Estimates of locational shifts of the retail feed industry in two functional economic areas in Iowa

Stephen Keith DeCook

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ESTIMATES OF LOCATIONAL SHIFTS OF THE RETAIL
FEED INDUSTRY IN TWO FUNCTIONAL ECONOMIC AREAS IN IOWA

by

Stephen Keith DeCook

A Thesis Submitted to the
Graduate Faculty in Partial Fulfillment of
The Requirements for the Degree of
MASTER OF SCIENCE

Major Subject: Agricultural Economics

Signatures have been redacted for privacy

Iowa State University
Of Science and Technology
Ames, Iowa
1967
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I. INTRODUCTION

A. Background

The location of feed retailers has been largely determined by happenings at the beginning of the century. As Iowa developed into a grain producing state, there became a need for facilities to market the grain. Grain elevators started to dot the landscape. These grain elevators were invariably located along railroad tracks, which usually preceded the grain elevators by only a year or two. With horses the sole method of transportation available, grain elevators were located as close as six miles to each other, although eight or ten miles was more common. As the years passed, business increased for all elevators and very few went out of business. It was during the 30's that most grain elevators added grinding and mixing facilities to satisfy the demand for livestock feed. A complementary relationship had developed between grain and livestock production. It was also in this period of time that elevators started to market commercial feed. This commercial feed was usually manufactured in a larger plant and shipped by rail to the newly-born feed retailer. This was the beginning of a new era in agriculture. The changes that were to accelerate at this time were more rapid than anyone anticipated. More and better markets became available to the farmer. But probably the biggest boost to agriculture can be attributed to technology. Greater use of the telephone and radio aided communication ties between farmers and markets. The use of tractors shifted from a novelty to near necessity. New equipment for planting, cultivation and harvesting permitted farmers to expand their operations. Hybrid seed corn along with fertilizer substantially boosted land
production and it was only a short time before herbicides and pesticides were in common usage. In addition, better feeds were formulated to meet newly established nutritional requirements.

These changes had a substantial impact on the structure of agriculture. The machine was more efficient than a strong back, and farm workers were not needed as they were used to be. Therefore, capital replaced labor. Specialized farming operations to various degrees became common. As farmers expanded their operations, small farms were consumed by larger farms. Farm numbers decreased and farm size increased. With all these changes, agriculture today would be an almost unrecognizable industry to the farmers of past generations. The end is not in sight. Agriculture today is moving as fast as at any time in the past.

Changes in the general economy have matched that of agriculture. The two have gone hand in hand. But at the beginning of the century, slow transportation limited farmer participation in most economic progress. Nearly all of his purchases and sales were limited to the nearest village. With horses as the only transportation, it was about an hour ride to travel five miles. A trip to the county seat was reserved for rare occasions, and a trip out of the county was sometimes never realized. But in the 1920's, Henry Ford provided a means of transportation that many could afford. The automobile and truck, along with hard surfaced roads, gave the farmer an opportunity to select where to buy and sell. There was a choice between the county seat and local village. Today, automobiles and roads are even better and the choice of markets ranges from the local village to distant markets. Since the turn of the century, transportation advances have expanded the marketing horizon from 5 to 50 miles without changing the
travel time of one hour. It is likely that purchase and sales patterns have and will respond to the expanded market area. Fox has explained these changes in purchase and sales patterns in his concept of the functional economic area (5, pp. 13-23).

B. Functional Economic Area

The Fox model theorizes that the county is no longer a practical unit of economic organization, but an area (functional economic area) larger than the county comprises a relatively self-contained economic area. Geographically, a functional economic area can be described as an area that is diamond-shaped, rotated square about a central city. The central city usually has a population of at least 25,000. The four points of the square are all exactly 50 miles from the central city. It is also 50 miles to every point on the perimeter of the square. This is true because of the rectangular road grid in the state of Iowa and much of the Corn Belt area.

Let us examine Figure 1. If point X is the destination from the central city, then one must drive 25 miles west and 25 miles south. Fifty miles is approximately one hours driving time, and Fox has hypothesized that this is the approximate upper limit that people will commute to work or to drive for a major shopping trip.

Besides the central city, of 25,000 population or over, there are complete shopping centers with populations of 5,000 - 25,000, partial shopping centers with 2,500 - 5,000 populations, and convenience centers with populations of less than 2,500 (6, pp. 13-14). It is hypothesized that the shopping centers can offer a wide range of products and services, and lower prices than the convenience centers because of use of a higher
Figure 1. Diagram of Functional Economic Area
level of technology and economies of size. And by the same reasoning, the central city can in turn offer a wider range of products and services, and lower prices than the shopping centers.

To the farmer this would mean a saving on purchases and a bonus on sales. Today's farmers have their own trucks to take advantage of these opportunities. In 1964, 53% of farmers owned their own trucks (11, pp. 13, 35). This is an increase from 35% in 1955 (10, pp. 13, 35), and 11% in 1945 (9, pp. 14, 47). The number of farm trucks will undoubtedly become larger as the central city opportunities increase.

Through all the agriculture and economic development, the feed retailer has attempted to stay abreast. Decentralization of feed manufacturing is occurring in all parts of the country. Smaller, highly automated and efficient plants are being built in or near the market area to be served. The role of the retail dealer is changing as he is called upon to offer a broader line of products designed for specific uses, as well as a broader line of services to his progressive customers. Most important of the services offered in grain producing areas is custom grinding and mixing. Some of the other services offered are bulk delivery, credit, grain banking, a sales-service man, and marketing assistance (4, p. 15).

But with all these changes, where, how many, what size, and what kind of feed retailer would best serve the farmer?
II. OBJECTIVES

This study is a part of a much larger study. The main objective of the larger study is to predict changes in job opportunities and vocational training needs in rural labor markets.

This study was conducted within the framework of the functional economic area concept and is concerned with one agri-business industry; namely, the feed retailing industry.

The objectives of this thesis are:

1. To determine if any relocation of feed retailers to a different size city is taking place, and if so, at what rate and to what size city.

2. To determine if feed retailers in different locations using different levels of technology are offering different prices or different services to their customers.

3. To determine the current education and vocational requirements for employees of feed retailers using different levels of technology.

4. To predict the level of technology to be used by feed retailers in the future, and to determine the future educational and vocational requirements for employees in this predicted level of technology.
There is a great deal of literature on the subject of cost standards in feed mills. It is important to point out that these reports are primarily concerned with feed manufacturing rather than feed retailing. However, feed retailers are engaged in some of the same activities as feed manufacturers.

Vosloh has published several marketing research reports on cost standards for different activities of feed manufacturing plants. These publications deal with cost standards for the receiving (19), processing (22), pelleting (20), packing (21), and warehousing (1) activities. The emphasis is placed on labor and capital requirements for feed manufacturers with differing volume capacity. Standards include operating and investment costs.

The Midwest Feed Manufacturers Association published a report on costs of different size feed mills (13). The publication gives man-hour requirements per ton for receiving, processing, mixing, pelleting, packing, and warehousing in 30 ton, 100 ton, and 200 ton capacity feed mills. Again the standards are more meaningful to manufacturers than retailers.

There have been many publications of mutual interest to feed retailers and feed manufacturers. Greer and Dahl made a study on industrial and geographical changes in feed manufacturing (7). The conclusions of the study were: 1. a sizable decrease in the number of small mills occurred from 1954 to 1959, followed by a modest decrease from 1959 to 1964, 2. a locational shift in commercial feed manufacturing from the Twin Cities area and northern Minnesota to areas of heavy livestock concentration, and 3. the
development of "satellite" plants in heavy feed consumption areas by large feed manufacturers. The authors conclude that "It appears reasonable to raise new hope for the location of large-scale feed manufacturing activity in rural areas of Minnesota" (7, p. 2).

Voeloh and Brensike also made a study of the changes in the feed mixing industry (18). Among the principal trends noted were the increase in farm size, integration of the feed industry and livestock production, bulk delivery of feed, direct sales to farmers, and the growth of on-farm and custom mixing. From 1955 to 1959, geographical trade areas increased more for Iowa feed retailers who offered mixing facilities than those retailers who did not mix. About one-half of feed retailers in Iowa offered mixing services.

Schruben and Clifton recently published a detailed set of various truck costs (17). Costs per ton and per mile for both bulk and sacked feed would be a valuable application to determine the possibilities of expanding a trade area.

A publication that is of primary concern to feed retailers is by Phillips (15). It is concerned with costs of procuring, manufacturing, and distributing mixed feeds. Cost data from four different types of retailers were studied: 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. Results showed that the independent manufacturer-retailer had slightly lower costs than the others. The publication studies the components of production, procurement, overhead, sales, and transportation costs for each of the four feed distribution
methods. This publication is important because its objectives overlap with the objectives of this thesis.
IV. RECURSIVE LINEAR PROGRAM

A. Basic Hypothesis

Based on the Functional Economics Area concept, the basic hypothesis is that people would increase purchases and sales in retail centers and decrease purchases and sales in convenience centers. This in turn would give way to the trend of increasing business activity in central cities and decreasing business activity in retail centers and convenience centers. The basis of this hypothesis is that larger business operations can offer lower prices and/or better services because of use of a higher level of technology and economies of scale.

B. Model

A recursive linear program was formulated to study this problem of the retail feed industry. A recursive linear program is a sequence of linear programming problems in which the objective function and the constraint matrix depend on the solution of the previous time period (2, p. 51).

A linear programming problem has three quantitative components: an objective function (typically to maximize income or minimize cost), alternative methods or processes for attaining the objective, and resource or other restrictions (8, p. 3). The problem can be restated: Which of the alternative processes and what levels should be used to maximize income, given that certain quantities of resources are available?

Linear programming is mainly a procedure for providing normative answers to problems. By normative we refer to the course of action which ought to be taken by an individual, business unit, area, or other economic sector (8, p. 8).
One might summarize the meaning of a recursive linear program as the description of optimizing over a limited time horizon on the basis of knowledge gained from past experience. A recursive linear program expresses the manner in which economic plans are reformulated as each period's experience is accumulated (2, p. 52). The solution to the recursive linear program of the last time period will be used as parameters in the recursive linear program of this time period. And the solution to the recursive linear program of this time period will be used as parameters in the recursive linear program of the next time period.

The recursive linear program required the subdivision of a functional economic area into eight different types of townships depending on their distance to the three location centers. The three location centers are defined as: 1. convenience center with population 2,500 or less, 2. retail center with population 2,501 to 25,000, and 3. a central city with population greater than 25,000. As Table 1 and Figure 2 indicate, each type of township was a different number of transportation units from each location center.

Table 1. Hypothetical transportation units to location centers from different types of townships in a functional economic area

<table>
<thead>
<tr>
<th>Township</th>
<th>Convenience Center</th>
<th>Retail Center</th>
<th>Central City</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>T2</td>
<td>1</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>T3</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>T4</td>
<td>1</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>T5</td>
<td>1</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>T6</td>
<td>1</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>T7</td>
<td>1</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>T8</td>
<td>1</td>
<td>3</td>
<td>11</td>
</tr>
</tbody>
</table>
Figure 2. Hypothetical subdivision of one-fourth of a functional economic area into eight types of townships with three types of location centers

c = convenience center
s = retail center
f = central city
Each set of townships had an objective function. For the $T_3$ townships, the objective function was:

$$\text{Minimum Total Cost} = (r_1 + p_c) x^t_{3c} + (r_2 + p_s) x^t_{3s} + (r_3 + p_f) x^t_{3f}$$

where,

- $r_1$ = transportation cost to the convenience center
- $p_c$ = price of feed per ton at the convenience center
- $x^t_{3c}$ = total tons of feed sold at the convenience centers in $T_3$ townships in the current time period
- $(r_1 + p_c) x^t_{3c}$ = total feed and transportation cost to all farmers in all $T_3$ townships for purchases in convenience centers
- $r_2$ = transportation cost to the retail center
- $p_s$ = price of feed per ton at the retail center
- $x^t_{3s}$ = total tons of feed sold at the retail centers in $T_3$ townships in the current time period
- $(r_2 + p_s) x^t_{3s}$ = total feed and transportation cost to all farmers in all $T_3$ townships for purchases in retail centers
- $r_3$ = transportation cost to the central city
- $p_f$ = price of feed per ton at the central city
- $x^t_{3f}$ = total tons of feed sold at the central city in $T_3$ townships in the current time period
- $(r_3 + p_f) x^t_{3f}$ = total feed and transportation cost to all farmers in all $T_3$ townships for purchases in central city

The program was recursive in that the values for $x^t_{3c}$, $x^t_{3s}$, and $x^t_{3f}$ changed in each time period, subject to constraints. Suppose the following:

- $0.9x^t_{3c} < x^t_{3c} < 1.1x^t_{3c}$
- $0.8x^t_{3s} < x^t_{3s} < 1.2x^t_{3s}$
- $0.7x^t_{3f} < x^t_{3f} < 1.3x^t_{3f}$
The total demand for feed in \( T_3 \) townships was:

\[
x^t + x^b + x^f = x^t
\]

Another recursive characteristic of the program was that the total demand for feed increased over time. Suppose the following for \( T_3 \) townships:

\[
\overline{x}^t = 1.05 \overline{x}^{t-1}
\]

For a practical example, suppose in a given township feed and transportation costs per ton are $72, $71, and $70 at the convenience center, retail center, and central city, respectively. Also, suppose the restraints allow sales increases or decreases of 10% for convenience centers, 20% for retail centers, and 30% for central cities. The results would be a 10% sales decrease at the convenience center, a 30% increase at the central city, and the retail center absorbing any difference as the loose constraint.

A questionnaire was formulated for feed retailers to try to estimate the values of the parameters. Specifically, the questionnaire attempted to answer the following questions: Where are sales increasing and decreasing and at what rate? What levels of technology are being used and what are the relative costs of each level? What are the educational and vocational requirements for employees in each level of technology?

C. Definition of Four Types of Feed Retailers

Four different types of technology levels of feed retailers were defined. The four types were:

a. **Independent manufacturer-retailer** The independent retailer-manufacturer formulates his own feed and retails it directly to farmers.
He represents a completely integrated operation in that he operates independently of any other feed manufacturing company or any other feed retailer. He mixes his own brand of feed according to his own formulas, purchases and adds all vitamins, minerals, and antibiotics as well as all other ingredients, in direct competition with the retail outlets of these major feed companies (15, p. 4).

b. **Satellite retailer-manufacturer** The satellite retailer-manufacturer buys a concentrated premix of minerals, vitamins, and antibiotics which are used to formulate a complete feed. The premix companies furnish the satellite retailer-manufacturer the formulas and formulating instructions for the complete feed. All other ingredients are procured independently of the feed company. The mixed feed is retailed by the satellite retailer-manufacturer under the brand name of the premix company. This type of organization results in a highly decentralized system of feed manufacture but a highly centralized system of sales and advertising programs.

c. **Depot or warehouse retailer** The depot or warehouse retailer is a retail outlet owned by the feed manufacturing company. The manager is an employee of the manufacturer. There are no grinding or mixing facilities. Facilities for bulk feed may or may not be available. The majority of feed sold is bagged. Very little or no complete feed is sold, but rather, concentrates to mix with grain are retailed to the farmer.

d. **Custom mix retailer** The custom mix retailer adds farm grains to a high protein concentrate to obtain a complete feed. These 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 concentrates 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 (15, pp. 3-4).

It was arbitrarily decided to interview three feed retailers of each type. However, several problems were encountered with the questionnaire and feed retailers. The most serious problem was that of technology identification. Preliminary interviews indicated that firms were using two or three different levels of technology. One part of a mill would be modern, while another part would be antiquated. One specific level of technology could not be identified.

A second problem was cost identification. Most feed retailers also retailed other lines of merchandise; namely, hardware, petroleum, lumber, and poultry. It was impossible to separate costs into the applicable product marketed or specific technology level. For instance, what part of the managers salary should be charged to feed cost when several other products required his time? Many firms used different accounting procedures which complicated the problem. For instance, truck depreciation
was called truck expense by some and grouped with general depreciation of
the physical plant by others. Some firms had made no effort to keep
adequate records.

D. Decline in Number of Feed Retailers

At the same time the cost and technology identification problems were
being studied, data from the Iowa Grain and Feed Dealers Association was
being examined for changes in number of feed retailers in Iowa (23) (12).

Table 2. Number of feed retailers and feed retailer-manufacturers listed
by the Iowa Grain and Feed Dealers Assn. in the Fort Dodge
functional economic area, 1958 and 1966

<table>
<thead>
<tr>
<th>Location Center</th>
<th>Feed Retailers 1958</th>
<th>Feed Retailers 1966</th>
<th>Feed Retailers who also manufacture 1958</th>
<th>Feed Retailers who also manufacture 1966</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convenience Center</td>
<td>125</td>
<td>91</td>
<td>15</td>
<td>35</td>
</tr>
<tr>
<td>Retail Center</td>
<td>35</td>
<td>23</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Central City</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The data presented in Table 2 showed a decreasing number of feed
retailers in all location centers of the Fort Dodge functional economic
area. From 1958 to 1966, the number of feed retailers in the state of
Iowa decreased from 2,067 to 1,462 (23) (12). It is interesting to note
that the number of feed retailers who also manufacture feed showed a sharp
increase for the same time period. The data showed the changes in number
of firms for each location center, but revealed nothing about the total
dollar volume of feed business or locational shifts by feed retailers in
each of the location centers.
The data suggested that the first step should be to determine if shifts in feed retailer business or location had taken place and to what magnitude. Therefore, a simpler approach was employed to determine if either shifts in dollar volume of business or shifts in feed retailer location had occurred, or were occurring, and why. If this new approach revealed any evidence that relocation of feed retailers or changes in purchasing patterns by farmers were taking place, then the recursive linear program would be applicable.
V. THE SURVEY

The simpler method was a survey of feed retailers in two functional economic areas in Iowa in which managers gave factual information on feed sales, services, prices, and trade area. The managers were also asked for their opinions about advantages and disadvantages for feed retailers in the different location centers.

A. Sampling Procedure

The population was comprised of firms listed as feed retailers in the handbook of the Iowa Grain and Feed Dealers Association that were located within the NIAD and TENCO Functional Economic Areas. NIAD is a nine county area centered around Mason City (3). TENCO is a ten county area centered around Ottumwa (16). The list was supplemented by a priori knowledge to make the population more complete.

The population was stratified on the basis of the size of the location center. The selected locations were the control cities (greater than 25,000 population), retail centers (2,501 - 25,000), and convenience centers (2,500 and less). Included in the population were 11 retailers in the two central cities, 45 in retail centers, and 143 in convenience centers. It was arbitrarily decided that the sample would include all feed retailers in the central city, one-half of the firms in the retail centers, and one-fourth of the firms in the convenience center.

All retailers in the retail centers and convenience centers were numbered consecutively within their location centers. To determine which firms in the retail centers would be chosen for the sample, a pencil was dropped on a table of random numbers until a 1 or 2 was chosen. By this
method, firms numbered 2, 4, 6, 8, etc. were selected from the population list. By a similar procedure (until a 1, 2, 3, or 4 was selected), firms numbered 4, 8, 12, 16, etc. were selected to be in the convenience center sample. Sixty-eight firms comprised the sample. Eleven were located in the central city, 22 in the retail centers, and 35 in the convenience centers.

Some problems were encountered in locating the selected firms. Some firms had gone out of business or discontinued retailing feed. In other cases, the manager was not available or refused to participate. In the event that a firm could not be interviewed, the firm next on the population list was chosen for a substitute. For example, if firm number 8 was out of business, then firm number 9 was chosen for a substitute. However, no substitutions were possible for central city firms because a census was taken of this population.

B. Analysis of Variance

1. Model

The data collected by the survey were analyzed by the analysis of variance technique. The following linear statistical model was used in this analysis:

\[ Y_{ij} = U + A_i + L_j + E_{ij} \]

where
- \( U \) = true effect of the mean
- \( A_i \) = true effect of the \( i^{th} \) area
- \( L_j \) = true effect of the \( j^{th} \) location
- \( E_{ij} \) = true effect of the error

In addition, the summation of the \( A_i \) effect equals zero, \( \sum_{i=1}^{2} A_i = 0 \); the summation of the \( L_j \) effect equals zero, \( \sum_{j=1}^{3} L_j = 0 \); the error is
normally and independently distributed with mean equal to zero and variance equal to $\sigma^2$, $E_{1j}$ is $\text{NID}(0, \sigma^2)$ (14, p. 364).

2. Analysis of data

The numerical data obtained from the questionnaire were analyzed in the seven different categories of:

1. Dollar feed sales
2. Sales per employee
3. Percent of total business in feed
4. Percent of total feed business within a 10 mile driving distance
5. Miles to most distant customer
6. Number of feed services offered
7. Feed prices

a. Dollar feed sales

The null hypotheses are:

1. $H_0$: There is no difference in 1965 dollar feed sales between the NIAD and TENCO areas.

2. $H_0$: There is no difference in 1965 dollar feed sales among the three location centers.

Table 3. Average 1965 dollar feed sales and number of retailers for the different location centers in NIAD and TENCO

<table>
<thead>
<tr>
<th>Area</th>
<th>Location Center</th>
<th>Number of Retailers</th>
<th>Average 1965 Feed Sales in Thousands</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIAD</td>
<td>Convenience Centers</td>
<td>20</td>
<td>$336</td>
</tr>
<tr>
<td></td>
<td>Retail Centers</td>
<td>10</td>
<td>$208</td>
</tr>
<tr>
<td></td>
<td>Central City</td>
<td>4</td>
<td>$555</td>
</tr>
<tr>
<td>TENCO</td>
<td>Convenience Centers</td>
<td>11</td>
<td>$59</td>
</tr>
<tr>
<td></td>
<td>Retail Centers</td>
<td>9</td>
<td>$227</td>
</tr>
<tr>
<td></td>
<td>Central City</td>
<td>5</td>
<td>$102</td>
</tr>
</tbody>
</table>
As Table 3 indicates, the average 1965 feed sales are quite different for NIAD and TENC0. In NIAD, the average sales are lowest for the retail centers; but in TENC0, the retail centers have the highest average. It is also interesting to note the absolute difference in average sales for convenience centers and central cities between the two areas. Results from the Analysis of Variance test are in Table 4.

Table 4. Results from Analysis of Variance that test null hypotheses number 1 and 2 using data in Table 3

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Area)</td>
<td>84253.44</td>
<td>1</td>
<td>84253.44</td>
<td>2.96</td>
</tr>
<tr>
<td>L (Location Center)</td>
<td>19921.32</td>
<td>2</td>
<td>9960.66</td>
<td>0.35</td>
</tr>
<tr>
<td>Error</td>
<td>56805.80</td>
<td>2</td>
<td>28447.90</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>161070.56</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1A similar test for 1965 dollar feed sales was conducted using a factor of interaction between area and location center. The model was

$$Y_{ijk} = U + A_i + L_j + (AL)_{ij} + e_{ijk}$$

However, the calculated F value was not significant at the 95% level for area, location center, or interaction.
The table values for \( F_{.95(1,2)} = 18.5 \) and \( F_{.95(2,2)} = 19.0 \). Therefore, the calculated \( F \) is not significant and both null hypotheses are accepted. Apparently there is no difference in 1965 dollar feed sales between the NIAD and TENC0 areas or among the location centers within the areas.

b. **Sales per employee**

The null hypotheses are:

3. \( H_0: \) There is no difference in 1965 dollar feed sales per employee between the NIAD and TENC0 areas.

4. \( H_0: \) There is no difference in 1965 dollar feed sales per employee among the three location centers.

Table 5. Average 1965 dollar feed sales per employee and number of retailers for different location centers in NIAD and TENC0

<table>
<thead>
<tr>
<th>Area</th>
<th>Location Center</th>
<th>Number of Retailers</th>
<th>Average Sales per Employee</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIAD</td>
<td>Convenience Centers</td>
<td>20</td>
<td>$87</td>
</tr>
<tr>
<td></td>
<td>Retail Centers</td>
<td>10</td>
<td>$73</td>
</tr>
<tr>
<td></td>
<td>Central City</td>
<td>4</td>
<td>$180</td>
</tr>
<tr>
<td>TENC0</td>
<td>Convenience Centers</td>
<td>11</td>
<td>$27</td>
</tr>
<tr>
<td></td>
<td>Retail Centers</td>
<td>9</td>
<td>$33</td>
</tr>
<tr>
<td></td>
<td>Central City</td>
<td>5</td>
<td>$39</td>
</tr>
</tbody>
</table>

The results in Table 5 show average 1965 dollar feed sales per employee to be much larger for the NIAD area. Within each area the average for the central cities is larger than for the other location centers. A high sales per employee should point out the more efficient firms and
probably a higher level of technology. Results from the Analysis of Variance test are in Table 6.

Table 6. Results from Analysis of Variance that test null hypotheses number 3 and 4 using data in Table 5

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Area)</td>
<td>9680.16</td>
<td>1</td>
<td>1680.16</td>
<td>6.77</td>
</tr>
<tr>
<td>L (Location Center)</td>
<td>3976.33</td>
<td>2</td>
<td>1988.16</td>
<td>1.39</td>
</tr>
<tr>
<td>Error</td>
<td>2860.33</td>
<td>2</td>
<td>1430.17</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>16516.82</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The table values for $F_{.95(1,2)} = 18.5$ and $F_{.95(2,2)} = 19.0$. Therefore, the calculated $F$ is not significant and both null hypotheses are accepted. Apparently there is no difference in 1965 dollar feed sales per employee between the NIAD and TENCO areas or among the location centers within the areas. The feed retailers are about equally efficient, and on the average are probably using approximately the same level of technology.

c. Percent of total business in feed

The null hypotheses are:

5. $H_0$: There is no difference in the percentage of total business in feed between the NIAD and TENCO areas.

6. $H_0$: There is no difference in the percentage of total business in feed among the three location centers.
Table 7. Average percent of total business in feed and number of retailers for different location centers in NIAD and TENCO in 1965

<table>
<thead>
<tr>
<th>Area</th>
<th>Location Center</th>
<th>Number of Retailers</th>
<th>Percent of Total Business in Feed</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIAD</td>
<td>Convenience Centers</td>
<td>21</td>
<td>39%</td>
</tr>
<tr>
<td></td>
<td>Retail Centers</td>
<td>12</td>
<td>46%</td>
</tr>
<tr>
<td></td>
<td>Central City</td>
<td>4</td>
<td>61%</td>
</tr>
<tr>
<td>TENCO</td>
<td>Convenience Centers</td>
<td>14</td>
<td>53%</td>
</tr>
<tr>
<td></td>
<td>Retail Centers</td>
<td>10</td>
<td>48%</td>
</tr>
<tr>
<td></td>
<td>Central City</td>
<td>5</td>
<td>56%</td>
</tr>
</tbody>
</table>

Table 7 indicates that in the NIAD area, the average percent of total business in feed increases as the size of the location center increases. In the TENCO area, the average percent among location centers is very similar. The percent of total business in feed would indicate to some degree how much firms were specializing in feed. And the degree of specialization would indicate what type of business the retailer is conducting. Results from the Analysis of Variance test are in Table 8.

Table 8. Results from Analysis of Variance that test null hypotheses number 5 and 6 using data in Table 7.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Area)</td>
<td>13.50</td>
<td>1</td>
<td>13.50</td>
<td>0.07</td>
</tr>
<tr>
<td>L (Location Center)</td>
<td>646.33</td>
<td>2</td>
<td>323.17</td>
<td>1.62</td>
</tr>
<tr>
<td>Error</td>
<td>399.00</td>
<td>2</td>
<td>199.50</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1058.83</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The table values for $F_{.95(1,2)} = 18.5$ and $F_{.95(2,2)} = 19.0$. The calculated $F$ is not significant at the 95% level and the null hypotheses are accepted. Apparently there is no difference in the percentage of total business in feed between the NIAID and TENCO areas or among the location centers within each area. The degree of specialization in feed is about the same for feed retailers in all location centers and both areas.

d. **Percent of total feed business within a 10 mile driving distance**

The null hypotheses are:

7. $H_0$: There is no difference in the percentage of total feed sold within a 10 mile driving distance between NIAID and TENCO areas.

8. $H_0$: There is no difference in the percentage of total feed sold within a 10 mile driving distance among the three location centers.

Table 9. Average percent of total feed business within a 10 mile driving distance and number of retailers for the different location centers in NIAID and TENCO in 1966.

<table>
<thead>
<tr>
<th>Area</th>
<th>Location Center</th>
<th>Number of Retailers</th>
<th>Percent of Total Feed Business within a 10 Mile Driving Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NIAID</td>
<td>Convenience Centers</td>
<td>21</td>
<td>91%</td>
</tr>
<tr>
<td></td>
<td>Retail Centers</td>
<td>12</td>
<td>95%</td>
</tr>
<tr>
<td></td>
<td>Central City</td>
<td>4</td>
<td>44%</td>
</tr>
<tr>
<td>TENCO</td>
<td>Convenience Centers</td>
<td>14</td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>Retail Centers</td>
<td>10</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>Central City</td>
<td>5</td>
<td>89%</td>
</tr>
</tbody>
</table>
If the percentage of total feed business within a 10 mile driving distance would be low, it would indicate a larger trade area. As Table 9 indicates, the percentage in NIAD is much lower in the central city. In TENCO, the percentage is somewhat lower in the retail center. Results of the Analysis of Variance test are in Table 10.

Table 10. Results from Analysis of Variance that test null hypotheses number 7 and 8 using data in Table 9

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Area)</td>
<td>60.17</td>
<td>1</td>
<td>60.17</td>
<td>0.09</td>
</tr>
<tr>
<td>L (Location Center)</td>
<td>597.33</td>
<td>2</td>
<td>298.67</td>
<td>0.47</td>
</tr>
<tr>
<td>Error</td>
<td>1265.33</td>
<td>2</td>
<td>632.67</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1922.63</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The table values for $F_{.95(1,2)} = 18.5$ and $F_{.95(2,2)} = 19.0$. The calculated $F$ is not significant at the 95% level and the null hypotheses are accepted. Apparently there is no difference in the percent of total feed sold within a 10 mile driving distance between the NIAD and TENCO areas or among the location centers within each area. Trade areas for different location centers and areas are about the same.

e. **Miles to most distant customer**

The null hypotheses are:

9. $H_0$: There is no difference in the miles to the most distant customer between the NIAD and TENCO areas.
10. $H_0$: There is no difference in the miles to the most distant customer among the three location centers.

<table>
<thead>
<tr>
<th>Area</th>
<th>Location Center</th>
<th>Number of Retailers</th>
<th>Miles to most Distant Customer</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIAD</td>
<td>Convenience Centers</td>
<td>21</td>
<td>12.5 mi.</td>
</tr>
<tr>
<td></td>
<td>Retail Centers</td>
<td>12</td>
<td>13.7 mi.</td>
</tr>
<tr>
<td></td>
<td>Central City</td>
<td>4</td>
<td>31.0 mi.</td>
</tr>
<tr>
<td>TENCO</td>
<td>Convenience Centers</td>
<td>14</td>
<td>15.4 mi.</td>
</tr>
<tr>
<td></td>
<td>Retail Centers</td>
<td>10</td>
<td>26.4 mi.</td>
</tr>
<tr>
<td></td>
<td>Central City</td>
<td>5</td>
<td>21.0 mi.</td>
</tr>
</tbody>
</table>

It was thought that the size of the trade area would have a direct relationship to the miles to the most distant customer. Results are in Table 11. In the NIAD area, the average of the miles increases with the size of the town. In the TENCO area, the retail center shows the highest average of miles to the most distant customer. Results of the Analysis of Variance test are in Table 12.

The table values for $F_{.95(1,2)} = 18.5$ and $F_{.95(2,2)} = 19.0$. The calculated $F$ is not significant at the 95% level and the null hypotheses are accepted. Apparently there is no difference in miles to the most distant customer between the NIAD and TENCO areas or among the location centers with each area. Trade areas for different location centers and areas are about the same.
Table 12. Results from Analysis of Variance that test null hypotheses number 9 and 10 using data in Table 11

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Area)</td>
<td>5.23</td>
<td>1</td>
<td>5.23</td>
<td>0.08</td>
</tr>
<tr>
<td>L (Location Center)</td>
<td>145.21</td>
<td>2</td>
<td>72.61</td>
<td>1.12</td>
</tr>
<tr>
<td>Error</td>
<td>129.62</td>
<td>2</td>
<td>64.81</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>280.06</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

f. Number of feed services offered

The null hypotheses are:

11. $H_0$: There is no difference in number of services offered between NIAD and TENCO.

12. $H_0$: There is no difference in number of services offered among the location centers.

Table 13. Average number of services offered and number of retailers for the different location centers in NIAD and TENCO in 1966

<table>
<thead>
<tr>
<th>Area</th>
<th>Location Center</th>
<th>Number of Retailers</th>
<th>Number of Feed Services Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIAD</td>
<td>Convenience Centers</td>
<td>21</td>
<td>5.1</td>
</tr>
<tr>
<td></td>
<td>Retail Centers</td>
<td>12</td>
<td>5.1</td>
</tr>
<tr>
<td></td>
<td>Central City</td>
<td>4</td>
<td>3.8</td>
</tr>
<tr>
<td>TENCO</td>
<td>Convenience Centers</td>
<td>14</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td>Retail Centers</td>
<td>10</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>Central City</td>
<td>5</td>
<td>2.6</td>
</tr>
</tbody>
</table>
It is logical to assume that farmers would tend to patronize retailers who offered more services. The results on number of feed services are in Table 13. In both NIAD and TENCO, the average number of services decreases as the size of the location center increases. Also, the average number of services is larger in NIAD than TENCO. Grain banking and drying were two services that most NIAD feed retailers offered that most TENCO feed retailers did not offer. Results of the Analysis of Variance test are in Table 14.

Table 14. Results from Analysis of Variance that test null hypotheses number 11 and 12 using data in Table 13

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Area)</td>
<td>2.28</td>
<td>1</td>
<td>2.28</td>
<td>37.00</td>
</tr>
<tr>
<td>L (Location Center)</td>
<td>2.29</td>
<td>2</td>
<td>1.14</td>
<td>18.57</td>
</tr>
<tr>
<td>Error</td>
<td>.12</td>
<td>2</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4.69</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The table values for $F_{0.95(1,2)} = 18.5$ and $F_{0.90(2,2)} = 9.0$. The calculated $F$ is significant at the 90% level for location centers, and is also significant at the 95% level for NIAD and TENCO areas. Apparently there is a real difference in number of services offered between the NIAD and TENCO areas, and also among the location centers in each area. Convenience centers offer more services than retail centers, and retail centers offer more than central cities. NIAD offers more services than TENCO.
g. **Feed prices**

The null hypotheses are:

13. $H_0$: There is no difference in feed prices between NIAD and TENCO.  

14. $H_0$: There is no difference in feed prices among the location centers.

Table 15. Average feed prices and number of retailers for the different location centers in NIAD and TENCO on August 15, 1966

<table>
<thead>
<tr>
<th>Area</th>
<th>Location Center</th>
<th>Number of Retailers</th>
<th>Feed Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIAD</td>
<td>Convenience Centers</td>
<td>21</td>
<td>$6.46/cwt.</td>
</tr>
<tr>
<td></td>
<td>Retail Centers</td>
<td>12</td>
<td>$6.43</td>
</tr>
<tr>
<td></td>
<td>Central City</td>
<td>4</td>
<td>$6.37</td>
</tr>
<tr>
<td>TENCO</td>
<td>Convenience Centers</td>
<td>14</td>
<td>$6.38</td>
</tr>
<tr>
<td></td>
<td>Retail Centers</td>
<td>10</td>
<td>$6.44</td>
</tr>
<tr>
<td></td>
<td>Central City</td>
<td>5</td>
<td>$6.43</td>
</tr>
</tbody>
</table>

If farmers are going to change their purchase patterns, a lower feed price would be a probable prerequisite. Results in Table 15 show the average prices are nearly the same for all location centers in both areas. Results of the Analysis of Variance test are in Table 16.

The table values for $F_{.95(1,2)} = 18.5$ and $F_{.95(2,2)} = 19.0$. The calculated $F$ is not significant at the 95% level and the null hypotheses are accepted. Apparently there is no difference in feed prices between the NIAD and TENCO areas or among the location centers within each area. Feed prices are approximately the same for all location centers and both areas.
Table 16. Results from Analysis of Variance that test null hypotheses number 13 and 14 using data in Table 15

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Area)</td>
<td>.0000</td>
<td>1</td>
<td>.0000</td>
<td>0.0066</td>
</tr>
<tr>
<td>L (Location Center)</td>
<td>.0012</td>
<td>2</td>
<td>.0006</td>
<td>0.2450</td>
</tr>
<tr>
<td>Error</td>
<td>.0050</td>
<td>2</td>
<td>.0025</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>.0062</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C. Analysis of Covariance

1. Model

Analysis of covariance is a technique which blends two other tools of statistics; namely, regression and analysis of variance. It is used when it becomes necessary to adjust the final results \((Y)\), by a factor \((X)\), in order to obtain a more meaningful solution. For example, the final results \((Y)\) on a test might be adjusted by the students I.Q. \((X)\) to see which students actually made the most progress. With the exception of the \(BX_{ij}\) adjusting factor, the model is the same as in analysis of variance,

\[ Y_{ij} = U + A_i + T_j + BX_{ij} + E_{ij} \quad i = 1, 2 \\
\quad j = 1, 2, 3 \]

where

- \(U\) = true effect of the mean
- \(A_i\) = true effect of \(i^{th}\) area
- \(T_j\) = true effect of \(j^{th}\) location center
- \(BX_{ij}\) = covariance adjustment factor in \(i^{th}\) area and \(j^{th}\) location center
- \(E_{ij}\) = true effect of experimental error
In addition, the summation of the $A_i$ effect equals zero, $\sum_{i=1}^{2} A_i = 0$; the summation of the $T_j$ effect equals zero, $\sum_{j=1}^{3} T_j = 0$; the summation of the $BX_{ij}$ adjustment equals zero, $\sum BX_{ij} = 0$; and the error is normally and independently distributed with mean equal to zero and variance equal to $\sigma^2$, $E_{ij}$ is NID(0,$\sigma^2$).

2. Analysis of data

By analysis of variance, it was determined that there was a difference in number of services offered between areas and among location centers. A question arises: If services had been the same for both areas and all location centers, would there have been any difference in 1965 dollar feed sales? Covariance analysis was used to determine if any difference existed in 1965 dollar feed sales after adjusting with number of services.

The null hypotheses are:

15. $H_0$: There is no difference in 1965 dollar feed sales between the NIAD and TENC0 area after adjusting for number of services by covariance analysis.

16. $H_0$: There is no difference in 1965 dollar feed sales among the location centers after adjusting for number of services by covariance analysis.

Table 17 shows the number of feed services to be quite variable. The analysis of variance test indicated that there is a real difference in number of services between areas and among location centers. If feed services had been the same for both areas and all location centers, would there be a difference in 1965 dollar feed sales? Analysis of covariance was used to determine if feed sales would be affected by adjustment of number of services. The results are presented in Table 18.
Table 17. Average 1965 dollar feed sales and average number of services for the different location centers in NIAD and TENCO in 1965

<table>
<thead>
<tr>
<th>Area</th>
<th>Location Center</th>
<th>Average 1965 Feed Sales in Thousands</th>
<th>Number of Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIAD</td>
<td>Convenience Centers</td>
<td>$336</td>
<td>5.1</td>
</tr>
<tr>
<td></td>
<td>Retail Centers</td>
<td>208</td>
<td>5.1</td>
</tr>
<tr>
<td></td>
<td>Central City</td>
<td>555</td>
<td>3.8</td>
</tr>
<tr>
<td>TENCO</td>
<td>Convenience Centers</td>
<td>59</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td>Retail Centers</td>
<td>227</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>Central City</td>
<td>102</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Table 18. Results from Analysis of Covariance that test null hypotheses number 5 and 6 using data in Table 17.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (Area)</td>
<td>50344.94</td>
<td>1</td>
<td>50344.94</td>
<td>1.66</td>
</tr>
<tr>
<td>L (Location Center)</td>
<td>16265.68</td>
<td>2</td>
<td>8132.74</td>
<td>0.27</td>
</tr>
<tr>
<td>Error</td>
<td>30366.88</td>
<td>1</td>
<td>30366.88</td>
<td></td>
</tr>
</tbody>
</table>

The table value for $F .95(1,1) = 161$ and $F .95(2,1) = 200$. Therefore, the calculated $F$ is not significant and both null hypotheses are accepted. There is no difference in 1965 dollar feed sales between the NIAD and TENCO areas or among the location centers within the areas after adjusting for number of services by covariance analysis.
D. Opinions

One part of the questionnaire was concerned with opinions and ideas about locational advantages of feed retailers. Managers were asked if they thought they had an advantage with respect to the locational advantages listed in Table 19. Many managers thought they had no real advantage. Others had no opinion or didn’t know.

Table 19. Percentage of feed retailers interviewed in each location center in the NIAD and TENCO areas who thought they had an advantage because of their location with respect to the locational advantages listed

<table>
<thead>
<tr>
<th>Locational Advantages</th>
<th>Convenience Center</th>
<th>Retail Center</th>
<th>Central City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation-in</td>
<td>31%</td>
<td>32%</td>
<td>33%</td>
</tr>
<tr>
<td>Transportation-out</td>
<td>34%</td>
<td>23%</td>
<td>11%</td>
</tr>
<tr>
<td>Labor</td>
<td>40%</td>
<td>36%</td>
<td>11%</td>
</tr>
<tr>
<td>Lower property tax</td>
<td>66%</td>
<td>45%</td>
<td>0%</td>
</tr>
<tr>
<td>Farmers doing more business here</td>
<td>17%</td>
<td>45%</td>
<td>22%</td>
</tr>
<tr>
<td>Close to customers</td>
<td>43%</td>
<td>23%</td>
<td>0%</td>
</tr>
<tr>
<td>Close to packing company</td>
<td>0%</td>
<td>0%</td>
<td>33%</td>
</tr>
</tbody>
</table>

Let us examine each of the locational advantages listed in Table 19.

a. Transportation-in Table 19 shows the percentage of favorable responses to transportation-in is nearly the same for retailers in all locations. This would indicate that the size of location center would make
no difference on transportation-in. Most feed is transported in by rail, and nearly all feed retailers were along railroad lines. Railroads that pass through central cities would most likely be main railroad lines. Convenience centers or retail centers may or may not be on a main railroad line.

b. Transportation-out In Table 19 a higher percentage of convenience center managers counted it an advantage than the retail center managers. And the retail center managers thought it more of an advantage than the central city managers. Those in the convenience centers wanted no part of central city traffic. Retail center managers and central city managers preferred to be on the edge of town to avoid the traffic problem. But in moving to the edge of town, managers thought you probably would have a lop-sided trade area. The managers felt it has the affect of cutting off customers on the other side of town. Farmers do not like to drive through traffic, especially with a tractor and wagon.

c. Labor Convenience and retail center managers counted labor an advantage more often than the central city manager. Labor was more plentiful but also more expensive in the central city. Other industries in central cities forced up the wage price. Two managers in convenience centers said they had better quality labor than could be found in the central city. The reason stated was that farm boys and part-time farmers make good laborers for feed retailers. Three managers preferred towns of less than 2,500 to avoid the minimum wage law.

d. Property tax As might be expected in Iowa, managers had the strongest opinions about property taxes. As Table 19 indicates, sixty-six percent of convenience center managers thought they had a relative
advantage with lower property tax. The general opinion seemed to be: The smaller the town, the lower the tax.

e. **Farmers doing more general business here** More retail center managers thought their size town was a drawing card than either of the other two location centers. Twenty-two percent of central city managers thought their size city had more bargains, lower prices, and a wider range of products to draw customers. Convenience center managers based their opinion on home-town loyalty.

f. **Close to customers** About half the convenience center managers, one-fourth the retail center managers, and no central city managers counted closeness to customers an advantage. It should be pointed out that the central city managers who had larger trade areas did not consider themselves at a disadvantage because they were a bit further from their customers. The convenience center was thought to be a better climate for friendship to develop between manager and customer. Convenience center managers thought it was important to be within a few minutes drive to the farmer.

g. **Close to packing company** The packing companies are in the central city and one-third of central city managers counted it an advantage. After farmers deliver livestock to a packing plant, they pick up feed for the back haul. Thus, a complementary relationship develops between the meat packer and feed retailer.

Other miscellaneous opinions by one or more managers were:

1. **Grinder-mixers for farmers have become a status symbol, and farmers will no longer have to buy feed where this service is offered.**
2. From a social point of view, farm people are going to make a real effort to save the small town. They will return their business to the local dealer to promote the home town.

3. There are too many feed retailers. The market is saturated. No real growth can occur until some drop out of business.

4. The central city is better place to live because it offers better schools, churches, recreation, and social opportunities.

5. The small town is the best place to live and work. The close personal contact cannot be found in larger cities.

Some opinions were widely varied and a matter of personal preference. But nevertheless, they have and will continue to affect location of the feed retailing business.
VI. SUMMARY AND CONCLUSIONS

A. The Problem

The problem of this study was twofold: 1. to determine if any relocation of feed retailers to a different size city was taking place, and if so, at what rate; 2. to determine the level of technology being used by different feed retailers and the educational requirements for employees in each level.

B. Method of Solution

The initial effort to investigate this problem was through the use of a recursive linear program within the concept of a functional economic area. A functional economic area was subdivided into eight hypothetical types of townships with each type having a different objective function. For the $T_J$ townships, the objective function was:

$$\text{Minimum Total Cost} = (r_1 + p_c)x_{3c}^t + (r_2 + p_s)x_{3s}^t + (r_3 + p_f)x_{3f}^t$$

where

- $r$ = transportation cost for the different location centers to $T_J$ townships
- $p$ = feed price per ton at the different location centers
- $x$ = tons of feed sold at the different location centers
- $c$ = convenience center
- $s$ = retail center
- $f$ = central city
- $t$ = current time period

The recursive feature of the model was that tons of feed sold in each location center ($x_{3j}^t$) changed in each time period. These changes were limited by constraints to specified increases or decreases.
Four different types of feed retailers were defined, and it was arbitrarily decided to interview three of each type. In interviewing, there were two problems encountered. First, different levels of technology could not be clearly identified. Most firms were using more than one level of technology for the different activities performed in the feed retailing business. The second problem was that of cost identification. Inconsistencies between retailers in bookkeeping prevented obtaining meaningful cost data. Meanwhile, data from the Iowa Grain and Feed Dealers Association Directory showed a decreasing number of retailers in all location centers of the Fort Dodge functional economic area. But the data revealed nothing about total dollar feed business in each location center, or levels of technology being used by feed retailers.

A more direct approach was then taken to investigate the problem. A survey was taken of 66 feed retailers in all three location centers of the NIAD and TENCO functional economic areas. The numerical data obtained from the questionnaire was tested in seven different categories.

1. 1965 dollar feed sales
2. Sales per employee
3. Percent of total business in feed
4. Percent of total business within a 10 mile driving distance
5. Miles to most distant customer
6. Number of feed services offered
7. Feed prices

An Analysis of Variance test was used to determine if any real differences existed between the NIAD and TENCO areas or among the three location centers.
The model was:

\[ Y_{ij} = U + A_1 + L_j + E_{ij} \]

where

- \( Y_{ij} \) = one of the seven factors to be tested
- \( U \) = effect of mean
- \( A_1 \) = effect of \( i \)th area
- \( L_j \) = effect of \( j \)th location center
- \( E_{ij} \) = error

Also an Analysis of Covariance test was used to test difference in 1965 dollar feed sales. The covariance adjusting factor used was number of services offered. The model used was:

\[ Y_{ij} = U + A_1 + L_j + B_{ij} + E_{ij} \]

where

- \( Y_{ij} \) = 1965 dollar feed sales
- \( U \) = effect of mean
- \( A_1 \) = effect of \( i \)th area
- \( B_{ij} \) = covariance factor
- \( E_{ij} \) = error

1. There is no difference in dollar feed sales between NIAD and TENCO or among the location centers within these areas.

2. After adjusting dollar feed sales with number of services by covariance analysis, there remains no difference in dollar feed sales between NIAD and TENCO or among the location centers within these areas.

3. There is no difference in dollar feed sales per employee between NIAD and TENCO or among the location centers within these areas.
4. There is no difference in percent of total business in feed between NIAD and TENCO or among the location centers within these areas.

5. There is no difference in percent of total feed sold within 10 miles driving distance between NIAD and TENCO or among the location centers within these areas.

6. There is no difference in miles to most distant customer between NIAD and TENCO or among the location centers within these areas.

7. There is no difference in feed prices between NIAD and TENCO or among the location centers within these areas.

The following null hypotheses were rejected:

1. There is no difference in number of services offered between NIAD and TENCO.

2. There is no difference in number of services offered among location centers.

In the opinion of the feed retailers interviewed, locational advantages were thought to be an advantage in the following location centers:

1. Convenience centers had the advantage in lower property tax, closeness to customers, and better transportation-out.

2. Retail centers thought it was an advantage that farmers were doing more non-agricultural business in their location center that, in turn, increased feed sales.

3. Convenience centers and retail centers together had an advantage in cheaper labor.

4. Central cities were thought to have an advantage in being close to a packing company.
5. Transportation-in was thought to be equally advantageous to all location centers.

This study was not successful in identifying different levels of technology or determining labor requirements in the feed retailing industry. Therefore, objectives number 2, 3, and 4 were not achieved.

D. Conclusions

At this time there is no evidence to show that relocation of feed retailers to different size cities is taking place.

E. Implications

The study suggests that the feed retailing industry tends to be a convenience oriented industry. On the average, there appears to be no incentive for the farmer to go any further than his nearest feed retailer who in most cases, is just a few miles away. However, this does not preclude that a few individual firms have not been successful in attracting new customers from a local trading center. If other feed retailers expect to increase feed sales, incentives must be established. More and better services and lower feed prices would be the most obvious incentives to increase feed sales. Innovations in organization and services are other possibilities for increased feed sales.

F. Suggestions for Further Research

Further studies should be made on other industries to achieve the stated objectives of this study with the use of the recursive linear program. The selected industry might be one that has obvious economies of scale, markets a single product, or markets a so called shoppers-good; that is, a product for which price and selection are relatively more important.
in purchase decisions. Industries to be studied further might include meat packing, soybean processing, groceries, clothing, appliances, furniture, hospitals, restaurants, and wholesaling.

In those industries in which some firms use more than one technology, a better approach might be to study firms in which only the new technology is being used. This approach would avoid the problem of identification of inputs, outputs, and costs in those firms using more than one technology.
VII. LITERATURE CITED


VIII. APPENDIX

FEED LOCATION QUESTIONNAIRE

Name ____________________________

Location:

City ____________________________

Location in City:

Downtown ____________________________

In but near city limits ____________________________

Miles from city ____________________________

Personal Characteristics of Owner or Manager:

Years in feed business ____________________________

Years in this feed business ____________________________

Age ____________________________

Education

High School 0 1 2 3 4

College 0 1 2 3 4 5 6 7

Major areas of study ____________________________

Trade School 0 1 2 3 4

Major areas of study ____________________________

Employees:

Total ____________________________

In Feed Department ____________________________
Feed Sales

1955 $________  Not in business________  Other________
1960 $________  Not in business________  Other________
1965 $________

Percent of total business done in feed: _________ %

What percent of feed is sold within the following areas?

10 mile driving distance _________ %
20 mile driving distance _________ %
30 mile driving distance _________ %
40 mile driving distance _________ %
50 mile driving distance _________ %

Miles to most distant customer _________  5 years ago _________

Prices on August 15, 1966:

Hog finisher, 12%-14%, bulk $________/ton
Pig starter, pelleted, bagged $________/ton
Sow supplement 30%-35%, pelleted, bagged $________/ton
Beef finisher 30%-35%, pelleted, bagged stilbestrol $________/ton

Feed Services Offered:

Grinding
Pelleting
Weighing
Bulk Delivery
Grain Moisture Testing
Technical Advice
Other (Specify)
In what year was the original plant built? _______

Why was this feed mill located here originally?

- Organiser lived here _______
- Good transportation lines _______
- Labor supply _______
- Livestock concentration _______
- Other (Specify) _______
- Don't know _______

Why did you choose this location to do business?

Do you have any particular advantage or disadvantage in doing business at this location center?

<table>
<thead>
<tr>
<th></th>
<th>Convenience Center 2,500 or less</th>
<th>Retail Center 2,501-25,000</th>
<th>Central City Over 25,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation in</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>Transportation out</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>Labor</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>Taxes</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>Farmers are doing more business here</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>Close to packing plant</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>Use of advertising</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>Other (Specify)</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
</tbody>
</table>

Would you rather be in any other location? Yes _______ No _______

Where? ____________________________________________

Reasons: ____________________________________________
IX. ACKNOWLEDGEMENT

The author wishes to express his appreciation and gratitude to Dr. C. Phillip Baumel, his Major Professor, for his valuable suggestions and guidance. Without his advice and encouragement this thesis never would have materialized.