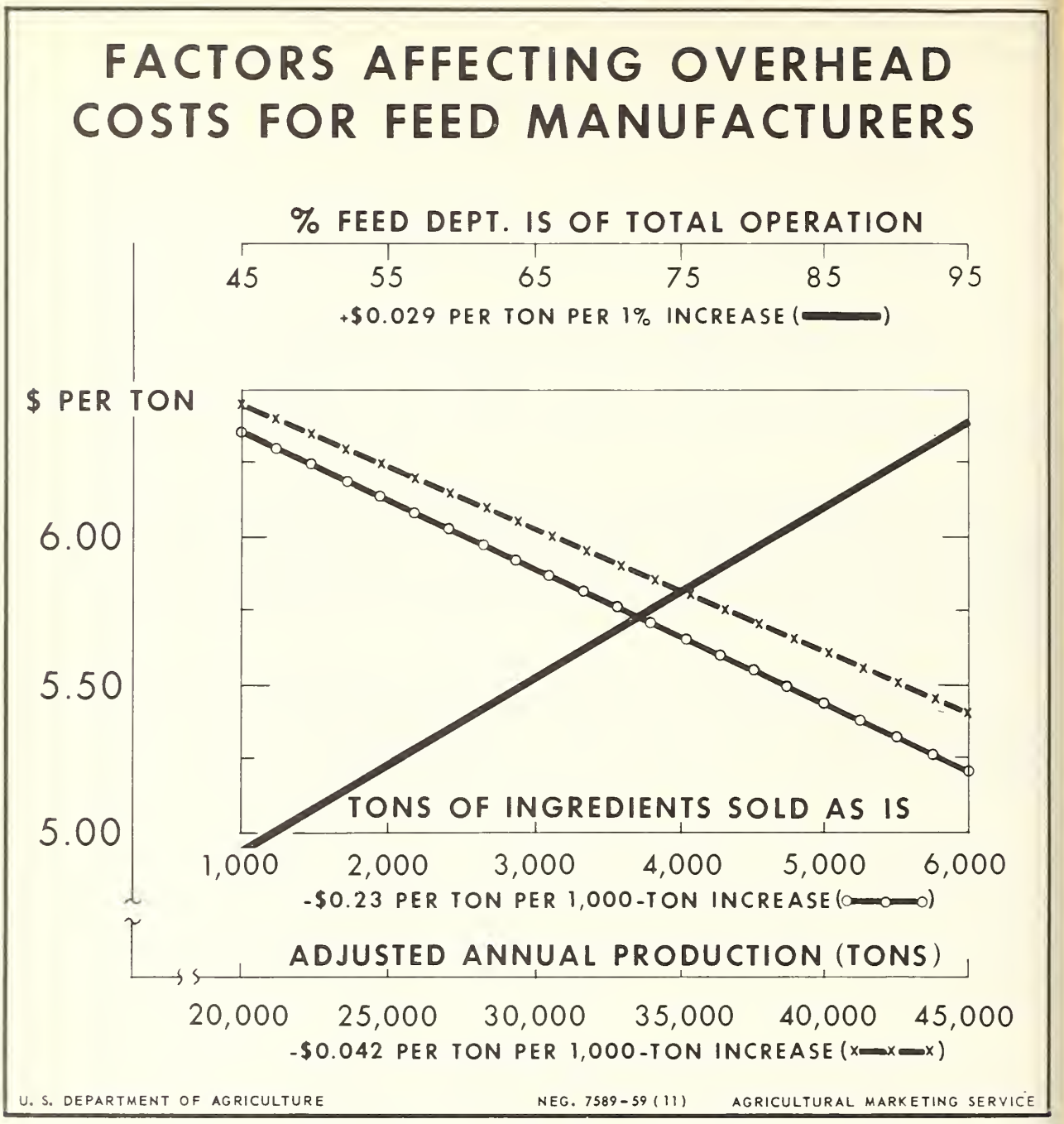
FACTORS AFFECTING OVERHEAD COSTS FOR FEED MANUFACTURERS
% FEED DEPT. IS OF TOTAL OPERATION
45
55
65
75
85
95
+$0.029 PER TON PER 1% INCREASE
$ PER TON
6.00
5.50
5.00
TONS OF INGREDIENTS SOLD AS IS
1,000
2,000
3,000
4,000
5,000
6,000
-$0.23 PER TON PER 1,000-TON INCREASE
ADJUSTED ANNUAL PRODUCTION (TONS)
20,000
25,000
30,000
35,000
40,000
45,000
-$0.042 PER TON PER 1,000-TON INCREASE
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Figure 2

Table 17.--Overhead cost per ton and number of feed retailers with and without mixing facilities by annual volume handled, 1955

| Annual volume in tons | Retailers with mixing facilities | | Retailers without mixing facilities | | All retailers | |
|---|---|---|---|---|---|---|
| | Number | Average cost per ton | Number | Average cost per ton | Number | Average cost per ton |
| | Number | Dollars | Number | Dollars | Number | Dollars |
| Less than 500 | 3 | 4.83 | 2 | 3.71 | 5 | 4.38 |
| 501 - 1,000 | 3 | 3.72 | 2 | 3.87 | 5 | 3.78 |
| 1,000 - 1,500 | 2 | 4.11 | 2 | 2.76 | 4 | 3.43 |
| 1,501 - 2,000 | 3 | 3.26 | 1 | 1.98 | 4 | 2.94 |
| Over 2,000 | 2 | 1.54 | | | 2 | 1.54 |
| Total | 13 | 3.59 | 7 | 3.24 | | |

down to $1.54 per ton for the two retailers with mixed feed volumes of over 2,000 tons per year. Although there are a couple of exceptions between individual brackets, this same relationship between overhead costs per ton and volume is apparent for the separate averages shown in table 17 for the retailers with mixing facilities and those without mixing facilities.

Graphic correlation was used to determine the approximate magnitude of the relationship between annual volume and overhead costs per ton among the 20 retailers studied. The approximate relationship found was: 12/

$$(3)\quad Y = 5.00 - .0014\ T,$$

where Y is the total overhead cost in dollars per ton and T is the volume of feed sold in tons per year.

On the basis of the relationship in equation (3), the computed total annual overhead cost for feed retailers would be $4.30 per ton at an annual sales volume of 500 tons and $2.90 per ton at an annual sales volume of 1,500 tons. Although this relationship should not be interpreted as conclusive, it seems reasonable as to both direction and magnitude. It certainly indicates a very substantial reduction in overhead costs per ton to feed retailers as their annual volume of feed sales is increased.

## Budgeted Overhead Costs for the Four Types of Operation

The budgeted total overhead cost per ton to the manufacturers is $8.75 per ton for the premix operation, $3.40 per ton for both the concentrate and the complete-feed operation and $4.25 per ton for the retailer-manufacturer operation (table 18). These figures reflect the smaller output for the premix manufacturers and the retailer-manufacturers as compared to that of the other two types of manufacturers as well as differences in the nature of the operations among the different types of manufacturers.

These budgeted total overhead costs per ton may be compared to the averages of these costs for the manufacturers representing the four types of operation which are shown on the first two lines of table 16. The average overhead cost for the three premix plants is $2.78 more than the budgeted overhead cost for this type of operation largely because of one premix plant which had the abnormally high overhead cost of $17.75 per ton. On the other hand, the average overhead cost for the three concentrate plants is 99 cents below that budgeted for this type of operation because of one concentrate plant which had the abnormally low total overhead cost of 31 cents per ton. All three of the complete-feed manufacturers had per ton overhead costs which were higher than that budgeted for this type of operation. But because of the relatively large annual volume for complete-feed manufacturers, their per ton overhead costs ordinarily should not be more than those for concentrate manufacturers. As

12/ This formula was used to budget costs at annual volumes of 500 and 1,700 tons per year. It should not be extended and used for predicting costs for an unlimited range of operating volumes.

Table 18.--Budgeted overhead costs per ton for feed manufacturers and retailers, 4 types of organization

| Type of organization | Manufacturers | | | | | | | | Retail total | Overall total | Retail as percentage of overall |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Supervision | Labor | Depreciation | Telephone | Postage and printing | Travel and entertainment | All other | Total | | | |
| | Dol. | Dol. | Dol. | Dol. | Dol. | Dol. | Dol. | Dol. | Dol. | Dol. | Pct. |
| Premix: | | | | | | | | | | | |
| Mix | 4.55 | 1.40 | 0.26 | 0.09 | 0.09 | 0.17 | 2.19 | 8.75 | | | |
| Equivalent complete-feed 1/ | .34 | .11 | .02 | .01 | .01 | .01 | .16 | .66 | 3.29 | 3.95 | 83 |
| Concentrate: | | | | | | | | | | | |
| Mix | .85 | .85 | .17 | .10 | .07 | .14 | 1.22 | 3.40 | | | |
| Equivalent complete-feed 1/ | .47 | .47 | .09 | .06 | .04 | .07 | .67 | 1.87 | 3.29 | 5.16 | 64 |
| Complete-feed 1/ | .85 | .85 | .17 | .10 | .07 | .14 | 1.22 | 3.40 | 3.29 | 6.69 | 49 |
| Retail-manufacturing 1/ | 1.06 | 1.06 | .21 | .13 | .09 | .17 | 1.53 | 4.25 | 0 | 4.25 | 0 |

1/ On 40,000-ton equivalent.

Table 19.--Annual volume of feed produced and actual and budgeted research costs, 4 types of manufacturers

| Item | Premix | | Concentrate | | Complete-feed | | Retail-manufacturing | |
|---|---|---|---|---|---|---|---|---|
| | Average | Range | Average | Range | Average | Range | Average | Range |
| Volume produced ..... 1,000 tons | 2 | 2 - 3 | 25 | 16 - 35 | 30 | 5 - 78 | 8 | 5 - 10 |
| Actual research cost per ton mixed ..... dollars | 2.82 | 0.95 - 5.28 | .50 | 0 - 1.00 | .28 | 0 - 0.85 | .13 | 0 - 0.27 |
| Budgeted research cost: | | | | | | | | |
| Per ton mixed ..... dollars | 4.00 | --- | 1.00 | --- | 1.00 | --- | 0.15 | --- |
| Per ton equivalent complete-feed 1/ ..... dollars | .30 | --- | .55 | --- | 1.00 | --- | .15 | --- |

1/ Budgeted to 40,000 tons at the retail level.

budgeted, the overhead costs per ton are identical for complete-feed manufacturers and concentrate manufacturers. The observed per ton overhead costs for the three retailer-manufacturers ranged uniformly above and below the budgeted cost for this type of operation even though the average for the group was 43 cents per ton below the budgeted cost.

These same budgeted costs computed on the basis of the tons of complete feed made from the premix and concentrate are shown in table 18 for the premix and the concentrate operation. It will be noted that while the per ton expense for all these items to the manufacturer is higher for the premix operation, on the basis of the tonnage of the final feed output they are lower for the premix operation than for the concentrate operation. It also will be noted that these expenses per ton of final feed output are lower for both the premix and the concentrate operations than for the complete-feed manufacturer and the retailer-manufacturer.

The budgeted total per ton overhead costs incurred at the retail level under the four types of operation also are shown in table 18. 13/ The budgeted total overhead cost is $2.62 per ton for the 1,700-ton retailers under all three types of operation. And because of their relatively small volume over which to spread total overhead cost, these costs are budgeted at $4.30 per ton for the 500-ton retailers. The weighted average of these two per ton costs makes a budgeted total overhead cost at the retail level of $3.29 per ton of feed sold by all three types of retailers.

Table 18 also shows the combined total budgeted overhead cost per ton for manufacturers and retailers. This cost is substantially highest for the complete-feed operation and lowest for the premix operation.

These figures measure the relative efficiency of the four types of operation with respect to total overhead costs, since the volume, type, and quality of the feed delivered to farmers is identical under the four budgeted operations. The total overhead cost per ton of the final feed to the farmer is lowest for the premix operation because of the percentage of the total tonnage produced at the central company level is so small that the overhead costs at this level amount to only 66 cents per ton of the final complete feed (table 18). Retailing accounted for 83 percent of the total overhead cost under this type of operation. The total per ton overhead cost for the retailer-manufacturer operation is relatively low because only one company is maintained for both manufacture and retailing under this type of operation. The total per ton overhead cost is highest for the complete-feed operation, because a total volume of 40,000 tons is handled both by the manufacturer and the retailers. Even though the retailers only merchandise the feed, they do not gain sufficient economies in overhead to offset the relatively high total overhead cost to the manufacturer for this type of operation. The retailers account for 49 percent of the total overhead cost even under this type of operation.

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13/ These costs are based on 60 percent of the total volume handled by retailers doing an annual volume of 1,700 tons each and 40 percent of the total volume handled by retailers doing an annual volume of 500 tons each.

## COSTS OF RESEARCH, EXPERIMENTATION, AND FORMULA DEVELOPMENT

Research, experimentation, and formula development represent a unique function and give rise to a separate class of costs in feed companies. These costs include the salaries of any research people maintained on the company's payroll, either on a full-time or a part-time basis. They include the cost of maintaining and using a laboratory for testing feeds or the fees paid for having feed samples tested by a commercial agency. But the big expense usually is the net cost to the company of the proving farm or farms where livestock are maintained for testing feeds, management practices, and so on. These farms frequently are used as demonstration farms also, and have some value for feed sales promotion. Although an income is realized from the sale of livestock from such farms, it is ordinarily not large enough to cover the total costs to the company of operating the proving farm.

### Research Costs in the Plants Studied

The average total costs of research and formula development for the case-study manufacturers were computed from these cost figures for each of the plants studied (table 19). The average costs per ton for research and formula development were highest for the premix plants and lowest for the retailer-manufacturer plants. The plants in all four groups exhibited a fairly wide range around these averages.

Research costs averaged 1.87 percent of the total cost in the premix plants, 0.56 percent in the concentrate plants, 0.29 percent in the complete-feed plants, and 0.16 percent of the total cost (including ingredient costs) in the retailer-manufacturer plants.

No attempt was made to analyze quantitatively the causes for the differences in research cost among the 12 manufacturing plants studied. These differences are caused primarily by the attitude and policies of management in the various companies. In some cases, management feels that a company-owned proving farm is a necessity even though its costs are high and the volume of the plant may not justify it. Sometimes management feels that a proving farm is an essential part of the company's sales program for tours, demonstrations, salesmen's meetings and so on. For these reasons, total research costs are likely to be higher in feed companies that have relatively high gross sales returns. But when management of the feed company is cost conscious, feed-testing arrangements may be made with individual customers to avoid the cost of a proving farm and help keep total research costs down.

Generally the retailer-manufacturer plants spend a good deal less on research and proving-farm expenses than do the large feed manufacturers. They depend largely upon companies supplying premixes and public research institutions for research on feed formula development.

## Budgeted Research Costs for the Four Types of Operation

The budgeted research cost per ton of output by the manufacturers is $4.00 for the premix operation, $1.00 per ton for the concentrate operation, $1.00 per ton for the complete-feed operation, and 15 cents per ton for the retailer-manufacturer operation (table 19). The premix company must do research and testing not only of the premix formulas themselves, but likewise of the feeds made by the retailer from the premixes. Consequently, the total research cost when based only on the volume of the premix manufactured is substantially higher for this type of operation than for the others. The retailer-manufacturer companies do less formula and nutrition research than the other types of companies, so that their per ton total research costs are smaller.

These budgeted costs for research may be compared to the actual research costs for the plants of each type of operation (table 19). While the budgeted costs are slightly higher than the actual costs in all four cases, they are within the range of this cost among the plants representing each type of operation except the complete-feed plants. The averages for all four types of operation are pulled down by one plant in each group which had little or no research cost. These plants are not reflected in the budgeted research cost shown.

The last line of table 19 shows the total research cost per ton of the comparable final feed delivered to farmers under the four types of operation.

# SELLING COSTS

Selling and advertising efforts represent an essential function in the mixed-feeds industry, both for the manufacturing companies and for the retail outlets. Those concerned with the management of both feed companies and retail feed outlets are justifiably concerned about the most profitable level of total sales costs to the business. Some companies incur relatively large sales costs on the grounds that this is the best way to achieve the volume necessary for efficient operations. Others incur a minimum total sales cost on the grounds that the costs saved permit a lower selling price of the mixed feed, which in turn brings the volume needed for efficient operations. Many companies follow a sales policy somewhere between these two extremes. Research specifically directed toward defining the best policy for feed companies in this regard would be of great value to the industry and ultimately to the farmers who furnish much of the raw products and use virtually all of the final output of the mixed feeds industry.

## Sales Costs in the Plants Studied

Feed manufacturers:--The average sales cost per ton ranged from $28.35 per ton for the premix plants to $4.59 per ton for the retailer-manufacturer plants. A substantial range in the total per ton sales cost was found among the plants of all four types of operation (table 20).

Table 20.--Sales expenses per ton by type of expense for the feed manufacturing plants, by type of organization, 1955

| Expense item | Premix | | Concentrate | | Complete-feed | | Retail-manufacturing | | All groups |
|---|---|---|---|---|---|---|---|---|---|
| | Average | Range | Average | Range | Average | Range | Average | Range | Average |
| | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars |
| Supervision | 1.71 | 0- 4.47 | 0.44 | 0.34-0.62 | 0.36 | 0-0.99 | 0 | 0- 0 | 0.63 |
| Salesmen | 13.87 | 1.25-36.83 | 2.24 | .13-4.88 | 2.71 | 2.08-3.93 | 1.73 | .16-4.56 | 5.14 |
| Travel and meetings | 2.96 | .32- 7.96 | .51 | .07-1.12 | 1.42 | 1.17-1.82 | .15 | .09- .19 | 1.26 |
| Bad debts | .12 | 0- .36 | .20 | 0- .60 | .24 | .19- .27 | .27 | 0- .80 | .21 |
| Telephone | .24 | 0- .56 | .09 | .07- .11 | .13 | 0- .21 | .19 | 0- .58 | .17 |
| Advertising | 7.05 | 2.23-12.83 | .95 | .08-1.39 | 1.08 | .64-1.69 | 1.83 | 1.13-3.03 | 2.73 |
| All others | 2.38 | 1.71- 2.85 | .34 | .09- .53 | .29 | .11- .47 | .41 | .02- .88 | .85 |
| Total | 28.35 | 6.17-59.16 | 4.77 | .78-9.22 | 6.16 | 4.83-7.55 | 4.59 | 1.80-7.66 | 10.97 |
| | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons | 1,000 tons |
| Volume | 2 | 2 - 3 | 25 | 16 - 35 | 30 | 5 - 78 | 8 | 5 - 10 | --- |



Table 21.--Annual volume, and average selling and advertising costs for the classes of feed retailers studied, 1955

| Item | Plants | Annual volume per plant | | Total selling cost per ton | | Advertising cost per ton | |
|---|---|---|---|---|---|---|---|
| | | Average | Range | Average | Range | Average | Range |
| | Number | Tons | Tons | Dollars | Dollars | Dollars | Dollars |
| Retailers who mix: | | | | | | | |
| Premix | 7 | 1,504 | 140-3,052 | 0.97 | 0.19-1.76 | 0.58 | 0.17-1.57 |
| Concentrate | 4 | 913 | 285-1,567 | 2.25 | .83-2.89 | .84 | .44-1.28 |
| Complete-feed | 2 | 730 | 300-1,160 | 1.21 | .98-1.43 | 1.16 | 1.00-1.31 |
| Retailers who do not mix: | | | | | | | |
| Concentrate | 2 | 771 | 500-1,042 | 1.25 | .60-1.89 | .26 | .20- .32 |
| Complete-feed | 5 | 818 | 70-1,650 | .95 | .84-1.05 | .51 | .07-1.18 |

Sales costs represented an average of 20 percent of total costs to the premix manufacturers, 6 percent for the concentrate manufacturers, 7 percent for the complete-feed manufacturers, and 6 percent for the retailer-manufacturer operation.

The average sales cost for each type of expense for the three manufacturing plants representing each of the four kinds of operation is also shown in table 20. The two most important sale expense items for the plants are salesmen's salaries and advertising expenses. The averages for all four groups together amount to $5.14 per ton for salesmen's salaries and $2.73 per ton for advertising expenses.

The monthly average total sales costs in the premix plants varied from $6.17 to $59.16 per ton. Average monthly total sales costs varied from $0.78 to $9.22 per ton for the concentrate plants, from $4.83 to $7.55 per ton for the complete-feed plants, and from $1.80 to $7.66 per ton for the retailer-manufacturer plants. Again there is a tendency for the low cost to be associated with the larger volume months and the reverse (see appendix).

Feed retailers:--Selling costs per ton averaged highest ($2.25) for the concentrate retailers with mixing facilities and lowest ($0.95) for the complete-feed retailers without mixing facilities (table 21). The range in this cost also was greatest among the concentrate dealers with mixing facilities and smallest among the complete-feed retailers without mixing facilities.

Total advertising costs per ton averaged highest ($1.16) for the complete-feed retailers with mixing facilities and lowest (26 cents) for the concentrate retailers without mixing facilities (table 21). The range in this cost was greatest among the premix dealers and smallest among the concentrate dealers without mixing facilities.

The proportion of the total cost represented by selling costs was 4 percent for the premix retailers, 8 percent for the concentrate dealers with mixing facilities, 12 percent for the concentrate dealers without mixing facilities, 4 percent for the complete-feed dealers with mixing facilities, and 8 percent for the complete feed dealers without mixing facilities. The proportion of the total cost represented by advertising cost averaged 3 percent for the premix retailers, 3 percent for the concentrate dealers with mixing facilities, 2 percent for the concentrate dealers without mixing facilities, 4 percent for the complete-feed dealers with or without mixing facilities. Wide ranges in both percentages were exhibited among the retailers in almost all classes.

## Variations in Total Sales Costs

The level of the total sales cost to a feed company is largely determined by the selling and advertising policies of that company. Optimum sales efficiency certainly is not measured by a minimum total sales cost. Rather, the most efficient sales program is one which returns the company the greatest additional revenue through increased sales volume in relation to the total

cost of the selling and advertising program. This study was not designed to define the most efficient feed sales program in this sense. However, a related phase of the study does shed some light on the question.

In a related phase of the study, Dr. J. T. Scott applied a general linear program to resource allocation and profit maximization within an individual company. 14/ The coefficients for both production and market used in the analysis were obtained from the actual records of the feed company and from the best estimates of top managerial personnel in the company. The solution on the basis of these coefficients indicated that by far the most productive activity in the company was field sales effort. Feed salesmen were worth $25.20 per hour to the company in terms of increased profit. 15/ By contrast, the next most productive input was worth only $5.01 per unit to the company in increased profit.

Scott's linear program solution indicated an increase of 315 tons per month in total volume was advisable in this feed company. It called for an increase in sales volume of 28 feeds, a decrease in sales volume of 13 feeds, with the sales volume of 3 feeds remaining unchanged. The program solution indicated that the feed company's net earnings would be more than doubled by the plan indicated.

The high marginal productivity of sales efforts is of particular significance. The solution indicates that profits could have been raised still more by additional sales effort (provided that additional salesmen with productivities equal to that of present salesmen could be employed for anything less than $25.20 per hour). If salesmen could be employed at $5.00 per hour, each additional hour of sales contacts would have added $20.20 to the net earnings of the feed company. 16/

While this analysis is applicable in the narrow sense only to the specific company whose operation was programmed, it is indicative of the relative importance of sales expenditures to feed companies generally. This is logical, too, in view of the excess feed manufacturing capacity of many companies in the industry and the lower per unit costs and higher net returns that come with increased sales volume. 17/

The per ton selling and advertising costs for the retailers studied indicate a slight inverse relationship to the volume of feed sales by the retailers. Table 22 shows the average per ton selling cost for the retailers studied

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14/ Scott, J. T. Application of Linear Programming for Profit Maximization in the Feed Firm. Unpublished Ph. D. dissertation. Iowa State College Library, Ames, Iowa, 1957.

15/ Strictly this is true only at the margin, that is, the first additional hour of sales contact added.

16/ See footnote 15.

17/ Further research in this area would be indeed valuable. It seems probable that an experimental design for different levels of total sales expenditure and different types of sales efforts in different localities for a particular feed company would be the most fruitful approach. A proper design that would permit a refined analysis of variance should then enable the researcher to evaluate alternative sales programs and arrive at significant conclusions.

Table 22.--Selling and advertising costs per ton for feed retailers with and without mixing facilities, by annual volume handled, 1955

| Volume in tons | Retail selling costs | | | Retail advertising costs | | |
|---|---|---|---|---|---|---|
| | With mixing facilities | Without mixing facilities | Total | With mixing facilities | Without mixing facilities | Total |
| | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars |
| Less than 500 | 1.46 | 1.44 | 1.45 | 1.11 | 0.24 | 0.76 |
| 501 - 1,000 | 1.84 | .86 | 1.45 | .93 | .66 | .82 |
| 1,001 - 1,500 | 1.94 | .82 | 1.38 | .88 | .59 | .73 |
| 1,501 - 2,000 | 1.20 | .97 | 1.14 | .44 | .07 | .34 |
| Over 2,000 | .43 | | .43 | .26 | | .26 |
| Total | 1.40 | 1.03 | | .75 | .44 | |



Table 23.--Budgeted selling costs per ton for manufacturers and retailers, for the 4 types of organization

| Item | Manufacturers | | | | | | | | Retail: total | Overall: total | Retail as percentage of overall |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Super-vision | Salesmen's salaries | Travel and meetings | Bad debts | Tele-phone | Adver-tising | All other | Total | | | |
| | Dol. | Dol. | Dol. | Dol. | Dol. | Dol. | Dol. | Dol. | Dol. | Dol. | Pct. |
| Premix: | | | | | | | | | | | |
| Per ton premix | 1.40 | 7.00 | 1.80 | 0.20 | 0.60 | 4.00 | 5.00 | 20.00 | --- | --- | --- |
| Per ton of complete feed 1/ | .11 | .53 | .13 | .01 | .05 | .30 | .37 | 1.50 | 1.91 | 3.41 | 56 |
| Concentrate: | | | | | | | | | | | |
| Per ton concentrate | .35 | 1.75 | .45 | .05 | .15 | .75 | 1.50 | 5.00 | --- | --- | --- |
| Per ton of complete feed 1/ | .19 | .96 | .25 | .03 | .08 | .41 | .83 | 2.75 | 1.91 | 4.66 | 41 |
| Complete-feed: | | | | | | | | | | | |
| Per ton 1/ | .29 | 1.70 | .44 | .05 | .14 | .73 | 1.50 | 4.85 | 1.91 | 6.77 | 28 |
| Retail-manufacturing: | | | | | | | | | | | |
| Per ton 1/ | .58 | 2.89 | .74 | .08 | .25 | 1.24 | 2.47 | 8.25 | --- | 8.25 | --- |

1/ On 40,000-ton equivalent.

ranged from $1.45 for retailers with annual volumes of 1,000 tons and less to $0.43 for those with more than 2,000 tons. Although not so clearly evident as for total selling costs, the same general inverse relationship is indicated for retailers with and without mixing facilities.

A negative relationship was also found between volume of sales and the per ton advertising costs for the two types of retailers. For all of the retailers, advertising costs ranged from an average of $0.82 per ton for those with volumes between 500 and 1,000 tons, to $0.26 per ton for those with volumes of more than 2,000 tons.

Graphic correlation was used to determine the indicated relationships between annual volume and per ton selling costs and between annual volume and per ton advertising costs among the retailers studied. The approximate relationships are: 18/

$$(4)\quad Y = 1.50-.0002\ T,$$

where Y is the total selling cost in dollars per ton and T is the volume of feed sales in tons per year and

$$(5)\quad Y = .90-.0002\ T,$$

where Y is the total advertising cost in dollars per ton and T is again the volume of feed sales in tons per year.

On the basis of these formulas, the computed costs to retailers when annual sales are 500 tons would be $1.40 per ton for selling costs and 80 cents per ton for advertising costs. At an annual volume of 1,500 tons sales costs would be $1.20 per ton and advertising costs would be 60 cents per ton.

## Budgeted Sales Costs for the Four Types of Operation

The budgeted total per ton sales cost to the manufacturers is $20 for the premix operation, $5 for the concentrate operation, $4.85 for the complete-feed operation, and $8.25 for the retailer-manufacturer operation (table 23). These figures may be compared to the actual sales costs per ton for the plants representing each of the four types of operation which are shown on the next to the last line of table 20. The average actual cost for the premix plants is $8.35 per ton higher than the budgeted figure for this type of operation largely because of the one premix plant with the very high total sales cost figure of $59.16 per ton. The average actual cost for the concentrate plants is 23 cents lower than the budgeted figure for this type of operation, but the budgeted figure is well within the range among the plants of this group in total per ton sales cost. The budgeted figure for the complete-feed plants also is within the range of these costs found among the complete-feed plants studied, even

18/ These formulas were used to budget costs at annual volumes of 500 and 1,700 tons per year. They should not be extended and used for predicting costs for an unlimited range of operating volumes.

though it is $1.31 per ton lower than the average sales cost for these plants. The budgeted per ton total sales cost for the retailer-manufacturer operation deserves special explanation since it is $3.66 higher than the average for the three retailer-manufacturer plants studied and 59 cents higher than that in the plant which had the highest total sales cost. The budgeted figure is $8.25 per ton to make the retailer-manufacturer operation (when the one company must do both the central company and the retail selling and advertising) comparable to the other types of operation in total advertising and sales effort expended.

The budgeted sales supervision costs to the manufacturers ranges from $1.40 per ton for the premix operation, to 29 cents per ton for the complete-feed operation.

Salesmen's salaries are the biggest single sales expense for the manufacturers of all four of the operations budgeted. Total budgeted advertising expenses come to $4.00 per ton for the premix manufacturer, 75 cents per ton for the concentrate manufacturer, 73 cents per ton for the complete-feed manufacturer, and $1.24 per ton for the retailer-manufacturer operation.

For comparative purposes, the costs per ton of complete feed manufactured by retailers from the manufacturers' premix and concentrate for each of the classes of sales expenses are shown in table 23 for the premix and concentrate manufacturers. The manufacturers' total sales cost amounts to $1.50 per ton of the complete feed made by retailers from the premix and to $2.75 per ton of the complete feed produced by retailers from the concentrate.

The budgeted sales cost is $1.72 per ton for the 1,700-ton retailers under all three types of operation. 19/ And because of their relatively small volume, the sales cost is budgeted at $2.20 per ton for the 500-ton retailers. The weighted average of these two costs makes a budgeted total sales cost at the retail level of $1.91 per ton by all three types of retailers (table 23).

The next to last column in table 23 shows the combined budgeted sales cost for manufacturers and retailers. This cost is substantially highest for the retailer-manufacturer operation and substantially lowest for the premix operation.

These figures at least approximately measure the relative efficiency of the four types of operation with respect to total sales costs. The volume, type, and quality of the feed delivered to farmers is identical under the four budgeted operations. The total selling and advertising effort is budgeted for comparability among the four types of operation. As budgeted, the premix operation has the greatest comparative sales cost advantage, followed in order by the concentrate operation and the complete-feed operation.

19/ These costs are based on 60 percent of the total volume handled by retailers doing an annual volume of 1,700 tons each and 40 percent of the total volume handled by retailers doing an annual volume of 500 tons each.

The main factors affecting the total costs of outbound transportation of mixed feeds are the distance from the feed plant to the retailer, the distance from the retailer to the customer, and the percentage of the complete feed formula added by the retailer, if any. The distance from the feed plant to the retailer is partly a matter of how well the feed plant is located with respect to the dealer outlets. But it is partly a matter of the type of operation also, since premix manufacturers have to reach out over a larger area to obtain an economic operating volume due to the concentrated nature of the product. A concentrate manufacturer has to reach out farther than a complete-feed manufacturer, other things being equal. The complete-feed independent manufacturer has to reach out farther than a retail outlet, but not so far as manufacturers selling through dealers. This is borne out by the distribution pattern actually experienced by the plants in the four different groups studied (see tables 24 and 25).

The percentage of the complete feed added by the retailer is solely a function of the concentration of the feed manufactured and sold to retailers by the feed company. Under the premix operation, only the "trace" ingredients in the mixed feed are transported from the manufacturer to the retailer. At the other extreme, under the complete-feed operation the complete formula (including farm grain) is transported from the manufacturer to the retailer. Of course, under the independent manufacturer-retailer operation, no transportation of the formula feed from the manufacturer to the retailer is required at all.

## Feed Transportation Costs in the Plants Studied

The average distribution pattern of feed sales found for the three case-study plants under each of the four types of operation and for the six retailers under each of the three types of operation involving them is shown in tables 24 and 25. The percentages of total volume hauled for each distance zone from each group of manufacturers are the simple averages for the individual plants studied. The same was done for retailers. The figures in each cell for the average of all manufacturers are the simple averages of the averages for the four groups; the averages of all retailers are the simple averages of the averages for the three groups.

The average distribution pattern was most widespread geographically for the premix operation and the least so for the complete-feed operation. The most closely knit total distribution pattern of all was for the retailer-manufacturer operation.

The average volume of mixed feed transported and the average transportation cost, by distance zones, from manufacturers to retailers for the four types of operation are given in table 26. These figures are the simple averages for the plants studied in each group. The transportation costs for each plant were computed from that plant's volume-distance distribution pattern by means of the equation (6), 1.6065 + .0241d. 20/ They do not represent the actual

20/ See page 53.

Table 24.--Percentage distribution by mileage zones, of feed transported from plants of the 4 types of manufacturers

| Type of organization | Mileage zones | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Less than 25 | 26-50 | 51-75 | 76-100 | 101-125 | 126-150 | 151-175 | 176-200 | 201-225 | 226-250 | Over 250 |
| | Percent | Percent | Percent | Percent | Percent | Percent | Percent | Percent | Percent | Percent | Percent |
| Premix | 22.07 | 5.50 | 4.00 | 5.67 | 6.47 | 9.87 | 13.03 | 7.83 | 3.73 | 6.23 | 15.60 |
| Concentrate | 17.90 | 32.30 | 20.10 | 14.70 | 3.40 | 3.23 | 1.06 | 1.47 | 1.30 | .99 | 3.57 |
| Complete-feed | 11.67 | 28.20 | 13.53 | 14.70 | 10.23 | 9.74 | 4.13 | 6.13 | .74 | --- | .93 |
| Retail-manufacturing | 59.20 | 36.87 | 3.93 | --- | --- | --- | --- | --- | --- | --- | --- |
| Average | 27.71 | 25.72 | 10.39 | 11.69 | 6.70 | 7.61 | 6.07 | 5.14 | 1.92 | 3.60 | 6.70 |

Table 25.--Percentage distribution by mileage zones, of feed transported from retailers of the 3 types of organization

| Type of retail organization | Mileage zones | | | |
|---|---|---|---|---|
| | Less than 10 | 11-20 | 21-30 | Over 30 |
| | Percent | Percent | Percent | Percent |
| Premix | 65.83 | 19.70 | 10.56 | 3.90 |
| Concentrate | 81.33 | 15.33 | 3.34 | --- |
| Complete-feed | 87.43 | 12.57 | --- | --- |
| Average | 78.20 | 15.87 | 4.63 | 1.30 |

Table 26.--Computed volume and transportation cost per plant of feed transported specified distances, for the 4 types of organization, 1955

| Mileage zones | Premix | | Concentrate | | Complete-feed | | Retailer-manufacturer | | All groups | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantity | Cost | Quantity | Cost | Quantity | Cost | Quantity | Cost | Quantity | Cost |
| | Cwt. | Dol. | Cwt. | Dol. | Cwt. | Dol. | Cwt. | Dol. | Cwt. | Dol. |
| Less than 25 | 7,927 | 761 | 85,353 | 8,193 | 38,633 | 3,708 | 88,367 | 8,482 | 55,070 | 5,286 |
| 26 - 50 | 2,673 | 344 | 145,247 | 18,668 | 115,293 | 14,818 | 62,180 | 7,992 | 81,348 | 10,455 |
| 51 - 75 | 2,580 | 409 | 99,533 | 15,791 | 93,580 | 14,846 | 7,440 | 1,180 | 50,783 | 8,057 |
| 76 -100 | 3,260 | 615 | 79,593 | 15,025 | 125,633 | 23,716 | --- | --- | 52,122 | 9,839 |
| 101 -125 | 3,453 | 756 | 20,260 | 4,435 | 52,373 | 11,465 | --- | --- | 19,022 | 4,164 |
| 126 -150 | 5,120 | 1,275 | 20,800 | 5,180 | 75,480 | 18,796 | --- | --- | 25,350 | 6,313 |
| 151 -175 | 7,867 | 2,196 | 7,413 | 2,069 | 26,800 | 7,481 | --- | --- | 10,520 | 2,937 |
| 176 -200 | 4,187 | 1,295 | 9,173 | 2,837 | 56,013 | 17,324 | --- | --- | 17,343 | 5,364 |
| 201 -225 | 1,807 | 613 | 7,140 | 2,423 | 11,413 | 3,874 | --- | --- | 5,090 | 1,728 |
| 226 -250 | 2,240 | 828 | 6,460 | 2,387 | --- | --- | --- | --- | 2,175 | 804 |
| Over 250 | 5,187 | 2,135 | 24,620 | 10,136 | 5,733 | 2,360 | --- | --- | 8,885 | 3,658 |
| Total | 46,300 | 11,227 | 505,593 | 87,145 | 600,953 | 118,389 | 157,987 | 17,654 | 327,708 | 58,604 |
| Cost per hundredweight: | | | | | | | | | | |
| Average | | .25 | | .16 | | .18 | | .11 | | .18 |
| Range | | .20-.30 | | .14-.21 | | .14-.20 | | .10-.12 | | .10-.30 |

out-of-pocket transportation costs incurred by the plant. Instead they represent comparable costs based on identical rates and the actual distribution pattern for each plant.

The average transportation cost ranged from 11 cents per hundredweight for the retailer-manufacturer group to 25 cents per hundredweight for the premix group and averaged 18 cents for all groups combined. These averages are for the feed actually transported in all cases. Neither those for the concentrate group nor those for the premix group have been converted to a complete-feed basis. 21/

The average percentage of the actual total trucking expenses represented by the major classes of costs in the plants of the four types of operation are shown in table 27. For all 12 plants as a group, wages and salaries represented 36 percent of the total trucking cost, while fuel represented 26 percent, repairs and maintenance represented 13 percent, depreciation represented 12 percent, insurance and licenses each represented 4 percent, and all other expenses represented 5 percent of the total trucking cost.

## Causes of Variation in Feed Transportation Costs

Many different arrangements for transporting and paying for the transportation costs of the mixed feeds existed in the 12 case-study plants. Some shipments were made from the manufacturer to the dealer by rail, but most were made by trucks. Some of the truck shipments were made in trucks owned by the feed manufacturer, some in trucks owned by retailers, and some were made in contract trucks owned neither by the manufacturer nor the retailers. These differences made it difficult to compare the transportation costs on the basis of freight bills and truck operating cost records obtained from the case-study plants.

The transportation costs were difficult to compare even for those plants which transported the mixed feeds largely in company-owned trucks because of the differences in the way the trucking records were kept. Some plant records did not separate trucking costs of ingredients to the plant from trucking costs of mixed feed from the plant. Some plant records included the expenses of salesmen's automobiles with trucking expenses. Some plants had trucking revenue both from delivery charges made to feed retailers and from backhaul loads. Such revenue often was deducted from gross truck expenses before these expenses were entered into the summary records.

Detailed records of truck freight charges to retail points of varying distances from the manufacturing plant were obtained from three of the case-study plants. Two of these plants were in the premix group and one was in the

21/ The actual trucking costs averaged 25 cents per hundredweight for the premix plants, 14 cents per hundredweight for the concentrate plants, and 20 cents per hundredweight for both the complete-feed plants and the retailer-manufacturer plants. One of the retailer-manufacturer plants had very high trucking costs, the average of the other two being only 14 cents per hundredweight.

Table 27.--Percentage breakdown of trucking costs by classes of expenses for the feed manufacturing plants, in the 4 groups studied, 1955

| Cost Item | Premix | Concentrate | Complete | Retail manufacturing | All groups |
|---|---|---|---|---|---|
| | Percent | Percent | Percent | Percent | Percent |
| Wages and salaries | 32.21 | 42.58 | 35.70 | 32.78 | 35.82 |
| Gasoline and fuel | 32.86 | 22.17 | 22.32 | 26.22 | 25.89 |
| Repairs and maintenance | 8.60 | 13.92 | 11.76 | 16.73 | 12.75 |
| Depreciation | 12.52 | 8.08 | 14.48 | 12.88 | 11.99 |
| Insurance | 4.08 | 2.03 | 5.08 | 5.66 | 4.21 |
| Licenses and taxes | 3.76 | 3.65 | 5.36 | 4.79 | 4.39 |
| Other | 5.97 | 7.57 | 5.30 | .94 | 4.94 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

concentrate group. These records covered distances of 8 to 536 miles and freight costs of $1.00 to $12.20 per ton. The records kept by two of the plants were separated by truck size, which made five sets of transportation cost and distance records in all.

Linear regression functions of the form a + bx were fitted to each of the five sets of data and to the pooled data for the five sets by the method of least squares. The parameters obtained are shown in table 28 where the source of the data is listed in the first column, the number of observations is listed in the second column, and the observed range in miles from the manufacturing plant is listed in the third column. The fourth column shows the Y-intercept or the per ton cost for zero miles haul obtained for each of the groups. This varied from $0.92 to $4.91 and averaged $1.61 for the pooled data for all groups. The regression coefficient or the increase in freight cost per mile hauled is shown in the fifth column. It varied from 1.67 cents to 2.53 cents and averaged 2.41 cents for the pooled data for all groups.

The correlation coefficients shown in the seventh column are all statistically highly significant. However, as can be seen by comparing the $r^2$s shown in the sixth column, the individual regressions were not superior to the overall regression. Therefore the equation (6) 1.6065 + .0241d was accepted and used to compute the transportation costs for the model operations as discussed above.

This method of computing the transportation cost for the mixed feeds defined the total transportation cost independently of the first incidence of this cost--the manufacturer, the retailer, or the farmer customer. Thus it facilitates direct comparison of the four types of operation and avoids problems of noncomparability in the transportation cost records of the case-study plants. However, it overlooks certain feed transportation economies that some feed companies may be able to effectuate. For example, one of the case-study plants also processed soybeans and operated a large fleet of trucks of its own on a two-way haul basis. The trucks hauled mixed feed from the plant to the

Table 28.--Parameters obtained from the feed transportation cost and distance data by fitting linear regression equations

| (1) Source of data | (2) Number of observations | (3) Range in miles | (4) Y intercept | (5) Regression coefficient | (6) $r^2$ | (7) r |
|---|---|---|---|---|---|---|
| All groups | 269 | 8-536 | $1.6065 | 0.0241 | 0.8479 | 0.92 |
| Premix plant No. 1 (10-ton minimum) | 32 | 79-536 | 4.9118 | .0167 | .6935 | .84 |
| Premix plant No. 1 (16-ton minimum) | 32 | 79-536 | 3.9118 | .0167 | .6935 | .84 |
| Premix plant No. 2 | 65 | 8-180 | 1.6283 | .0225 | .7466 | .86 |
| Concentrate plant No. 2 (semitrailer) | 27 | 10-202 | .9246 | .0253 | .8894 | .94 |
| Concentrate plant No. 2 ($7\frac{1}{2}$-ton trucks) | 113 | 12-303 | 2.2525 | .0178 | .7916 | .89 |

retail outlet and soybeans from the retail outlet to the plant for the return load. Such an operation enabled this plant to provide transportation for its mixed feeds at a cost substantially less than that estimated by equation (6). But of course this resulted from the unique situation of the plant, and had nothing to do with whether it was operated on a premix, a concentrate, or a complete-feed basis. Other special transportation economies that some plants may enjoy are not recognized by the application of equation (6).

The relationship between average distance hauled and the cost of per ton hauling the manufactured feeds as computed from equation (6) is shown graphically in figure 3. As the figure shows, the computed transportation cost is $2.81 per ton for an average distance of 50 miles and on up to $8.84 per ton for an average distance hauled of 300 miles.

Trucking costs averaged $4.24 per ton for the 20 retailers, $4.17 per ton for the 7 retailers without mixing facilities, and $4.27 per ton for the 13 retailers with mixing facilities (table 29). While there is little difference in this cost between retailers with mixing facilities and those without them, there is an evident negative relationship between volume and per ton transportation costs.

For both classes of retailers as a group, the transportation cost declined from an average of $5.91 per ton for dealers with volumes of less than 500 tons down to $2.01 per ton for dealers with volumes over 2,000 tons. While not striking, the same relationship is evident for the two types of retailers separately.

Graphic correlation was used to determine the approximate quantitative relationship between annual volume and transportation costs per ton among the retailers studied. This relationship was found to be

$$(7) \quad Y = \$6.80 - .0018\ T,$$

where Y is the total transportation cost in dollars per ton and T is the total volume in tons per year.

On the basis of this formula, the computed average trucking cost per ton of feed for retailers with an average haul of approximately 20 miles is $5.90 when annual retail sales and delivery of feed are only 500 tons. This computed total delivery cost per ton is $4.10 at a retail volume of 1,500 tons.

## Budgeted Feed Transportation Costs for the Four Types of Operation

The comparison of transportation costs of the manufactured feeds for the premix operation, the concentrate operation, the complete-feed operation, and the integrated manufacturer-retailer operation is made on the basis of the single model formula given in the first column of table 5. This means that for the premix operation, only 150 pounds out of every ton of mixed feed is transported from the manufacturer to the retailer-mixer. For the concentrate operation, 1,100 pounds out of every ton of mixed feed is transported from the

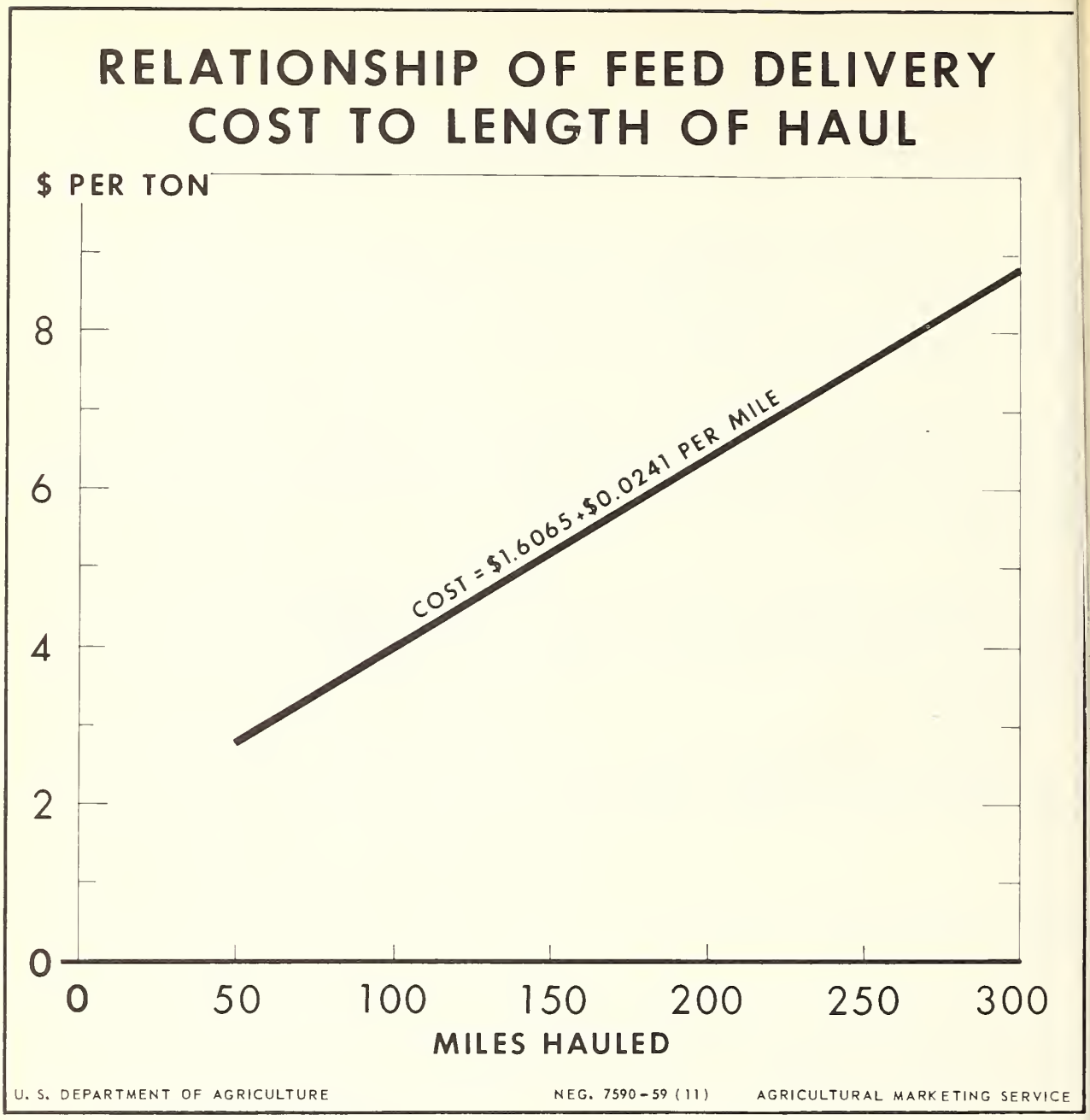
RELATIONSHIP OF FEED DELIVERY COST TO LENGTH OF HAUL
$ PER TON
8
6
4
2
0
COST = $1.6065 + $0.0241 PER MILE
0
50
100
150
200
250
300
MILES HAULED
U. S. DEPARTMENT OF AGRICULTURE
NEG. 7590-59 (11)
AGRICULTURAL MARKETING SERVICE

Figure 3

Table 29.--Transportation costs per ton for feed retailers with and without mixing facilities, by size of annual volume handled, 1955

| Annual volume in tons | Retailers with mixing facilities | | Retailers without mixing facilities | | All retailers | |
|---|---|---|---|---|---|---|
| | Plants | Average cost per ton | Plants | Average cost per ton | Plants | Average cost per ton |
| | Number | Dollars | Number | Dollars | Number | Dollars |
| 0 - 500 | 3 | 6.07 | 2 | 5.66 | 5 | 5.91 |
| 501 - 1,000 | 3 | 4.76 | 2 | 3.82 | 5 | 4.38 |
| 1,001 - 1,500 | 2 | 5.01 | 2 | 3.32 | 4 | 4.17 |
| 1,501 - 2,000 | 3 | 2.98 | 1 | 3.60 | 4 | 3.14 |
| Over - 2,000 | 2 | 2.01 | | | 2 | 2.01 |
| Total or average | 13 | 4.27 | 7 | 4.17 | 20 | 4.24 |

manufacturer to the retailer-mixer. But for the complete-feed operation, all of the mixed feed is transported from the manufacturer to the retailer. Of course, none of the complete feed is transported in the independent retailer-manufacturer operation.

Table 30 shows the budgeted distribution pattern of feed sales by mileage zones under the premix, the concentrate, the complete-feed, and the retailer-manufacturer operations. The tonnage distribution in each of the distance zones from the manufacturing plant is based closely upon the average distribution pattern shown in table 26 for the three case-study plants in each group. For the budgeted distribution, tonnages were simplified by rounding and eliminating some of the peaks and valleys in the average distributions. In the complete-feed operation, the tonnage to the first distance zone was increased over the three-plant average for that group because two of the case-study plants in this group were located in metropolitan areas where only limited sales could be made in the first distance zone.

Table 31 shows the budgeted feed sales pattern by mileage zones for retailing plants under the three types of operation where separate retailers are involved. The distribution by mileage zones from the retail plants is based directly on those found for the six case-study retailers under each type of operation, as shown in table 25. However, the patterns were simplified by rounding in each cell.

On the basis of the budgeted distribution patterns in tables 30 and 31, transportation costs from manufacturer to retailer and from retailer to customer are shown for each of the four types of operation in table 32.

The transportation costs for each cell were determined from the tonnage transported to each distance zone by applying equation (6).

Table 30.--Budgeted distribution of sales by mileage zones, for the 4 types of manufacturers 1/

| Type of organization | Mileage zones | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0-25 | 26-50 | 51-75 | 76-100 | 101-125 | 126-150 | 151-175 | 170-200 | 201-225 | 226-250 | Over 250 | Total |
| | Tons | Tons | Tons | Tons | Tons | Tons | Tons | Tons | Tons | Tons | Tons | Tons |
| Premix | 600 | 150 | 150 | 150 | 150 | 300 | 300 | 300 | 150 | 150 | 600 | 3,000 |
| Concentrate | 4,400 | 6,600 | 3,300 | 3,300 | 1,100 | 1,100 | 1,100 | 1,100 | --- | --- | --- | 22,000 |
| Complete | 8,000 | 12,000 | 6,000 | 6,000 | 4,000 | 4,000 | --- | --- | --- | --- | --- | 40,000 |
| Retail-manufacturing | 6,000 | 3,500 | 500 | --- | --- | --- | --- | --- | --- | --- | --- | 10,000 |

1/ See table 24 for percentage distributions in the case-study plants.



Table 31.--Budgeted distribution of sales, by mileage zones, for the 3 types of retail organization 1/

| Type of organization | Mileage zones | | | | |
|---|---|---|---|---|---|
| | 0-10 | 11-20 | 21-30 | Over 30 | Total |
| | Tons | Tons | Tons | Tons | Tons |
| Premix | 26,000 | 8,000 | 4,000 | 2,000 | 40,000 |
| Concentrate | 32,000 | 6,000 | 2,000 | --- | 40,000 |
| Complete | 34,000 | 6,000 | --- | --- | 40,000 |

1/ See table 25 for average percentages.

Table 32.--Budgeted transportation costs per ton for the 4 types of organization

| Item | Premix | Concentrate | Complete | Retail manufacturing |
|---|---|---|---|---|
| | Dollars | Dollars | Dollars | Dollars |
| Manufacturer to retailer | 5.13 | 3.28 | 3.16 | --- |
| Retailer to consumer .... | 1.88 | 1.82 | 1.80 | 2.28 |
| Total per ton of complete feed sold 1/ .. | 2.26 | 3.62 | 4.96 | 2.28 |

1/ Equivalent 40,000 tons.

The budgeted total per ton cost of transporting the tonnage of mixed feed involved from the manufacturer to the retailer is $5.13 for the premix operation, $3.28 for the concentrate operation, and $3.16 for the complete-feed operation. The total per ton cost of transporting the 40,000 tons of completed feed from the retailer to the customer is $1.88 for the premix operation, $1.82 for the concentrate operation and $1.80 for the complete-feed operation.

The budgeted total cost per ton for transporting the complete-feed to the farm of the customer is $2.26 for the premix operation, $3.62 for the concentrate operation, $4.96 for the complete-feed operation, and $2.28 for the retailer-manufacturer operation. Thus premixes are most economical among the four types of operation from the standpoint of total transportation costs of mixed feeds, while retailer-manufacturers are a close second. The complete-feed operation is the most expensive of the four as far as this factor is concerned.

The total transportation cost per ton shown in table 32 is not the sum of the cost from the manufacturer to the retailer and from the retailer to the customer except in the complete-feed operation. Only 150 pounds of the ton of complete feed are transported from the manufacturer to the retailer in the premix operation. And in the concentrate operation, only 1,100 pounds of the ton of complete feed are transported from the manufacturer to the retailer. This factor as well as the distance distribution pattern under each of the four types of operation enters into the relative total transportation cost involved.

## TOTAL COSTS OF MANUFACTURING AND DISTRIBUTING FEED

Many factors other than the basic method of organization and operation in the formula feed industry affect plant operating costs and efficiency. This is true of both feed manufacturing companies and feed retailers. In many respects, each of the 12 feed plants and 20 feed retailers exhibited characteristics and operating problems peculiar to itself. They differed in distance from their sources of ingredients and outlets for mixed feeds. They differed somewhat in

both capacity and volume. The number and type of feed formulas varied from one plant to another, as did methods of selling, pricing policies, methods of transportation used, amount of feed pelleted, and the percentage sold in bulk. They differed in plant layout and design and type of machinery used. They differed in management efficiency, organizational structure, and the type of related activities which were integrated with the feed operation. Such differences among operating firms are characteristic of the mixed feeds industry.

Yet, the plants within the four types of operation exhibited many common characteristics in patterns of organization and operation and in cost structure as well. These common characteristics provide the basic framework for comparisons among the four different types of operation. Furthermore, many of the differences which did exist in the cost structure in the selected plants were explained by operating differences and could be compensated for through careful study of plant records. Other differences were held constant for purposes of analysis by building uniformities into the budgeted costs for each of the four different types of operation.

## Total Costs in the Plants Studied

Manufacturing plants.--The average and the ranges in the volume of sales and costs per ton for the three case-study plants for each type of operation are given in table 33 for the feed manufacturing plants. The annual volumes correspond to those reported in previous tables.

None of the premix plants sold in bulk or pelleted the premix. The average total cost per ton ranged from $150.79 for the premix plants to $82.53 for the retailer-manufacturer plants.

The per-ton cost figures shown in table 33 are not directly comparable among the four types of operation for several reasons. They do not include the cost of retailing for the first three groups nor do they represent the same quality and concentration of mixed feed. The costs are based on the actual tonnage of output for the case-study manufacturers. This tonnage is much more concentrated in the premix plants than in the retailer-manufacturer plants, for example. Also, other differences such as volume of output, percentage sold in bulk, percentage pelleted, and the degree of integration of other activities such as soybean processing and rendering, cause variations in the cost per ton which are not attributable to differences in the type of operation as such.

Feed retailers.--Table 34 summarizes the sales volume and costs per ton for the retailers under the three types of operation using separate retailers. Retailers with mixing facilities are summarized separately from those without mixing facilities. Seven premix retailers, six concentrate retailers, and seven complete-feed retailers were studied. In all, 13 of these retailers had mixing facilities and 7 of them did not. Because all of the premix retailers had mixing facilities, this leaves 5 groups of retailers (table 35).

The average annual volume was highest for the premix retailers and lowest for the complete-feed retailers with mixing facilities. The largest retailer among the 20 was a premix dealer with 3,052 tons and the smallest was a complete-feed dealer with only 70 tons annual feed volume.

Table 33.--Summary of volume sold and costs per ton of laying mash for feed manufacturing plants, 4 types of organization, 1955

| Item | Unit | Premix | | Concentrate | | Complete | | Retail-manufacturing | |
|---|---|---|---|---|---|---|---|---|---|
| | | Average | Range | Average | Range | Average | Range | Average | Range |
| Annual feed sales | Tons | 2,315 | 1,607-3,630 | 25,280 | 15,882-34,692 | 30,048 | 4,551-77,817 | 7,899 | 4,545-9,783 |
| Percentage sold in bulk | Pct. | 0 | 0 - 0 | 8 | 3-14 | 1 | 0-2 | 17 | 10-23 |
| Percent pelleted | Pct. | 0 | 0 - 0 | 83 | 76-92 | 86 | 65-98 | 70 | 38-96 |
| Procurement | Dol. | .26 | .17- .35 | .42 | .34- .53 | .12 | 0- .36 | .03 | .02- .05 |
| Production | Dol. | 9.02 | 7.21- 13.15 | 8.89 | 8.06- 9.82 | 13.03 | 7.33- 19.92 | 8.15 | 6.22- 9.52 |
| Research | Dol. | 2.82 | .95- 5.28 | .50 | 0- 1.00 | .28 | 0- .85 | .13 | 0- .27 |
| Sales | Dol. | 28.35 | 6.17- 59.16 | 4.77 | .78- 9.22 | 6.16 | 4.83- 7.55 | 4.59 | 1.80- 7.66 |
| Overhead | Dol. | 11.53 | 8.05- 17.75 | 2.41 | .31- 3.55 | 5.72 | 4.38- 7.24 | 3.82 | 2.05- 6.85 |
| Transportation | Dol. | 4.93 | 4.00- 6.00 | 3.27 | 2.80- 4.20 | 3.60 | 2.80- 4.00 | 2.20 | 2.00- 2.40 |
| Subtotal | Dol. | 56.91 | 27.28- 99.01 | 20.26 | 13.02-27.65 | 28.91 | 23.01- 33.08 | 18.92 | 12.73-25.75 |
| Ingredients | Dol. | 93.88 | 80.88-106.88 | 68.54 | 60.56-72.78 | 66.48 | 60.88- 70.78 | 63.61 | 58.36-69.00 |
| Total | Dol. | 150.79 | 134.16-179.89 | 88.80 | 80.66-99.93 | 95.39 | 91.50-100.88 | 82.53 | 71.09-94.75 |

Table 34.--Summary of volume sold and costs per ton for feed retailers, 3 types of organization, 1955

| Item | Unit | Premix--all with mixing facilities | | Concentrate | | | | Complete-feed | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | With mixing facilities | | Without mixing facilities | | With mixing facilities | | Without mixing facilities | |
| | | Average | Range | Average | Range | Average | Range | Average | Range | Average | Range |
| Annual sales | Tons | 1,504 | 140-3,052 | 913 | 285-1,567 | 771 | 500-1,042 | 730 | 300-1,160 | 818 | 70-1,650 |
| Plant mixing and handling | Dol. | 13.51 | 6.04-27.16 | 16.97 | 10.26-31.35 | 2.82 | 2.33- 3.31 | 15.98 | 10.60-21.35 | 2.52 | 1.16- 3.89 |
| Sales | Dol. | .97 | .19- 1.76 | 2.25 | .83- 2.89 | 1.25 | .60- 1.89 | 1.21 | .98- 1.43 | .95 | .84- 1.05 |
| Advertising | Dol. | .58 | .17- 1.57 | .84 | .44- 1.28 | .26 | .20- .32 | 1.16 | 1.00- 1.31 | .51 | .07- 1.18 |
| Overhead | Dol. | 3.08 | .78- 6.12 | 3.93 | 2.01- 5.54 | 3.01 | 2.42- 3.60 | 4.77 | 4.27- 5.26 | 3.33 | 1.92- 5.01 |
| Trucks | Dol. | 3.67 | 1.04- 6.10 | 3.62 | .04- 6.57 | 3.48 | 2.66- 4.29 | 5.31 | 5.07- 5.55 | 4.45 | 2.88- 7.03 |
| Total 1/ | Dol. | 21.81 | 10.40-38.95 | 27.61 | 18.47-46.84 | 10.81 | 9.51-12.11 | 28.41 | 22.23-34.59 | 11.75 | 7.78-17.20 |

1/ Excludes ingredient costs.

Table 35.--Budgeted costs for producing and marketing laying mash, 4 types of organization

| Type of organization | Ingredients | | Procurement | | Production | | Research | |
|---|---|---|---|---|---|---|---|---|
| | Costs | Percent of total | Costs | Percent of total | Costs | Percent of total | Costs | Percent of total |
| | Dollars | Percent | Dollars | Percent | Dollars | Percent | Dollars | Percent |
| Premix | | | | | | | | |
| Manufacturing (3,000 tons) | 524,790 | 20.18 | 1,050 | 100.00 | 24,000 | 3.32 | 12,000 | 100.00 |
| Retail (40,000 tons) | 2,076,010 | 79.82 | --- | --- | 698,400 | 96.68 | --- | --- |
| Total | 2,600,800 | 100.00 | 1,050 | 100.00 | 722,400 | 100.00 | 12,000 | 100.00 |
| Total per ton | 1/65.02 | 69.89 | 2/0.03 | .03 | 3/18.06 | 19.41 | 4/0.30 | .32 |
| Concentrate | | | | | | | | |
| Manufacturing (22,000 tons) | 1,606,440 | 64.08 | 7,700 | 100.00 | 187,000 | 32.25 | 22,000 | 100.00 |
| Retail (40,000 tons) | 905,560 | 35.92 | --- | --- | 392,800 | 67.75 | --- | --- |
| Total | 2,512,000 | 100.00 | 7,700 | 100.00 | 579,800 | 100.00 | 22,000 | 100.00 |
| Total per ton | 1/62.80 | 68.65 | 2/.19 | .21 | 3/14.50 | 15.85 | 4/.55 | .60 |
| Complete-feed | | | | | | | | |
| Manufacturing (40,000 tons) | 2,540,800 | 100.00 | 14,000 | 100.00 | 330,000 | 79.17 | 40,000 | 100.00 |
| Retail (40,000 tons) | --- | --- | --- | --- | 86,800 | 20.83 | --- | --- |
| Total | 2,540,800 | 100.00 | 14,000 | 100.00 | 416,800 | 100.00 | 40,000 | 100.00 |
| Total per ton | 1/63.52 | 67.78 | 2/.35 | .37 | 3/10.42 | 11.12 | 4/1.00 | 1.07 |
| Retailer-Manufacturer | | | | | | | | |
| Total (40,000 tons) | 2,579,600 | 100.00 | 14,000 | 100.00 | 370,000 | 100.00 | 6,000 | 100.00 |
| Total per ton | 1/64.49 | 72.44 | 2/0.35 | 0.39 | 3/9.25 | 10.39 | 4/0.15 | 0.17 |

See footnotes at end of table.

Table 35.--Budgeted costs for producing and marketing laying mash, 4 types of organization--continued

| Type of organization | Selling | | Overhead | | Transportation | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Costs | Percent of total | Costs | Percent of total | Costs | Percent of total | Costs | Percent of total |
| | Dollars | Percent | Dollars | Percent | Dollars | Percent | Dollars | Percent |
| Premix | | | | | | | | |
| Manufacturing (3,000 tons ) | 60,000 | 43.96 | 26,250 | 16.62 | 15,401 | 17.00 | 663,491 | 17.83 |
| Retail (40,000 tons) | 76,480 | 56.04 | 131,680 | 83.38 | 75,200 | 83.00 | 3,057,770 | 82.17 |
| Total | 136,480 | 100.00 | 157,930 | 100.00 | 90,601 | 100.00 | 3,721,261 | 100.00 |
| Total per ton | 5/3.41 | 3.67 | 6/3.95 | 4.25 | 7/2.26 | 2.43 | 93.03 | 100.00 |
| Concentrate | | | | | | | | |
| Manufacturing (22,000 tons) | 110,000 | 58.99 | 74,800 | 36.23 | 72,112 | 49.76 | 2,080,052 | 56.84 |
| Retail (40,000 tons) | 76,480 | 41.01 | 131,680 | 63.77 | 72,800 | 50.24 | 1,579,320 | 43.16 |
| Total | 186,480 | 100.00 | 206,480 | 100.00 | 144,912 | 100.00 | 3,659,372 | 100.00 |
| Total per ton | 5/4.66 | 5.09 | 6/5.16 | 5.64 | 7/3.62 | 3.96 | 91.48 | 100.00 |
| Complete-feed | | | | | | | | |
| Manufacturing (40,000 tons) | 194,000 | 71.63 | 136,000 | 50.81 | 126,293 | 63.69 | 3,381,093 | 90.20 |
| Retail (40,000 tons) | 76,840 | 28.37 | 131,680 | 49.19 | 72,000 | 36.31 | 367,320 | 9.80 |
| Total | 270,840 | 100.00 | 267,680 | 100.00 | 198,293 | 100.00 | 3,748,413 | 100.00 |
| Total per ton | 5/6.77 | 7.23 | 6/6.69 | 7.14 | 7/4.96 | 5.29 | 93.71 | 100.00 |
| Retailer-Manufacturer | | | | | | | | |
| Total (40,000 tons) | 330,000 | 100.00 | 170,000 | 100.00 | 91,200 | 100.00 | 3,560,800 | 100.00 |
| Total per ton | 5/8.25 | 9.27 | 6/4.25 | 4.78 | 7/2.28 | 2.56 | 89.02 | 100.00 |

1/ Table 5.
2/ Table 7.
3/ Table 12.
4/ Table 19.
5/ Table 23.
6/ Table 18.
7/ Table 32.

The total of all costs except ingredient costs on a per-ton basis averaged most for the complete-feed dealers with mixing facilities and least for the concentrate dealers without mixing facilities. The range in the total per ton cost to retailers was greatest for the premix retailers and the concentrate retailers with mixing facilities, and smallest for the concentrate retailers without mixing facilities.

The amount of each of the major classes of expenses also is shown in table 34.

## Budgeted Total Costs for the Four Types of Operation

Budgeted total operating costs under the four types of operation are summarized in table 35. Seven types of cost are shown separately for the manufacturing plant and the retailers for each of the four types of operation. Costs per ton and the percentage of total costs represented by each major class of costs are also shown. The last two columns shows the budgeted total costs for the entire function of manufacture and distribution of livestock feeds under each of the four types of operation.

These differences in the relative efficiencies of the four methods of procuring ingredients, and mixing and selling the feed are designed to represent general tendencies in the industry. Because of efficiencies or inefficiencies in the operations of any given plant or company using any of the four types of organization, individual operations can be expected to deviate from this general tendency. Differences in managerial efficiency, capacity utilization, return haul arrangements, and other factors, frequently will overcome the tendencies towards efficiency or inefficiency as determined in this report for any given operation.

The percentage figures show first the fraction of each type of expense incurred by manufacturers and by retailers under each type of operation. Then the percentage figures on the total per-ton lines show the fraction of the total cost of manufacturing and distributing feeds under each type operation represented by each class of expenses.

The highlight of the table is the budgeted total cost per ton of the entire operation. The retailer-manufacturer operation is the lowest-cost type of operation of any of the four, having a total cost of $89.02 per ton. The complete-feed operation has the highest total cost -- $93.71 per ton. Thus, under the assumptions made, it cost the industry $4.69 more to manufacture and deliver every ton of complete feed to the farmer under a complete-feed arrangement than under a retailer-manufacturer arrangement. The total budgeted costs were $91.48 per ton for the concentrate operation and $93.03 per ton for the premix operation. Compared to the retailer-manufacturer, these budgeted costs give the complete-feed manufacturer and retailers a cost disadvantage of $2.46 per ton, and the premix manufacturer and retailer-mixers a cost disadvantage of $4.01 for every ton of feed sold and delivered to farmers.

The lower total production and distribution costs of the retailer-manufacturers are explained by their lower operating costs in production and

plant operation, overhead and delivery of feeds. The retailer-manufacturers actually show a cost disadvantage on a per ton basis in the delivered cost of ingredients, selling and advertising expenses, and ingredient procurement expenses (table 35).

The complete-feed operation is the most costly of the four types. This type of operation is highest among the four in two classes of costs -- overhead expenses and expenses of transporting the complete feeds (table 35). The manufacturing level overhead is less per ton for the complete-feed operation than for the retailer-manufacturer operation, but when the retailers' overhead is added in, the total overhead for the complete-feed operation is almost $2.50 per ton, the higher of the two. The transportation cost is highest for the complete-feed operation because the grain tonnage in the total ration must be transported farther under this type of operation than under any of the other three.

The reasons premix operations have the second highest total costs lie primarily in their higher costs for ingredient purchases and production expenses. Both of these higher costs arise from the fact that the retailers purchase most of the ingredients and do most of the manufacturing as far as tonnage is concerned under this type of operation. By comparison with feed manufacturers, retailer-mixers operate on a small tonnage and a relatively high cost per ton, both for ingredients purchased and for feed manufacturing and handling costs. The premix operation as budgeted has a cost advantage as far as procurement, selling, overhead, and feed transportation expenses are concerned. But the savings in these expense items are not great enough to offset the higher costs of ingredients and production.

Next to the retailer-manufacturer operation, the concentrate operation was the least costly among those studied. This type of operation has the lowest cost for ingredients among the four types of operation. It saves on non-grain ingredients because they are purchased in large quantities by the feed manufacturer, and on feed grain ingredients because they are purchased directly from farmers by the retailer-mixer. For other types of budgeted costs, the concentrate operation is neither high cost nor low cost among the four different types of operation. This type of operation is more costly than the retailer-manufacturer operation in both plant and production expenses and overhead expenses per ton of feed output.

APPENDIX

## Monthly Variation in Ingredient Procurement Costs

Sufficient information on procurement costs in the three concentrate plants was obtained to determine the relationship between volume of purchases and procurement costs on a monthly basis (table 36). The detailed procurement costs for these three plants were obtained on a monthly as well as on annual basis. The average volume of ingredients purchased and the corresponding average procurement costs for these three plants are shown in table 36. These figures are the simple averages as obtained from the actual figures for the three plants. The monthly figures have been rearranged to put them in ascending volume order from left to right.

While there is some deviation from the general relationship, these figures show a definite negative relationship between volume of ingredients purchased and the per ton procurement cost. The highest average per ton procurement cost (55 cents) occurred at the lowest average monthly volume (1,634 tons). The lowest average per ton procurement cost (33 cents) occurred at the highest average monthly volume (2,767 tons). Evidently once the purchasing facilities and personnel are established for a plant, total per ton procurement costs definitely go down as the volume of ingredients purchased goes up.

The approximate quantitative relationship between the monthly tonnage of ingredients purchased and the cents per ton procurement cost was found by graphic correlation from the data for the three plants to be

$$(8)\quad C = 85 - .02T,$$

where C is the procurement cost in cents per ton and T is the tons of ingredients purchased. This formula would mean a procurement cost of 55 cents per ton when monthly purchases were only 1,500 tons, 40 cents per ton when monthly purchases were 2,250 tons, and only 25 cents per ton when monthly purchases were as much as 3,000 tons. Of course, the reason for this is that much of the procurement cost (such as administrative salaries) is relatively constant from month to month regardless of the volume of purchases made.

The relationship in equation (8) is strictly in the nature of a short-run cost curve, and should not be interpreted as anything else. Annual volume of 24,000 tons consisting of 12 monthly purchases of 2,000 each would result in an annual average per ton procurement cost of 45 cents per ton on the basis of the relationship in table 36. It would not be obtained by applying 24,000 tons in equation (8). Likewise, equation (8) cannot be used for valid comparisons of the procurement costs between different feed plants which operate at different annual (or monthly) volumes of ingredients procured. It is only applicable for comparisons from month to month within the same plant where the facilities and personnel for procurement have been set up.

Table 36.--Monthly volume of ingredients purchased and procurement costs per ton for the 3 concentrate plants, 1955 (arranged in ascending volume order)

| Item | Unit | Months | | | | | | | | | | | | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| Ingredients purchased | Tons | 1,634 | 1,700 | 1,823 | 1,929 | 1,963 | 1,991 | 1,997 | 2,168 | 2,247 | 2,340 | 2,484 | 2,767 | 25,044 |
| Average procurement cost per ton | Dollars | 0.55 | 0.51 | 0.49 | 0.38 | 0.43 | 0.51 | 0.42 | 0.43 | 0.41 | 0.40 | 0.36 | 0.33 | 0.42 |

Equation:--Monthly procurement cost in cents per ton = 85 - .02 (tons purchased)

## Monthly Variation in Production Costs

The average monthly tonnage produced and monthly total production costs for the manufacturers in each of the four groups are shown in table 37. These averages were obtained by adding the volumes and costs for the consecutive months of operation for the three plants in each group and dividing the sum by three. The volume and cost figures were not rearranged so that the lowest and highest volumes of costs fell at the same month for each plant in the group. Consequently, the averages certainly do not exaggerate the monthly variations found in the plants studied -- instead they tend to level out these variations. Nevertheless, the figures show that substantial month-to-month variations remain in these average volumes and costs.

No seasonal production pattern exists in the average monthly production figures shown in the table for any of the types of operation. The averaging process covers up any seasonal variation in individual plants, since the accounting years of these individual plants start at different months. A slight seasonal production pattern was evident from the monthly production figures for some of the individual plants. The high production cost per ton for the complete-feed plants was in part due to year-end accounting adjustments in two of the plants in this group. The second highest average production cost for these complete-feed plants was $14.96 per ton in the eleventh month.

The inverse relationship between monthly output and per-ton production costs is apparent for all four groups of plants (table 37). While the lowest cost occurred at the largest volume for only one group (the premix plants), the lowest costs tend to be at the highest volumes and the highest costs tend to be at the lowest volumes for all four types of operation.

Graphic correlation was used to determine the approximate magnitude of the relationship between average monthly output and average per-ton production costs from the data in table 37. The results are shown in table 38. The monthly costs per ton were found to decrease most with given increases in volume for the premix plants. The smallest decrease with given volume increases from month to month was found for the complete-feed plants. For each 1-ton increase in output, total production costs per ton decreased approximately 11.6 cents in the premix plants, 2.1 cents in the retailer-manufacturer plants, 0.338 cents in the concentrate plants, and 0.247 cents in the complete-feed plants.

But the average monthly output varied a great deal from one type of operation to another, so that a 1-ton increase in output was a much bigger percentage in the output in some cases than others. The average monthly output was only 161 tons for the premix plants as contrasted to 2,512 tons for the complete-feed plants at the other extreme.

The decreases in costs with increases in volume were converted to a comparable basis between the different types of operation by putting them in terms of percentage changes, based on the average monthly volumes for each type of operation. A 1-percent change in volume for the premix plants means a change of 1.61 tons. But a 1-percent change in volume for the complete-feed plants means a change of 25.12 tons. The approximate average changes in the production costs per ton with a 1-percent change in volume of output are shown for

Table 37.--Monthly tonnage produced and total production costs per ton for the feed manufacturers, in the 4 types of organization, 1955

| Item | Unit | Months | | | | | | | | | | | | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| Premix | | | | | | | | | | | | | | |
| Volume | Tons | 154 | 169 | 180 | 182 | 184 | 172 | 150 | 117 | 165 | 148 | 150 | 163 | 1,934 |
| Cost per ton | Dollars | 10.85 | 7.71 | 8.14 | 8.71 | 7.63 | 8.21 | 8.46 | 11.12 | 9.05 | 13.40 | 11.34 | 9.21 | 9.02 |
| Concentrate | | | | | | | | | | | | | | |
| Volume | Tons | 1,654 | 1,625 | 2,353 | 2,695 | 2,010 | 2,084 | 2,330 | 2,287 | 2,531 | 2,042 | 1,969 | 1,926 | 25,296 |
| Cost per ton | Dollars | 10.16 | 9.12 | 9.55 | 7.45 | 8.93 | 9.85 | 8.67 | 7.39 | 7.65 | 10.46 | 9.12 | 10.66 | 8.89 |
| Complete-feed | | | | | | | | | | | | | | |
| Volume | Tons | 2,188 | 2,386 | 2,650 | 2,657 | 3,424 | 3,991 | 2,561 | 2,209 | 1,742 | 1,959 | 1,976 | 2,334 | 30,145 |
| Cost per ton | Dollars | 14.58 | 13.38 | 12.12 | 11.30 | 10.92 | 11.21 | 13.27 | 14.61 | 13.77 | 14.42 | 14.96 | 18.28 | 13.03 |
| Retailer-Manufacturer | | | | | | | | | | | | | | |
| Volume | Tons | 567 | 594 | 643 | 744 | 679 | 656 | 553 | 607 | 644 | 703 | 761 | 757 | 7,961 |
| Cost per ton | Dollars | 7.27 | 9.97 | 10.42 | 6.42 | 7.93 | 9.53 | 7.00 | 11.37 | 8.79 | 5.82 | 9.81 | 7.45 | 8.15 |

Table 38.--Relationship between monthly volume of feed produced and production costs per ton for the 4 types of manufacturers, 1955

| Item | Unit | Average change in cost per ton with 1% change in volume | Percentage variation from average monthly volume of production | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | -25 | -20 | -15 | -10 | -5 | Average | +5 | +10 | +15 | +20 | +25 |
| Premix | | | | | | | | | | | | | |
| Volume | Tons | | 121 | 129 | 137 | 145 | 153 | 161 | 169 | 177 | 185 | 193 | 201 |
| Cost per ton | Dollars | -0.187 | 13.69 | 12.76 | 11.83 | 10.89 | 9.95 | 9.02 | 8.09 | 7.15 | 6.22 | 5.28 | 4.35 |
| Concentrate | | | | | | | | | | | | | |
| Volume | Tons | | 1,581 | 1,636 | 1,792 | 1,897 | 2,003 | 2,108 | 2,213 | 2,319 | 2,424 | 2,530 | 2,635 |
| Cost per ton | Dollars | - .071 | 10.67 | 10.31 | 9.96 | 9.60 | 9.25 | 8.89 | 8.54 | 8.18 | 7.83 | 7.47 | 7.12 |
| Complete-feed 1/ | | | | | | | | | | | | | |
| Volume | Tons | | 1,884 | 2,010 | 2,135 | 2,261 | 2,386 | 2,512 | 2,638 | 2,763 | 2,889 | 3,014 | 3,140 |
| Cost per ton | Dollars | - .062 | 11.13 | 10.82 | 10.51 | 10.20 | 9.89 | 9.58 | 9.27 | 8.96 | 8.65 | 8.34 | 8.03 |
| Retailer-Manufacturer | | | | | | | | | | | | | |
| Volume | Tons | | 497 | 530 | 564 | 497 | 630 | 663 | 696 | 729 | 762 | 796 | 829 |
| Cost per ton | Dollars | - .139 | 11.62 | 10.93 | 10.23 | 9.54 | 8.84 | 8.15 | 7.45 | 6.76 | 6.06 | 5.37 | 4.67 |
| All Groups | | | | | | | | | | | | | |
| Volume | Tons | | 1,042 | 1,111 | 1,181 | 1,250 | 1,320 | 1,389 | 1,458 | 1,528 | 1,597 | 1,667 | 1,736 |
| Cost per ton | Dollars | - .115 | 11.62 | 11.04 | 10.47 | 9.89 | 9.32 | 8.74 | 8.17 | 7.59 | 7.02 | 6.44 | 5.87 |

1/ Excludes the one high-cost plant in this group.

each of the four types and for all plants as a group in the first column of table 38. The signs on all of these coefficients are minus, indicating a decrease in the monthly per-ton production cost when the volume increases, and vice versa.

These approximate coefficients have been used to compute the monthly total production costs per ton from the average monthly volume and per ton production costs for each of the four types of operation (and for all four as a group). The percentage variation above and below the average volume for each type of operation is shown at the top of each column, and the volume and cost per ton are shown in the column. A 50-percent variation in volume is considered -- 25 percent below the average and 25 percent above the average.

For all manufacturers taken together the computed monthly production costs varies from $5.87 per ton when the plant output is 1,736 tons to $11.62 per ton when the monthly plant output is 1,042 tons.

These figures show only the short-run cost-volume relationships, given the company's investment in plant facilities and equipment, supervisory labor, and so on. They are not suitable for making long-run comparisons, such as comparisons between plants which have different average monthly outputs.

## Monthly Variation in Overhead Costs

The average monthly tonnage produced and the average monthly total overhead cost for the manufacturers in each of the four groups are shown in table 39. The average monthly tonnage figures are the same as those shown in table 37 in conjunction with the average production costs for the four types of operation. Both the average volumes and the average overhead costs per ton varied considerably from month to month within all four types of operation.

The monthly overhead costs per ton for the feed manufacturing plants studied were considerably lower in months when total production was higher, as one would expect. The average overhead costs per ton varied from month to month for the manufacturing plants in all four groups.

Graphic regression analysis was used to determine the approximate magnitude of the relationship between average monthly output and average per-ton overhead costs from the data in this table. The per-ton overhead costs were found to decrease most with given increases in monthly volume for the premix plants. The smallest decrease in overhead cost with given volume increases from month to month was found for the complete-feed plants. With each 1-ton increase in output the total per ton overhead costs decreased approximately 11.3 cents in the premix plants, 0.31 cent in the concentrate plants, 0.23 cent in the complete-feed plants, and 0.54 cent in the retailer-manufacturer plants. But because of the differences in average volume among the four types of operation (table 40), these coefficients are not directly comparable between the different types of operation.

Table 39.--Monthly tonnage produced and total overhead costs per ton for the feed manufacturers, in the 4 types of organization, 1955

| Item | Unit | Months | | | | | | | | | | | | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| Premix | | | | | | | | | | | | | | |
| Volume | Tons | 154 | 169 | 180 | 182 | 184 | 172 | 151 | 117 | 165 | 148 | 151 | 163 | 1,934 |
| Cost per ton | Dollars | 11.95 | 11.29 | 11.21 | 10.98 | 9.92 | 10.92 | 11.64 | 16.98 | 10.44 | 14.78 | 14.14 | 10.66 | 11.53 |
| Concentrate | | | | | | | | | | | | | | |
| Volume | Tons | 1,654 | 1,625 | 2,144 | 2,695 | 2,010 | 2,084 | 2,330 | 2,288 | 2,531 | 2,042 | 1,969 | 1,926 | 25,296 |
| Cost per ton | Dollars | 2.79 | 3.01 | 2.45 | 2.22 | 2.50 | 2.32 | 2.14 | 2.12 | 1.98 | 2.58 | 2.65 | 3.10 | 2.41 |
| Complete-feed | | | | | | | | | | | | | | |
| Volume | Tons | 2,188 | 2,386 | 2,650 | 2,657 | 3,425 | 3,991 | 2,561 | 2,209 | 1,742 | 1,959 | 1,977 | 2,334 | 30,078 |
| Cost per ton | Dollars | 6.94 | 5.61 | 5.99 | 4.92 | 3.84 | 4.38 | 5.82 | 6.37 | 6.74 | 7.01 | 7.25 | 7.74 | 5.72 |
| Retailer-Manufacturer | | | | | | | | | | | | | | |
| Volume | Tons | 567 | 594 | 643 | 744 | 679 | 656 | 553 | 608 | 664 | 703 | 761 | 758 | 7,928 |
| Cost per ton | Dollars | 4.27 | 4.72 | 4.51 | 4.42 | 3.67 | 3.71 | 4.15 | 3.58 | 3.52 | 3.60 | 3.52 | 3.75 | 3.82 |

Table 40.--Relationship between monthly volume of feed produced and overhead costs per ton for the 4 types of manufacturers, 1955

| Item | Unit | Average change in cost per ton with 1% change in volume | Percentage variation from average monthly volume of production | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | -25 | -20 | -15 | -10 | -5 | Average | +5 | +10 | +15 | +20 | +25 |
| Premix | | | | | | | | | | | | | |
| Volume | Tons | | 121 | 129 | 137 | 145 | 153 | 161 | 169 | 177 | 185 | 193 | 201 |
| Cost per ton | Dollars | -0.182 | 16.08 | 15.17 | 14.26 | 13.35 | 12.44 | 11.53 | 10.62 | 9.71 | 8.80 | 7.89 | 6.98 |
| Concentrate | | | | | | | | | | | | | |
| Volume | Tons | | 1,581 | 1,686 | 1,792 | 1,897 | 2,003 | 2,108 | 2,213 | 2,319 | 2,424 | 2,530 | 2,635 |
| Cost per ton | Dollars | - .063 | 3.99 | 3.67 | 3.36 | 3.04 | 2.73 | 2.41 | 2.10 | 1.78 | 1.47 | 1.15 | .84 |
| Complete-feed | | | | | | | | | | | | | |
| Volume | Tons | | 1,884 | 2,010 | 2,135 | 2,261 | 2,386 | 2,512 | 2,638 | 2,763 | 2,889 | 3,014 | 3,140 |
| Cost per ton | Dollars | - .058 | 7.17 | 6.88 | 6.59 | 6.30 | 6.01 | 5.72 | 5.43 | 5.14 | 4.85 | 4.56 | 4.27 |
| Retailer-Manufacturer | | | | | | | | | | | | | |
| Volume | Tons | | 497 | 530 | 564 | 579 | 630 | 663 | 696 | 729 | 762 | 796 | 829 |
| Cost per ton | Dollars | - .036 | 4.72 | 4.54 | 4.36 | 4.18 | 4.00 | 3.82 | 3.64 | 3.46 | 3.28 | 3.10 | 2.92 |
| All Groups | | | | | | | | | | | | | |
| Volume | Tons | | 1,042 | 1,111 | 1,181 | 1,250 | 1,320 | 1,389 | 1,458 | 1,528 | 1,597 | 1,667 | 1,736 |
| Cost per ton | Dollars | - .085 | 8.03 | 7.60 | 7.18 | 6.75 | 6.33 | 5.90 | 5.48 | 5.05 | 4.63 | 4.20 | 3.78 |

The decreases in overhead costs with increases in monthly volume were converted to a comparable basis between the different types of operation by putting them in terms of percentage changes, based on the average monthly volumes for each type of operation. The approximate average changes in the overhead costs per ton with a 1-percent change in volume of output are shown for the plants of each of the four types of operation and for all plants as a group in the first column of table 40. With each 1-percent increase in volume these costs decreased 18.2 cents per ton in the premix plants, 6.3 cents in the concentrate plants, 5.8 cents in the complete-feed plants, 3.6 cents in the retailer-manufacturer plants, and 8.5 cents in all 12 plants taken together.

These approximate coefficients have been used to compute the monthly per ton total overhead costs from the average monthly volume and per-ton overhead costs for each of the four types of operation (and for all four as a group). These computed costs are shown with the corresponding monthly output in table 40. The percentage variation above and below the average volume for each type of operation is shown at the top of each column, and the volume and overhead cost per ton are shown in the column. A 50-percent variation in volume is considered -- 25 percent below the average and 25 percent above the average.

For all manufacturers taken together, the computed total overhead cost varies from $3.78 per ton at a monthly volume of 1,736 tons to $8.03 per ton at a monthly volume of 1,042 tons of feed production.

These overhead cost and volume figures show only the short-run cost-volume relationships, given the company's investment in the office building, equipment, administrative and office personnel and so on. They are not suitable for making comparisons among different plants which have different average monthly outputs.

## Monthly Variation in Sales Costs

The average monthly volume of feed sales and average total sales costs for the manufacturers in each of the four groups are shown in table 41. These averages were obtained by adding the volumes and costs for the consecutive months of operation for the three plants in each group and dividing the sum by three.

No seasonal pattern in either sales volume or sales expenditures is evident from the monthly averages shown in table 41. The averaging process covers up any seasonal variation in individual plants since the accounting years of these individual plants start at different months. Slight seasonal patterns were evident for some of the individual plants studied.

Table 41.--Monthly tonnage sold and total sales costs per ton for the feed manufacturers, 4 types of organization, 1955

| Item | Unit | Months | | | | | | | | | | | | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| Premix | | | | | | | | | | | | | | |
| Volume | Tons | 206.7 | 210.0 | 184.1 | 170.5 | 191.4 | 217.6 | 213.3 | 175.6 | 205.1 | 164.6 | 165.0 | 210.7 | 2,315 |
| Cost per ton | Dollars | 28.51 | 25.45 | 27.42 | 20.56 | 21.29 | 24.06 | 27.96 | 43.24 | 31.00 | 45.75 | 38.69 | 31.02 | 28.35 |
| Concentrate | | | | | | | | | | | | | | |
| Volume | Tons | 1,634.3 | 1,662.3 | 2,177.2 | 2,767.0 | 1,886.3 | 2,124.5 | 2,329.3 | 2,328.9 | 2,516.6 | 1,990.6 | 1,995.8 | 1,866.8 | 25,280 |
| Cost per ton | Dollars | 4.92 | 4.75 | 4.76 | 3.97 | 4.35 | 5.00 | 4.34 | 4.18 | 4.12 | 7.01 | 5.39 | 5.65 | 4.77 |
| Complete-feed | | | | | | | | | | | | | | |
| Volume | Tons | 2,183.7 | 2,506.0 | 2,369.4 | 3,029.5 | 3,329.6 | 3,856.1 | 2,535.8 | 2,153.5 | 2,027.2 | 1,752.1 | 2,140.7 | 2,164.0 | 30,048 |
| Cost per ton | Dollars | 6.31 | 6.42 | 6.23 | 5.53 | 4.63 | 5.47 | 6.12 | 7.01 | 7.88 | 7.37 | 6.92 | 8.06 | 6.16 |
| Retailer-Manufacturer | | | | | | | | | | | | | | |
| Volume | Tons | 567.6 | 592.1 | 653.3 | 756.1 | 664.5 | 617.2 | 557.3 | 611.6 | 665.7 | 682.0 | 749.3 | 765.8 | 7,883 |
| Cost per ton | Dollars | 5.05 | 5.45 | 4.36 | 4.98 | 4.82 | 4.76 | 4.87 | 4.11 | 4.48 | 4.15 | 4.69 | 5.45 | 4.59 |



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