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DEATH AND CRIPPLING IN THE MARKETING OF SWINE

BY

RICHARD MARION LUTHER

A thesis submitted
in partial fulfillment of the requirements for the
degree Master of Science, Department of
Animal Husbandry, South Dakota State
College of Agriculture

March, 1959

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DEATH AND CRIPPLING IN THE MARKETING OF SWINE

This thesis is approved as a creditable, independent investigation by a candidate for the degree, Master of Science, and acceptable as meeting the thesis requirements for this degree; but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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R. M. L.

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CHAPTER I

INTRODUCTION

Livestock production is a major agricultural enterprise in South Dakota. The South Dakota Crop and Livestock Reporting Service (1957) reported that in 1956 over 74 percent of the total cash farm income of farmers and ranchers in South Dakota was derived from the sale of livestock and livestock products. Swine enterprises alone accounted for one-fifth of the total, ranking second only to the income from the sale of cattle. Marketing agencies, processing plants, transportation firms, dealers and other allied interests are supported entirely or to a large extent by the livestock industry. The efficiency with which these agencies perform their part of the service of marketing is of major concern to the livestock producer. Through the use of improved technology, livestock production is at an all-time high. It is of necessity that advancements be made in livestock marketing, particularly in the safe moving of live animals from the farm or ranch to market and into retail channels.

Loss and damage of livestock in transit assume a major role in the cost of marketing livestock. These losses directly affect the producer, market and transportation agencies and ultimately the consumer of meat products. In the past three or four decades, there has been an increased effort to collect and disseminate reliable information to aid in the reduction of death and crippling losses. Some reduction has occurred mainly through the use of educational programs, but such programs have been limited by the type and amount of scientific data available.

It is evident there are many factors that contribute to death and crippling of livestock. Some of these factors cannot be readily measured. However, the more tangible factors can be studied. The purpose of this investigation is to, (1) determine the incidence of death and crippling and its relationship to total numbers of swine marketed, (2) to graphically illustrate annual, seasonal, monthly, weekly and daily patterns of swine marketing, death and injury, (3) to relate length-of-haul to incidence of loss and, (4) to study the combined effect of year, month and distance hauled on rate of loss and damage.

CHAPTER II

REVIEW OF LITERATURE

Annual Losses

The magnitude and economic significance of swine death and crippling losses have been described by workers in the livestock marketing field. Considerable literature is available concerning losses at various points in the United States. Annual losses have been summarized by Smith (1949), Cuff (1949), Pickard (1951), Mossberg (1958) and Luther (1958) and are tabulated in Table I.

In studies of truck and rail shipments to the Cleveland, Ohio market in 1926-1927, Henning (1929) reported death losses of swine arriving by truck at 8.9 and by rail at 20.5 per 10,000 received. Crippled swine were absent in truck shipments; rail shipments accounted for 42.5 cripples per 10,000.

Although these losses are small in relation to number of swine received at the markets, their economic importance is revealed by the dollar value.

In recent years estimates of livestock loss due to bruising, death, crippling and handling in transporting have been made by various organizations allied to the livestock industry. Livestock Conservation Inc., formerly known as the National Livestock Loss Prevention Board, has been most active in the campaign to reduce this costly waste. Livestock Conservation Inc. (1955) reported an estimate of livestock losses

TABLE I. SUMMARY OF SWINE DEATH AND CRIPPLING INVESTIGATIONS
(Reported as Percentage of Swine Received)

| Year | Smith ^{1/} | Cuff ^{2/} | Pickard ^{3/} | Mossberg ^{4/} | Luther ^{5/} |
|------------------|---------------------|--------------------|-----------------------|------------------------|----------------------|
| Deaths: | | | | | |
| 1946 | - | 0.126 | 0.148 | 0.212 | 0.075 |
| 1947 | - | 0.141 | 0.138 | 0.208 | 0.077 |
| 1948 | 0.182 | 0.144 | 0.139 | 0.213 | 0.074 |
| 1949 | 0.172 | 0.127 | 0.138 | 0.198 | 0.066 |
| 1950 | - | - | 0.126 | 0.190 | 0.055 |
| 1951 | - | - | - | 0.166 | 0.049 |
| 1952 | - | - | - | 0.183 | 0.039 |
| 1953 | - | - | - | 0.175 | 0.047 |
| 1954 | - | - | - | 0.139 | 0.051 |
| 1955 | - | - | - | 0.139 | 0.035 |
| Cripples: | | | | | |
| 1946 | - | 0.117 | - | - | 0.096 |
| 1947 | - | 0.149 | - | - | 0.108 |
| 1948 | 0.316 | 0.139 | - | - | 0.137 |
| 1949 | 0.344 | 0.146 | - | - | 0.127 |
| 1950 | - | - | - | - | 0.096 |
| 1951 | - | - | - | - | 0.092 |
| 1952 | - | - | - | - | 0.084 |
| 1953 | - | - | - | - | 0.082 |
| 1954 | - | - | - | - | 0.075 |
| 1955 | - | - | - | - | 0.061 |

^{1/} For five midwestern public markets.

^{2/} For the Kansas City public market.

^{3/} For 20 public markets.

^{4/} For the South St. Paul public market.

^{5/} For the Sioux Falls public market.

from death and crippling on arrival at principal markets in the United States in 1954. These data for each species are shown in Table II.

TABLE II. DEATH AND CRIPPLING LOSSES ON ARRIVAL AT PRINCIPAL MARKETS FOR 1954

| | Percentage of Livestock Received | | Total Value in Thousands of Dollars | |
|-----------------|----------------------------------|-----------------|-------------------------------------|-----------------|
| | <u>Dead</u> | <u>Crippled</u> | <u>Dead</u> | <u>Crippled</u> |
| Cattle | 0.0294 | 0.0418 | \$1,261 | \$ 785 |
| Hogs | 0.1340 | 0.1280 | 4,659 | 2,077 |
| Calves | 0.1143 | 0.1239 | 559 | 237 |
| Sheep and Lambs | 0.1396 | 0.0465 | 415 | 56 |
| Total | | | \$6,894 | \$3,155 |
| Total Loss | | | \$10,049 | |

Rickenbacker (1958) reported that results of 1955 and 1956 studies indicate the national dead and cripple loss to the livestock industry to be approximately \$8,000,000 per year for these years at average annual prices.

Seasonal Losses

Studies at various livestock markets have emphasized the importance of season of the year on swine losses. Henning (1929) reported that truck losses were highest during March, April and May and lowest during February and September. Losses by rail were largest in January and smallest in August.

Wiley (1927) investigated death and crippling in swine shipments arriving by rail at four eastern terminal markets during 1922-1926. He reported the incidence of loss per 1,000 swine received. Death losses averaged 1.19 for November, the lowest month, while January and June were the highest with 2.71 deaths each. Cripple losses were lowest in September with 1.73 while the highest months were January and February with 5.30 and 5.32, respectively.

Table III shows monthly percentages reported by Dowell and Eggert (1939) of death and crippling losses at the South St. Paul market for 1937. The percentages are for losses occurring between the time of loading at the farm and arrival at the market. There was a considerable amount of monthly variation with the winter months (December, January and February) being the highest for both dead and crippled losses.

TABLE III. SEASONAL VARIATION IN LOSSES AT THE SOUTH ST. PAUL MARKET, 1937

| Month | Percentage of Receipts | |
|-----------|------------------------|----------|
| | Dead | Crippled |
| January | 0.125 | 0.368 |
| February | 0.122 | 0.442 |
| March | 0.096 | 0.281 |
| April | 0.067 | 0.208 |
| May | 0.104 | 0.263 |
| June | 0.089 | 0.206 |
| July | 0.109 | 0.198 |
| August | 0.085 | 0.140 |
| September | 0.061 | 0.094 |
| October | 0.072 | 0.141 |
| November | 0.095 | 0.269 |
| December | 0.152 | 0.389 |

Mossberg (1958) found at the St. Paul market that the percentage of deaths was highest in June in seven out of ten and lowest in September in eight of ten years compared. The average of all years show that April, May, June and July were the critical months with values of 0.206, 0.209, 0.271 and 0.214 percent followed closely by December, January and February with 0.185, 0.189 and 0.171, respectively. September, the lowest month, had a loss value of 0.116 percent.

Type of Transportation

The Livestock Division of the United States Department of Agriculture periodically compiles market news and statistics for livestock marketed through the major public markets. Fowler (1957) tabulated data from this source for the period 1932-1954. During these years the use of the motor truck for livestock transportation has increased 37.3 percent. The United States Department of Agriculture (1957) reported that truck receipts in 1956 accounted for 87.2 percent of total livestock receipts at the major public markets. Data compiled by the Sioux Falls Stock Yards Company (1956) for a forty-year period, 1917-1956, show that swine arriving by truck increased 88.0 percent from 1917 to 1932. Since 1932 practically all swine have been delivered to this market by motor truck. In the last five years two shipments of swine arrived by rail, accounting for 1,419 head.

Length-of-Haul

The influence of length-of-haul on swine death and crippling

losses has been studied by some workers. Dowell and Eggert (1939) compiled data for Minnesota shipments by five mileage zones. The zones were 0-50, 51-100, 101-150, 151-200 and over 200 miles from market. Percentage of dead swine received amounted to 0.04, 0.10, 0.15, 0.17 and 0.14 while crippling was 0.20, 0.28, 0.37, 0.44 and 0.20 for each zone, respectively.

In studies at three Wisconsin livestock cooperatives during 1952, Rickenbacker (1955) compared incidence of loss with total receipts according to length-of-haul. The results are shown in Table IV.

TABLE IV. PERCENTAGE OF SWINE RECEIPTS AND COMBINED DEATH AND CRIPPLING LOSS AT THREE WISCONSIN MARKETS, 1952

| Mileage Block | Percentage of Total Receipts | Percentage of Total Deaths and Cripples |
|---------------|------------------------------|---|
| 0 - 10 | 1.6 | 0.0 |
| 11 - 20 | 4.1 | 1.0 |
| 21 - 30 | 16.2 | 7.3 |
| 31 - 40 | 13.0 | 10.7 |
| 41 - 50 | 15.3 | 10.7 |
| 51 - 60 | 7.0 | 3.0 |
| 61 - 70 | 12.8 | 14.6 |
| 71 - 80 | 4.0 | 4.4 |
| 81 - 90 | 0.4 | 0.0 |
| 91 - 100 | 12.4 | 22.3 |
| Over 100 | 13.1 | 26.2 |
| Total | 99.9 | 100.2 |

It is apparent in Table IV that death and cripple losses are related to the number of swine received. Length-of-haul seems to have an effect since the greatest loss occurred in the mileage blocks of 91-100 and over 100 miles beyond the market.

Luther (1958) compared total receipts of livestock arriving at the Sioux Falls terminal market by mileage zones for the years 1938-1942 with receipts of 1954. These data are shown in Table V. Comparing the average

TABLE V. COMPARISON OF SWINE RECEIPTS FOR 1938-1942 WITH RECEIPTS OF 1954 BY MILEAGE ZONE^{1/}

| Mileage Zone | 1938 | 1939 | 1940 | Year 1941 | 1942 | 1938-1942 | 1954 |
|--------------|-------|-------|-------|-----------|-------|-----------|-------|
| 0 - 10 | 3.1 | 3.5 | 3.8 | 3.8 | 3.7 | 3.6 | 5.6 |
| 11 - 20 | 18.0 | 18.3 | 20.4 | 20.9 | 21.8 | 20.0 | 24.3 |
| 21 - 30 | 23.9 | 21.8 | 19.8 | 21.0 | 20.5 | 21.1 | 22.7 |
| 31 - 40 | 27.6 | 27.8 | 26.6 | 26.6 | 26.6 | 27.0 | 21.9 |
| 41 - 50 | 12.5 | 12.1 | 12.5 | 11.8 | 11.5 | 12.1 | 8.7 |
| 51 - 60 | 7.5 | 7.3 | 7.6 | 7.4 | 7.0 | 7.4 | 8.1 |
| 61 - 70 | 2.6 | 2.3 | 2.4 | 2.1 | 2.0 | 2.3 | 4.7 |
| 71 - 80 | 1.3 | 1.5 | 1.6 | 1.6 | 1.6 | 1.5 | 1.5 |
| 81 - 90 | 0.9 | 1.5 | 0.9 | 1.4 | 1.3 | 1.2 | 0.8 |
| 91 - 100 | 0.3 | 0.9 | 0.7 | 0.5 | 0.7 | 0.7 | 0.5 |
| Over 100 | 2.3 | 3.0 | 3.7 | 2.9 | 3.3 | 3.1 | 1.2 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

^{1/} Reported as percentage of swine received from all zones.

percentage of swine received for the 1938-1942 period with 1954, zones 0-10, 11-20, 21-30 and 61-70 increased in receipts at the expense of other zones. The zone of 71-80 miles from market was the only zone to remain constant in the two comparisons. The greatest change occurred in the 31-40 mile zone which was 5.1 percent lower in swine numbers in 1954 than the five-year average.

The literature reviewed gives some indication of the magnitude and economic significance of death and crippling losses in swine marketing.

Losses are costing the livestock producer in the United States approximately

eight to ten million dollars annually. There is disagreement in the literature as to the critical months of swine loss. In general, January, February, June, November and December are the most critical months for swine losses.

A large percentage of the total livestock receipts are transported to market by motor truck. Length-of-haul has been shown to be important in swine losses but the number of swine received appears to be the most important single factor. However, variations encountered between years, months and markets indicate that other important factors are involved.

Annual losses at the Sioux Falls market are considerably lower than at some other markets (see Table I). The fact that the major portion of the swine are trucked less than 50 miles (Table V) probably has an important influence.

CHAPTER III

MATERIALS AND METHODS

The livestock marketing industry and particularly the individual marketing agency is marked by numerous traditions and special characteristics. Among these are certain terms or words used to describe the business or operation. A knowledge of the terminology characteristic of the public livestock market and that used in the livestock marketing industry may aid in understanding the discussion which follows.

Explanation of Terms Used in Manuscript

Crippled Swine:

A live animal at the time of unloading that is unable to walk without assistance from the unloading docks to the receiving pens is classified as crippled (Appendix Figure 1). In addition, animals which limp or show signs of injury, pain, emaciation or exhaustion upon arrival at the market are also classified as crippled. Such animals must be transported to the point of slaughter in a "cripple cart." Animals which were crippled in the yards after unloading are not included.

Dead Swine:

Animals that have died between the time of loading at the farm and unloading at the market are recorded as dead swine (Appendix Figure 2). Animals that die in the yards are not included in this study.

Drive-in:

Drive-in includes all livestock received at a market other than livestock received by rail (Appendix Figure 3).

Length-of-Haul:

The term length-of-haul refers to the total miles a swine shipment was transported between the point of origin, which may be at the farm, ranch or local loading point and the market.

Loss or Losses:

Death or crippling to a swine shipment or an animal therein occurring during loading or transit to market is termed a loss. Such losses are absorbed by the consignor of the shipment except when insurance is provided by the transportation agency. Loss refers to number rather than economic value.

Loss Ratio:

The number of dead or number of crippled animals per 10,000 animals received.

Market:

Sioux Falls Stock Yards, Sioux Falls, South Dakota.

Marketing:

Includes all transactions that occur between the time the decision is made to dispose of livestock until the sale has been completed at the market.

Market Day:

The 24-hour period from 3:00 p.m. of the day preceding to 3:00 p.m. of the day on which the data were reported.

Market Week:

The market week includes week days, Monday through Friday. There is no trading on Saturday and Sunday and some holidays, however, livestock are received and cared for as usual.

Receipts:

The number of head of livestock shipped by truck from the farm, ranch or other loading points to the market. Rail shipments are excluded in this study.

Source of Data

There are several agencies in South Dakota that accumulate information regarding death, crippling and bruising in livestock marketing. It was necessary to select a market with sufficient volume of livestock that would provide loss data in the amounts needed to yield reliable results. The data available for this investigation allow comparisons of the incidence of dead and crippled swine delivered to market by truck over a five-year period.

Swine loss data used in this study were collected from the records of the Sioux Falls Stock Yards Company, Sioux Falls, South Dakota (Appendix Figure 4). The stockyards, a forty-eight acre establishment, provides 1,297 pens which accommodate 8,000 cattle, 15,500 hogs and 10,800 sheep. Eight commission firms, 12 order buyers and 17 livestock dealers registered and bonded by the Stockyards Branch of the United States Department of Agriculture operate on the market. An inspector from the United States Department of Agriculture makes regular visits to the market to

inspect livestock scales and supervise market practices. A Market News Service is maintained and a staff of Federal veterinarians are responsible for the enforcement of strict sanitation practices.

The Sioux Falls Stock Yards, located in Minnehaha County, South Dakota, is adjacent to the highly productive livestock producing and feeding areas of the midwest. Livestock shipments are received from South Dakota, Minnesota, Iowa, Nebraska, Montana, North Dakota, Wyoming, Colorado, Idaho, Utah, Texas, California and Canada. More than 106,000 trucks unload livestock at yard chutes annually.

The United States Department of Agriculture (1957) reported that the Sioux Falls Market ranked eleventh of the 63 terminal markets in total saleable livestock receipts. It is ranked thirteenth in cattle with 428,804 head, forty-sixth in calves with 15,968 head, twelfth in hogs with 743,361 head and nineteenth in sheep and lambs with 203,498 head.

Methods of Procedure

Relationship of Volume of Receipts to Losses

Daily drive-in swine receipts and number of deaths and cripples were obtained from the stockyards company records for the period 1953-1957. Distribution percentages and loss ratios were calculated for dead swine independently of crippled swine. The information was coded and classified according to day of the week, week of the month, month, season and year. The year was divided into three-month periods which have been designated as spring (February, March and April), summer (May, June and

July), fall (August, September and October), and winter (November, December and January). The loss data were punched on IBM cards to permit grouping for statistical analyses. Each card contained initial, calculated and coded data for each market day.

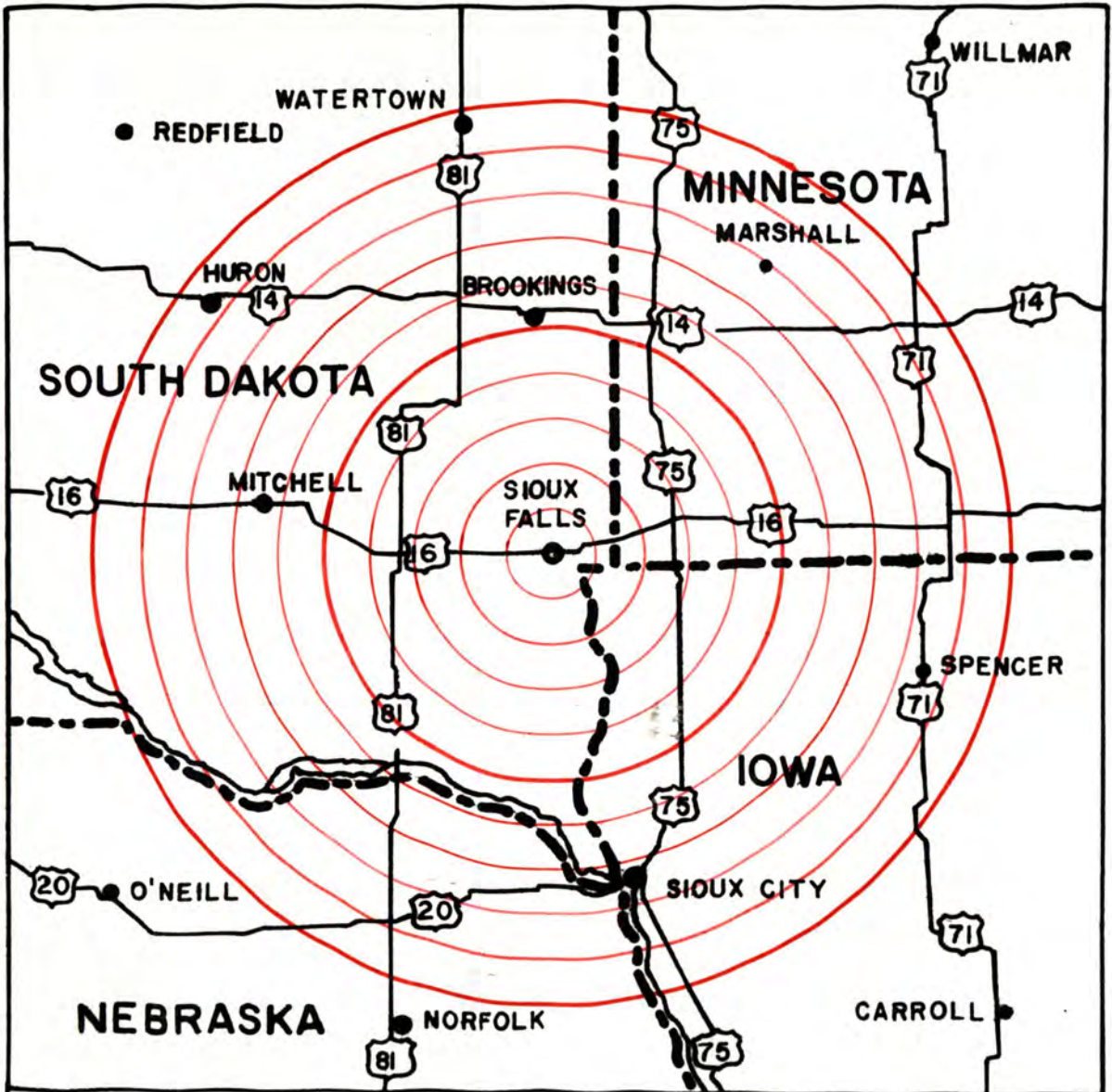
Length-of-Haul and Incidence of Losses

During the period 1955-1957, origin of individual shipments having a death or cripple in them when delivered to the market was recorded apart from the punch card study. The origin was determined from the postal address of the consignor of the shipment. Using a Rand McNally "Road Atlas," 1956, concentric circles were drawn to represent mileage zones in ten-mile increments around the city of Sioux Falls. Zone 11 was used for all shipments originating over 100 miles beyond the market.

Figure 1 shows the eleven mileage zones and the four-state area surrounding the Sioux Falls market. The city or town shown in the address was located on the map and the zone recorded. Because of the location of a city or town in a particular zone, the zone indicated does not accurately reflect the traveled distance to the market. This method was used to provide more uniformity in reporting the data since it was often difficult to establish miles traveled due to choice of routes and types of roadways.

Shipments included in the length-of-haul phase of the study originated in Minnesota, Iowa and South Dakota. The most distant point of origin of a shipment containing a dead animal was approximately 401 miles and a cripple approximately 423 miles from the market.

Since the length-of-haul data provided information regarding the origin of shipments having losses, it was necessary to determine the point



**Figure 1. Mileage Zones in Ten-mile Increments
Around the Sioux Falls Livestock Market.**

Legend

- Federal Highway
- - - State Boundaries

0 10 20 30 50 70

SCALE-ONE INCH EQUALS APPROXIMATELY 40 MILES

of origin of all swine shipments to the market for purposes of comparison. These data were obtained from a study of swine shipments at the market for 1954 (Luther, 1958).

The shipment study involved the punching of consignment data on IBM cards for each shipment of livestock that arrived at the market during 1954. Data were available for cattle, calves, swine and sheep. The cards were classified according to eleven mileage zones. Total receipts, number of deaths and cripples and number of shipments were obtained for each mileage zone by sorting and tabulating the cards. Studies cited in a previous section show that differences in origin of swine receipts exist between the average for the 1938-1942 period and 1954. Shifts in the origin of swine receipts might be expected during the long interim period. Differences between 1954 and the succeeding years would be relatively small.

The 1954 data (Appendix Table I), in addition to providing information on the origin of all swine receipts, provided another year of loss data. Receipts for 1954 classified by mileage zones are used as the base with which losses from 1955-1957 are compared.

A limitation of the 1954 data was that the monthly totals both for receipts and losses do not always agree with those obtained on a daily basis. This may be explained, in part, by the fact that shipments received on the last day of the month are not involved in trading until the first day of the succeeding month. Such would be the case for the beginning and ending of the year.

Method of Analysis

The data collected was limited to the five market days, Monday through Friday, at the Sioux Falls Stock Yards during the period 1953-1957. Livestock were received on Saturday, Sunday and holidays but company records indicated they were not involved in trading except on the regular market days. The data collected in this study includes 1,279 market days. Since it represents nearly complete receipts for this market, this analysis need not be concerned with testing the validity of hypothesis dealing with the sampling of a population and the resulting factors of distribution, variation and the drawing of inferences. There are, however, various comparisons and evaluations in the present data which involve related statistical methods.

The first objective of the analysis was to determine if a relationship existed between the number of swine received and the number of dead and crippled swine during a given period. An appraisal of the raw data would suggest a close relationship. The functional relationship, represented by the regression equation $Y = a + bX$, was obtained by using deviations from the mean for each factor. The degree or measurement of the relationship was obtained using the product-moment method of two-variable correlation for ungrouped data and is represented by the simplified formula:

$$r = \frac{\sum xy}{\sqrt{\sum x^2 \sum y^2}}$$

$\sum x^2$ is the sum of the squared deviations from the mean for the independent variable. $\sum y^2$ is the sum of the squared deviations from the mean for the

dependent variable. $\sum xy$ is the sum of the cross products for the independent and dependent variables corrected for the mean.

For this analysis the complete deck of IBM cards was sorted five times into the following groups: year, season, month, week and day. The number of receipts, deaths and cripples for each group was posted using the IBM tabulator. After mechanically rounding receipts to hundreds of head for ease of calculation, sums of squares and crossproducts were obtained using a desk calculator.

Distribution percentages of the number of swine marketed, deaths and cripples were calculated for the various divisions of time. The question arises as to the proper comparison of these data. The usual method of analysis would compare the number of swine received with number of deaths and cripples for each individual unit of a division of time. For example, in the annual data, 1954 would be the individual unit. The following data show the number of swine received, death and crippling losses. It is evident that the number of swine received is approximately

| <u>Year</u> | <u>Number Received</u> | <u>Number Dead</u> | <u>Number Crippled</u> |
|-------------|----------------------------|------------------------|----------------------------|
| 1953 | 666,017 | 316 | 548 |
| 1954 | 709,059 | 360 | 529 |
| 1955 | 886,075 | 306 | 540 |
| 1956 | 805,113 | 238 | 498 |
| 1957 | <u>743,361</u> | <u>275</u> | <u>298</u> |
| Total | 3,809,625 | 1,495 | 2,413 |

one thousand to three thousand times greater than either death or crippling. These values show only the magnitude of the differences which are small in relation to the number received.

An analysis is presented by means of tables and graphs showing the percentage of volume of receipts, deads and cripples by time periods. In this way, the importance of dead and crippled animals in the receipts become more evident. In each figure in the Results and Discussion section, distribution percentages are based upon the five-year total which is equal to 100 percent. Loss ratios were calculated and the analysis is also presented in tables and illustrated graphically.

The second objective of the analysis was to evaluate seasonal dead and cripple swine losses by means of a time series analysis. Croxton and Cowden (1955) state that time series data are typically a product of four components: secular trend (T), seasonal variation (S), cyclical movements (C), and irregular fluctuations (I). Trend is termed the amount of increase or decrease in the unit of measure over a series of years. Seasonal variation refers to periodic movements in which there is a recurrence of a movement with some degree of regularity within a definite period. Cyclical movements usually are of longer duration but do not occur with the regularity as seasonal movements. Episodic or accidental variation due to specific events or occurrences is called the irregular component.

Trend variation may be caused by annual changes in swine production and marketing. Seasonal movements due to climatic conditions including snow and ice, heat, humidity and wind may affect the time when swine are marketed. The cyclical movement is caused by production changes over a long period of time. Irregular variation in swine marketing may be caused by market or transportation strikes, severe storms, floods and other occurrences.

Trend, cyclical and irregular variation was partitioned from the five-year time series data leaving the seasonal component. The variation due to trend was obtained by determining a trend equation ($Y = a + bX$) for the original data and obtaining monthly trend values. The original monthly data are expressed as percentages of the monthly trend values. These percentages are termed "ratios to trend." The percentages are then placed in a table consisting of 12 columns, one for each month. The percentage of trend method does not account for the effect of cyclical highs and lows and irregular fluctuations. To eliminate these effects the data from the 12 column table were rearranged in five rows. The middle three rows were averaged providing a modified mean for each month. The seasonal index is calculated by adjusting the 12 monthly modified means so that they would total 1,200.

The third objective of the analysis was to determine if the origin of receipts for 1954 was compatible with the origin of dead and of crippled swine for that year and 1955, 1956 and 1957. This was accomplished by using a test for goodness of fit involving chi-square procedures. Snedecor (1957) suggests that chi-square is a means of evaluating possible observed frequency deviations from a hypothetical frequency. The number of swine received by mileage zone for 1954 (see Appendix Table I) was used as the hypothetical frequency (f). The number of dead and crippled losses served as the observed frequency (f_c). Chi-squares were calculated for each year and for the four-year total. The mathematical model for chi-square is:

$$\chi^2 = \frac{(f - f_c)^2}{f_c}$$

The length-of-haul data, 1954-1957, were analyzed by means of analysis of variance. Year was considered the initial sample and zone and month the sub-samples. A three-way table was used to classify the loss data according to eight mileage zones and 12 months within four years. Computations were made using a desk calculator.

CHAPTER IV

RESULTS AND DISCUSSION

Supplementary data have been tabulated in addition to the tables and illustrations which follow in this section. Mean swine receipts and losses for the time periods and additional data regarding volume of swine received, losses and length-of-haul are shown in the appendix tables.

Relationship of Receipts to Death and Crippling Losses

When the entire body of data is analyzed statistically, using 1,279 pairs of observations, the relationship of receipts and death loss was shown by the equation $X_2 = -.25317 + .04775X_1$ and crippled loss by $X_3 = -.55363 + .08194X_1$. A unit (one unit = ten hundred) increase in volume of receipts would result in an increase of .4775 deaths and an increase of .8194 in cripples.

Tables VI and VII show the analysis of variance for regression of volume of receipts with deaths and cripples.

TABLE VI. ANALYSIS OF VARIANCE FOR REGRESSION OF RECEIPTS ON DEATHS

| Source of Variation | Sums of Squares | Degrees of Freedom | Mean Squares |
|---------------------|-----------------|--------------------|--------------|
| Deaths (X_2) | 2,949 | 1,278 | |
| Regression | 549 | 1 | 549.00 ** |
| Remainder | 2,400 | 1,277 | 1.879 |

** Significant at the 1% level.

TABLE VII. ANALYSIS OF VARIANCE FOR REGRESSION OF RECEIPTS ON CRIPPLES

| Source of Variation | Sums of Squares | Degrees of Freedom | Mean Squares |
|---------------------|-----------------|--------------------|--------------|
| Cripples (X_3) | 5,809 | 1,278 | |
| Regression | 1,617 | 1 | 1,617.00 ** |
| Remainder | 4,192 | 1,277 | 3.283 |

** Significant at the 1% level.

The degree of relationship is shown by the correlation coefficient, $r = \sqrt{.4316}$ for receipts and dead swine and $\sqrt{.5277}$ for receipts and crippled swine. The proportion of variability in dead and crippled losses which is explained by swine receipts is illustrated by the coefficient of determination (r^2) which is equal to .19 for dead and .28 for cripples. From these figures it is seen that about 19.0 percent of the variation in death losses and 28.0 percent of the crippled losses are explained by receipts or volume of marketing. This leaves 81.0 percent and 72.0 percent of the variation respectively to be explained by factors other than receipts.

Letting X_1 the independent variable represent receipts and X_2 and X_3 the dependent variables deaths and cripples respectively, sums of squares and cross products were obtained for various time periods. The resulting regression and correlation coefficients (Table VIII) were positive and significant at the one percent level of probability. The highest correlation between number of swine received and crippling occurred in 1955. The correlation between number and deaths was greatest

TABLE VIII. CORRELATION AND REGRESSION COEFFICIENTS FOR RECEIPTS WITH DEAD AND CRIPPLED SWINE BY VARIOUS DIVISIONS OF TIME

| Division of Time | N ^{1/} | Correlation Coefficient | | Regression Coefficient | |
|------------------|-----------------|-------------------------|----------|------------------------|----------|
| | | Dead | Crippled | Dead | Crippled |
| Years | | | | | |
| 1953 | 256 | .504 | .576 | .064 | .107 |
| 1954 | 258 | .515 | .447 | .072 | .080 |
| 1955 | 255 | .377 | .649 | .036 | .090 |
| 1956 | 255 | .509 | .622 | .044 | .097 |
| 1957 | 255 | .436 | .276 | .057 | .034 |
| Season | | | | | |
| Spring | 320 | .267 | .425 | .034 | .073 |
| Summer | 322 | .330 | .303 | .057 | .063 |
| Fall | 322 | .344 | .242 | .022 | .022 |
| Winter | 315 | .389 | .498 | .048 | .088 |
| Week | | | | | |
| First | 285 | .466 | .581 | .051 | .090 |
| Second | 297 | .414 | .518 | .049 | .075 |
| Third | 300 | .447 | .532 | .054 | .086 |
| Fourth | 292 | .405 | .461 | .039 | .073 |
| Fifth | 105 | .405 | .555 | .039 | .091 |
| Days | | | | | |
| Monday | 253 | .387 | .394 | .047 | .059 |
| Tuesday | 258 | .337 | .468 | .043 | .079 |
| Wednesday | 257 | .399 | .544 | .048 | .099 |
| Thursday | 252 | .404 | .519 | .045 | .090 |
| Friday | 259 | .529 | .615 | .048 | .077 |

^{1/} N = Pairs of observations.

in 1954. The proportion of total variation (r^2) in death and crippling explained by the number of swine received was 42.1 and 14.2 percent, respectively. During these two years, a one-unit change in volume of receipts resulted in .90 and .72 change in deaths and cripples, respectively.

Seasonally, the loss coefficients were not unusually high. During the winter and spring each unit change in the number of swine received

resulted in a .73 and .88 change in crippling, while in the summer season .57 deaths resulted per unit change in volume of receipts. Winter coefficients of determination (r^2) were .24 and .15 for deaths and cripples, respectively.

Loss correlation coefficients did not differ greatly among the five weeks compared. The degree of relationship of number received and death and crippling losses was greatest in the first week. Approximately 22.0 and 34.0 percent of the death and crippling variation was explained by the volume of swine received. While volume of receipts significantly affected losses, a greater portion of variation was due to other factors.

Considerable variability was present in the correlation coefficients for the daily comparisons. Tuesday, a traditionally large day for swine marketings at the Sioux Falls market, had a correlation coefficient of .337 for deaths and .468 for cripples compared to .529 and .615 on Friday, a rapidly improving market day in terms of activity and price. The largest change in crippling per unit change in number occurred on Wednesday with a regression coefficient of .099. The regression coefficients for deaths did not differ greatly between days.

Distribution of Receipts, Dead and Crippled Swine

Table IX and Figure 2 give the percentage distribution values for each year of the period studied. The percentage of deaths and cripples followed different patterns from that of numbers received. Crippling varied little from year to year except in 1957 which was down 8.2 percent from 1956. Distributions of death loss were quite irregular over the period and did not correspond to either those of receipts or crippled loss.

TABLE IX. ANNUAL NUMBER AND DISTRIBUTION OF SWINE RECEIPTS,
DEATHS AND CRIPPLES WITH LOSS RATIOS

| | 1953 | 1954 | Year 1955 | 1956 | 1957 | Total |
|--------------------------------|------|------|--------------|------|------|-----------|
| Number | | | | | | |
| Receipts ^{1/} | 665 | 709 | 887 | 806 | 743 | 3810 |
| Dead | 316 | 360 | 306 | 238 | 275 | 1495 |
| Crippled | 548 | 529 | 540 | 498 | 298 | 2413 |
| Distribution (%) | | | | | | |
| Receipts | 17.5 | 18.6 | 23.3 | 21.1 | 19.5 | 100.0 |
| Dead | 21.1 | 24.1 | 20.5 | 15.9 | 18.4 | 100.0 |
| Crippled | 22.7 | 21.9 | 22.4 | 20.6 | 12.4 | 100.0 |
| Loss Ratio^{2/} | | | | | | |
| | | | | | | (Average) |
| Dead | 4.75 | 5.08 | 3.45 | 2.95 | 3.70 | 3.92 |
| Crippled | 8.24 | 7.46 | 6.09 | 6.18 | 4.01 | 6.33 |

^{1/} Thousands of head for receipts only.

^{2/} Loss per 10,000 swine received.

The seasonal comparisons of swine received with losses are shown in Table X and Figure 3. The largest number of receipts, deaths and cripples occurred in the winter season, although death and crippling to a greater extent than receipts. Distributions of the three criteria were quite comparable during the spring and summer season, but they differ considerably in the fall. Compared to number received, deaths and cripples were lowest in the fall season. This was particularly true for cripples.

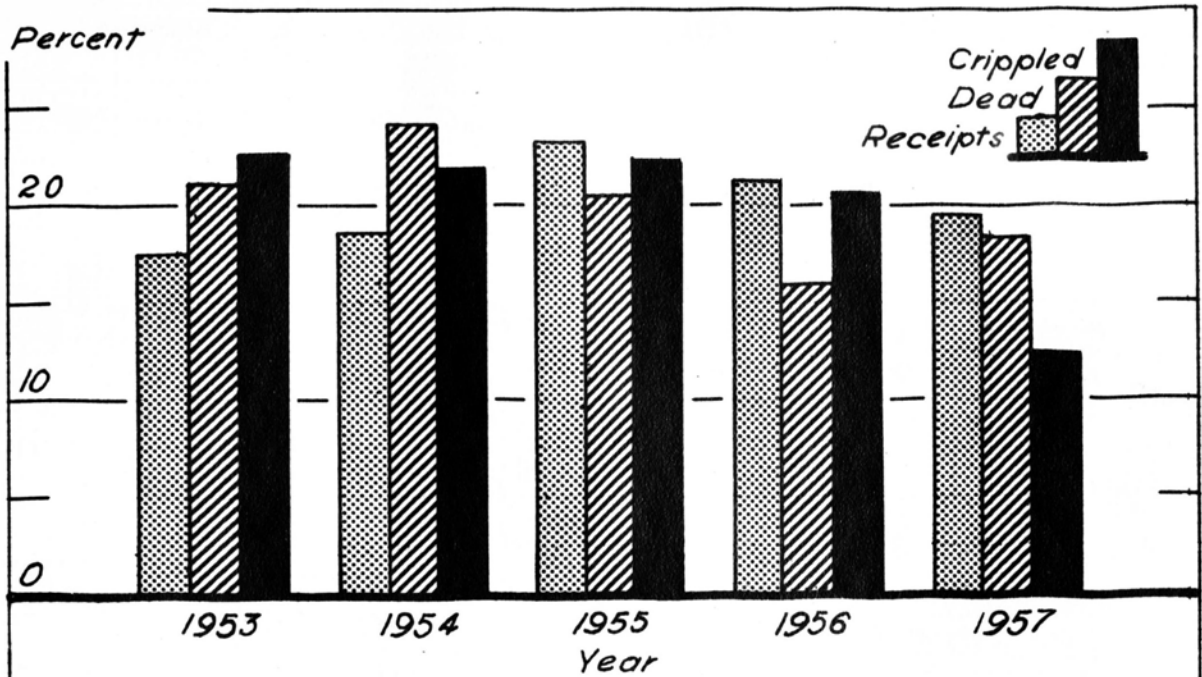


Figure 2. Annual Distribution of Receipts, Dead and Crippled Swine.

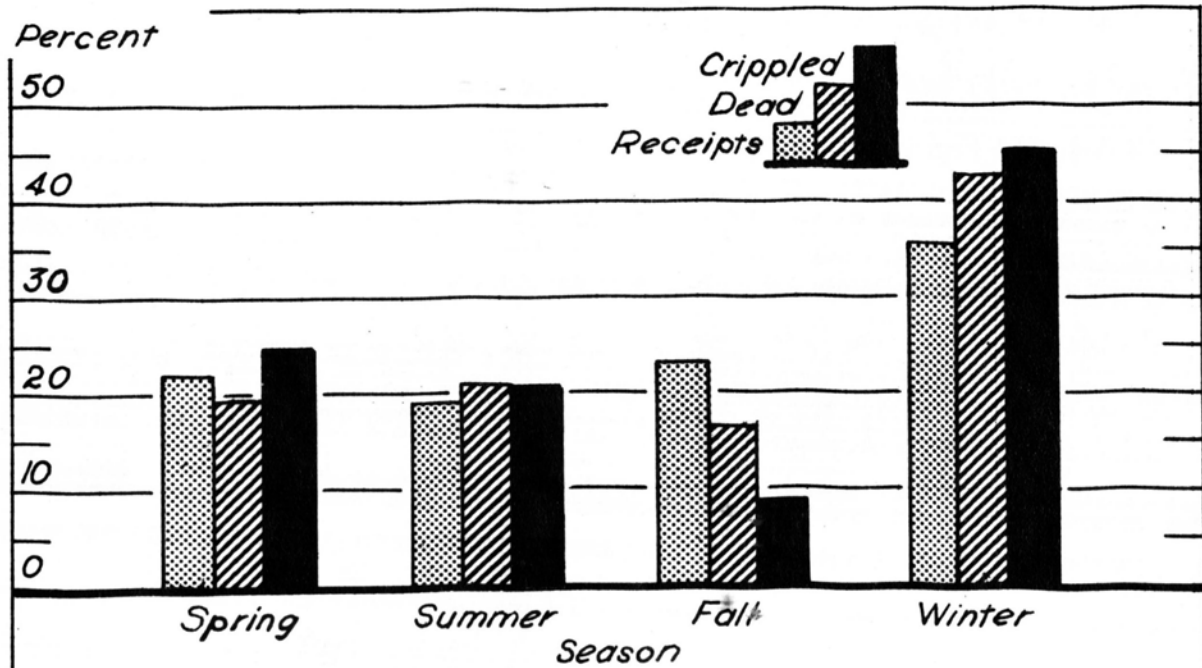


Figure 3. Seasonal Distribution of Receipts, Dead and Crippled Swine, 1953-1957.

TABLE X. SEASONAL NUMBER AND DISTRIBUTION OF SWINE RECEIPTS, DEATHS AND CRIPPLES WITH LOSS RATIOS, 1953-1957

| | Spring | Season Summer | Fall | Winter | Total |
|--------------------------------|--------|------------------|------|--------|------------------|
| Number | | | | | |
| Receipts ^{1/} | 843 | 726 | 880 | 1361 | 3810 |
| Dead | 291 | 312 | 250 | 642 | 1495 |
| Crippled | 601 | 501 | 215 | 1096 | 2413 |
| Distribution (%) | | | | | |
| Receipts | 22.1 | 19.1 | 23.1 | 35.7 | 100.0 |
| Dead | 19.5 | 20.9 | 16.7 | 42.9 | 100.0 |
| Crippled | 24.9 | 20.8 | 8.9 | 45.4 | 100.0 |
| Loss Ratio^{2/} | | | | | (Average) |
| Dead | 3.45 | 4.30 | 2.84 | 4.72 | 3.92 |
| Crippled | 7.13 | 6.90 | 2.44 | 8.05 | 6.33 |

^{1/} Thousands of head for receipts only.

^{2/} Loss per 10,000 swine received.

The largest numbers of swine were received during the months of January, October, November and December as shown in Table XI and Figure 4. The number of deaths followed a similar pattern as receipts, except for June which had a fairly large number of deaths in relation to receipts. January, November and December have the greatest number of crippled swine. In January the number of both deaths and cripples was proportionally greater than the increase in volume of swine received would seem to justify.

TABLE XI. MONTHLY NUMBER AND DISTRIBUTION OF SWINE RECEIPTS, DEATHS AND CRIPPLES
WITH LOSS RATIOS, 1953-1957

| | Month | | | | | | | | | | | | Total |
|--------------------------|-------|------|------|------|------|------|------|------|-------|------|------|------|-----------|
| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | |
| Number | 445 | 289 | 299 | 255 | 239 | 255 | 232 | 226 | 265 | 389 | 447 | 469 | 3810 |
| Receipts ^{1/} | 254 | 99 | 100 | 92 | 98 | 126 | 88 | 55 | 71 | 124 | 163 | 225 | 1495 |
| Dead | 487 | 243 | 176 | 182 | 172 | 197 | 132 | 62 | 49 | 104 | 257 | 352 | 2413 |
| Crippled | | | | | | | | | | | | | |
| Distribution (%) | | | | | | | | | | | | | |
| Receipts | 11.7 | 7.6 | 7.8 | 6.7 | 6.3 | 6.7 | 6.1 | 5.9 | 7.0 | 10.2 | 11.7 | 12.3 | 100.0 |
| Dead | 17.0 | 6.6 | 6.7 | 6.1 | 6.6 | 8.4 | 5.9 | 3.7 | 4.7 | 8.3 | 10.9 | 15.1 | 100.0 |
| Crippled | 20.2 | 10.1 | 7.3 | 7.5 | 7.1 | 8.2 | 5.5 | 2.6 | 2.0 | 4.3 | 10.6 | 14.6 | 100.0 |
| Loss Ratio ^{2/} | | | | | | | | | | | | | (Average) |
| Dead | 5.71 | 3.43 | 3.34 | 3.61 | 4.10 | 4.94 | 3.79 | 2.43 | 2.68 | 3.19 | 3.65 | 4.80 | 3.92 |
| Crippled* | 10.94 | 8.41 | 5.89 | 7.14 | 7.20 | 7.73 | 5.69 | 2.74 | 1.85 | 2.67 | 5.75 | 7.51 | 6.33 |

^{1/} Thousands of head for receipts only.
^{2/} Loss per ten thousand head received.

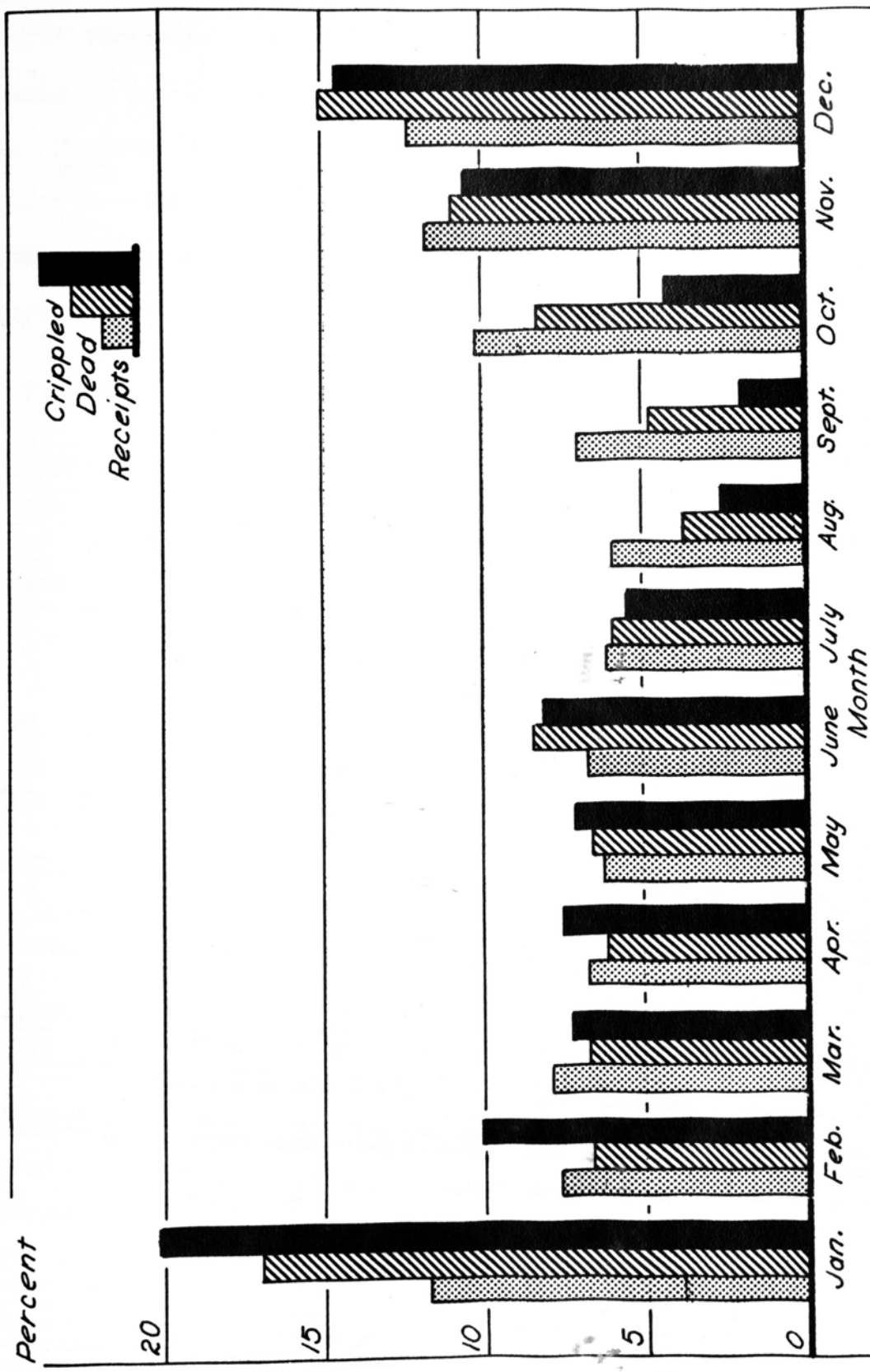


Figure 4. Monthly Distribution of Receipts, Dead and Crippled Swine, 1953-1957.

Weekly percentages are shown in Table XII and Figure 5. Distribution of deaths and cripples were comparable to numbers of swine received in all weeks except the fourth. The percentage of deaths were somewhat lower in relationship to receipts in the fourth week compared to other weeks. Lower values in the fifth week are due to the smaller number of days involved.

TABLE XII. WEEKLY NUMBER AND DISTRIBUTION OF SWINE RECEIPTS, DEATHS AND CRIPPLES WITH LOSS RATIOS, 1953-1957

| | First | Second | Week Third | Fourth | Fifth | Total |
|--------------------------------|-------|--------|---------------|--------|-------|-----------|
| Number | | | | | | |
| Receipts ^{1/} | 857 | 877 | 884 | 861 | 331 | 3810 |
| Dead | 339 | 377 | 381 | 272 | 126 | 1495 |
| Crippled | 548 | 569 | 541 | 556 | 199 | 2413 |
| Distribution (%) | | | | | | |
| Receipts | 22.5 | 23.0 | 23.2 | 22.6 | 8.7 | 100.0 |
| Dead | 22.7 | 25.2 | 25.5 | 18.2 | 8.4 | 100.0 |
| Crippled | 22.7 | 23.6 | 22.4 | 23.0 | 8.3 | 100.0 |
| Loss Ratio^{2/} | | | | | | (Average) |
| Dead | 3.96 | 4.30 | 4.31 | 3.16 | 3.81 | 3.92 |
| Crippled | 6.39 | 6.49 | 6.12 | 6.46 | 6.01 | 6.33 |

^{1/} Thousands of head for receipts only.

^{2/} Loss per 10,000 swine received.

Daily distributions are shown in Table XIII and Figure 6. The variation in percentage values between number of swine received and losses was small. Friday was lowest for receipts and losses.

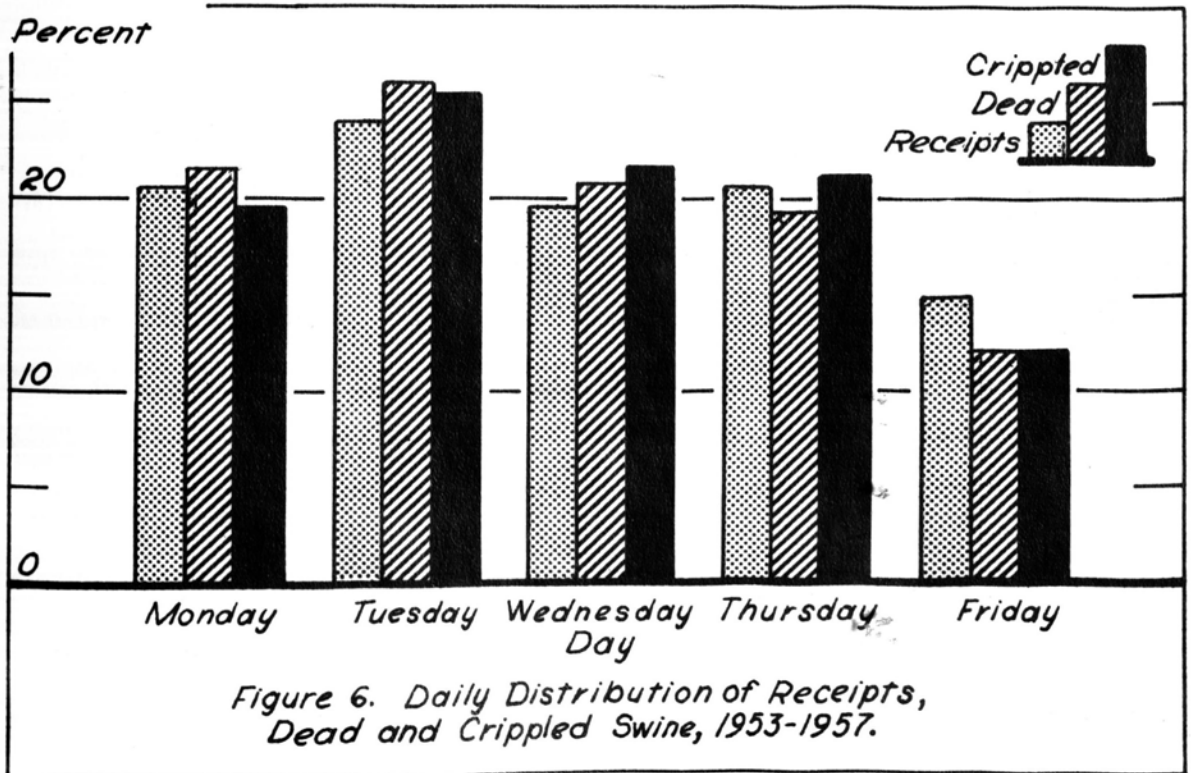
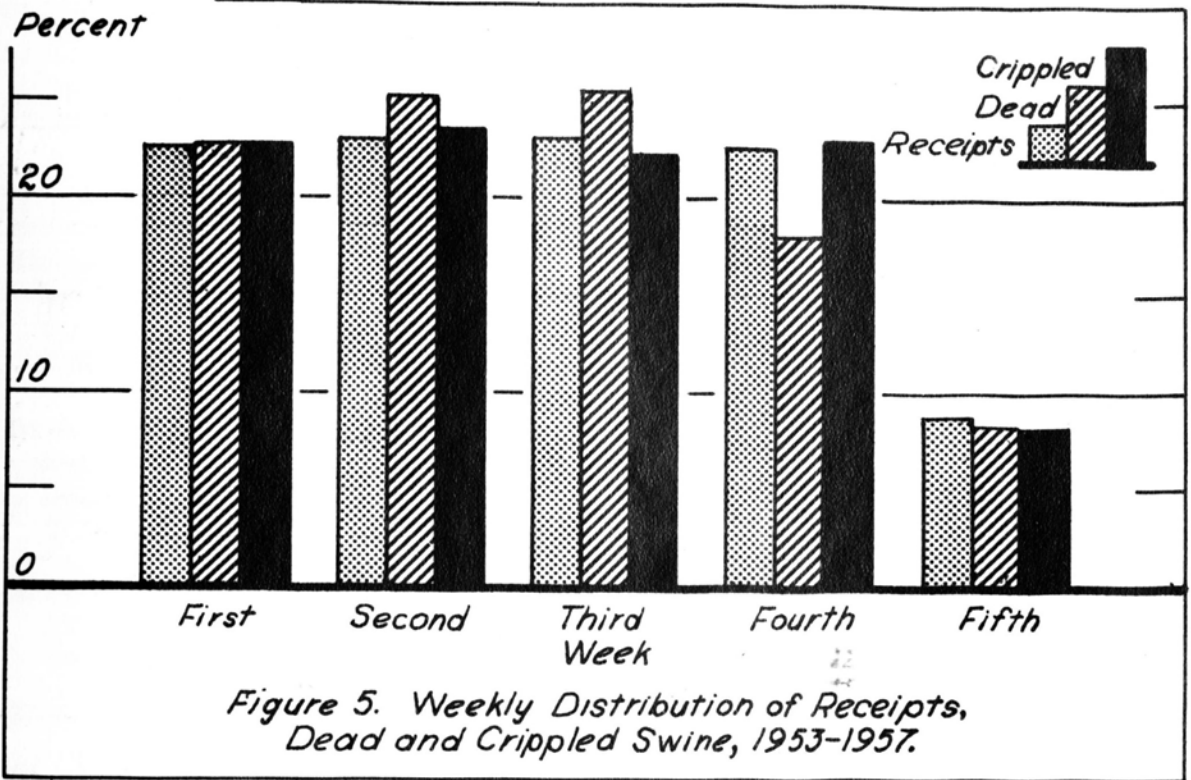


TABLE XIII. DAILY NUMBER AND DISTRIBUTION OF SWINE RECEIPTS, DEATHS AND CRIPPLES WITH LOSS RATIOS, 1953-1957

| | Day | | | | | Total |
|--------------------------------|--------|---------|-----------|----------|--------|----------------|
| | Monday | Tuesday | Wednesday | Thursday | Friday | |
| Number | | | | | | |
| Receipts ^{1/} | 790 | 914 | 752 | 787 | 567 | 3810 |
| Dead | 323 | 390 | 311 | 290 | 181 | 1495 |
| Crippled | 473 | 614 | 523 | 511 | 292 | 2413 |
| Distribution (%) | | | | | | |
| Receipts | 20.7 | 24.0 | 19.7 | 20.7 | 14.9 | 100.0 |
| Dead | 21.6 | 26.1 | 20.8 | 19.4 | 12.1 | 100.0 |
| Crippled | 19.6 | 25.4 | 21.7 | 21.2 | 12.1 | 100.0 |
| Loss Ratio^{2/} | | | | | | |
| Dead | 4.09 | 4.27 | 4.14 | 3.68 | 3.19 | (Average) 3.92 |
| Crippled | 5.99 | 6.72 | 6.95 | 6.49 | 5.15 | 6.33 |

^{1/} Thousands of head for receipts only.

^{2/} Loss per 10,000 swine received.

Swine Loss Ratios

Figure 7 shows that ratios for crippling are greater than those for deaths in each of the years compared. The loss ratios do not follow the pattern of receipts, particularly during 1955. Death and crippling losses are significantly correlated with the number of swine receipts. When the loss ratio line shows annual fluctuations some factor (s) other than receipts has influenced the extent of loss. Considering the amount of variation in losses explained by the number of swine received (19.0 and 28.0 percent previously cited), the fluctuations shown in Figure 7 are likely to occur.

Comparing annual death ratios of the Sioux Falls market with those calculated from data reported by Smith (1949), Cuff (1949), Pickard (1951)

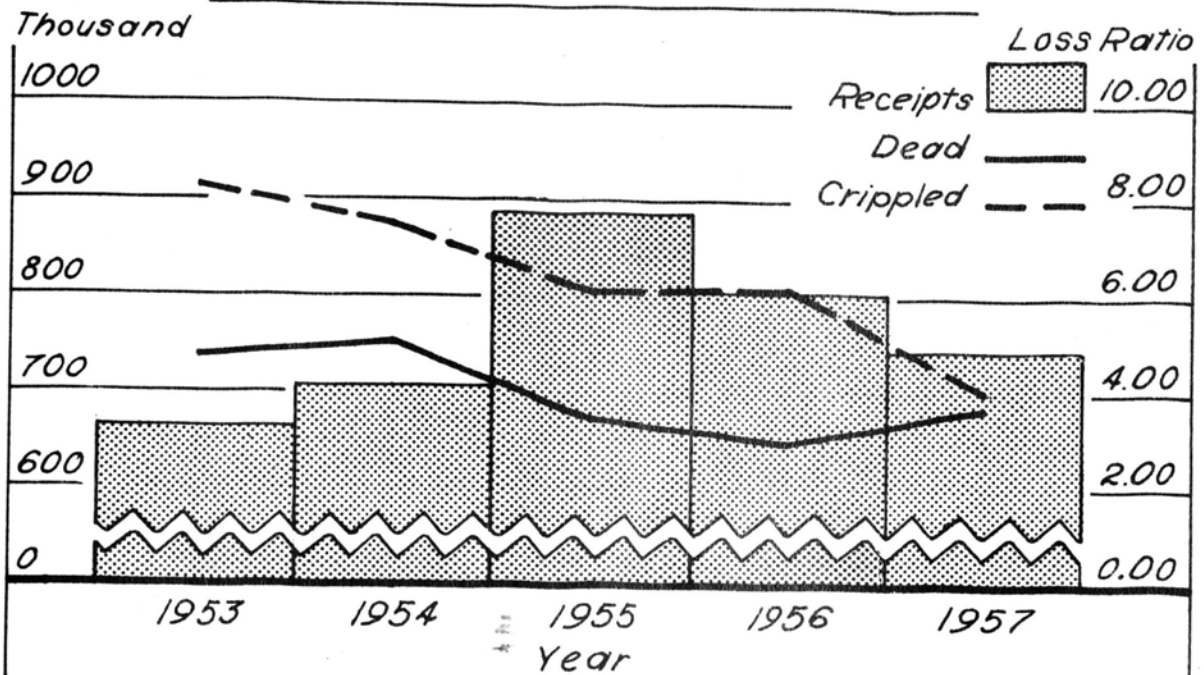


Figure 7. Comparison of Annual Swine Receipts with Dead and Crippled Loss Ratios.

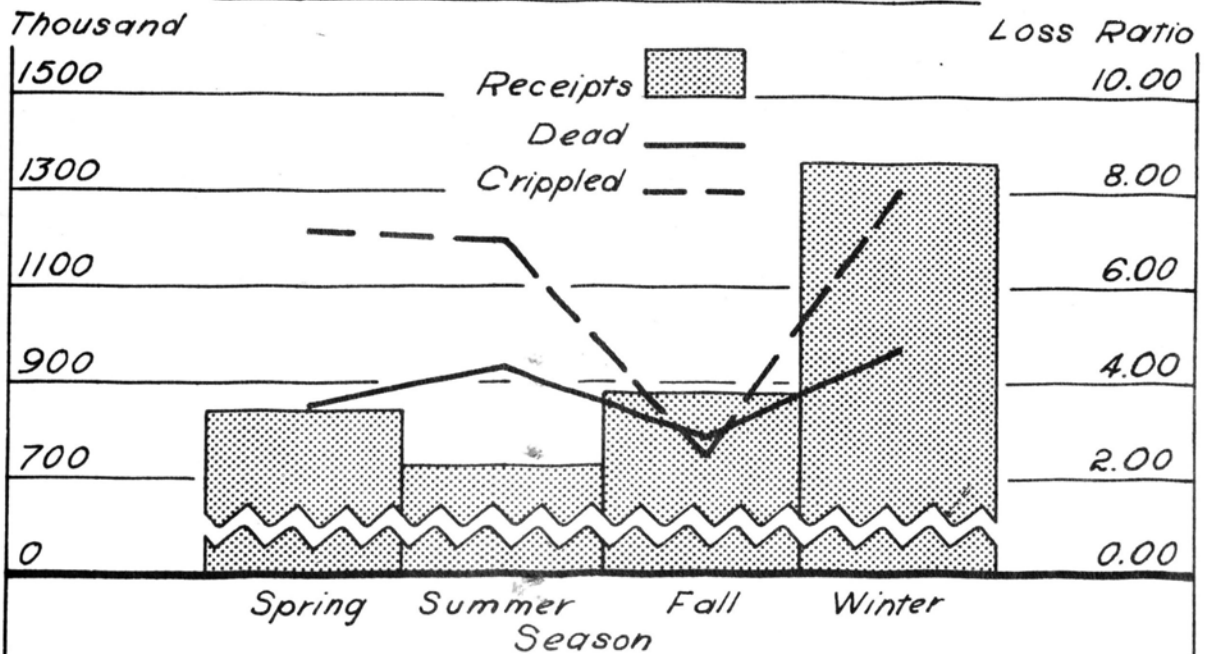


Figure 8. Comparison of Seasonal Swine Receipts with Dead and Crippled Loss Ratios, 1953-1957.

and Mossberg (1958), it will be noted that the former is considerably lower. However, different years and markets are involved. It is possible that rail losses were included in the data cited. The death ratios for the St. Paul market were approximately 11 deaths per 10,000 head more than for the Sioux Falls market during the period 1953-1955. Because of the limited amount of data available, cripple comparisons were not made.

The importance of season of the year on loss ratios is shown in Figure 8. The pattern of loss does not correspond to the flow of receipts. Death ratios were considerably lower than cripples except in the fall.

Monthly comparisons of receipts with ratios for death and crippling are presented in Figure 9. A parallel relationship of these factors occurs but ratios for crippled are greater than ratios for dead during all months except August, September and October. January and December were the high months for receipts while August was the low month. Death ratios (see Table XI) were greatest in January and June with 5.71 and 4.94 per 10,000. December, January and February had the greatest ratios for crippled with 7.51, 10.94 and 8.41, respectively. Death loss was lowest in August with 2.43 while the low month for crippling was September with 1.85 per 10,000. These data are not in agreement with the high and low months established by Henning (1929) in truck studies but are more nearly in agreement with his rail data. Wiley's (1927) data is similar in that the high months agree, however, rail losses were lower in November. The data cited were collected during a time when the majority of swine receipts were shipped by rail. Dowell and Eggert (1939) reported that December was the highest and April and September were the lowest months for deaths. Data from the St. Paul market, reported by Mossberg (1958)

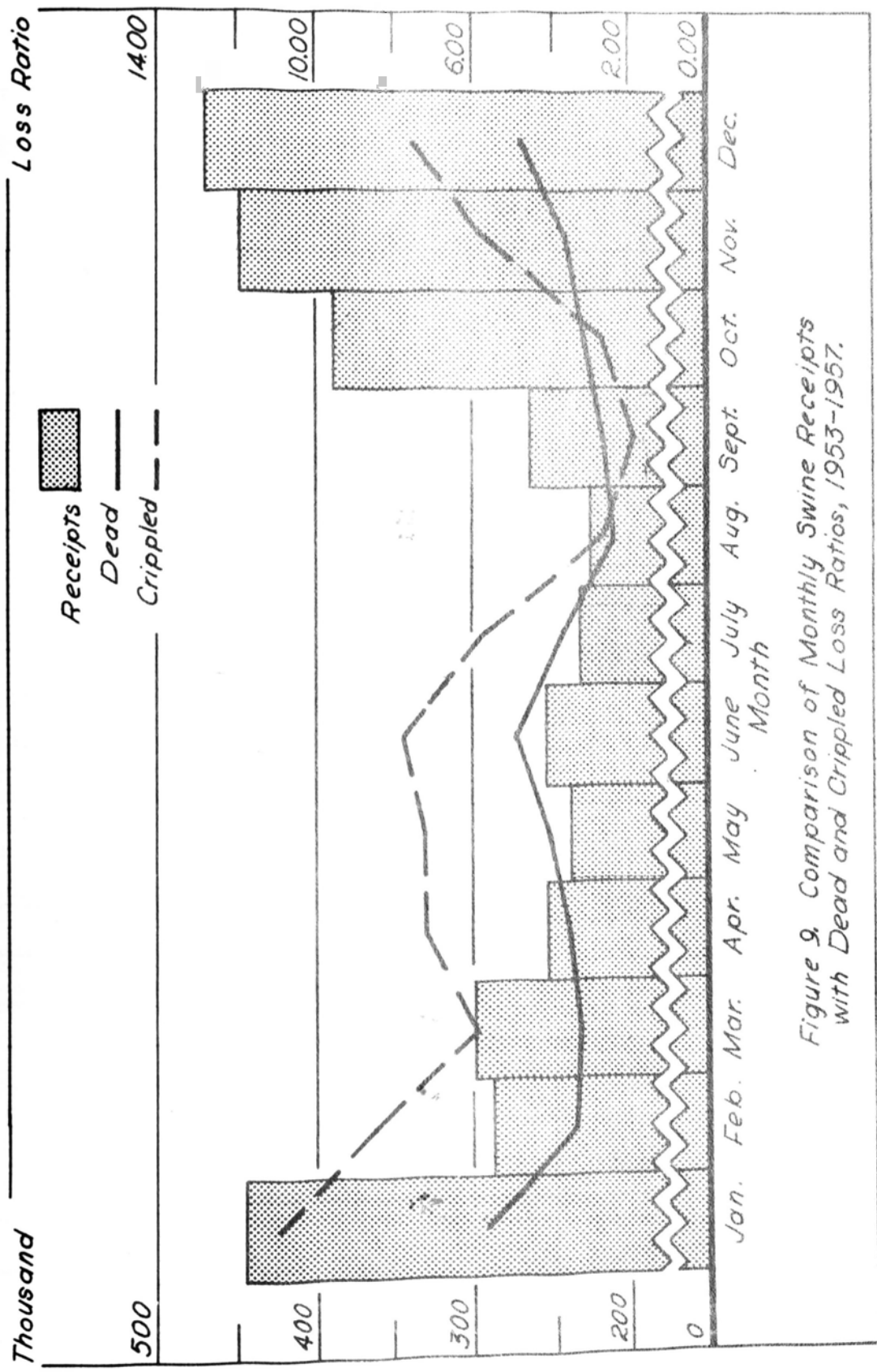


Figure 9. Comparison of Monthly Swine Receipts with Dead and Crippled Loss Ratios, 1953-1957.

are quite similar in regard to the months of highest and lowest crippling loss. Mossberg found that June was the month of greatest death loss rather than January as noted in the present data.

Little difference was noted in weekly loss ratios for cripples as shown in Figure 10. Death ratios differed somewhat. The number of swine received during the fifth week was considerably lower than the other weeks compared due to the smaller number of observations.

Daily loss ratios are shown in Figure 11. Receipts were highest on Tuesday with loss ratios highest on Tuesday and Wednesday but declined thereafter.

In general, the ratios for crippling were greater than for death in most of the divisions of time studied.

Components of Variation of Loss Data in Time Series

The number of deaths and the number of cripples presented in Appendix Table IV were transformed to indices. In so doing, the variation due to trend (T), cycle (C) and irregular movement (I) was determined. The trend variation was obtained by methods of least squares and is represented by $Y = 28.3167 / (-.1416)$ for dead swine and $Y = 49.0680 / (-.3688)$ for crippled swine. The C and I components were eliminated in the process of factoring ratios to trend which are shown in Table XIV for dead swine and Table XV for crippled swine. The middle three items in the array were averaged giving the modified mean. The seasonal index (S) for dead swine was obtained and together with the average death loss per month for the five-year period are shown graphically for deaths in Figure 12. The highs and lows in the data mean curve for deaths are greatly

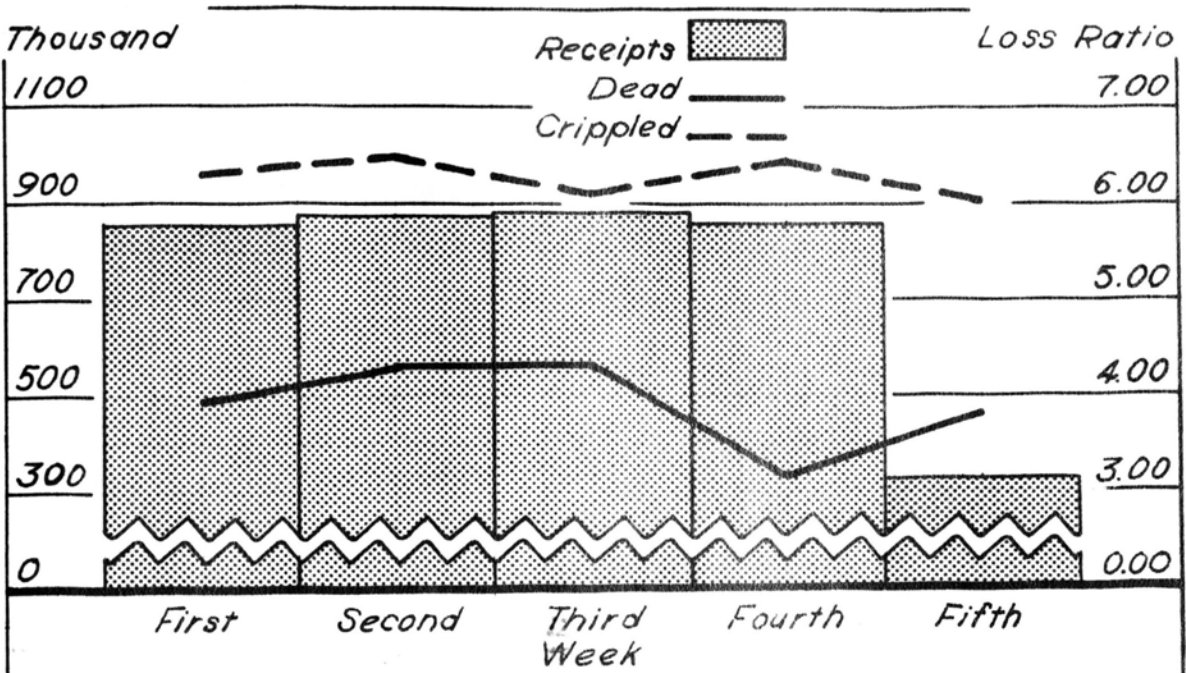


Figure 10. Comparison of Weekly Swine Receipts with Dead and Crippled Loss Ratios, 1953-1957.

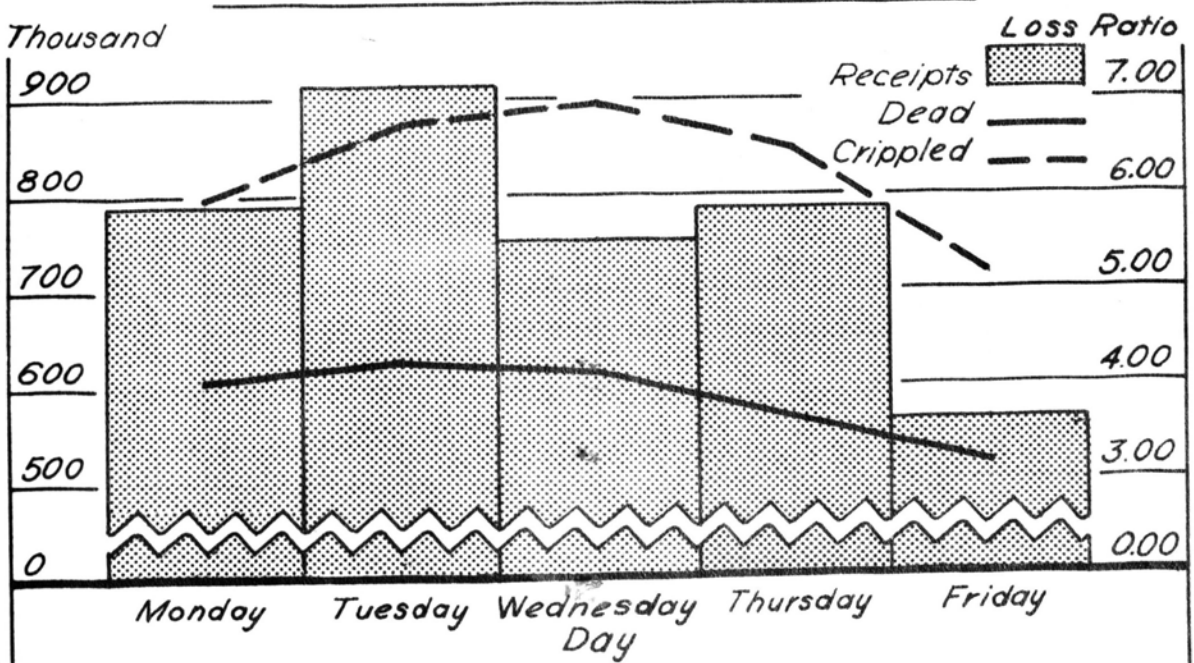


Figure 11. Comparison of Daily Swine Receipts with Dead and Crippled Loss Ratios, 1953-1957.

TABLE XIV. RATIOS TO TREND FOR DEAD SWINE, 1953-1957

| Year | Month | | | | | | | | | | | |
|----------------------|--------------------------|------|-------|-------|-------|-------|-------|------|-------|-------|-------|-------|
| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
| 1953 | 229.5 | 78.1 | 85.6 | 46.6 | 39.6 | 101.4 | 61.9 | 54.9 | 77.3 | 70.3 | 96.7 | 205.5 |
| 1954 | 210.4 | 90.6 | 45.6 | 137.5 | 115.2 | 111.9 | 108.7 | 58.5 | 58.9 | 78.9 | 170.6 | 207.5 |
| 1955 | 236.8 | 92.8 | 93.3 | 81.7 | 65.7 | 123.9 | 99.7 | 29.3 | 33.6 | 71.9 | 136.2 | 201.2 |
| 1956 | 198.1 | 65.0 | 74.1 | 48.3 | 88.3 | 62.2 | 22.4 | 18.0 | 58.9 | 155.0 | 128.4 | 143.1 |
| 1957 | 130.1 | 70.2 | 113.0 | 56.9 | 100.2 | 120.1 | 67.7 | 68.2 | 68.7 | 167.9 | 169.2 | 200.4 |
| | Ratio to Trend | | | | | | | | | | | |
| | Array of Ratios to Trend | | | | | | | | | | | |
| | 130.1 | 65.0 | 45.6 | 46.6 | 39.6 | 62.2 | 22.4 | 18.0 | 33.6 | 70.3 | 96.7 | 143.1 |
| | 198.1 | 70.2 | 74.1 | 48.3 | 65.7 | 101.4 | 61.9 | 23.9 | 58.9 | 71.9 | 128.4 | 200.4 |
| | 210.4 | 78.1 | 85.6 | 56.9 | 88.3 | 111.9 | 67.7 | 54.9 | 58.9 | 78.9 | 136.2 | 201.2 |
| | 229.5 | 90.6 | 93.3 | 81.7 | 100.2 | 120.1 | 99.7 | 58.5 | 68.7 | 155.0 | 169.2 | 205.5 |
| | 236.8 | 92.8 | 113.0 | 137.5 | 115.2 | 123.9 | 108.7 | 68.2 | 77.3 | 167.9 | 170.6 | 207.5 |
| 3-Item Modified Mean | 225.6 | 79.6 | 84.3 | 62.3 | 84.7 | 111.1 | 76.4 | 45.8 | 62.0 | 101.9 | 144.6 | 202.4 |
| Seasonal Index | 211.4 | 74.6 | 79.0 | 58.4 | 79.4 | 104.1 | 71.6 | 42.9 | 58.1 | 95.5 | 135.5 | 189.6 |

TABLE XV. RATIOS TO TREND FOR CRIPPLED SWINE, 1953-1957

| Year | Month | | | | | | | | | | | |
|----------------------|--------------------------|-------|-------|-------|-------|-------|------|------|-------|------|-------|-------|
| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
| 1953 | 256.8 | 110.9 | 70.3 | 89.7 | 92.5 | 101.7 | 81.1 | 17.2 | 23.9 | 59.0 | 108.0 | 146.6 |
| 1954 | 248.7 | 92.6 | 75.2 | 66.6 | 108.9 | 93.5 | 87.2 | 57.1 | 40.8 | 50.8 | 151.4 | 165.1 |
| 1955 | 198.9 | 115.4 | 91.2 | 81.8 | 85.2 | 125.1 | 50.0 | 31.9 | 24.1 | 59.6 | 208.0 | 351.2 |
| 1956 | 340.9 | 208.9 | 114.1 | 149.9 | 87.4 | 88.4 | 38.7 | 36.1 | 24.4 | 73.9 | 127.7 | 163.9 |
| 1957 | 153.1 | 90.3 | 107.7 | 85.9 | 60.2 | 105.0 | 85.8 | 20.8 | 14.1 | 35.7 | 104.8 | 146.5 |
| | Ratio to Trend | | | | | | | | | | | |
| | 153.1 | 90.3 | 70.3 | 66.6 | 60.2 | 88.4 | 38.7 | 17.2 | 14.1 | 35.7 | 104.8 | 146.5 |
| | 198.9 | 92.6 | 75.2 | 81.8 | 85.2 | 93.5 | 50.0 | 20.8 | 23.9 | 50.8 | 108.0 | 146.6 |
| | 248.7 | 110.9 | 91.2 | 85.9 | 87.4 | 101.7 | 81.1 | 31.9 | 24.1 | 59.0 | 127.7 | 163.9 |
| | 256.8 | 115.4 | 107.7 | 89.7 | 92.5 | 105.0 | 85.8 | 36.1 | 24.4 | 59.6 | 151.4 | 165.1 |
| | 340.9 | 208.9 | 114.1 | 149.9 | 108.9 | 125.1 | 87.2 | 57.1 | 40.8 | 73.9 | 208.0 | 351.2 |
| | Array of Ratios to Trend | | | | | | | | | | | |
| 3-Item Modified Mean | 234.8 | 106.3 | 91.4 | 85.8 | 88.4 | 100.1 | 72.3 | 29.6 | 24.1 | 56.5 | 129.0 | 158.5 |
| Seasonal Index | 239.4 | 108.4 | 93.2 | 87.5 | 90.1 | 102.1 | 73.7 | 30.2 | 24.6 | 57.6 | 131.5 | 161.6 |

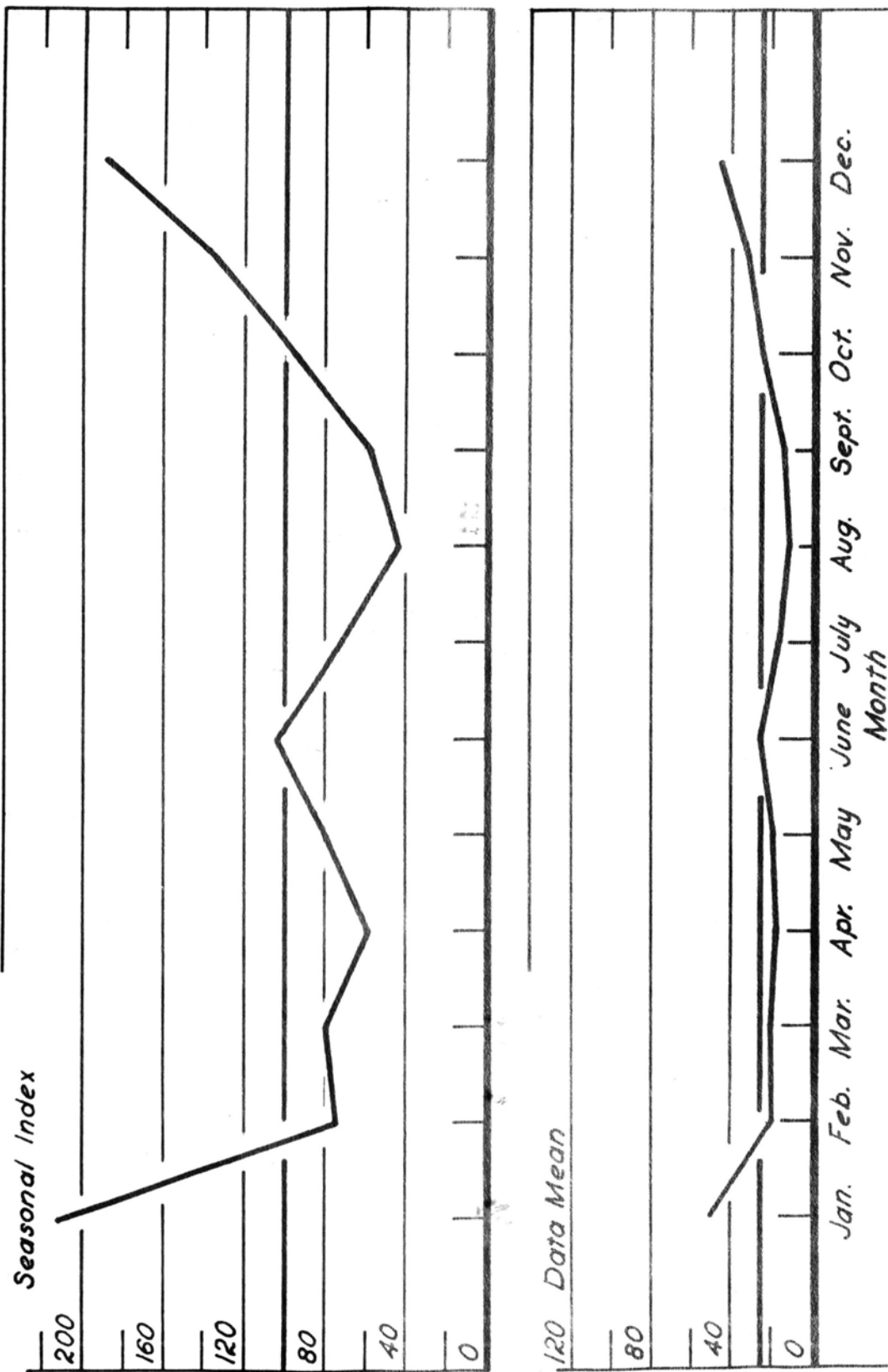


Figure 12. Monthly Comparison of the Modified Seasonal Index with the Data Mean for Swine Death Losses, 1953-1957.

accentuated when trend, cyclical and irregular effects are removed. Figure 13 shows the index and data mean curves for crippled swine. The effect of $T \times C \times I$ is not as pronounced as in the preceding figure. The data curves for both death and crippling losses are quite similar. The seasonal index curve for death losses differs somewhat from the cripple index. The greatest difference appears to be in the months of March, April and May. The seasonal index, computed by adjusting the monthly data means, is a more realistic curve for evaluating seasonal occurrence of losses.

The Effect of Length-of-Haul on Incidence of Swine Losses

The observed frequency of death losses and theoretical frequency, based on the base year 1954, are shown in Table XVI. The analysis of death losses and length-of-haul resulted in chi-square values of 34.17 in 1957 and 58.30 for the four-year total, which were significant at the one percent level of probability. Of the four years compared, the frequency of 1957 death losses differed significantly from number of swine received when mileage zone was considered. The significant chi-square value for total deaths may be due to the large numbers of deaths in the last four zones compared to those of the theoretical frequency.

Table XVII shows the observed and theoretical frequencies for crippled swine. The chi-square values were not significant. During 1955 the frequency of crippled losses was quite similar to the frequency of receipts by mileage zones.

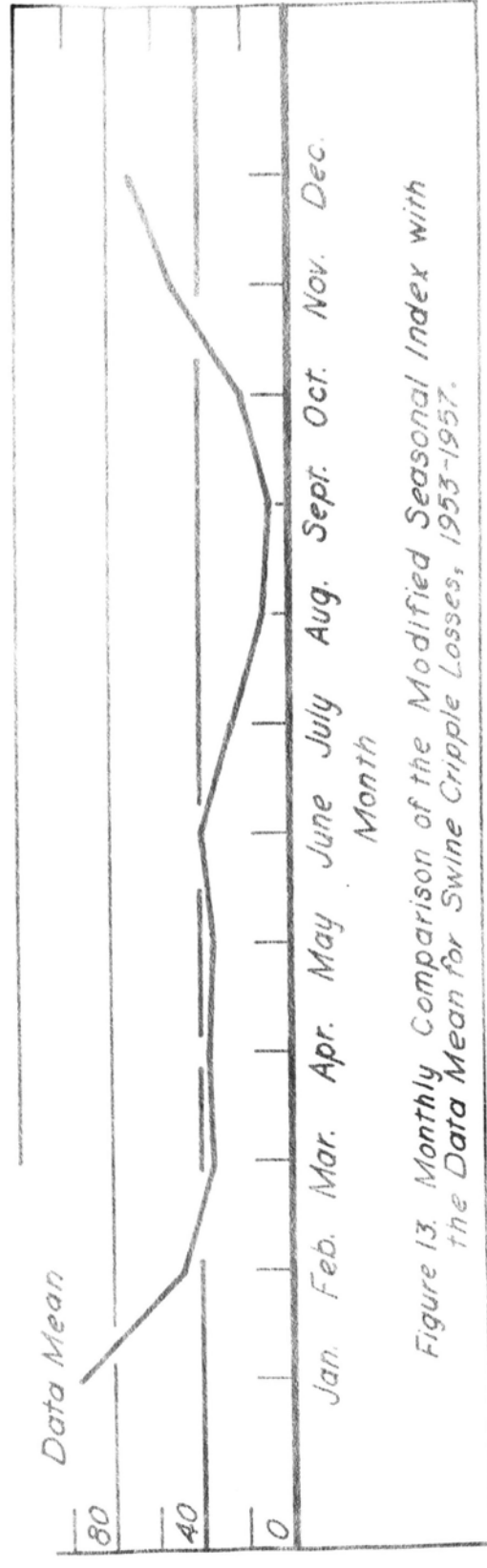
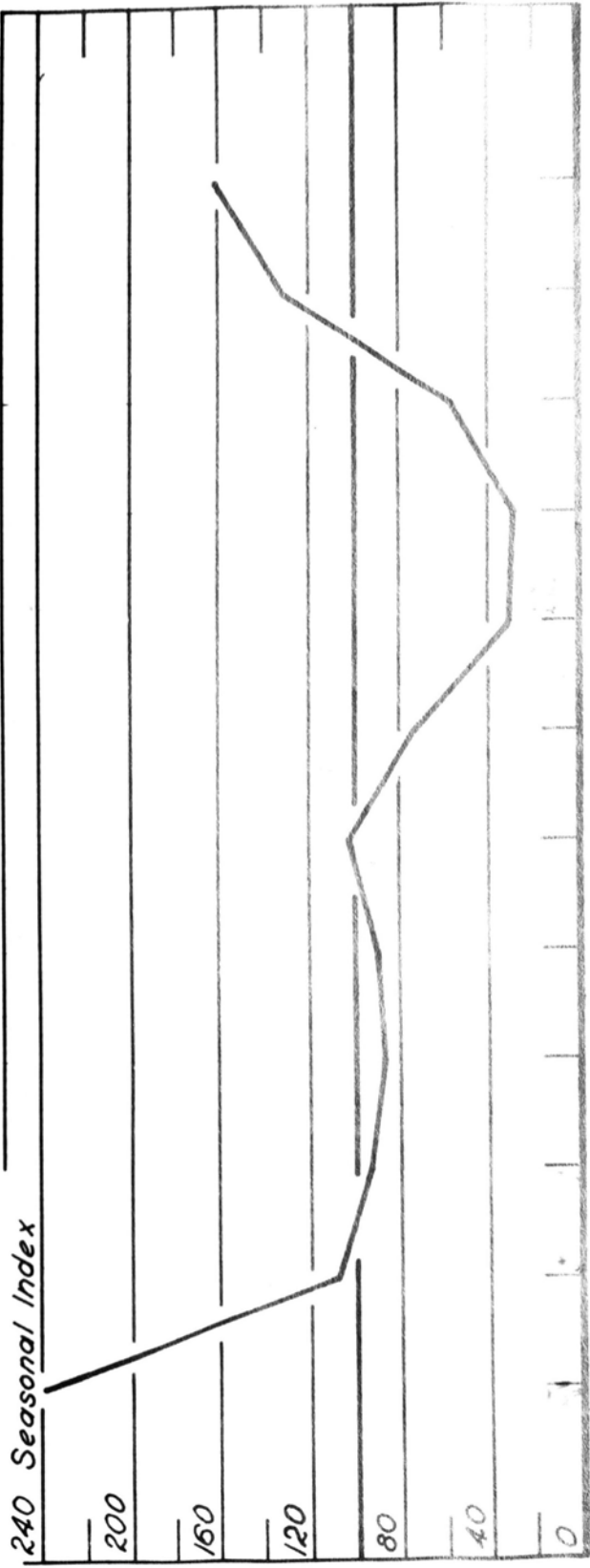


Figure 13. Monthly Comparison of the Modified Seasonal Index with the Data Mean for Swine Cripple Losses, 1953-1957.

TABLE XVI. OBSERVED AND THEORETICAL FREQUENCIES OF DEAD SWINE
BY MILEAGE ZONES, 1954-1957

| Mileage Zone | Observed Frequency of Dead Swine | | | | Total |
|-----------------|----------------------------------|------|------|------|-------|
| | 1954 | 1955 | 1956 | 1957 | |
| 0 - 10 | 8 | 5 | 7 | 1 | 21 |
| 11 - 20 | 31 | 26 | 23 | 25 | 105 |
| 21 - 30 | 66 | 71 | 28 | 49 | 214 |
| 31 - 40 | 97 | 68 | 51 | 46 | 262 |
| 41 - 50 | 43 | 35 | 37 | 28 | 143 |
| 51 - 60 | 47 | 35 | 27 | 42 | 151 |
| 61 - 70 | 25 | 42 | 32 | 35 | 134 |
| 71 - 80 | 13 | 3 | 9 | 13 | 38 |
| 81 - 90 | 8 | 7 | 5 | 8 | 28 |
| 91 - 100 | 3 | 2 | 1 | 6 | 12 |
| Over 100 | 23 | 12 | 18 | 22 | 75 |
| Total | 364 | 306 | 238 | 275 | 1183 |

| Mileage Zone | Theoretical Frequency of Dead Swine ^{1/} | | | | Total |
|-----------------|---|-------|-------|-------|--------|
| | 1954 | 1955 | 1956 | 1957 | |
| 0 - 10 | 20.4 | 17.2 | 13.4 | 15.5 | 66.4 |
| 11 - 20 | 88.6 | 74.5 | 57.9 | 66.9 | 288.1 |
| 21 - 30 | 82.5 | 69.3 | 53.9 | 62.3 | 268.1 |
| 31 - 40 | 79.5 | 66.9 | 52.0 | 60.1 | 258.4 |
| 41 - 50 | 31.6 | 26.6 | 20.7 | 23.9 | 102.8 |
| 51 - 60 | 29.4 | 24.7 | 19.2 | 22.2 | 95.4 |
| 61 - 70 | 16.9 | 14.2 | 11.1 | 12.8 | 55.0 |
| 71 - 80 | 5.5 | 4.6 | 3.6 | 4.1 | 17.8 |
| 81 - 90 | 3.1 | 2.6 | 2.0 | 2.3 | 10.0 |
| 91 - 100 | 2.0 | 1.6 | 1.3 | 1.5 | 6.3 |
| Over 100 | 4.5 | 3.8 | 2.9 | 3.4 | 14.7 |
| Total | 364.0 | 306.0 | 238.0 | 275.0 | 1183.0 |

| | | | | | |
|------------|-------|-------|---------|---------|---------|
| Chi-Square | 16.83 | 15.30 | * 12.37 | 34.17** | 58.30** |
|------------|-------|-------|---------|---------|---------|

^{1/} Based on frequency of swine receipts in 1954.
** Significant at the 1% level.

TABLE XVII. OBSERVED AND THEORETICAL FREQUENCIES OF CRIPPLED SWINE BY MILEAGE ZONES, 1954-1957

| Mileage Zone | Observed Frequency of Crippled Swine | | | | Total |
|--------------|--------------------------------------|------|------|------|-------|
| | 1954 | 1955 | 1956 | 1957 | |
| 0 - 10 | 15 | 23 | 13 | 9 | 60 |
| 11 - 20 | 89 | 101 | 83 | 42 | 315 |
| 21 - 30 | 113 | 106 | 97 | 60 | 376 |
| 31 - 40 | 128 | 122 | 118 | 57 | 425 |
| 41 - 50 | 47 | 54 | 47 | 37 | 185 |
| 51 - 60 | 65 | 51 | 53 | 22 | 191 |
| 61 - 70 | 36 | 51 | 38 | 35 | 160 |
| 71 - 80 | 12 | 16 | 18 | 10 | 56 |
| 81 - 90 | 2 | 4 | 12 | 6 | 24 |
| 91 - 100 | 2 | 5 | 4 | 0 | 11 |
| Over 100 | 13 | 7 | 15 | 20 | 55 |
| Total | 522 | 540 | 498 | 298 | 1858 |

| Mileage Zone | Theoretical Frequency of Crippled Swine ^{1/} | | | | Total |
|--------------|---|-------|-------|-------|--------|
| | 1954 | 1955 | 1956 | 1957 | |
| 0 - 10 | 29.3 | 30.3 | 28.0 | 16.7 | 104.4 |
| 11 - 20 | 127.1 | 131.5 | 121.2 | 72.6 | 452.3 |
| 21 - 30 | 118.3 | 122.3 | 112.8 | 67.5 | 420.9 |
| 31 - 40 | 114.1 | 118.0 | 108.8 | 65.1 | 406.0 |
| 41 - 50 | 45.3 | 46.9 | 43.3 | 25.9 | 161.4 |
| 51 - 60 | 42.1 | 43.6 | 40.2 | 24.0 | 149.9 |
| 61 - 70 | 24.2 | 25.0 | 23.1 | 13.9 | 86.4 |
| 71 - 80 | 7.9 | 8.2 | 7.5 | 4.5 | 28.0 |
| 81 - 90 | 4.4 | 4.6 | 4.2 | 2.5 | 15.7 |
| 91 - 100 | 2.8 | 2.9 | 2.7 | 1.6 | 10.0 |
| Over 100 | 6.5 | 6.7 | 6.2 | 3.7 | 23.0 |
| Total | 522.0 | 540.0 | 498.0 | 298.0 | 1858.0 |

| | | | | | |
|------------|------|------|------|------|-------|
| Chi-Square | 5.15 | 3.42 | 6.42 | 6.56 | 18.02 |
|------------|------|------|------|------|-------|

^{1/} Based on the frequency of swine receipts in 1954.

The relative size of the chi-square values for cripples compared to deaths would indicate that the pattern of receipts by mileage zone does not differ greatly from that of crippling. Length-of-haul may be affecting the differences noted between the pattern of receipts and death losses.

Distribution of Receipts and Losses

Table XVIII and Figure 14 show the distribution of receipts and loss by eleven mileage zones as a percentage of all zones. The percentage of loss increases with length-of-haul up to 40 miles from the market. Cripple losses are greater than deaths up to 40 miles. In all zones beyond the 31-40 mile zone the percentage of death losses are greater than either percentage volume of receipts or cripple losses.

TABLE XVIII. COMPARISON OF THE PERCENTAGE OF SWINE RECEIVED IN 1954 WITH THE AVERAGE PERCENTAGE OF DEATH AND CRIPPLES FOR THE 1954-1957 PERIOD

| Mileage Zone | Receipts 1954 | Percentage ^{1/} Deaths 1954-1957 | Cripples 1954-1957 |
|--------------|---------------|---|--------------------|
| 0 - 10 | 5.6 | 1.8 | 3.2 |
| 11 - 20 | 24.3 | 8.9 | 17.0 |
| 21 - 30 | 22.7 | 18.1 | 20.2 |
| 31 - 40 | 21.9 | 22.1 | 22.9 |
| 41 - 50 | 8.7 | 12.1 | 10.0 |
| 51 - 60 | 8.1 | 12.8 | 10.3 |
| 61 - 70 | 4.7 | 11.3 | 8.6 |
| 71 - 80 | 1.5 | 3.2 | 3.0 |
| 81 - 90 | 0.8 | 2.4 | 1.3 |
| 91 - 100 | 0.5 | 1.0 | 0.6 |
| Over 100 | 1.2 | 6.3 | 2.9 |

^{1/} Percentage of the total received from all zones.

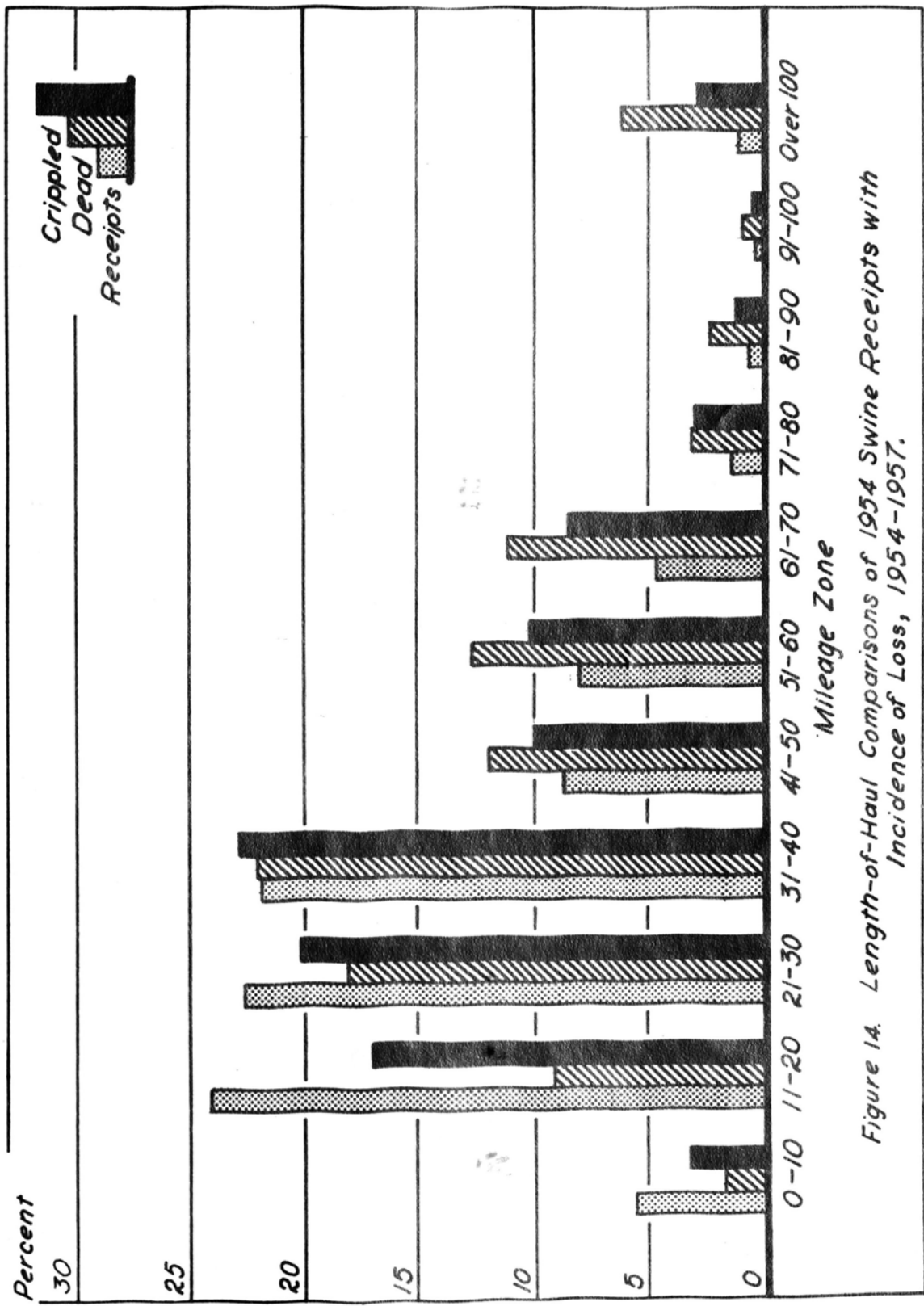


Figure 14. Length-of-Haul Comparisons of 1954 Swine Receipts with Incidence of Loss, 1954-1957.

The study reported by Rickenbacker (1955) showed that the percentage of receipts and loss were considerably lower in the 0-50 mile zone than those obtained in this study. In the mileage zone 51-90, Rickenbacker reported 24.2 percent of the receipts and 22.0 percent of the combined loss compared to 15.1 percent of the receipts, 29.7 percent of the deaths and 23.2 percent of the cripples for the Sioux Falls market in the period studied.

Season and Length-of-Haul

Seasonal distribution of receipts and loss ratios were compared by grouping the data according to six mileage zones (Table XIX). A greater percentage of receipts occur in the winter season in each of the mileage zones compared.

Death loss ratios tend to progressively increase in zones up to 80 miles from the market (Figure 15). Greatest death loss ratios occurred during the winter season in all zones except the 21-40 mile zone when the summer season was the greatest. A rather steady rise in death loss ratios from spring to winter occurred in the 61-80 mile zone. In four of the six zones studied loss ratios were lowest in the fall season. Erratic changes in loss ratios for dead swine are present in the zone over 100 miles from the market.

Comparison of crippled ratios with season and zone is shown in Figure 16. Ratios from season to season and from zone to zone fluctuate considerably. The number of crippled swine was greatest in the fall in zone 21-40 with 22.64 per 10,000 while the next highest season and zone was summer with 21.98 cripples per 10,000 in the zone over 100 miles (see Table XIX).

TABLE XIX. COMPARISON OF SWINE RECEIPTS FOR 1954 WITH DEAD AND CRIPPLE RATIOS BY SEASON AND MILEAGE ZONE

| Mileage Zone | Season | | | | Total |
|------------------------------|--------|--------|-------|--------|-----------|
| | Spring | Summer | Fall | Winter | |
| Swine Receipts ^{1/} | | | | | |
| Under 20 | 21.1 | 20.2 | 24.9 | 33.8 | 100.0 |
| 21 - 40 | 20.1 | 20.4 | 25.5 | 34.0 | 100.0 |
| 41 - 60 | 18.7 | 21.7 | 23.4 | 36.2 | 100.0 |
| 61 - 80 | 16.0 | 22.4 | 21.9 | 39.7 | 100.0 |
| 81 - 100 | 19.9 | 19.0 | 21.8 | 39.3 | 100.0 |
| Over 100 | 16.2 | 14.2 | 21.6 | 48.0 | 100.0 |
| Loss Ratios ^{2/} | | | | | |
| Dead | | | | | (Average) |
| Under 20 | 1.22 | 1.57 | 1.32 | 1.70 | 1.48 |
| 21 - 40 | 4.08 | 4.42 | 2.23 | 4.33 | 3.76 |
| 41 - 60 | 7.08 | 6.19 | 3.77 | 7.27 | 6.18 |
| 61 - 80 | 7.98 | 8.43 | 9.14 | 11.82 | 9.84 |
| 81 - 100 | 7.67 | 6.67 | 4.66 | 16.16 | 10.16 |
| Over 100 | 20.96 | 3.60 | 9.18 | 22.43 | 21.25 |
| Crippled | | | | | |
| Under 20 | 5.18 | 4.70 | 12.28 | 6.08 | 4.40 |
| 21 - 40 | 8.68 | 6.36 | 22.64 | 7.98 | 6.34 |
| 41 - 60 | 10.79 | 5.90 | 3.41 | 10.52 | 7.90 |
| 61 - 80 | 15.40 | 12.77 | 5.23 | 14.84 | 12.36 |
| 81 - 100 | 10.22 | 5.34 | 2.33 | 13.57 | 8.89 |
| Over 100 | 10.48 | 21.98 | 3.94 | 20.66 | 15.58 |

^{1/} Percentage of the total for the year.

^{2/} Losses per 10,000 swine received.

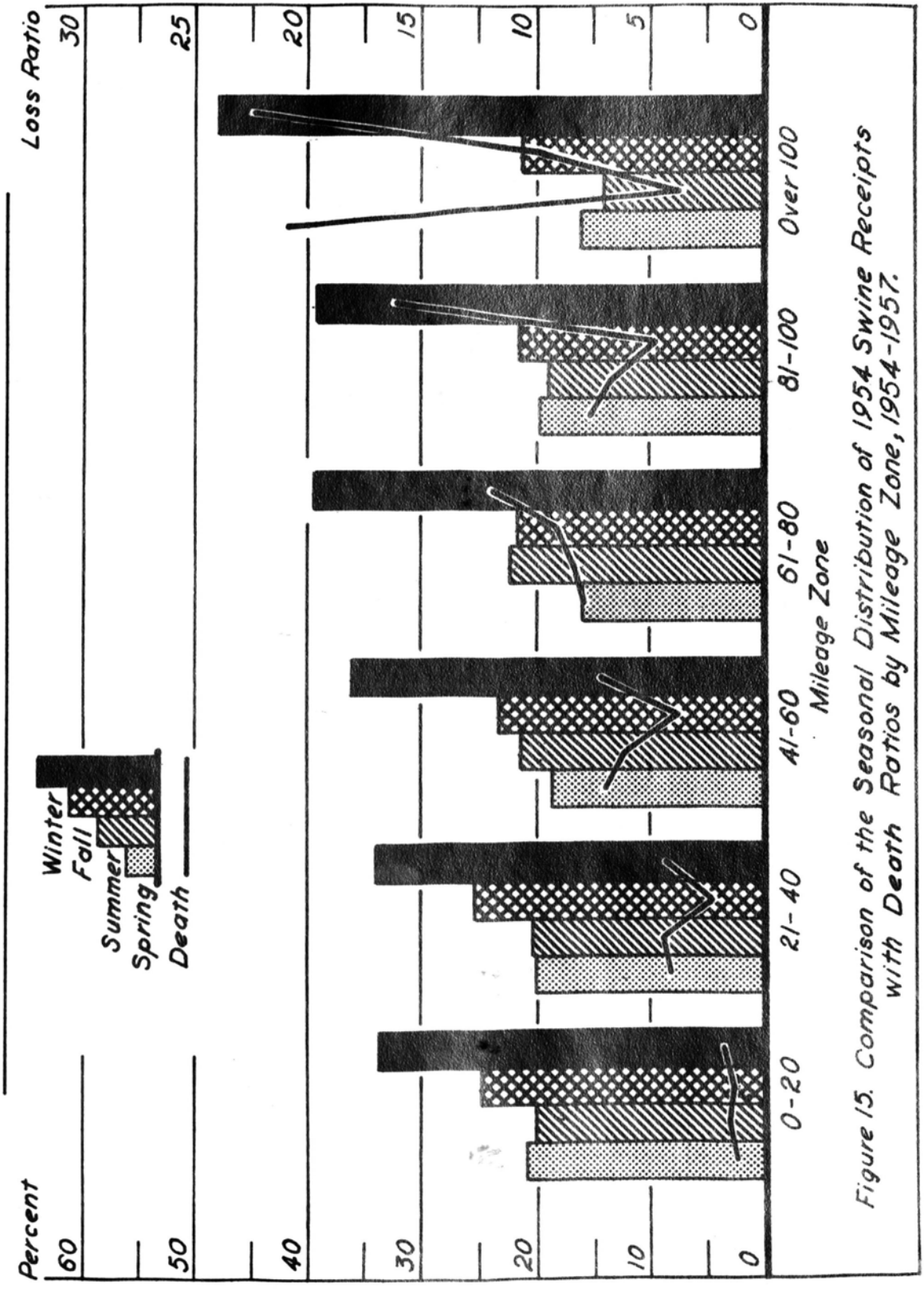


Figure 15. Comparison of the Seasonal Distribution of 1954 Swine Receipts with Death Ratios by Mileage Zone, 1954-1957.

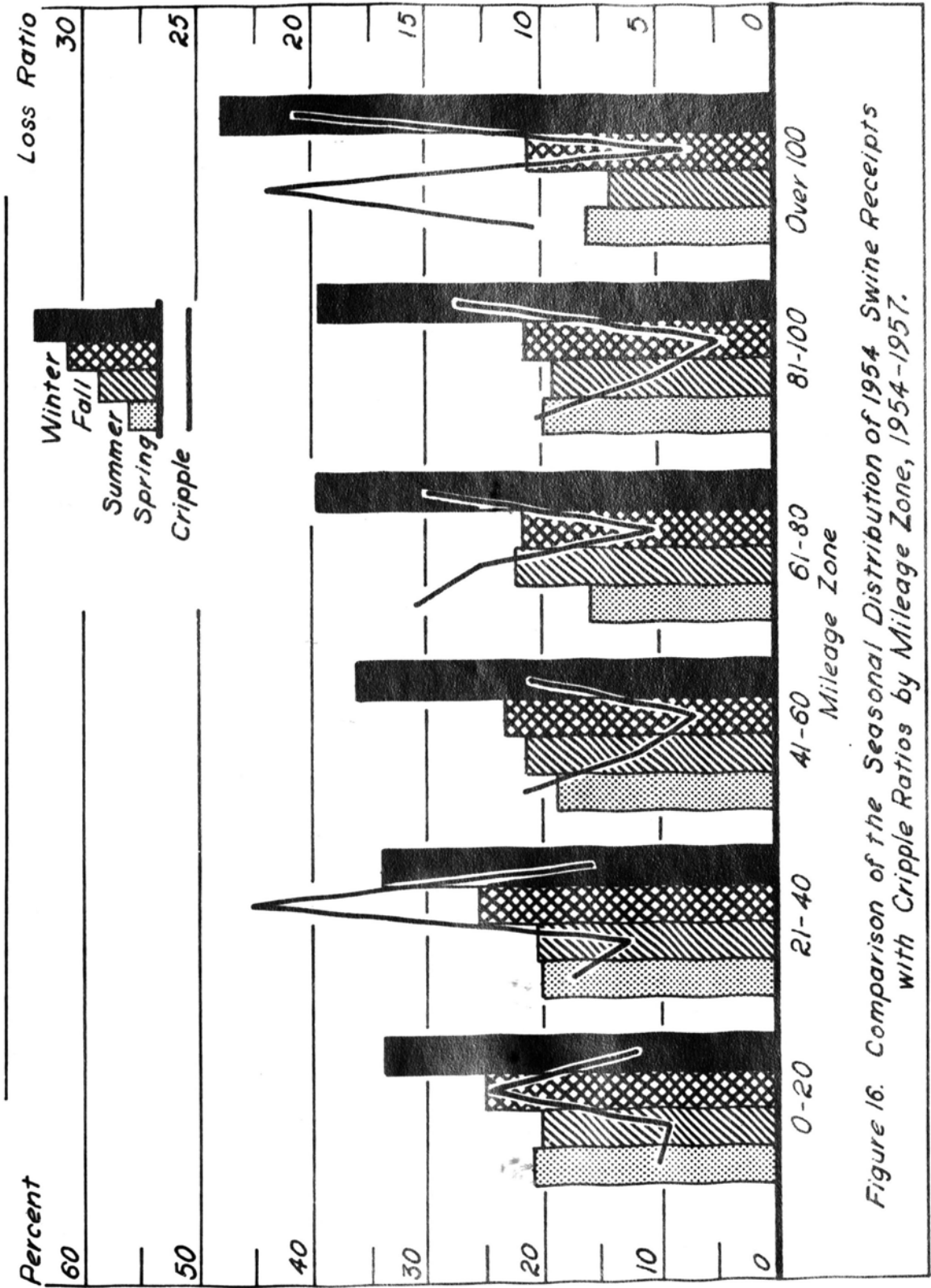


Figure 16. Comparison of the Seasonal Distribution of 1954 Swine Receipts with Cripple Ratios by Mileage Zone, 1954-1957.

The Combined Effect of Length-of-Haul and Division of Time
on the Rate of Death and Injury

The results of the analysis of swine death loss are shown in
Table XX. Differences between years were significant at the five percent

TABLE XX. ANALYSIS OF VARIANCE FOR DEAD SWINE

| Source of Variation | Sums of Squares | Degrees of Freedom | Mean Squares |
|---------------------------|-----------------------|--------------------------|-----------------|
| Total | 3562.50 | 383 | |
| Between Years | 88.84 | 3 | 29.61* |
| Zones in Years | 652.51 | 28 | 23.30** |
| (Between Zones | 741.35 | 31 | 23.91**) |
| Months in Years | 2821.15 | 352 | 8.01 |

* Significant at the 5% level.

** Significant at the 1% level.

level of probability. Mean squares were highly significant for zones in years which indicates that considerable variation exists between zones in each of the years compared. When the sums of squares for year and zones in years were combined, the result obtained represented variation between zones. The mean square for zones was highly significant. Since the analysis proceeded on the basis of a sampling study with zone and month being sub-samples, the variation between months could not be partitioned. Neither could the interaction effects be tested for significance.

Table XXI gives the analysis of variance for crippled swine. The analysis of crippling losses indicates that a greater amount of variation

TABLE XXI. ANALYSIS OF VARIANCE FOR CRIPPLED SWINE

| Source of Variation | Sums of Squares | Degrees of Freedom | Mean Squares |
|---------------------|-----------------|--------------------|--------------|
| Total | 9747.99 | 383 | |
| Between Years | 394.28 | 3 | 131.43** |
| Zones in Years | 1916.71 | 28 | 68.45** |
| (Between Zones | 2310.99 | 31 | 74.55**) |
| Months in Years | 7437.00 | 352 | 21.13 |

** Significant at the 1% level.

exists between years than in zones or zones in years. All differences were highly significant.

When the two analyses are compared the variation in crippling losses between years appeared to be greater than for deaths. Differences between months were quite apparent, however, they could not be tested using this experimental design.

Several limitations exist in this analysis. The fact that more variation could not be partitioned to both main effects and interaction severely hinders the drawing of useful inferences about the data. A small unit of measure, such as deaths per shipment per day, added as a subclass to months would permit an evaluation of the effects of months. Interaction effects cannot be tested in this type of analysis. The number of shipments and loss per shipment are available for all years of the length-of-haul study except 1954. Frequencies of shipments were not obtained for the 1954 data due to the manner in which the data were processed.

CHAPTER V

SUMMARY AND CONCLUSIONS

During 1953-1957, information concerning swine death and crippling losses was collected from the Sioux Falls Stock Yards Company. The major portion of the data was placed on IBM cards but the length-of-haul data were prepared in statistical tables. The swine receipts for 1954 were drawn upon to support certain areas in the present study. The data were analyzed using statistical procedures.

Both death and crippling in swine marketing are positively related to volume of receipts. The correlation coefficients were .43 and .53, respectively. Coefficients for crippling were consistently higher than those for deaths in most of the divisions of time. Nineteen and 28.0 percent of the death and crippling variation may be explained by volume of receipts. The volume of receipts was most closely correlated with losses during the winter season, the first week of the month and on Friday of the market week.

Considering distribution, the greatest difference between death and crippling occur in 1956 and 1957, in all seasons except summer and in the months of January, February, August, September and October. The number of death losses was greater than crippling during the year 1957, in the fall season and in the months of August through October. Crippling losses exceeded death losses in all other divisions.

Loss ratios when related to the number of swine received are quite different from the distribution data. Loss ratios for crippled swine were greater than those for dead swine. Relative changes in magnitude of ratios for dead and crippled swine were most significant in the comparison of market days and throughout the first six months of the year.

The effect of trend, cyclical and irregular movements when removed from the data by adjusting the monthly loss means resulted in seasonal indices which are more realistic than the original data means. There appears to be a definite seasonal effect with the greatest losses occurring during the winter months. Differences between years were also significant. In this study, greater differences between years were noted for swine deaths than for crippling.

Length-of-haul significantly influenced the extent of swine deaths and crippling. In this study, the number of deaths and cripples follows the pattern of receipts in the eleven mileage zones except 1957 which differed significantly for dead swine. Receipts tend to be concentrated in the 11-20, 21-30 and 31-40 mile zones while both deaths and cripples were greatest in the 31-40 mile zone. Approximately 83.0 percent of the receipts and 63.0 percent of the deaths and 73.0 percent of the cripples originate in the zones up to fifty miles from the market. The pattern of death loss differed from that of crippling in most mileage zones. Seasonally, death loss ratios increased up to 80 miles but crippling loss ratios did not follow this pattern or that of receipts. Greatest death loss occurred in winter in the zone of 100 miles and crippling was greater in the 21-40 mile zone.

The results of the present study should be useful in most marketing areas of South Dakota and adjacent states. They may not be as conclusive as desired by people interested in eliminating losses in swine marketing, however, they possess a useful and practical value. Knowledge of the dangers associated with length-of-haul, receipts and season of the year will be helpful in reducing future losses. An understanding of the various patterns of swine receipts, an important factor in the demand-supply function, may point the way to more efficient production and marketing programs.

Not all losses reported in this investigation are a result of carelessness or improper handling during transit to market. It is a common and legitimate practice among stockmen to ship poor-doing or injured animals to market as a means of salvaging them. It was not possible from available data to determine the proportion of these animals that were weak, emaciated or injured prior to loading at the farm. It was impossible to ascertain whether animals that were dead upon arrival were in sound condition or near death at the time of loading. Frequently animals are labeled as cripples or die in the yards of the marketing agency during the process of marketing. Such losses may be due to an injury inflicted during transit or to careless handling by yard personnel.

Loss associated factors which are common knowledge to those involved in the handling of market livestock are:

- (1) The number of animals in the load.
- (2) The type and quantity of bedding used.
- (3) The adequacy or inadequacy of ventilation.

- (4) The trucking of mixed species and classes.
- (5) The use made of partitions.
- (6) The condition of truck racks and endgates.

No doubt these factors should be weighed heavily with one or all of the major criteria considered in this study.

Future studies in the area of swine losses should be concerned with, (1) the observation of livestock shipments upon arrival at the market to determine the specific role of the loss factors listed above, (2) the use of climatological data, such as temperature, wind velocity and humidity as predisposing factors in swine losses and, (3) the further study of shipments involving crippling to determine how much of this loss is due to improper handling, disease or other factors associated with production.

CHAPTER VI

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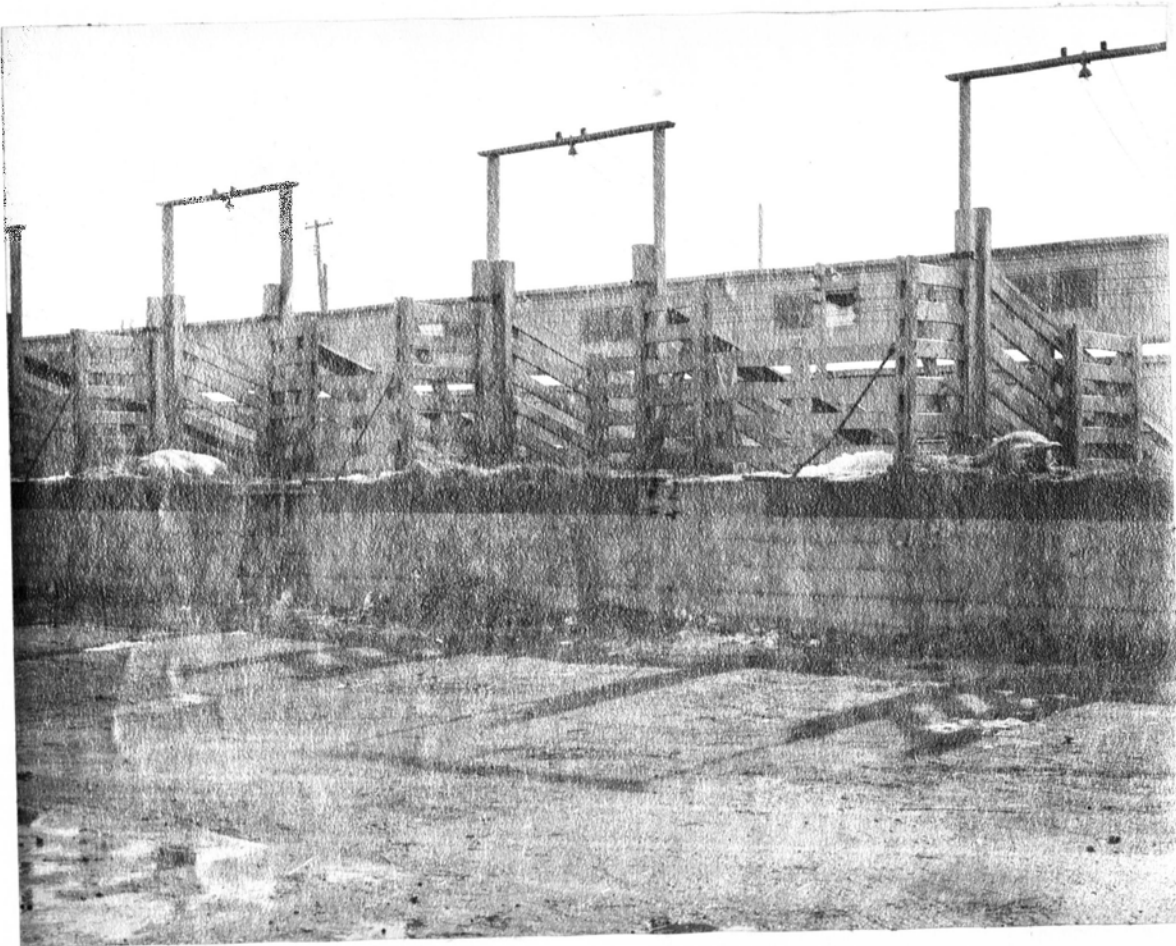
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APPENDIX

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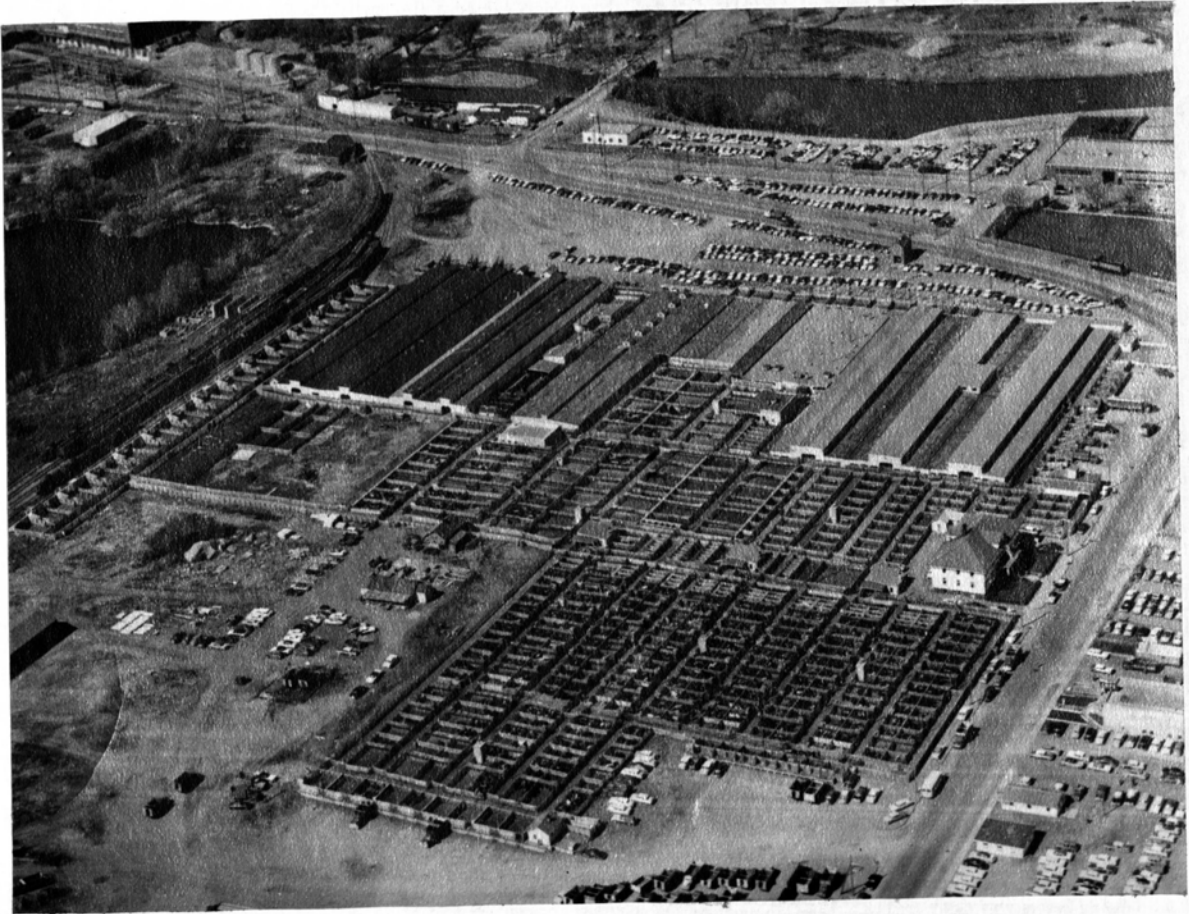
Appendix Figure 1. Loading a Cripple into a Yard "Cripple Cart."



Appendix Figure 2. View of Dead Swine on the Unloading Dock at the Sioux Falls Stock Yards.



Appendix Figure 3. Truck Loads of Drive-in Swine Unloading at the Dock of the Sioux Falls Stock Yards.



Appendix Figure 4. An Aerial View of the Sioux Falls Stock Yards, 1958.
(Courtesy of the Sioux Falls Stock Yards Company)

APPENDIX TABLE I. TOTAL SWINE RECEIPTS, DEATHS AND CRIPPLES
WITH LOSS RATIOS BY MILEAGE ZONES, 1954

| Mileage Zone | Total Receipts | Incidence | | Loss Ratio ^{1/} | |
|-----------------|-------------------|-----------|----------|--------------------------|----------|
| | | Dead | Crippled | Dead | Crippled |
| 0 - 10 | 39,941 | 8 | 15 | 2.00 | 3.76 |
| 11 - 20 | 172,913 | 31 | 89 | 1.79 | 5.15 |
| 21 - 30 | 160,931 | 66 | 113 | 4.10 | 7.02 |
| 31 - 40 | 155,223 | 97 | 128 | 6.25 | 8.25 |
| 41 - 50 | 61,702 | 43 | 47 | 6.97 | 7.62 |
| 51 - 60 | 57,274 | 47 | 65 | 8.21 | 11.35 |
| 61 - 70 | 32,996 | 25 | 36 | 7.58 | 10.91 |
| 71 - 80 | 10,692 | 13 | 12 | 12.16 | 11.22 |
| 81 - 90 | 6,011 | 8 | 2 | 13.31 | 3.33 |
| 91 - 100 | 3,833 | 3 | 2 | 7.83 | 5.22 |
| Over 100 | 8,824 | 23 | 13 | 26.07 | 14.73 |
| Total | 710,340 | 364 | 522 | 5.12* | 7.35* |

^{1/} Loss per 10,000 swine received.

* Average.

APPENDIX TABLE II. MEAN DAILY RECEIPTS, DEAD AND CRIPPLED SWINE
FOR VARIOUS DIVISIONS OF TIME

| Division of Time | Receipts | Deaths | Crippled |
|---------------------|----------|--------|----------|
| <u>Years</u> | | | |
| 1953 | 2,598 | 1.23 | 2.14 |
| 1954 | 2,748 | 1.40 | 2.05 |
| 1955 | 3,478 | 1.20 | 2.12 |
| 1956 | 3,161 | 0.93 | 1.95 |
| 1957 | 2,914 | 1.08 | 1.17 |
| <u>Season</u> | | | |
| Spring | 2,634 | 0.91 | 1.88 |
| Summer | 2,255 | 0.97 | 1.56 |
| Fall | 2,733 | 0.78 | 0.67 |
| Winter | 4,321 | 2.04 | 3.48 |
| <u>Months</u> | | | |
| January | 4,238 | 2.42 | 4.64 |
| February | 2,861 | 0.98 | 2.41 |
| March | 2,694 | 0.90 | 1.59 |
| April | 2,361 | 0.85 | 1.69 |
| May | 2,234 | 0.92 | 1.61 |
| June | 2,383 | 1.18 | 1.84 |
| July | 2,148 | 0.81 | 1.22 |
| August | 2,055 | 0.50 | 0.56 |
| September | 2,598 | 0.70 | 0.48 |
| October | 3,536 | 1.13 | 0.95 |
| November | 4,340 | 1.58 | 2.50 |
| December | 4,383 | 2.10 | 3.29 |
| <u>Week</u> | | | |
| First | 3,007 | 1.19 | 1.92 |
| Second | 2,953 | 1.27 | 1.92 |
| Third | 2,947 | 1.27 | 1.80 |
| Fourth | 2,949 | 0.93 | 1.90 |
| Fifth | 3,152 | 1.20 | 1.90 |
| <u>Days</u> | | | |
| Monday | 3,123 | 1.28 | 1.87 |
| Tuesday | 3,543 | 1.51 | 2.38 |
| Wednesday | 2,926 | 1.21 | 2.04 |
| Thursday | 3,123 | 1.15 | 2.03 |
| Friday | 2,189 | 0.70 | 1.13 |

APPENDIX TABLE III. SEASONAL VARIATION IN SWINE RECEIPTS, DEATHS
AND CRIPPLES, 1953-1957

| Year | Season | | | | Total |
|-------------------------------------|--------|--------|------|--------|-------|
| | Spring | Summer | Fall | Winter | |
| <u>Swine Receipts</u> ^{1/} | | | | | |
| 1953 | 148 | 125 | 140 | 252 | 665 |
| 1954 | 143 | 144 | 174 | 248 | 709 |
| 1955 | 180 | 160 | 197 | 350 | 887 |
| 1956 | 208 | 146 | 178 | 274 | 806 |
| 1957 | 164 | 151 | 191 | 237 | 743 |
| <u>Dead</u> | | | | | |
| 1953 | 59 | 56 | 55 | 146 | 316 |
| 1954 | 72 | 87 | 50 | 151 | 360 |
| 1955 | 66 | 70 | 32 | 138 | 306 |
| 1956 | 43 | 39 | 51 | 105 | 238 |
| 1957 | 51 | 60 | 62 | 102 | 275 |
| <u>Crippled</u> | | | | | |
| 1953 | 131 | 130 | 46 | 241 | 548 |
| 1954 | 103 | 124 | 62 | 240 | 529 |
| 1955 | 114 | 100 | 43 | 283 | 540 |
| 1956 | 166 | 73 | 44 | 215 | 498 |
| 1957 | 87 | 74 | 20 | 117 | 298 |

^{1/} Thousands of head for receipts only.

APPENDIX TABLE IV. MONTHLY VARIATION IN SWINE RECEIPTS, DEATHS AND CRIPPLES, 1953-1957

| Year | Month | | | | | | | | | | | | Total |
|-------------------------------------|-------|------|------|------|-----|------|------|------|-------|------|------|------|-------|
| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | |
| <u>Swine Receipts</u> ^{1/} | | | | | | | | | | | | | |
| 1953 | 99 | 54 | 52 | 42 | 38 | 47 | 40 | 29 | 46 | 65 | 77 | 76 | 665 |
| 1954 | 65 | 46 | 51 | 46 | 44 | 51 | 49 | 48 | 53 | 73 | 86 | 97 | 709 |
| 1955 | 89 | 56 | 68 | 56 | 53 | 58 | 49 | 53 | 57 | 87 | 129 | 132 | 887 |
| 1956 | 118 | 80 | 72 | 56 | 52 | 50 | 44 | 44 | 54 | 80 | 83 | 73 | 806 |
| 1957 | 74 | 53 | 56 | 55 | 52 | 49 | 50 | 52 | 55 | 84 | 72 | 91 | 743 |
| <u>Dead</u> | | | | | | | | | | | | | |
| 1953 | 65 | 22 | 24 | 13 | 11 | 28 | 17 | 15 | 21 | 19 | 26 | 55 | 316 |
| 1954 | 56 | 24 | 12 | 36 | 30 | 29 | 28 | 15 | 15 | 20 | 43 | 52 | 360 |
| 1955 | 59 | 23 | 23 | 20 | 16 | 30 | 24 | 7 | 8 | 17 | 32 | 47 | 306 |
| 1956 | 46 | 15 | 17 | 11 | 20 | 14 | 5 | 4 | 13 | 34 | 28 | 31 | 238 |
| 1957 | 28 | 15 | 24 | 12 | 21 | 25 | 14 | 14 | 14 | 34 | 34 | 40 | 275 |
| <u>Crippled</u> | | | | | | | | | | | | | |
| 1953 | 126 | 54 | 34 | 43 | 44 | 48 | 38 | 8 | 11 | 27 | 49 | 66 | 548 |
| 1954 | 111 | 41 | 33 | 29 | 47 | 40 | 37 | 24 | 17 | 21 | 62 | 67 | 529 |
| 1955 | 80 | 46 | 36 | 32 | 33 | 48 | 19 | 12 | 9 | 22 | 76 | 127 | 540 |
| 1956 | 122 | 74 | 40 | 52 | 30 | 30 | 13 | 12 | 8 | 24 | 41 | 52 | 498 |
| 1957 | 48 | 28 | 33 | 26 | 18 | 31 | 25 | 6 | 4 | 10 | 29 | 40 | 298 |

^{1/} Thousands of head for receipts only.

APPENDIX TABLE V. WEEKLY VARIATION IN SWINE RECEIPTS, DEATHS
AND CRIPPLES, 1953-1957

| Year | First | Second | Week Third | Fourth | Fifth | Total |
|------------------------------------|-------|--------|---------------|--------|-------|-------|
| Swine Receipts^{1/} | | | | | | |
| 1953 | 138 | 151 | 155 | 153 | 68 | 665 |
| 1954 | 162 | 167 | 167 | 154 | 59 | 709 |
| 1955 | 201 | 202 | 215 | 195 | 74 | 887 |
| 1956 | 191 | 178 | 179 | 189 | 69 | 806 |
| 1957 | 165 | 179 | 168 | 170 | 61 | 743 |
| Dead | | | | | | |
| 1953 | 61 | 77 | 85 | 55 | 38 | 316 |
| 1954 | 88 | 86 | 106 | 58 | 22 | 360 |
| 1955 | 68 | 84 | 73 | 55 | 26 | 306 |
| 1956 | 55 | 54 | 58 | 49 | 22 | 238 |
| 1957 | 67 | 76 | 59 | 55 | 18 | 275 |
| Crippled | | | | | | |
| 1953 | 98 | 130 | 121 | 139 | 60 | 548 |
| 1954 | 134 | 127 | 116 | 118 | 34 | 529 |
| 1955 | 129 | 120 | 119 | 129 | 43 | 540 |
| 1956 | 117 | 108 | 119 | 114 | 40 | 498 |
| 1957 | 70 | 84 | 66 | 56 | 22 | 298 |

^{1/} Thousands of head for receipts only.

APPENDIX TABLE VI. DAILY VARIATION IN SWINE RECEIPTS, DEATHS
AND CRIPPLES, 1953-57

| Year | Monday | Tuesday | Day Wednesday | Thursday | Friday | Total |
|------------------------------------|--------|---------|------------------|----------|--------|-------|
| Swine Receipts^{1/} | | | | | | |
| 1953 | 149 | 158 | 129 | 132 | 97 | 665 |
| 1954 | 152 | 173 | 145 | 141 | 98 | 709 |
| 1955 | 179 | 215 | 181 | 183 | 129 | 887 |
| 1956 | 157 | 192 | 148 | 178 | 131 | 806 |
| 1957 | 153 | 176 | 149 | 153 | 112 | 743 |
| Dead | | | | | | |
| 1953 | 89 | 85 | 58 | 53 | 31 | 316 |
| 1954 | 79 | 91 | 82 | 73 | 35 | 360 |
| 1955 | 51 | 87 | 65 | 65 | 38 | 306 |
| 1956 | 43 | 57 | 50 | 52 | 36 | 238 |
| 1957 | 61 | 70 | 56 | 47 | 41 | 275 |
| Crippled | | | | | | |
| 1953 | 111 | 130 | 116 | 113 | 78 | 548 |
| 1954 | 113 | 140 | 121 | 113 | 42 | 529 |
| 1955 | 103 | 141 | 112 | 115 | 69 | 540 |
| 1956 | 88 | 126 | 108 | 110 | 66 | 498 |
| 1957 | 58 | 77 | 66 | 60 | 37 | 298 |

^{1/} Thousands of head for receipts only.

APPENDIX TABLE VII. SEASONAL DISTRIBUTION OF SWINE RECEIPTS, DEATHS
AND CRIPPLES, 1953-1957

| Year | Season | | | | Total |
|---------------------------|--------|--------|------|--------|-------|
| | Spring | Summer | Fall | Winter | |
| Swine Receipts (%) | | | | | |
| 1953 | 22.2 | 18.8 | 21.1 | 37.9 | 100.0 |
| 1954 | 20.2 | 20.3 | 24.5 | 35.0 | 100.0 |
| 1955 | 20.3 | 18.0 | 22.2 | 39.5 | 100.0 |
| 1956 | 25.8 | 18.1 | 22.1 | 34.0 | 100.0 |
| 1957 | 22.1 | 20.3 | 25.7 | 31.9 | 100.0 |
| Dead (%) | | | | | |
| 1953 | 18.7 | 17.7 | 17.4 | 46.2 | 100.0 |
| 1954 | 20.0 | 24.2 | 13.9 | 41.9 | 100.0 |
| 1955 | 21.6 | 22.9 | 10.4 | 45.1 | 100.0 |
| 1956 | 18.1 | 16.4 | 21.4 | 44.1 | 100.0 |
| 1957 | 18.6 | 21.8 | 22.5 | 37.1 | 100.0 |
| Crippled (%) | | | | | |
| 1953 | 23.9 | 23.7 | 8.4 | 44.0 | 100.0 |
| 1954 | 19.5 | 23.4 | 11.7 | 45.4 | 100.0 |
| 1955 | 21.1 | 18.5 | 8.0 | 52.4 | 100.0 |
| 1956 | 33.3 | 14.7 | 8.8 | 43.2 | 100.0 |
| 1957 | 29.2 | 24.8 | 6.7 | 39.3 | 100.0 |

APPENDIX TABLE VIII. MONTHLY DISTRIBUTION OF SWINE RECEIPTS, DEATHS AND CRIPPLES, 1953-1957

| Year | Month | | | | | | | | | | | | Total |
|---------------------------|-------|------|------|------|-----|------|------|------|-------|------|------|------|-------|
| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | |
| Swine Receipts (%) | | | | | | | | | | | | | |
| 1953 | 14.9 | 8.1 | 7.8 | 6.3 | 5.7 | 7.1 | 6.0 | 4.4 | 6.9 | 9.8 | 11.6 | 11.4 | 100.0 |
| 1954 | 9.1 | 6.5 | 7.2 | 6.5 | 6.2 | 7.2 | 6.9 | 6.8 | 7.5 | 10.3 | 12.1 | 13.7 | 100.0 |
| 1955 | 10.0 | 6.3 | 7.7 | 6.3 | 6.0 | 6.5 | 5.5 | 6.0 | 6.4 | 9.8 | 14.6 | 14.9 | 100.0 |
| 1956 | 14.6 | 9.9 | 8.9 | 6.9 | 6.5 | 6.2 | 5.5 | 5.5 | 6.7 | 9.9 | 10.3 | 9.1 | 100.0 |
| 1957 | 10.0 | 7.1 | 7.5 | 7.4 | 7.0 | 6.6 | 6.7 | 7.0 | 7.4 | 11.3 | 9.7 | 12.3 | 100.0 |
| Dead (%) | | | | | | | | | | | | | |
| 1953 | 20.6 | 7.0 | 7.6 | 4.1 | 3.5 | 8.9 | 5.4 | 4.7 | 6.6 | 6.0 | 8.2 | 17.4 | 100.0 |
| 1954 | 15.6 | 6.7 | 3.3 | 10.0 | 8.3 | 8.1 | 7.8 | 4.2 | 4.2 | 5.5 | 11.9 | 14.4 | 100.0 |
| 1955 | 19.3 | 7.5 | 7.5 | 6.5 | 5.2 | 9.8 | 7.8 | 2.3 | 2.6 | 5.6 | 10.5 | 15.4 | 100.0 |
| 1956 | 19.3 | 6.3 | 7.1 | 4.6 | 8.4 | 5.9 | 2.1 | 1.7 | 5.5 | 14.3 | 11.8 | 13.0 | 100.0 |
| 1957 | 10.2 | 5.5 | 8.7 | 4.3 | 7.6 | 9.1 | 5.1 | 5.1 | 5.1 | 12.4 | 12.4 | 14.5 | 100.0 |
| Crippled (%) | | | | | | | | | | | | | |
| 1953 | 23.0 | 9.9 | 6.2 | 7.9 | 8.0 | 8.8 | 6.9 | 1.5 | 2.0 | 4.9 | 8.9 | 12.0 | 100.0 |
| 1954 | 21.0 | 7.7 | 6.2 | 5.5 | 8.9 | 7.6 | 7.0 | 4.5 | 3.2 | 4.0 | 11.7 | 12.7 | 100.0 |
| 1955 | 14.8 | 8.5 | 6.7 | 5.9 | 6.1 | 8.9 | 3.5 | 2.2 | 1.7 | 4.1 | 14.1 | 23.5 | 100.0 |
| 1956 | 24.5 | 14.9 | 8.0 | 10.5 | 6.0 | 6.0 | 2.6 | 2.4 | 1.6 | 4.8 | 8.2 | 10.5 | 100.0 |
| 1957 | 16.1 | 9.4 | 11.1 | 8.7 | 6.1 | 10.4 | 8.4 | 2.0 | 1.3 | 3.4 | 9.7 | 13.4 | 100.0 |

APPENDIX TABLE IX. WEEKLY DISTRIBUTION OF SWINE RECEIPTS, DEATHS
AND CRIPPLES, 1953-1957

| Year | First | Second | Week Third | Fourth | Fifth | Total |
|---------------------------|-------|--------|---------------|--------|-------|-------|
| Swine Receipts (%) | | | | | | |
| 1953 | 20.8 | 22.7 | 23.3 | 23.0 | 10.2 | 100.0 |
| 1954 | 22.8 | 23.6 | 23.6 | 21.7 | 8.3 | 100.0 |
| 1955 | 22.7 | 22.8 | 24.2 | 22.0 | 8.3 | 100.0 |
| 1956 | 23.7 | 22.1 | 22.2 | 23.4 | 8.6 | 100.0 |
| 1957 | 22.2 | 24.1 | 22.6 | 22.9 | 8.2 | 100.0 |
| Dead (%) | | | | | | |
| 1953 | 19.3 | 24.4 | 26.9 | 17.4 | 12.0 | 100.0 |
| 1954 | 24.4 | 23.9 | 29.5 | 16.1 | 6.1 | 100.0 |
| 1955 | 22.2 | 27.4 | 23.9 | 18.0 | 8.5 | 100.0 |
| 1956 | 23.1 | 22.7 | 24.4 | 20.6 | 9.2 | 100.0 |
| 1957 | 24.4 | 27.6 | 21.5 | 20.0 | 6.5 | 100.0 |
| Crippled (%) | | | | | | |
| 1953 | 17.9 | 23.7 | 22.1 | 25.4 | 10.9 | 100.0 |
| 1954 | 25.4 | 24.0 | 21.9 | 22.3 | 6.4 | 100.0 |
| 1955 | 23.9 | 22.2 | 22.0 | 23.9 | 8.0 | 100.0 |
| 1956 | 23.5 | 21.7 | 23.9 | 22.9 | 8.0 | 100.0 |
| 1957 | 23.5 | 28.2 | 22.1 | 18.8 | 7.4 | 100.0 |

APPENDIX TABLE X. DAILY DISTRIBUTION OF SWINE RECEIPTS, DEATHS
AND CRIPPLES, 1953-1957

| Year | Monday | Tuesday | Day Wednesday | Thursday | Friday | Total |
|---------------------------|--------|---------|------------------|----------|--------|-------|
| Swine Receipts (%) | | | | | | |
| 1953 | 22.4 | 23.8 | 19.4 | 19.8 | 14.6 | 100.0 |
| 1954 | 21.4 | 24.4 | 20.5 | 19.9 | 13.8 | 100.0 |
| 1955 | 20.2 | 24.2 | 20.4 | 20.6 | 14.6 | 100.0 |
| 1956 | 19.5 | 23.8 | 18.4 | 22.1 | 16.2 | 100.0 |
| 1957 | 20.6 | 23.7 | 20.0 | 20.6 | 15.1 | 100.0 |
| Dead (%) | | | | | | |
| 1953 | 28.2 | 26.9 | 18.3 | 16.8 | 9.8 | 100.0 |
| 1954 | 21.9 | 25.3 | 22.8 | 20.3 | 9.7 | 100.0 |
| 1955 | 16.6 | 28.4 | 21.3 | 21.3 | 12.4 | 100.0 |
| 1956 | 18.1 | 24.0 | 21.0 | 21.8 | 15.1 | 100.0 |
| 1957 | 22.2 | 25.4 | 20.4 | 17.1 | 14.9 | 100.0 |
| Crippled (%) | | | | | | |
| 1953 | 20.3 | 23.7 | 21.2 | 20.6 | 14.2 | 100.0 |
| 1954 | 21.4 | 26.4 | 22.9 | 21.4 | 7.9 | 100.0 |
| 1955 | 19.1 | 26.1 | 20.7 | 21.3 | 12.8 | 100.0 |
| 1956 | 17.7 | 25.3 | 21.7 | 22.1 | 13.2 | 100.0 |
| 1957 | 19.5 | 25.8 | 22.2 | 20.1 | 12.4 | 100.0 |

APPENDIX TABLE XI. SEASONAL DEATH AND CRIPPLING LOSS PER 10,000 SWINE RECEIVED, 1953-1957

| Year | Spring | Seasonal Loss Ratios | | Winter |
|-----------------|--------|----------------------|------|--------|
| | | Summer | Fall | |
| <u>Dead</u> | | | | |
| 1953 | 3.40 | 4.48 | 3.93 | 5.79 |
| 1954 | 5.03 | 6.04 | 2.87 | 6.09 |
| 1955 | 3.67 | 4.37 | 1.62 | 3.94 |
| 1956 | 2.07 | 2.67 | 2.87 | 3.83 |
| 1957 | 3.11 | 3.97 | 3.25 | 4.30 |
| <u>Crippled</u> | | | | |
| 1953 | 8.85 | 10.40 | 3.29 | 9.56 |
| 1954 | 7.20 | 8.61 | 3.56 | 9.68 |
| 1955 | 6.33 | 6.25 | 2.18 | 8.09 |
| 1956 | 7.98 | 5.00 | 2.47 | 7.85 |
| 1957 | 4.73 | 4.90 | 1.05 | 4.94 |

APPENDIX TABLE XII. MONTHLY DEATH AND CRIPPLING LOSS PER 10,000 SWINE RECEIVED, 1953-1957

| Year | Month | | | | | | | | | | | | Average | | |
|----------|-------|-------|------|-------|-------|-------|------|------|-------|------|------|------|---------|--|--|
| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | | | |
| Dead | | | | | | | | | | | | | | | |
| 1953 | 6.57 | 4.07 | 4.62 | 3.10 | 2.89 | 5.96 | 4.25 | 5.17 | 4.57 | 2.92 | 3.38 | 7.24 | 4.75 | | |
| 1954 | 8.62 | 5.22 | 2.35 | 7.83 | 6.82 | 5.69 | 5.71 | 3.12 | 2.83 | 2.74 | 5.00 | 5.36 | 5.08 | | |
| 1955 | 6.63 | 4.11 | 3.38 | 3.57 | 3.02 | 5.17 | 4.90 | 1.32 | 1.40 | 1.95 | 2.48 | 3.56 | 3.45 | | |
| 1956 | 3.90 | 1.88 | 2.36 | 1.96 | 3.85 | 2.80 | 1.14 | 0.91 | 2.41 | 4.25 | 3.37 | 4.25 | 2.95 | | |
| 1957 | 3.78 | 2.83 | 4.29 | 2.18 | 4.04 | 5.10 | 2.80 | 2.69 | 2.55 | 4.05 | 4.72 | 4.40 | 3.70 | | |
| Crippled | | | | | | | | | | | | | | | |
| 1953 | 12.73 | 10.00 | 6.42 | 10.24 | 11.58 | 10.21 | 9.50 | 2.76 | 2.39 | 4.15 | 6.36 | 8.68 | 8.24 | | |
| 1954 | 17.08 | 8.91 | 6.47 | 6.30 | 10.44 | 7.84 | 7.55 | 5.00 | 3.21 | 2.88 | 7.21 | 6.91 | 7.46 | | |
| 1955 | 8.99 | 8.21 | 5.29 | 5.71 | 6.23 | 8.28 | 3.88 | 2.26 | 1.58 | 2.53 | 5.89 | 9.62 | 6.09 | | |
| 1956 | 10.34 | 9.25 | 5.56 | 9.29 | 5.77 | 6.00 | 2.95 | 2.73 | 1.48 | 3.00 | 4.94 | 7.12 | 6.18 | | |
| 1957 | 6.49 | 5.28 | 5.89 | 4.73 | 3.46 | 6.33 | 5.00 | 1.15 | 0.73 | 1.19 | 4.03 | 4.40 | 4.01 | | |

APPENDIX TABLE XIII. WEEKLY DEATH AND CRIPPLING LOSS PER 10,000 SWINE RECEIVED, 1953-1957

| Year | First | Second | Week Third | Fourth | Fifth | Average |
|-----------------|-------|--------|---------------|--------|-------|---------|
| <u>Dead</u> | | | | | | |
| 1953 | 4.42 | 5.10 | 5.48 | 3.59 | 5.59 | 4.75 |
| 1954 | 5.43 | 5.15 | 6.35 | 3.77 | 3.73 | 5.08 |
| 1955 | 3.38 | 4.16 | 3.40 | 2.82 | 3.51 | 3.45 |
| 1956 | 2.88 | 3.03 | 3.24 | 2.59 | 3.19 | 2.95 |
| 1957 | 4.06 | 4.25 | 3.51 | 3.24 | 2.95 | 3.70 |
| <u>Crippled</u> | | | | | | |
| 1953 | 7.10 | 8.61 | 7.81 | 9.08 | 8.82 | 8.24 |
| 1954 | 8.27 | 7.60 | 6.95 | 7.66 | 5.76 | 7.46 |
| 1955 | 6.42 | 5.94 | 5.53 | 6.62 | 5.81 | 6.09 |
| 1956 | 6.13 | 6.07 | 6.65 | 6.03 | 5.80 | 6.18 |
| 1957 | 4.24 | 4.69 | 3.93 | 3.29 | 3.61 | 4.01 |

APPENDIX TABLE XIV. DAILY DEATH AND CRIPPLING LOSS PER 10,000 SWINE RECEIVED, 1953-1957

| Year | Monday | Tuesday | Day Wednesday | Thursday | Friday | Average |
|-----------------|--------|---------|------------------|----------|--------|---------|
| <u>Dead</u> | | | | | | |
| 1953 | 5.97 | 5.38 | 4.50 | 4.02 | 3.20 | 4.75 |
| 1954 | 5.20 | 5.26 | 5.66 | 5.18 | 3.57 | 5.08 |
| 1955 | 2.85 | 4.05 | 3.59 | 3.55 | 2.95 | 3.45 |
| 1956 | 2.74 | 2.97 | 3.38 | 2.92 | 2.75 | 2.95 |
| 1957 | 3.99 | 3.98 | 3.76 | 3.07 | 3.66 | 3.70 |
| <u>Crippled</u> | | | | | | |
| 1953 | 7.45 | 8.23 | 8.99 | 8.56 | 8.04 | 8.24 |
| 1954 | 7.43 | 8.09 | 8.34 | 8.01 | 4.29 | 7.46 |
| 1955 | 5.75 | 6.56 | 6.19 | 6.28 | 5.35 | 6.09 |
| 1956 | 5.61 | 6.56 | 7.30 | 6.18 | 5.04 | 6.18 |
| 1957 | 3.79 | 4.38 | 4.43 | 3.92 | 3.30 | 4.01 |

APPENDIX TABLE XV. MONTHLY DISTRIBUTION OF SWINE RECEIPTS BY MILEAGE ZONE, 1954^{1/}

| Mileage Zone | Month | | | | | | | | | | | | |
|-----------------|-------|------|------|------|------|------|------|------|-------|------|------|------|---------|
| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Average |
| 0 - 10 | 5.4 | 6.6 | 7.4 | 6.8 | 5.7 | 6.3 | 5.8 | 5.6 | 4.7 | 5.3 | 4.3 | 5.3 | 5.6 |
| 11 - 20 | 24.5 | 24.4 | 27.1 | 22.8 | 24.2 | 22.8 | 23.6 | 24.0 | 25.3 | 25.5 | 25.3 | 22.6 | 24.3 |
| 21 - 30 | 20.8 | 22.2 | 24.6 | 23.2 | 24.4 | 21.4 | 20.4 | 24.9 | 27.4 | 21.6 | 21.9 | 21.6 | 22.7 |
| 31 - 40 | 23.2 | 22.7 | 20.3 | 22.4 | 22.5 | 22.1 | 21.5 | 21.0 | 21.4 | 22.5 | 21.3 | 21.5 | 21.9 |
| 41 - 50 | 8.2 | 8.3 | 7.9 | 9.7 | 8.7 | 8.9 | 8.0 | 7.7 | 8.3 | 9.1 | 9.2 | 9.4 | 8.7 |
| 51 - 60 | 7.5 | 7.2 | 6.7 | 7.7 | 7.1 | 10.0 | 10.2 | 8.6 | 6.1 | 7.7 | 8.4 | 8.9 | 8.1 |
| 61 - 70 | 4.5 | 3.7 | 3.2 | 4.2 | 4.4 | 5.3 | 5.8 | 3.9 | 3.6 | 4.3 | 5.6 | 5.6 | 4.6 |
| 71 - 80 | 1.3 | 1.5 | 0.8 | 1.4 | 1.2 | 1.3 | 2.0 | 1.4 | 1.2 | 1.8 | 2.0 | 1.6 | 1.5 |
| 81 - 90 | 0.7 | 0.9 | 0.3 | 0.4 | 0.7 | 0.5 | 1.3 | 0.9 | 0.9 | 1.1 | 0.7 | 1.3 | 0.9 |
| 91 - 100 | 1.6 | 1.0 | 0.8 | 0.7 | 0.5 | 0.2 | 0.6 | 0.4 | 0.2 | 0.2 | 0.2 | 0.4 | 0.5 |
| Over 100 | 2.3 | 1.5 | 0.9 | 0.7 | 0.6 | 1.2 | 0.8 | 1.6 | 0.9 | 0.9 | 1.1 | 1.8 | 1.2 |

^{1/} Percent receipts from all zones.

APPENDIX TABLE XVI. MONTHLY DISTRIBUTION OF DEAD SWINE BY MILEAGE ZONE, 1954-1957^{1/}

| Mileage Zone | Month | | | | | | | | | | | | Average |
|--------------|-------|------|------|------|------|------|------|------|-------|------|------|------|---------|
| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | |
| 0 - 10 | 1.6 | 0.0 | 1.3 | 1.3 | 1.1 | 5.0 | 1.4 | 5.3 | 2.1 | 0.0 | 2.9 | 1.2 | 1.8 |
| 11 - 20 | 5.7 | 12.0 | 11.8 | 2.6 | 5.6 | 6.1 | 12.3 | 10.6 | 19.1 | 11.6 | 5.8 | 12.1 | 8.9 |
| 21 - 30 | 18.7 | 20.0 | 19.7 | 19.2 | 16.8 | 26.3 | 13.7 | 15.8 | 29.8 | 17.5 | 13.0 | 15.0 | 18.1 |
| 31 - 40 | 21.8 | 20.0 | 25.0 | 32.0 | 29.2 | 23.2 | 19.2 | 28.9 | 19.1 | 13.6 | 23.7 | 17.9 | 22.1 |
| 41 - 50 | 10.9 | 6.7 | 13.2 | 19.2 | 12.4 | 6.1 | 13.7 | 7.9 | 10.6 | 5.8 | 18.7 | 14.4 | 12.1 |
| 51 - 60 | 11.9 | 17.3 | 15.8 | 10.2 | 9.0 | 19.2 | 13.7 | 15.8 | 4.3 | 19.4 | 11.5 | 8.1 | 12.8 |
| 61 - 70 | 15.0 | 8.0 | 7.9 | 7.7 | 7.9 | 9.1 | 6.8 | 10.5 | 4.3 | 22.3 | 10.8 | 12.7 | 11.3 |
| 71 - 80 | 1.6 | 2.7 | 0.0 | 2.6 | 4.5 | 4.0 | 5.5 | 2.6 | 4.3 | 2.9 | 5.0 | 3.5 | 3.2 |
| 81 - 90 | 1.0 | 4.0 | 0.0 | 1.3 | 2.2 | 0.0 | 1.4 | 0.0 | 6.4 | 1.0 | 2.9 | 6.4 | 2.4 |
| 91 - 100 | 2.1 | 1.3 | 0.0 | 1.3 | 0.0 | 0.0 | 2.7 | 0.0 | 0.0 | 0.0 | 0.0 | 2.3 | 1.0 |
| Over 100 | 9.7 | 8.0 | 5.3 | 2.6 | 11.3 | 1.0 | 9.6 | 2.6 | 0.0 | 5.9 | 5.7 | 6.4 | 6.3 |

^{1/} Average percentage for all years and zones.

APPENDIX TABLE XVII. MONTHLY DISTRIBUTION OF CRIPPLED SWINE BY MILEAGE ZONE, 1954-1957^{1/}

| Mileage Zone | Month | | | | | | | | | | | | |
|-----------------|-------|------|------|------|------|------|------|------|-------|------|------|------|---------|
| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Average |
| 0 - 10 | 1.9 | 2.1 | 2.8 | 3.6 | 4.0 | 3.2 | 2.2 | 0.0 | 5.7 | 2.7 | 2.9 | 6.3 | 3.2 |
| 11 - 20 | 16.0 | 15.5 | 17.0 | 19.4 | 17.6 | 20.5 | 16.7 | 13.0 | 14.3 | 13.7 | 19.2 | 16.0 | 17.0 |
| 21 - 30 | 17.4 | 22.5 | 16.3 | 25.9 | 22.4 | 21.8 | 23.3 | 22.2 | 22.8 | 20.5 | 17.4 | 20.1 | 20.2 |
| 31 - 40 | 21.8 | 23.0 | 29.1 | 25.9 | 20.0 | 24.4 | 20.0 | 20.3 | 20.0 | 27.4 | 21.7 | 21.5 | 22.9 |
| 41 - 50 | 10.7 | 12.8 | 9.3 | 7.2 | 12.0 | 8.3 | 8.9 | 14.8 | 11.4 | 6.9 | 9.2 | 9.4 | 10.0 |
| 51 - 60 | 11.3 | 8.6 | 12.8 | 10.8 | 5.6 | 5.1 | 11.1 | 14.8 | 14.3 | 11.0 | 9.2 | 12.5 | 10.3 |
| 61 - 70 | 8.5 | 9.6 | 7.1 | 4.3 | 11.2 | 10.3 | 10.0 | 5.5 | 8.6 | 13.7 | 9.7 | 6.9 | 8.6 |
| 71 - 80 | 3.3 | 1.6 | 2.8 | 1.5 | 1.6 | 2.6 | 5.6 | 3.7 | 0.0 | 2.7 | 5.3 | 3.1 | 3.0 |
| 81 - 90 | 2.2 | 1.6 | 1.4 | 0.7 | 0.0 | 0.6 | 1.1 | 1.9 | 0.0 | 1.4 | 1.0 | 1.4 | 1.3 |
| 91 - 100 | 1.1 | 1.1 | 0.0 | 0.0 | 0.0 | 1.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.7 | 0.6 |
| Over 100 | 5.8 | 1.6 | 1.4 | 0.7 | 5.6 | 1.9 | 1.1 | 3.8 | 2.9 | 0.0 | 3.9 | 2.1 | 2.9 |

^{1/} Average percentage for all years and zones.

APPENDIX TABLE XVIII. NUMBER OF DEAD SWINE CLASSIFIED BY YEAR, MONTH AND MILEAGE ZONE, 1954-1957

| Year | Mileage Zone | Month | | | | | | | | | | | |
|------|--------------|-------|------|------|------|-----|------|------|------|-------|------|------|------|
| | | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
| 1954 | 0 - 10 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 2 | 2 |
| | 11 - 20 | 2 | 5 | 1 | 2 | 3 | 4 | 4 | 1 | 1 | 3 | 2 | 5 |
| | 21 - 30 | 16 | 2 | 3 | 6 | 4 | 7 | 4 | 2 | 4 | 3 | 4 | 11 |
| | 31 - 40 | 16 | 4 | 3 | 12 | 14 | 8 | 4 | 3 | 3 | 3 | 13 | 14 |
| | 41 - 50 | 4 | 1 | 2 | 6 | 4 | 2 | 4 | 0 | 1 | 1 | 11 | 7 |
| | 51 - 60 | 9 | 5 | 0 | 2 | 3 | 8 | 1 | 1 | 1 | 5 | 4 | 4 |
| | 61 - 70 | 3 | 1 | 0 | 4 | 1 | 1 | 2 | 0 | 3 | 3 | 4 | 4 |
| | Over 70 | 10 | 4 | 2 | 2 | 3 | 1 | 7 | 2 | 3 | 0 | 5 | 8 |
| 1955 | 0 - 10 | 1 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 11 - 20 | 3 | 2 | 4 | 0 | 2 | 3 | 3 | 2 | 0 | 1 | 1 | 5 |
| | 21 - 30 | 12 | 9 | 4 | 7 | 6 | 9 | 4 | 5 | 5 | 2 | 7 | 6 |
| | 31 - 40 | 18 | 4 | 9 | 3 | 3 | 6 | 6 | 1 | 2 | 2 | 7 | 7 |
| | 41 - 50 | 6 | 0 | 1 | 5 | 1 | 1 | 5 | 1 | 1 | 3 | 2 | 9 |
| | 51 - 60 | 5 | 4 | 3 | 1 | 2 | 6 | 2 | 0 | 2 | 2 | 5 | 4 |
| | 61 - 70 | 9 | 0 | 2 | 2 | 2 | 3 | 2 | 0 | 6 | 5 | 5 | 10 |
| | Over 70 | 5 | 4 | 0 | 2 | 0 | 0 | 1 | 0 | 1 | 1 | 5 | 6 |

APPENDIX TABLE XVIII. CONTINUED

| Year | Mileage Zone | Month | | | | | | | | | | | | | | |
|---------|--------------|-------|------|------|------|-----|------|------|------|-------|------|------|------|---|----|---|
| | | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | | | |
| 1956 | 0 - 10 | 2 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 |
| | 11 - 20 | 2 | 2 | 4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 4 | 2 | 2 | 4 |
| | 21 - 30 | 4 | 0 | 3 | 2 | 2 | 4 | 1 | 2 | 1 | 3 | 4 | 7 | 5 | 4 | 3 |
| | 31 - 40 | 4 | 3 | 2 | 6 | 6 | 4 | 2 | 1 | 4 | 7 | 2 | 7 | 5 | 7 | 3 |
| | 41 - 50 | 8 | 4 | 3 | 3 | 3 | 2 | 0 | 1 | 3 | 0 | 3 | 5 | 2 | 5 | 5 |
| | 51 - 60 | 6 | 2 | 3 | 0 | 2 | 2 | 0 | 0 | 0 | 5 | 0 | 9 | 2 | 5 | 2 |
| | 61 - 70 | 14 | 1 | 1 | 0 | 1 | 2 | 1 | 0 | 0 | 9 | 0 | 1 | 1 | 1 | 2 |
| Over 70 | 6 | 3 | 1 | 0 | 5 | 2 | 0 | 0 | 0 | 5 | 1 | 2 | 8 | 2 | 8 | |
| 1957 | 0 - 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| | 11 - 20 | 4 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 5 | 5 | 5 | 3 | 7 |
| | 21 - 30 | 4 | 4 | 5 | 0 | 3 | 10 | 1 | 2 | 2 | 10 | 2 | 3 | 3 | 3 | 6 |
| | 31 - 40 | 4 | 4 | 5 | 4 | 3 | 5 | 2 | 6 | 2 | 2 | 2 | 6 | 8 | 8 | 3 |
| | 41 - 50 | 3 | 0 | 4 | 1 | 3 | 1 | 1 | 0 | 1 | 2 | 1 | 8 | 2 | 4 | 4 |
| | 51 - 60 | 3 | 2 | 6 | 5 | 1 | 3 | 3 | 4 | 1 | 8 | 1 | 5 | 2 | 4 | 4 |
| | 61 - 70 | 3 | 4 | 3 | 0 | 3 | 3 | 0 | 1 | 2 | 5 | 2 | 5 | 7 | 5 | 6 |
| Over 70 | 7 | 1 | 1 | 2 | 8 | 2 | 6 | 0 | 1 | 4 | 1 | 7 | 10 | 7 | 10 | |

APPENDIX TABLE XIX. NUMBER OF CRIPPLED SWINE CLASSIFIED BY YEAR, MONTH AND MILEAGE ZONE, 1954-1957

| Year | Mileage Zone | Month | | | | | | | | | | | |
|------|--------------|-------|------|------|------|-----|------|------|------|-------|------|------|------|
| | | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
| 1954 | 0 - 10 | 1 | 1 | 2 | 0 | 2 | 1 | 1 | 0 | 1 | 2 | 1 | 3 |
| | 11 - 20 | 23 | 5 | 4 | 5 | 8 | 10 | 6 | 2 | 1 | 5 | 13 | 7 |
| | 21 - 30 | 20 | 10 | 7 | 7 | 11 | 14 | 6 | 3 | 2 | 1 | 15 | 17 |
| | 31 - 40 | 29 | 8 | 7 | 10 | 10 | 9 | 8 | 5 | 3 | 6 | 14 | 19 |
| | 41 - 50 | 10 | 5 | 5 | 3 | 5 | 4 | 2 | 5 | 3 | 0 | 1 | 4 |
| | 51 - 60 | 15 | 5 | 4 | 2 | 2 | 3 | 7 | 6 | 2 | 3 | 7 | 9 |
| | 61 - 70 | 8 | 1 | 0 | 0 | 5 | 5 | 2 | 2 | 2 | 0 | 3 | 8 |
| | Over 70 | 7 | 4 | 3 | 2 | 1 | 1 | 1 | 1 | 0 | 0 | 7 | 2 |
| 1955 | 0 - 10 | 3 | 1 | 1 | 2 | 2 | 3 | 1 | 0 | 1 | 0 | 0 | 9 |
| | 11 - 20 | 14 | 11 | 7 | 6 | 7 | 8 | 3 | 2 | 0 | 4 | 15 | 24 |
| | 21 - 30 | 11 | 10 | 7 | 8 | 8 | 9 | 6 | 2 | 3 | 3 | 14 | 25 |
| | 31 - 40 | 12 | 15 | 10 | 8 | 5 | 12 | 6 | 5 | 3 | 6 | 16 | 24 |
| | 41 - 50 | 10 | 3 | 4 | 3 | 3 | 5 | 0 | 2 | 0 | 1 | 7 | 16 |
| | 51 - 60 | 6 | 2 | 4 | 3 | 3 | 3 | 2 | 0 | 1 | 2 | 8 | 17 |
| | 61 - 70 | 12 | 3 | 2 | 2 | 5 | 6 | 0 | 0 | 1 | 5 | 11 | 4 |
| | Over 70 | 12 | 1 | 1 | 0 | 0 | 2 | 1 | 1 | 0 | 1 | 5 | 8 |

APPENDIX TABLE XIX. CONTINUED

| Year | Mileage Zone | Month | | | | | | | | | | | | |
|---------|--------------|-------|------|------|------|-----|------|------|------|-------|------|------|------|----|
| | | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | |
| 1956 | 0 - 10 | 3 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 |
| | 11 - 20 | 15 | 10 | 9 | 11 | 6 | 6 | 1 | 1 | 3 | 1 | 7 | 1 | 11 |
| | 21 - 30 | 21 | 13 | 5 | 15 | 7 | 6 | 1 | 5 | 2 | 9 | 5 | 10 | 8 |
| | 31 - 40 | 34 | 13 | 11 | 14 | 6 | 11 | 2 | 1 | 1 | 5 | 10 | 4 | 10 |
| | 41 - 50 | 10 | 13 | 3 | 4 | 0 | 1 | 2 | 0 | 1 | 2 | 7 | 3 | 4 |
| | 51 - 60 | 16 | 7 | 6 | 7 | 1 | 0 | 0 | 2 | 1 | 3 | 3 | 2 | 7 |
| | 61 - 70 | 5 | 11 | 4 | 1 | 3 | 3 | 1 | 1 | 0 | 2 | 2 | 4 | 5 |
| Over 70 | 18 | 5 | 1 | 0 | 6 | 3 | 4 | 2 | 0 | 2 | 4 | 4 | 4 | |
| 1957 | 0 - 10 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 3 |
| | 11 - 20 | 6 | 3 | 4 | 5 | 1 | 8 | 3 | 2 | 1 | 3 | 5 | 0 | 4 |
| | 21 - 30 | 11 | 9 | 4 | 6 | 2 | 5 | 8 | 2 | 1 | 2 | 2 | 0 | 8 |
| | 31 - 40 | 4 | 7 | 13 | 4 | 2 | 6 | 2 | 0 | 0 | 3 | 5 | 3 | 9 |
| | 41 - 50 | 9 | 3 | 1 | 0 | 4 | 3 | 4 | 1 | 0 | 2 | 4 | 1 | 3 |
| | 51 - 60 | 4 | 2 | 4 | 3 | 7 | 2 | 1 | 0 | 1 | 0 | 1 | 4 | 3 |
| | 61 - 70 | 6 | 3 | 4 | 3 | 1 | 2 | 6 | 0 | 1 | 3 | 1 | 1 | 3 |
| Over 70 | 8 | 1 | 3 | 2 | 2 | 4 | 1 | 1 | 0 | 0 | 6 | 0 | 7 | |