ECONOMIES OF SCALE IN FARMER OPERATED CATTLE FEEDLOTS, KANSAS

by

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I INTRODUCTION

Finishing cattle is a major income producing activity for Kansas farmers. Recent publications have pointed to the expanded growth of commercial cattle feedlots throughout the United States.[1] Kansas is no exception; large commercial feedlots in the state have multiplied four times during the past ten years. Kansas in 1953, had ten commercial feedlots in operation; by January 1, 1963, the number had risen to forty-four. Commercial feedlots are defined as those with capacity for 1000 head or more and feeding, at least partially, on a contract basis, i.e., custom feeding cattle owned by outside sources.[2]

The rise in popularity of commercial feedlots has placed considerable importance on the answer to this question. What will happen to the farmer feedlots? Farmer feedlots were here defined as feedlots of less than 1000 head and all cattle are owned by the feedlot operator. The remainder of

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[1] Leo J. Moran, Nonfeed Costs of Arizona Cattle Feeding, Arizona Agricultural Experiment Station Technical Bulletin No. 136 (Tuscon, 1959), pp. 4-5.

Gordon A. King, Economies of Scale in Large Commercial Feedlots, California Agricultural Experiment Station, Giannini Foundation of Agricultural Economics Research Report No. 251 (Davis, 1962), p. 1.

Missouri, Economics Research Division Consumers Cooperative Association, Commercial Cattle Feed Yards Operating Policies, Facilities and Cooperative Organization Guides, (Kansas City, 1959), p. 25.

Willard F. Williams and James McDowell, Characteristics and Growth of Cattle Feedlot Operations in Oklahoma, Oklahoma Agricultural Experiment Station Processed Series P-418 (Stillwater, 1962), p. 4.

Robert H. Wuhrman, "Economic Aspects of Commercial Cattle Feed Lot Operations in Kansas" (unpublished Master's thesis, Library, Kansas State University, 1959), pp. 15-16.

[2] King, p. 1.

Wuhrman, p. 2.

California, Bank of America, Cattle Feeding in California, by John A. Hopkin (San Francisco, 1957), p. 12.

this report is devoted to an analysis which is designed to help answer this question.

Statistics compiled since 1945, by the Kansas Crop and Livestock Reporting Service indicate that total numbers of cattle on feed in Kansas have ranged from 322,000 January 1, 1945, immediately following World War II, to a low, due largely to drouth, of 153,000 January 1, 1957, and finally to the all time high of 392,000 January 1, 1963. Primary importance was focused on the over-all increase in cattle numbers as a portion of the farming program. Since January 1, 1956, data have been broken down for small feedlots and large feedlots (those with a capacity of 1000 head or more). While the total percentage being fed by large feedlots increased from 16 in 1956, to 38 in 1963, there also was a significant increase in absolute numbers being fed by small feedlots over this seven-year period. In 1956, small feedlots had 152,000 cattle on feed compared with 242,000 January 1, 1963, indicating the relative importance of fattening cattle on Kansas farms today.[3] Table 1 shows more clearly the significance of the above figures.

Farmer feedlots in Kansas operate for one, two, three, or any combination of three reasons. First, feeding makes possible the conversion of products with low demand into products with higher demand. For example, transformation of corn, grain sorghum, alfalfa, etc., all low demand products, into beef, prepares a product with a higher, more stable demand for market. This in turn tends to increase farmers incomes. Kansas has much permanent pasture which experiences little or no demand except through cattle feeding programs.

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[3]David M. Bartholomew, "Fed Cattle Still Come From the Farm", The 43rd Report of Kansas Agricultural, (June, 1960), p. 21.

TABLE 1

CATTLE AND CALVES ON GRAIN FEED, KANSAS,
JANUARY 1, 1956 TO JANUARY 1, 1961[a]

Date	Cattle on Feed in Lots with Capacity of Approximately 1,000 or More Head	Cattle on Feed in Lots of Less than 1,000 Head	Total of All Cattle on Feed	Percentage of Cattle on Feed which are in Lots with Capacity of Approximately 1,000 or More Head
Jan. 1, 1956	30,000	152,000	182,000	16%
Jan. 1, 1957	38,000	115,000	153,000	25%
Jan. 1, 1958[b]	44,000	127,000	171,000	26%
Jan. 1, 1959	49,000	166,000	215,000	23%
Jan. 1, 1960	58,000	217,000	275,000	21%
Jan. 1, 1961	88,000	249,000	337,000	26%
Jan. 1, 1962	99,000	248,000	347,000	29%
Jan. 1, 1963	150,000	242,000	392,000	38%

[a]Kansas Agriculture Forty Third Report, 1959-1960, Kansas State Board of Agriculture, Topeka, Kansas.

[b]Supplement supplied by the Kansas Crop and Livestock Reporting Service, Kansas State Board of Agriculture, Division of Statistics, Topeka, Kansas.

Second, seasonal fluctions in the live animal market with steady to stable consumer demand for dressed meat has resulted in cattle feeding enterprises designed to take advantage of high off-season markets. Rearranging existing feeding programs or changing them to increase turnover to something greater than one time per year can place cattle feeders on some seasonal market highs. This allows them to level out economic ups and downs from year to year. Thus, the dressed meat supply is made more nearly to coincide with demand for it throughout the year.

A third reason for cattle feeding on farms may be found in government controls on crops, primarily wheat. The increased reduction of wheat acreage has induced farmers to plant feed grain crops on non-wheat acres. With this abundant supply of feed grains going into an ever decreasing demand market, farmers have found it more profitable to transform feed grains into beef with its much higher demand market. As controls have expanded to cover feed grain acreages also, farmers have converted some idle land back to permanent pasture. The primary outlet for bulky materials, such as pasture, is through an animal feeding operation. Thus, there are three predominate reasons for farmers to continue to feed cattle.

Consumer demand for beef is expected to continue upward, therefore, adjustments shifting resources from wheat production into production of pasture and feed grains seem to be suitable.[4]

Cattle feeding on farms throughout the midwest, and particularly in Kansas, is customarily thought of as complementing crop farming.[5] Increases in feed grain and pasture acreage, along with new technological improvements of production methods, have contributed to the expansion of cattle feeding in Kansas. Thus, shifting of farm enterprises and technological advancements are preserving complementarity between crop farming and cattle feeding.

Buying and selling habits of Kansas cattlemen have assisted in

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[4]Missouri, Federal Reserve Bank of Kansas City, Financing Beef Production Systems, by Colyer and R. J. Doll (Kansas City, 1959), pp. 7, 35.

[5]California, Bank of America.

maintaining small farmer feedlots within the state. Numerous farm auctions and sale rings prevail throughout the state, providing both a buyer's and a seller's market for small lots of cattle. Farmers are able, therefore, to purchase small groups of cattle with a minimum of capital at any one time. This availability of small lots of cattle coupled with the similar ease which small numbers of cattle may be disposed of has gone far in maintaining the present status of small farmer feedlots. In some states, cattle buying and selling is done on a large scale with little or no out-let for small bunches.[6] Within those areas small farmer feedlots have been at a marked disadvantage the past few years. Therefore, it is quite easily seen that the present marketing structure for cattle in Kansas has done much to maintain the small cattle feeders position there.

The feeding program followed by most Kansas farm feeders, as indicated by the survey questionnaires, was that of winter, graze and full feed with winter and full feed second. Both programs complement farming operations.

For example, wintering is usually done on old grass, wheat pasture or stubble and grazing takes place on native grass during summer months. Neither of these operations requires an excessive amount of attention or work and, for the most part, each utilizes existing feed stocks. In the fall after crops have been harvested, ground prepared for next year's crops, etc., full feeding begins. This portion of the feeding program requires more labor, time and equipment than the other two, therefore, it has been so placed to utilize factors of production which otherwise would have been

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[6] *Ibid.*, p. 13.

idle. Also in keeping with the other two phases of the program, feed consumed during the full feeding phase has, in general, been produced on the farm. A similar example showing complementarity could be described for the winter and full feeding program.

Farmers under both feeding programs can easily dispose of their low demand, bulky feed products which have been produced through new technology and the undiminished shift of wheat acreage to feed grains and permanent pasture. Although these two feeding programs dominate among farmer cattle feedlots, there is a marked trend toward winter, full feed and strictly full feeding as size of farm feedlots approaches that of commercial feedlots.

Careful analysis indicates, however, as feeding enterprises specialize and expand capacity, they tend to become competitive with the farming operation. That is, the need of an outlet for low demand farm products has been surpassed to the point that, a majority of feed fed must be purchased from outside sources. At this point due to transportation costs, availability, quality, etc. it may be more economical to full feed continuously than to use other types of feeding operations.

A growing awareness that commercial fertilizers are not a complete substitute for organic fertilizers may increase the value of barnyard manure. If there proves to be a sufficient difference between fertilizers, farmers with a feeding operation may find they have another by-product which will add to their present income without any significant increase in costs.[7]

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[7]*Ibid*., p. 14
Wuhrman, p. 73.

Purpose

The purpose of this report is to determine the economies or diseconomies of scale associated with varied levels of cattle feeding and at varied percentages of any given level. It is designed to assist those already in the cattle feeding business and those beginning for the first time.

For those already feeding cattle the study is designed as a guide to future expansion programs. To the beginner it stresses size of operation and investment costs. For example, not all machinery and equipment purchased need be new. (The survey indicated clearly that existing feedlot operators quite often purchase second hand equipment or go in partnership on more expensive items.)

This study attempts to present some broad concepts of the farmer cattle feeding industry as it exists in Kansas today. It is an expressed desire that these concepts might assist (as guide lines) in the reorganization or commencement of feedlot operations.

Methodology

Five farm management field men, representing the state of Kansas, were contacted to supply information on the various sized cattle feedlots in their area. Thus, a listing of cattle feedlots within the Kansas farm management organization was secured. This list was then stratified into five separate groups, 1-75, 76-150, 151-300, 301-600 and 601-1250 head, respectively. The feedlots within each group were then placed together and a proportional random sample drawn, which dictated use of proportional stratified random sampling for statistical analyses.

Owners of the feedlots in each sample were contacted for personal interviews during the summer of 1962. A major proportion of the information obtained was for the year 1961, with some from the beginning of operation. Feedlots were distributed throughout the state, following no set pattern, as shown in Figure 1.

For purposes of this study samples taken were assumed to be representative of farmer cattle feedlots within Kansas. If this assumption is true, inferences may be made about all Kansas farmer cattle feedlots. As stated earlier, farmer cattle feedlots were defined as lots where the cattle are wholly owned by the operator. Among the sample farms a major porportion of the feed fed was raised on the same premises. This study was limited to herd sizes ranging up to 1250 head.

Five hypothetical model feedlots were constructed from the five groups above. A simple average was taken of each group, i.e. (151 + 300) ÷ 2 = 225, and classified as hypothetical Models I through V. The designed capacities are 40, 115, 225, 450, and 925 head, respectively. Some rounding error is evident as models were computed to the nearest multiple of five.

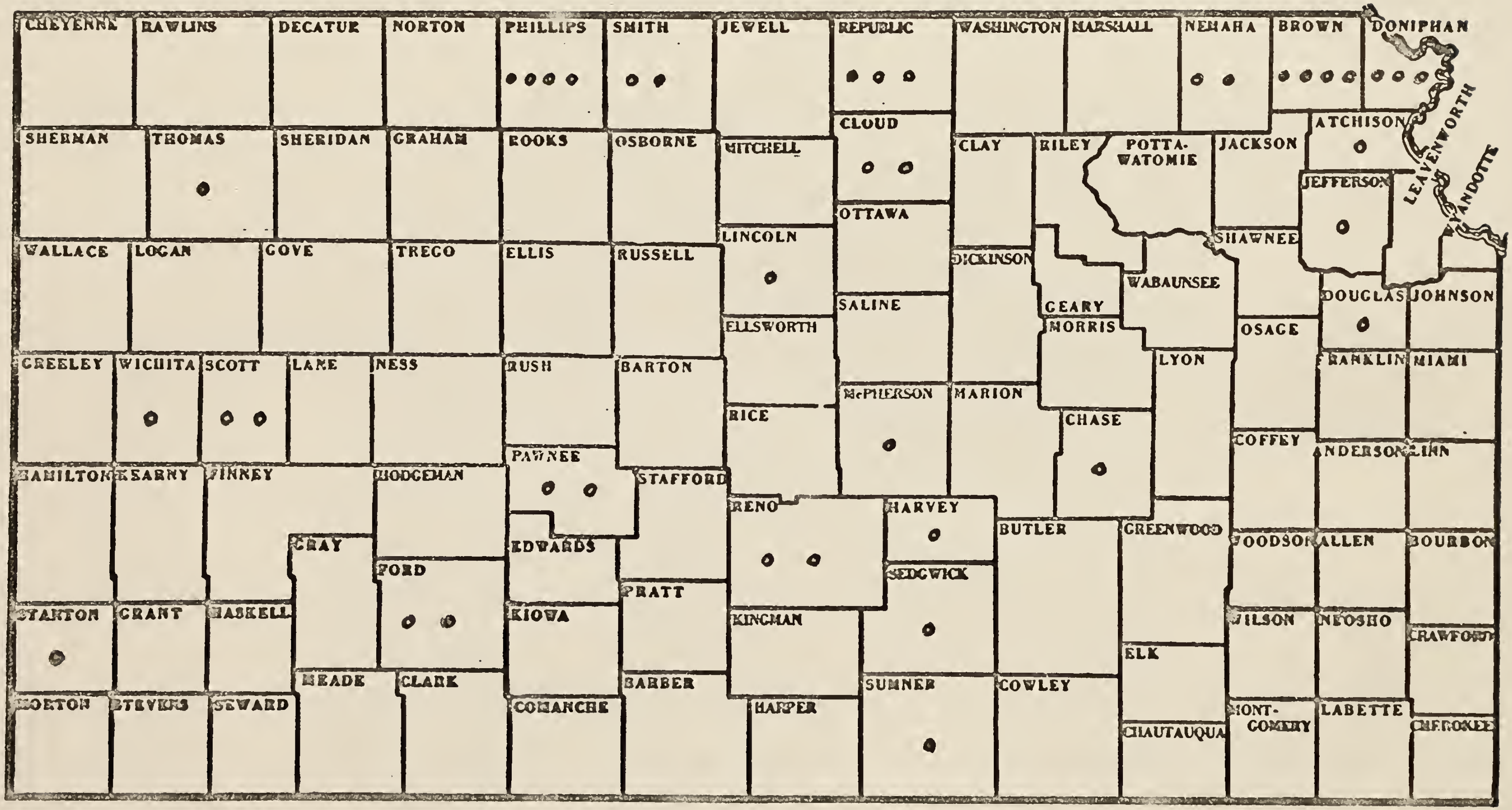

Fig. 1.--Map of Kansas counties showing location of feedlots interviewed (one dot representing one feedlot).

Capacity of a feedlot may be defined numerous ways. King[8] has defined capacity by using the area of feeding pens and the output of feed mills. This could have been broken down with either pen areas or mill output determining capacity of the feedlot. However, the survey used for this study found no evidence of feed mills and pen areas were not measured.

Capacity therefore, throughout this study, implies the normal number of cattle a feedlot will hold at any given time. Normal, in this case, has been estimated by the feedlot operators themselves.

The five hypothetical model feedlots were used to determine costs of operation at different levels of production and at various percentages of any given level. A synthetic or budget approach was used in conjunction with survey information to determine the machinery, equipment and building set up for each model.[9] Variable and fixed costs items were defined through the survey questionnaires. Costs for the items were compiled from a variety of sources and compared to obtain a logical estimate. These sources included; survey questionaires, farm management specialists, agricultural engineering specialists, agricultural economists, dealers, insurance agents, county clerks, and farmers. Some models at various times had items added or deleted which were not characteristic of the survey information. In any case where this has happened information has been

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[8] King, p. 7.

[9] For a discription of the budgetary approach, see E. L. Baum, J. E. Faris and G. H. Walkup, Economies of Scale in the Operation of Fryer Processing Plants with Special Reference to Washington, Washington Agricultural Experiment Station Technical Bulletin No. 7 (Pullman, 1952), p. 4.

R. G. Bressler, Jr., Economies of Scale in the Operation of Country Milk Plants with Special Reference to New England, New England Research Council in cooperation with New England Experiment Stations and the U.S.D.A. (Boston, Mass., 1942).

supplied as to why.

Review of Literature

This report utilizes economies of scale as a tool to measure the most profitable size operation for cattle feedlots under study. Economies of scale herein refer to cost economies or cost diseconomies, i.e., "the phenomena which cause unit costs to decrease or increase as size of the plant (number of technical units) and output are expanded".[10]

"Cost economies or diseconomies may be either internal or external to the individual producing unit. They may also be of a monetary nature or of a physical nature. Internal economies are those brought about by adjustments within an individual business."[11] Such economies are realized irrespective of the industry. For example, by increasing the number of head per feedlot and feeding with already existing equipment, per unit costs have been reduced and internal economies realized.

External economies are those brought about by the industry as a whole. After a sufficient time, allowing for adjustments in the factor producing industry, external economies may be realized by the individual producing units. Should industry begin demanding some item previously demanded by only a few individual firms, cost of producing this item may be lowered and passed on as a savings to industry and ultimately to the individual firms.[12] In this study, internal physical economies of scale (cost economies) were of primary significance.

Many original and enlightening pieces of work have been written

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[10]Earl O. Heady, Economics of Agricultural Production and Resource Use (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1960), p. 361.

[11]Ibid., pp. 361-62.

[12]Ibid., p. 361.

on economies of scale, of which the following are taken as representative.

In 1942, Bressler[13] set out to determine the effects of scale of operation on unit costs of country milk plants. He hypothesized that an increase in size of operation would produce economies of scale for these small plants. Also, these economies will finally dissipate or be offset by diseconomies in the shortrun for an individual plant. From the analysis presented in his bulletin, it is apparent that definite economies of scale exist in the operation of country milk plants. The specific level of any economy curve, for a given location, depends on two things:

1) The seasonal variation in production.

2) The particular cost rates applicable to the locality.

The average curve will, in most cases, give an adaquate answer. Mr. Bressler concludes, by eliminating duplication and uneconomical plants, costs could be reduced. This reduction in costs could then be disposed of three ways: (1) increased income for producers, (2) passed on as a savings to the consumer or (3) a combination of the two.

In 1952, Baum, Faris and Walkup[14] conducted a study on five poultry fryer processing plants within Washington to determine efficiencies of different size operations. They constructed five hypothetical plants to use as comparison models. From these they were able to determine economies associated with plants operation at 100, 90, 80, 70, 60, 50, and 40 per cent of plant capacity. They concluded that higher processing costs were experienced as plant utilization was decreased from 100 per cent. As all levels of output large plants were found to have lower average unit cost

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[13]Bressler, pp. 1-92.

[14]Baum, Faris and Walkup, pp. 1-33.

than small plants. When plants were operating at less than full capacity, costs of processing increase more for small plants than for large plants. Finally they listed five points to consider before constructing a processing plant or remodeling existing facilities:

> 1) A study of the present and future potential for fryer production in the supply area surrounding the plant location and from competing areas.
> 2) A careful study and estimate of the present and potential nearby markets for frozen and fresh cut-up fryers.
> 3) The economies that are associated with scale, i.e., plants of various sizes operating efficiently at 100 per cent capacity.
> 4) Average unit cost of processing fryers for a given size plant at various levels of plant utilization.
> 5) Average unit cost of processing a given volume in various-sized plants.[15]

It was generalized that a large plant operating at 70 or even 60 per cent of capacity would have lower per unit cost than a smaller plant operating at 100 per cent. The larger plant was designed to operate at 100 per cent of capacity in the near future to keep up with predicted market expansion.

In 1954, Baum, Riley and Weeks[16] set out to determine three objectives:

> 1) The extent of variation in costs per hundred-weight of receiving milk associated with varying levels of utilization expressed as percentages of plant capacity.
> 2) The extent of variation in costs per hundred-weight of receiving milk among different plant sizes each with similar levels of capacity utilization.
> 3) The comparative receiving costs per hundred-weight of milk for bulk receiving operations and can receiving operations.[17]

In their analyses, they concluded that costs increased as

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[15] *Ibid.*, p. ii.

[16] E. L. Baum, D. R. Riley and E. E. Weeks, *Economics of Scale in the Operation of Can and Tank Milk Receiving Rooms with Special Reference to Western Washington*, Washington Agricultural Experiment Station Technical Bulletin No. 12 (Pullman, 1954), pp. 1-62.

[17] *Ibid.*, p. 3.

utilization of plant capacity decreased. They pointed out, however, that increases in per unit costs were much greater for small plants than for large plants. Looking at this in reverse, i.e., as plants increase utilization toward economic optimum, small plants will experience a greater decrease in per unit costs than large plants. Therefore, conclusions drawn from this analyses may be misleading unless total absolute costs are also studied. Nevertheless, they determined that as plants approach their economic optimum, both large and small plants experienced cost economies.

For the second objective, it was demonstrated as plants increase their volume and operate at the same level of capacity economies of scale do exist. Those plants classified as larger were able, in many cases, to more fully utilize existing plant facilities and to purchase automatic equipment economically, therefore, they could speed up operation and increase efficiency.

Bulk receiving operations were analyzed as having appreciably lower average total unit costs relative to can receiving operations. This resulted from:

1) Greater utilization of equipment in bulk receiving operations.
2) Some of the functions of can receiving operations not carried over in the bulk receiving operation.
3) Milk brought to the plant at lower temperatures resulting in lower refrigeration costs.
4) Relatively less fuel necessary in the bulk milk receiving operation for comparable volumes of milk received.[18]

In 1955, French, Sammet and Bressler[19] analyzed the pear packing industry of California to determine if any economies of scale existed. This was done for different size plants and for least cost combinations of methods

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[18] Ibid., p. 53.

[19] B. C. French, L. L. Sammet and R. G. Bressler, Economies of Scale in Pear Packing, California Agricultural Experiment Station Mimeographed Report No. 181 (Davis, 1955), pp. 1-33.

or technologies in plants operating at a given capacity. This study was designed to improve marketing methods, practices and facilities to reduce the spread between producer and consumer. The conclusions extracted implied economies were possible with increases in scale of operation. However, at some point on the long-run cost curve, diseconomies occur and the long-run curve begins to turn upward.

Surpassing peak capacity of management appeared to be one possible cause of diseconomies within firms. The study disclosed one major area within pear packing plants where economies prevailed, in double-shift operations.

The final conclusion pointed out pear packing plants in California, for the most part, had achieved a relatively high degree of efficiency and possible adjustments leading to further cost reductions existed in only two places:

> 1) Selection of efficient technologies which would bring costs in individual plants down to the level of the planning cost curve and 2) movement along the curve in terms of both increased hours of operation per season and larger, and consequently fewer, plants.[20]

In 1959, Wuhrman[21] attempted to analyze the position of commercial cattle feedlots in Kansas and predict their place in the cattle feeding industry of the future. Although this was not technically an economies of scale study Wuhrman did list economies of scale as one of the possible benefiting factors in future expansion of commercial cattle feeding. A commercial cattle feedlot was defined as a lot where cattle were owned, in part at least, by outside parties and thus fed on a contract basis. He inferred advantages do exist for commercial lots in the form of increased

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[20] Ibid., p. 32.

[21] Wuhrman, pp. 1-136.

distribution of risk and financial investment. As a result of this and other advantages, the number of commercial feedlots, in Kansas, had multiplied by more than five times, to a total of sixteen lots from 1948-1957. The outcome of this growth in commercial feedlots increased, from 5.2 per cent to 37.9 per cent, their portion of all cattle fed in Kansas for the nine-year period. Wuhrman predicted an increase of commercial cattle feedlots in the future. Stimulating factors such as increased locally produced feed grains, a readily accessible supply of feeder cattle, the economies derived from scale operations and an increasing population demanding more beef, to only cite a few, will tend to result in further expansion of the commercial cattle feeding industry of Kansas, he said.

In 1962, King[22] conducted a study to determine: (1) "how nonfeed costs vary depending on utilization of a given sized feedlot and (2) how costs vary as size or capacity of the feedlot varies."[23] He was primarily concerned with large commercial feedlots (1000 head and above), as 98 per cent of the cattle fed in California as of October 1, 1961, were in such lots. This study, along with others done by Mr. King, was designed to aid established feedlot operators in future expansion programs and beginners in the building of new feeding establishments. Mr. King used five hypothetical models with designated capacities of 3,750, 7,520, 11,278, 15,038 and 22,560 head respectively. From these he was able to determine cost advantages associated with scale of operation and those associated with various levels of utilization for a given plant. He concluded that larger feedlots are justified by the economies of scale of feedlot operations but

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[22]King, pp. 1-50.
[23]*Ibid*., p. 3.

to attain complete economic optimum, plants must be operated at 100 per cent of capacity. King backed his conclusions with evidence gathered by John A. Hopkin that average daily nonfeed costs per animal day decline substantially as the size of the feedlot increases from a level of 1000 head per year to a level of 50,000.[24]

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[24]John A. Hopkin, "Economies of Size in the Cattle Feeding Industry of California", Journal of Farm Economics, Vol. 40, No. 2 (May, 1958), pp. 417-429.

II CAPITAL INVESTMENTS

Capital investment costs were divided into four major categories: (1) silage, grain and hay storage, (2) machinery and buildings, (3) feed yard and (4) feeding and miscellaneous equipment. Due to widespread diversification exhibited among the five lots, no single category was outstanding. However, it was apparent that silage, grain and hay storage facilities were always at the top or near the top as a major investment group (see Table 2).

TABLE 2

INVESTMENT COSTS FOR MODEL FEEDLOTS[a]

	Designed Capacity, in Number of Head				
Item :	40	115	225	450	925
			(dollars)		
Silage, grain and hay storage	1650	2400	4417	7505	11993
Machinery and building	1500	2650	3250	4250	9050
Feed yard	600	1100	1800	5800	13100
Feeding and miscellaneous equipment	1600	2300	3475	4450	7400
Total investment	5350	8450	12942	22005	41543
Investment per head capacity	134	73	58	49	45

[a]For a more complete discription of investment costs, see Tables 26, 27, 28, 29 and 30 in Appendix(A).

Total capital investment costs (Y), as estimated on the survey schedules, were plotted against capacity of the feedlots, as given on the schedules, and a linear trend line fitted to the resulting data. This linear relationship gave a correlation coefficient of R = .937427 and its "goodness of fit" was accepted as adaquate. Total capital investment costs in this study were, therefore, computed from sample farm data by the use of simple regression analysis. An equation of the form $Y = a + bX$ was used; where (Y) equals total capital investment for any given feedlot, (a) equals 3705.573 or the (y) intercept, (b) equals 39.694 or the slope of the regression line and (X) equals normal capacity of any given feedlot. A standard error of 4861.25 compared to a mean of 20384.62 was computed for the equation and a standard deviation of 3.01 was computed for (b). This equation ($Y = 3705.573 + 39.694X$)[1] was used to determine total investment requirements for each of five hypothetical feedlots.

Investment costs for the five hypothetical feedlots, as shown in Table 2, range from $134 per head for the smallest to $45 per head for the largest.

Total investment costs for each hypothetical feedlot were then broken down to costs of individual items within the feedlots. For comparison, a similar analysis of individual items with necessary adjustments to conform with total costs was preformed. Both analyses produced similar results. Information obtained from survey schedules, manufacturers, dealers and Kansas State University agricultural specialists was used to determine specific item costs.

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[1]Through consultation with Kansas State University agricultural specialist a feed tank, which did not appear on the interview schedules, was added to equipment in models III, IV, and V. Therefore, total investment costs for these models will be greater (greater by the fixed amount of each feed tank added) than the regression equation will compute.

Capital investment costs in this study were lower than those in many similar studies.[2] Some reasons for this difference are:

1) This study reflects actual costs of the item whether purchased new or second hand in 1961, 1931, or any other date. Other studies tend to use new equipment only or adjust existing equipment to new prices.

2) Many studies imply considerably more automation than was found on feedlots whose operators were interviewed during this study.

3) High cost items, such as cattle sheds, are present in other reports. Existence of such items was found lacking on a majority of Kansas feedlots. Neither were there plans to acquire them.

4) Partnerships on some items of large expense was observed on lots visited. This factor was seldom considered in other similar studies.

It was for these reasons an attempt was made through use of personal interviews to duplicate, as near as possible, actual situations as they existed in 1961, on Kansas farms. Many studies do not reflect true costs of firms already in business, therefore, this study was designed to give an accurate account of actual investment costs for the industry already in operation.

The feed yard does not include a cost for land itself. The wide variety of locations used for feedlots made an accurate cost figure impossible. Also many different size feedlots were found for the same number of cattle. This was due in part to location on the farm, quality of the feedlot, location in the state and type of feeding done.

A general consensus of the situation, however, is that as capacity

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[2]James E. Sharon, "Ten C's for Farm Feedlot Expansion", Doane's Business Magazine for American Agricultural, March, 1963, pp. 4-7.

"Guidelines for Beef Feeding", Successful Farming, July, 1963, p. 24F.

of a feedlot increases, the number of square feet allotted per head decreases slightly. However, this decrease lasts only until minimum requirements are reached. As capacity increases, absolute cost per acre increases also. Reasons for the above two changes are: (1) better location on the farm and (2) more improvements in the lot itself. These improved situations have been deemed good economical practices.

Silage, Grain and Hay Storage

Cost of feed storage was highest or second highest for all models. Had information given by Wilton Thomas, agricultural farm management specialist, Kansas State University,[3] been followed completely, feed storage costs for the four models using upright silos would have been the highest cost group (Appendix A). Mr. Thomas stated that owning and operating silage cutters for feedlots feeding under 200 tons of silage per year will produce diseconomies.

Taking this into consideration Model II, feeding under 200 tons of silage per year, would omit a $750 field cutter from its machinery and building category leaving feed storage the highest cost group within the model. However, this field cutter was left in as a cost component of the second model.

Feed storage facilities consisted of an assorted array of different structures. In general, silage facilities were composed of both an upright silo and a trench silo. Only on very high capacity feedlots were upright silos missing. These feedlots, who border on the large or commercial lots in Kansas, tend to follow many practices found in commercial feedlots of

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[3]Interview with Kansas State University farm management specialist, July 16, 1963.

Kansas, one of which is the almost total use of trench or bunker silos. Studies have indicated bunker or trench silos with capacities for 1000 tons and over can be built for as little as one half the cost of comparable concrete stave silos with unloaders.[4]

Most of the lower capacity feedlots, especially the lowest, tend to feed from upright silos. Many of these lots also have a trench silo built at very low cost for excess silage that may be produced by a bumper crop year.

In this study cattle feeders indicated, on the whole, that silage was fed from the upright silo manually. Here again, Kansas State farm management specialists,[5] feel economies can be gained, once a feeder is feeding above 250 tons of silage, by adding a silo unloader. But, as stated before, in trying to present the situation of the farmer cattle feeding industry as revealed by this study actual data were used.

Kansas State University Agricultural Engineering Department, conducted a study on mechanical silo unloaders. Conclusions drawn from this study were:

1) Cost per head per day for animals receiving 30 pounds of silage was 0.3 cent for hand feeding methods and from 0.6 to 3.6 cents for Mechanically unloading silage.
2) Mechanical unloaders replace many disagreeable chores in silage feeding as well as assisting in the over-all mechanization of forage handling.
3) With unloaders large silos of 24 to 30 foot diameters can be constructed. Hand feeding methods from these large silos are almost impossible.

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[4]Kansas State University Extension Release, "Comparison of Investment Costs and Annual Costs of 3 Different Type Silos", Prepared by Wilton Thomas (Manhattan, 1963), p. 1.

[5]Interview with Kansas State University farm management specialist, July 16, 1963.

4) Most farmers with silo unloaders said they would never do without one again.[6]

Total tonnage fed, ranged from 63 tons in the lowest capacity model to 1457 tons in the highest capacity model. Feeding requirements, used to compute size of storage facilities for the five models, were obtained from Dr. D. Richardson, Kansas State University Animal Husbandry Department.[7] Given a yearling animal weighing 700 pounds with a potential to grand choice and a full feeding period of 150 days an average daily ration for the 150 days was considered to consist of 21 pounds sorghum silage, 1.5 pounds supplement, 21 pounds grain and 4 pounds prairie hay. Assuming 3 pounds of silage equal to 1 pound air dry feed this would give a total average daily consumption of 33.5 pounds air dry feed.

Using this ration and the designed capacities of the five model feedlots, figures were computed for total bushels of grain fed, tons of silage fed and tons of hay fed per year. These were then used to derive a suitable estimate of storage space for the different feeds. Estimated storage space and data collected on the survey were used to confirm the calculated requirements. Low capacity feedlots tend to have more silage facilities than actually needed while those at 225 head capacity and up had only sufficient space to meet requirements.

Trench silos are not to be confused with bunker silos. The former, in most cases, is simply a trench dug into the ground with, in some instances, concrete, railroad ties or some other inexpensive bottom. The latter are more elaborate, always have a bottom, usually of concrete, and in most

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[6] Martin Decker, Mechanical Silo Unloaders, Kansas Agricultural Experiment Station Bulletin No. 412 (Manhattan, 1959)pp. 13-14.

[7] Interview with Kansas State University animal husbandry professor, April 10, 1963.

cases concrete sides. Bunker silos are more costly, by a considerable margin, than trench silos and are to-be found usually in the higher capacity feedlots and large commercial feedlots.

Grain storage, as silage storage, was found on all size operations. However, as the capacity of the feedlot increased, 100 per cent storage facilities decreased. For example the lowest capacity model has 100 per cent storage for grain fed during the feeding period whereas the highest capacity model only has grain storage facilities for approximately one half the grain consumed during the feeding period.

Quantity of grain fed per year ranged from 2,100 bushels to 48,563 bushels. Value of storage facilities ranged from $750 for the lowest capacity model to $7,500 for the highest capacity model. These low cost storage figures, especially in the smaller models reflect costs of wooden granaries, boxcar granaries, surplus government buildings used for granaries, etc. Many storage facilities were in old buildings, still very sound but built at a very low price compared with today's standards. Were someone to begin a cattle feeding operation today, it might still be possible to purchase land with more than adequate storage space within existing farm buildings. With little value placed on such buildings, low cost grain storage facilities are acquired.

As size of the operation increases, costs per bushel appear to increase, then taper off. Reasons for this may be that new storage facilities are built to accomodate increased volume and inexpensive existing facilities finally wear out and must be replaced by higher priced units. However, cost figures given here seem reasonable compared with costs supplied by Leo Wendling, Kansas State University agricultural engineering [illegible].

specialist.[8] Mr. Wendling quoted costs of \$.25 to \$.30 per bushel for facilities over 1250 bushels and \$.35 to \$.40 per bushel for facilities under 1250 bushels. It is only when comparing these costs with other studies done on similar material that they appear low.[9]

Some reasons for this could be that other studies include auger equipment, self-feeding equipment or other more expensive items do not cite them, but choose instead to treat them as part of the unit.

Costs of grain storage facilities in this report include no automatic equipment. They include only those costs required for storage space of grain. Costs of automatic equipment, such as augers, are presented under feeding and miscellaneous equipment. Reason for this is that some feedlots, especially lower capacity lots, move grain entirely by hand, therefore, to present accurate comparisons between lots automatic equipment had to be a separate item.

Hay sheds were used in three of the five models. Survey questionnaires for the two smallest models revealed no hay storage facilities, at least none which operators charged to their cattle feeding program. Hay consumed ranged from 14 tons in the smallest model to 278 tons in the largest model.

Marginal ability of the lowest capacity feedlots was apparent. For example, no storage was provided for hay and in some cases hay was stacked loose with cattle allowed to feed on the stack or it was hand fed

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[8]Interview with Kansas State University agricultural engineering specialist, April 10, 1963.

[9]King, p. 12.
Jay Swanson and B. J. Bond, Estimated Cost of Feeding Calves in Yakima County, Washington, 1958, Washington Agricultural Experiment Station Circular No. 360 (Pullman, 1959), p. 6.

from the stack. Costs for these smaller lots were prohibited both for construction of storage facilities and purchase of automatic or labor saving equipment. That means that most of their work is done manually. However, as capacity of lots increased, hay storage facilities were constructed. When quantity of hay consumed becomes sufficiently large, a need for storage facilities to protect against damage or loss from spoilage was realized, so their costs must be charged to the cattle feeding enterprise.

Feed tanks in this study apply to storage bins for supplement. For purposes of this report all tanks were assumed to be equipped with augers and ladders.

A majority of feedlots studied had no feed tanks listed on their survey schedules. However, Wilton Thomas[10] and Leo Wendling,[11] recommended including tanks in the three larger models. Estimated costs for the tanks were arrived at after consultation with Mr. Wendling. Tanks, like hay storage, seemed to be unwarranted in the two low capacity models.

The three larger models use 25, 51 and 105 tons of supplement per feeding period. Feed tanks with designed capacities of 4.3, 7.3 and 14.4 tons, respectively, are used in the three models. That is, a supplement supply is maintained for 2.5 to 3 weeks with the respective feed tanks. Feed tanks for Models III, IV and V were valued at $217, $255 and $493, respectively.

Machinery and Buildings

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[10]Interview with Kansas State University farm management specialist, July 16, 1963.

[11]Interview with Kansas State University agricultural engineering specialist, July 17, 1963.

The only building, outside of feed storage facilities, used in the five models was a machine shed. As all feedlots contacted were part of a farming program machine sheds were included on a large majority of the interview schedules.

A sizable portion of the total complement of machinery was used, at least part time, for the cattle feeding operation. This was the major excuse feedlot operators used to allocate a portion of the machine sheds total cost to the cattle feeding program. As would be expected this absolute total portion increased as the cattle feeding operation increased, however, per unit cost decreased.

Machinery for the five models increased to some extent, in both size and value, as capacity increased. Machinery for the lowest capacity feedlot (40 head) consists of a tractor, manure spreader and roller-crimper. Valuation of machinery allocated to this model was $1,350. This was compared with the largest capacity feedlot (925 head) which has a machinery complement consisting of approximately two tractors, a silage cutter and a roller-crimper. Valuation for this complement of machinery was $8,050. The cattle feeding operation was charged only with that percentage of the unit actually used in the feeding program. An increase in machinery size was quite apparent from the above cost figures. Quantity and type of machinery used has experienced very little change but costs have risen by $6,700 in moving from the smallest to the largest model. However, part of this cost increase may be accounted for as capacity of the feedlot expands machinery was used for longer and longer periods of time in the feeding operation, therefore, a greater and greater portion of total costs must be charged to cattle.

For example, in the 40 head model approximately 20 per cent of the tractors original cost was allocated to the feeding program, with the other 80 per cent going to the farming operation. Repairs, upkeep, depreciation, etc. were assigned in this same manner. Allocated value of the tractor or tractors ranged from $750 to $5,000 respectively for the five models.

A manure spreader was used on the first four models. Those operators interviewed were unanimous in their use of manure spreaders. Spreaders and front end tractor loaders were designated the most efficient and economical combination available to keep feedlots clean. Valuation of spreaders varied little among the four models, ranging from $300 to $400.

Due to the increased realization that commercial fertilizers may not provide all soil needs, expanded use of organic material, mainly in the form of manure, may be seen in the near future.[12] Although feeders were reluctant to place any real value on the manure, tending to offset returns from it by costs involved in its distribution, they continually emphasized the use of manure.

The largest capacity feedlot, due to its excessive amount and method of handling manure, did not utilize a manure spreader. Within this size feedlot manure was usually mounded up in some portion of the individual pens and utilized as a dry standing or loafing area by the cattle. This reduces considerably the number of times lots must be cleaned each year. Usually one or two cleanings will suffice. The actual number will depend on the number of times total capacity was turned each year. At time of cleaning tractors with front end loaders, scoop manure onto trucks or wagons equipped with hydrolic lifts and it is hauled to fields and spread. This process usually takes place at the end of a feeding cycle when equipment

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[12]California, Bank of America, Cattle Feeding in California, by John A. Hopkin (San Francisco, 1957), p. 14.

and labor are least busy.

Grain grinding equipment ranged from roller-crimpers to ordinary grinders with a decided majority of the feedlots using roller-crimpers. Therefore, all five hypothetical models were equipped with roller-crimpers.

There was some speculation on whether economies might exist for the larger capacity lots to purchase their grain from outside sources already ground. However, general consensus was, with partial grain storage and a tractor already committed it would be more economical to purchase and use a grinder for this portion of home grown grain than to hire it ground. Therefore, continued use of the grinder on grain purchased from outside sources would lengthen its period of use per year and spread costs over more bushels.

Estimated values ranged from $300 to $800. Some reasons for the rapid increase in costs were:

(1) New machines were purchased in the larger capacity lots compared to used machines in the lower capacity lots.

(2) There was some difference in size of roller-crimpers, larger sizes leading to higher costs. The larger grinders naturally being used by bigger feedlots.

Silage cutters were found in the four largest feedlots. Values varied from $750 to $2,250 respectively. Reasons for this rapid advance in costs may be the effect of; (1) new machines versus used machines, (2) larger capacity machines, such as one row, two row, without motor, with motor, etc. and (3) partnership purchases of machines.

Small feedlots tend to purchase second hand, small capacity machines. Some even reduce costs further by buying on a partnership basis with one or more neighbors. This was contrasted with larger operations where quantity of silage needed renders the sole ownership of larger capacity machines economical. Also, due to volumne of use, new machines were more profitable both from the standpoint of repairs and depreciation.

According to Wilton Thomas, farm management specialist, Kansas State University,[13] diseconomies would result from the complete ownership and operation of silage cutters in the two lowest capacity models. However, through the use of partnerships, ownership and operation of silage cutters were justified economically in this report. Through the survey, it was decided those feedlots at the lowest capacity level hired their silage harvested while those at the second level owned and operated silage cutters on a partnership basis. The third, fourth and fifth levels can economically justify complete ownership and operation of field cutters.

The fact should not be overlooked, however, that diseconomies may result for a lower capacity lot if in hiring its silage cut a custom cutter was not available at the time feed was normally ready for siloing. For this and other reasons each individual feedlot must weigh all the possibilities confronting it before making any decisions.

Feed Yard

Included in all feed yards of the five hypothetical models were bunks, fence, cattle chutes, oilers, windbreaks and water facilities. Fence line bunks were substituted for feed bunks in the larger capacity models and concrete aprons were built in conjuction with them.

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[13] Interview with Kansas State University farm management specialist, July 16, 1963.

Total cost of the feed yard ranges from the least cost capital investment group in Model I to the highest cost capital investment group in Model V. This can best be explained by comparing levels of specialization between individual models.

Models I, II and III were almost entirely complementary with the farming organization. This relationship usually serves to create a role of secondary enterprise for the cattle feeding operation. Cattle were maintained on the farm only as a secondary income. Under this assumption farmers have a tendency to "make do" with existing facilities and equipment. They feel it would be detrimental to have a high investment cost in equipment that could not be used for any other purpose except cattle feeding. Old items were repaired rather than replaced. Much of the operation was done manually rather than with automation. In time of crises the feeding operation was cut back first.

Personal interviews and survey questionnaires serve as evidence in support of the above situation. Farmers classed in Models I, II and III, for the most part, had average or better than average machinery and equipment for their farming operation. Where machinery and equipment was used in feeding cattle as well as in farming then the cattle operation also had average or better equipment. However, elaborate feeding pens, expensive fence line bunks, concrete aprons and other items utilized only by cattle were almost totally nonexistent in there three sizes.

Contrary to this were Models IV and V which have begun to specialize in cattle feeding to a much greater degree. The feeding operation was no longer entirely complementary to farming, in fact it may be competitive. It was observed in Model V that only one-half of the grain fed was stored on the farm, indicating the other one-half must be purchased from some outside source. This would imply the feeding operation is becoming a separate entity, therefore, it may be economical to purchase automatic, permanent equipment used only in the feeding enterprise. Management decisions are now made with improvement of the feeding enterprise the operators primary goal.

High capacity feedlots in this study border on the edge of commercial feedlots where the greatest single investment was the feed yard. Cost of the feed yard, for commercial lots, continues to increase as capacity increases.[14]

Investments in feed yards for the five models were $600, $1,100, $1,800, $5,800 and $13,100, respectively. Investment in the feed yard was the lowest cost group for Models I, II and III. The feed yard was second high category for Model IV and high for Model V. As stated earlier, cost of land within the feedlots was not included. However, it should be pointed out again, as capacity expands improvements on the feedlot were made, location of the lot becomes more important and valuation of the land increases.

Continued use of wooden feed bunks was the practice of Models I and II. Model III was in a transition period. When already existing equipment, such as feed bunks, were worn out they will be replaced with more modern fence line bunks. The two largest feedlots, due to their size, improved management practices and ability to spread costs of more expensive items over a greater number of units have already adopted fence line bunks and concrete aprons.

Perhaps it should be pointed out, if fence line bunks were superior to ordinary feed bunks, this study could find no serious reasons for not

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[14]King p. 11.

placing wooden bunks in a line end to end and temporarily using them as fence line bunks. This practice could be followed until full use has been extracted from the wooden feed bunks at which time they may be replaced by more modern fence line bunks. Although this seems to be a reasonable possibility no evidence of it was found.

There were as many different types of fences being used as there are types of fencing material to be found. Fences ranged from simple barb-wire around a timber area being used for a feedlot to the most elaborate modern day set-up utilizing especially prepared aluminium panels to form individual pens within the feedlot. In general, however, steel post, usually pipe, together with cable or sucker rod were used to fence in the feedlot. This was especially true of those feedlots confined to smaller areas and in good permanent locations. Improved fencing techniques seemed to follow expansions in capacity, with larger lots building the most permanent type fence.

Windbreaks were exhibited on a majority of feedlots interviewed. In most cases they were composed of trees either in the form of natural shelter belts or man-made. Only on very few lots were there any indication of more expensive type constructions and these few were so scattered a general trend could not be drawn. The nominal cost with which shelter belts may be established was probably the primary reason for their inclusion on most farms.

Every farmer cattle feedlot sampled displayed a cattle chute. These were, in general, about equal in cost from the smallest to the largest feedlot, ranging from $100 to $200 respectively.

Oilers or cattle rubs, for the most part, were relatively new items on most feedlots with all lots using them. Approximately one oiler to fifty head of cattle was the ratio followed. Oilers were valued, on the average, of $50 each. Cattle feeders pointed out oilers were helpful in preventing cattle from rubbing on fences and tearing them down as well as their designed role of cattle grub and fly control.

Many different types of water facilities were found. They ranged from natural creeks to completely man made automatic waters. As a rule, however, watering systems were wells equipped with electric pumps supplying some type of tank or trough with water.

In the smaller capacity models one well was used for the complete farm, i.e., cattle, household and other livestock housed around the farm buildings. As capacity increases separate units were established for the cattle feeding enterprise. Partial use of one water facility to complete use as capacity increases was one of the major factors contributing to the rapid increase of costs which ranged from $150 to $2,500. Also some indication of automatic waters were found in the larger lots. Another heavy contributor to costs.

Feeding and Miscellaneous Equipment

Feeding equipment in this category consists of; pickup, truck, truck power box, wagon power box and wagon. Miscellaneous equipment includes all those items falling in the miscellaneous category; loader tractor, portable auger, portable elevator and cattle spray equipment. In analysing costs of this category over the five models, it was found to be very erratic. Presumably this was due, at least in the larger capacity feedlots, to lumpy inputs of equipment, such as a truck power box, which must be charged 100 per cent to the feeding enterprise. As capacity of the lot increased costs of miscellaneous and feeding equipment increased at a decreasing rate until they were the lowest cost group of the four major categories. This was accounted for by spreading cost of these lumpy inputs over more and more units, thus producing economies of scale.

Pickups were found on all models with their cost increasing as capacity increased. Operators charge a greater percentage of the pickup to the cattle feeding operation as size enlarges. They were used as an all purpose vehicle on the smaller operations, sufficing as family car, feeding truck, transportation of livestock and all around farm utility wagon. As size of the feedlot expands an increasing proportion of the pickup was allocated to the cattle feeding operation. Although actual use of the vehicle, in terms of work, may decrease. It was no longer used much for hauling, but simply as an errand or passenger vehicle. Larger, better adapted pieces of equipment were used to haul cargo. However, pickups remain an all purpose vehicle, no longer used as family transportation but taking on a new role of feedlot time saver. Pickups were almost a necessity in doing odd jobs about the feedlot.

Exclusion of a truck on the lowest capacity model was anticipated. Because of marginal operation and ability of pickups and wagons to adaquately handle all hauling problems, cost of a truck was not warranted. Trucks make their appearance on all four larger models, increasing in importance as capacity expands.

As the feedlot expands, however, trucks play a different role in the feeding operation. In the middle range of feeding operations trucks were used as feed hauling vehicles, both from the elevators and to the cattle. Also some transportation of livestock was done with farm owned trucks. Trucks in the largest feedlots have been reduced to the role of general all purpose vehicles, i.e., post, fence, dead animal, etc. hauling. As more specialized equipment was bought to do individual jobs trucks become an odd job carrier also.

Wagon and pickup were combined as a unit for the smallest capacity feedlot to aid in the feeding operation. Silage, hay, etc. were largely fed with the wagon. It falls in the category of equipment already owned by the farmer and continued use until worn out becomes necessary. Resale value on equipment of this nature is very low, therefore, once purchased it must be used until scraped to obtain the valuation placed on it at purchase time.

Models II, III and IV feed with wagon power boxes. Model I was not economically large enough to purchase and maintain a power box. Diseconomies would result were it to do so. In Model II it was a management decision as to the feasibility of owning a power box. If other less specialized feeding equipment has been worn out or the desired economic returns derived from them, then it may be economically practicable to purchase a wagon power box to feed with.

Management may decide the operation has reached its peak, however, at which time it may become questionable to buy such specialized equipment convertable to no other use. Therefore, a point is reached when dollars and cents alone cannot decide the question whether to buy or not. When this point is reached sound management becomes the all important factor in maintaining a profitable operation.

Model V due to still further specialization has acquired the use of a truck power box. As capacity increases economies of scale were to be gained from the use of a truck power box relative to a wagon power box.

For example, feedlots need equipment to feed with, equipment to load manure, haul manure, etc. Smaller operations cannot purchase completely specialized equipment for each of these jobs because per unit cost would extend beyond that considered profitable. Therefore, equipment that can be utilized for more than one job must be purchased, i.e., a tractor may pull the feed wagon part time, load manure part time and haul manure part time. Thus the tractor is in use long enough each day to justify its costs. Had the tractor been purchased only to load and haul manure while the more specialized truck power box fed cattle, neither piece of equipment would be economically justifiable, because both would be operating at much less than 100 per cent of capacity.

Now in the larger capacity feedlot of Model V a truck power box may be used more each day because of the greater number of cattle to feed. Also, for the same reasons, the tractor has sufficient work to do each day without feeding cattle to justify its expense. Therefore, it may be observed increases in specialization come at the same time or after increases in capacity, but not before (i.e., not a long time before).

Finally, miscellaneous equipment, except portable elevators, were found on all models. The loader tractor may be used for a variety of jobs. Its primary functions were: (1) loading manure from the feedlot and (2) loading silage from the trench silo. It was probably one of the handiest and most versatile pieces of equipment around any feedlot. In addition to manure and silage loading it may be used to clear snow, make roads, clean ditches, carry things, lift heavy machinery, clean out silos, reach high places, etc. Therefore, it was quite easily seen why purchase of this piece of equipment becomes one of the first in most feedlot operations.

Portable augers increase in importance as capacity expands and they were found on all models. Augers were usually purchased for the farming operation and for the cattle feeding operation of small lots. As size increases, feedlot operators utilize the auger more and more for the feeding program. Finally at the highest levels augers were purchased entirely for the feedlot.

Cattle spray equipment, in one form or another was exhibited in most feedlots. Most spray equipment was of a type using water mixtures applied under pressure to the cattle. Feedlots keeping cattle for only a short period of time usually specified no spray equipment at all.

The final miscellaneous item, portable elevators, was found on all models using hay barns. Portable elevators were of the type usually seen elevating baled hay into barns or onto hay stacks. For those models using elevators, a standard straight design was assumed. There were many types of elevators with which hay may be moved through a successive number of difficult places. But price, size and length implied on survey questionnaires necessitate calling the portable elevator in this study a straight upright type. The type usually used in moving hay from a wagon to some higher place.

III FIXED COSTS

Fixed costs are associated with short-run conditions, for in the long-run all costs become variable. Fixed costs were defined as those costs not increasing or decreasing as total volume of production, in the short-run, increases or decreases. As production was increased (decreased) fixed costs were spread over more and more (less and less) units of production. Therefore, fixed costs per unit of production will vary with total production.[1]

Fixed costs are, in general, associated with investments. They encompass depreciation, taxes, insurance and interest on investment in this report. These factors were considered fixed for any given production cycle once the cycle has been entered. In the case of cattle feeding, once the commitment to feed has been made and factors of production were acquired the above four cost items were fixed for the remainder of the production cycle. Only at the end of this production period can the fixity of these costs be removed either by purchasing more factors and increasing costs or selling already existing factors and decreasing costs. In either case, at the time increases or decreases are taking place these costs are no longer fixed but variable. Variable in the sense they have been adjusted, however, after adjustment any costs remaining become fixed again for the next production cycle.

In this study maintenance and repairs were included as a portion of the depreciation rate. However, it should be pointed out maintenance

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[1]Baum, Faris and Walkup, p. 7.

and repair costs vary inversely to depreciation and depreciation has been adjusted to allow for this inverse relationship. Tangible factors of production may be used beyond that period specified with depreciation rates by applying repairs and sound maintenance. But, if this were done, additional costs would be encountered.[2]

Fixed costs are rather simple to compute, usually involving the application of fixed rates or percentages to machinery, equipment and buildings. However, due to the despotic way in which these rates are applied it is sometimes difficult to make accurate inferences about the industry as a whole. This does not reflect a laxity on the part of operators but simply a lack of any better criteria from which to follow. This was illustrated by depreciation in the following pages.

If each feedlot were new, having purchased new equipment and begun operation at precisely the same time the survey was taken, depreciation could be calculated quite easily. New costs could easily have been established, each item in the feedlot could have had a reasonable estimate of life expectency assigned to it and a straight line depreciation used. However, this study made a survey of feedlots ranging from new ones to those in operation for two decades or more and all levels inbetween. As this report is trying to present a picture of the non-feed costs Kansas farmer cattle feedlots were actually faced with, the best realistic approach possible was taken. Therefore, to make inferences about a population larger than the sample taken, some system of measurement had to be set up for

[2]John H. McCoy, "Grain Storage Policy with Particular Reference to Cost of Storing Wheat in Kansas" (unpublished Ph.D. dissertation, Library, University of Wisconsin, 1955), p. 137.

depreciation and other costs. The following methods for determining fixed costs have thus been derived.

Depreciation

Depreciation is a reduction in value as a result of wear and tear through use, action of the elements, inadequacy, accident or obsolescence.[3] Over the long-run it is essential that returns from plant operation be high enough so the operator can at least replace buildings, machinery and equipment as they wear out or become obsolete. Therefore, the depreciation rate becomes a function of total investment and length of life on buildings, machinery and equipment. It was assumed that this cost was fixed, i.e., it was associated with time in years rather than volume of output.

Through consultation with Kansas State University farm management specialist,[4] depreciation rates were determined. Value of investment items as obtained in the survey were adjusted to original value at time of purchase in the five hypothetical models (Appendix A). Five per cent of purchase value on those items lasting 20 years and 10 per cent of purchase value on those items lasting 10 years were determined reasonable rates.

Machinery, equipment and buildings were adjusted to their purchased valuation. The 5 per cent rate was then applied to this adjusted value to obtain the average depreciation cost per year for items with a 20 year life expectancy.

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[3]Harold S. Sloan and Arnold J. Zurcher, Dictionary of Economics (New York: Everyday Handbooks, Barns and Noble, Inc., 1961), p. 98.

[4]Interview with John College, Kansas State University farm management specialist, August 8, 1963.

Equipment with a 10 year life contingency was depreciated at 10 per cent of its purchased valuation. The same method as above was applied to determine the purchased value of equipment depreciated on a 10 year basis. This depreciation cost is again assumed the average per year for the 10 year life of each item.

Total investments are shown in Table 3. Grain bins, machine sheds, hay sheds and upright silos have 20 year life expectancies with the remaining capital investment items grouped as 10 year life expectancies. The four 20 year life expectancy items comprise approximately 20 per cent of capital investments on each model.

TABLE 3

TOTAL INVESTMENTS FOR FIVE MODEL FEEDLOTS, KANSAS, 1961

Investment Item[a]	Model				
	I	II	III	IV	V
			(dollars)		
Grain bins	750	1500	1500	2500	7500
Hay sheds	..	..	1000	2000	2500
Machine sheds	150	200	400	600	1000
Upright silos	800	800	1500	2500	..
Total buildings and feed storage	1700	2500	4400	7600	11000
Machinery, equipment and trench silo	3650	5950	8542	14405	30543
TOTAL	5350	8450	12942	22005	41543

[a]Items assumed half worn out for each model, therefore, investment costs given equal one-half origional purchase price.

On the basis of the above investments, depreciation ranges from $900 for Model I to $7,209 for Model V with Models II, III and IV showing $1,440, $2,149 and $3,641, respectively. Depreciation costs on a per head basis were $22.50, $12.52, $9.55, $8.09 and $7.79 for Models I through V (Table 4).

Daily depreciation costs were computed using 150 working days per year. One hundred fifty days was the maximum time assumed to prepare cattle for market after purchase date.[5] Farm feedlots, in general, feed only slightly over one group of cattle per year. The survey produced an actual computed value of 1.136 turnovers per year. This was opposed to commercial lots where turnover is approximately between 1.5 and 3 times per year.[6] Therefore, in keeping with the general trend of farmer feedlots in Kansas, 100 per cent of capacity as previously defined will be normal number of cattle the feedlot will accomodate at any one time as obtained from the operator.

Total daily depreciation costs per head varied from 15 cents for Model I to 5.19 cents for Model V. It was readily apparent that an increase in number of turnovers per year would reduce depreciation costs on a per head basis. However, this has complications which, as stated earlier, could make the cattle feeding program competitive with other farming operations and, therefore, increase total costs in the long-run.

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[5]Interview with Dr. D. Richardson, Kansas State University animal husbandry professor, June 3, 1963.

[6]Wuhrman, p. 48.
King, p. 30.
California, Bank of America, p. 17.

TABLE 4

DEPRECIATION COSTS FOR BUILDINGS, FEED STORAGE, MACHINERY AND EQUIPMENT FOR FIVE MODEL FEEDLOTS, KANSAS, 1961

	Model				
Item	I	II	III	IV	V
			(dollars)		
Annual depreciation costs of buildings and feed storage[a]	170	250	440	760	1100
Annual depreciation costs of machinery and equipment[b]	730	1190	1709	2881	6109
Total annual depreciation costs of feedlot	900	1440	2149	3641	7209
Daily depreciation costs of buildings and feed storage[c]	1.13	1.67	2.93	5.07	7.33
Daily depreciation costs of machinery and equipment[c]	4.87	7.93	11.39	19.21	40.73
Total daily depreciation costs of feedlot[c]	6.00	9.60	14.32	24.28	48.06
Total annual depreciation costs per unit	22.50	12.52	9.55	8.09	7.79
Total daily depreciation costs per unit	.1500	.0835	.0636	.0540	.0519

[a]Units adjusted from estimated half worn out value to new value by doubling half worn out value then applying the depreciation rate of 5 per cent.

[b]Units adjusted from estimated half worn out value to new value by doubling half worn out value then applying the depreciation rate of 10 per cent.

[c]Based on 150 working days per year. This is the time required to prepare cattle for market.

Taxes

Taxes consists of two types, (1) real property tax and (2) personal property tax. Personal property tax on cattle will be considered under variable costs. Property tax does not show up as a very important cost to farmer cattle feedlots in Kansas. Property tax, real and personal, was determined from assessed valuation of property. The average mill levy (one mill equals one-tenth of one cent) of Kansas rural areas was 50 mills per dollar valuation for 1961, as determined by the Property Valuation Department, State of Kansas. Rural real estate in Kansas for 1961-1962 was assessed, on an average for the state, at 22 per cent of its present valuation. Real estate includes land and improvements thereon which were assessed as real property.[7]

Through interviews with a Kansas State University economist,[8] a method for applying tax rates to personal property was established. It was assumed that capital investment figures represent the approximate present valuation of machinery, equipment and buildings on each of the models. One-third of present valuation was defined as assessed valuation for personal property.

The average state levy of 50 mills was then applied to this assessed valuation and total tax paid for personal property per model was obtained. Taxes, both real and personal, will vary considerably throughout the state. Rates presented above represent only an approximation of the individual rates paid within Kansas, i.e., they are at best only state wide averages.

Costs of taxes fluctuated from $76 in Model I to $546 in Model V. Models II, III and IV had tax costs of $122, $183 and $291. As capacity

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[7]Kansas, Property Valuation Department, Report of Real Estate Assessment Ratio Study State of Kansas, (Topeka, 1961), p. 2.

[8]Interview with Dr. Wilfred Pine, Kansas State University agricultural economist, June 6, 1963.

increased tax costs per head for Model V were reduced more than three times that shown for Model I. Annual total per head tax costs were $1.90, $1.06, $.81, $.65 and $.59 from Model I to Model V (Table 5).

TABLE 5

REAL AND PERSONAL PROPERTY TAX FOR FIVE MODEL FEEDLOTS, KANSAS, 1961[e]

Item	Model I	Model II	Model III	Model IV	Model V
Assessed value of real property[a]	473	704	1210	2882	5268
Assessed value of personal property[b]	1056	1733	2456	2939	5657
Assessed value of real and personal property	1529	2437	3666	5821	10925
Tax per year on real property[c]	24	35	61	144	263
Tax per year on personal property[c]	53	87	123	147	283
Tax per year on real and personal property[c]	77	122	184	291	546
Tax per day on real and personal property[d]	.51	.81	1.23	1.94	3.64
Annual tax per head on real and personal property	1.93	1.06	.82	.65	.59
Daily tax per head on real and personal property	.0128	.0070	.0055	.0043	.0039

[a]Based on 22 per cent of present valuation.

[b]Based on 33 per cent of present valuation.

[c]Based on 50 mills per dollar assessed value.

[d]Based on 150 days required to prepare cattle for market.

[e]See Appendix (A) Table 32 for a complete breakdown of capital investment.

Interest on Investment

Capital invested should yield a satisfactory return whether invested in ones own business or that of someone elses. Therefore, interest costs must contain a cost for actual money borrowed and a cost levied against the operators own money used in his business. The latter should be equal to that which he could expect to receive, if money were invested in another enterprise of approximately equal risk. Interest rates have remained fairly uniform for long periods of time, although some businesses have always been able to obtain funds at lower rates than others.[9] This has been due to a variety of reasons, volume borrowing and favoritism being examples.

In this study an allowance of 5 per cent for interest on investment was made. This seems to be in agreement with that used in similar studies.[10] As the assumption has already been made that buildings, machinery and equipment in all models were half worn out, the interest rate may be applied directly to total capital investments of each model. Articles depreciated range from full value to zero during the life of the article, therefore, interest costs will decrease with time. Interest rates when applied in this study should provide an average cost figure. Similar studies have applied interest rates to one-half the value of building and equipment.[11]

The computed interest costs are given in Table 5. Interest was

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[9]Baum, Faris and Walkup, p. 16.

[10]Ibid.
Bressler, pp. 51-52.
McCoy, p. 136.

[11]Bressler, p. 51.
Tom W. Prather and L. A. Maddox, Guide for Estimating Annual Return to Labor, Management and Capital, Texas Agricultural Extension Service MP-398 (College Station, 1959), p. 4.

TABLE 5

INTEREST COSTS FOR FIVE MODEL FEEDLOTS, KANSAS, 1961

Item	Model I	II	III	IV	V
			(dollars)		
Total capital investments	5350	8450	12942	22005	41543
Interest costs on capital investments per year[a]	268	443	647	1100	2077
Interest costs on capital investments per head	6.70	3.68	2.88	2.44	2.25
Interest costs on capital investments per day[b]	1.79	2.82	4.31	7.33	13.85
Daily interest costs on capital investment per head per day	.0448	.0245	.0192	.0163	.0150

[a]Based on one-half depreciated Capital Investments at a rate of 5 per cent.

[b]Based on 150 working days required to prepare cattle for market.

one of the major fixed cost items for Kansas farmer cattle feedlots. Costs of $268, $423, $647, $1,100 and $2,077 were recorded for the five model feedlots. Daily costs per head were approximately three times greater for Model I relative to Model V. This is based on 150 working days as the amount of time required to ready cattle for market. Models I, II, III, IV and V had costs per head per day of $.0448, $.0254, $.0192, $.0163 and $.0150, respectively.

Insurance

Insurance rates vary depending on location of insured articles to buildings, fire fighting equipment, approved fire prevention devises, per cent coverage desired and construction of buildings. All feedlots in the survey were assumed outside city limits with machinery, buildings and equipment insured at 80 per cent of actual value. Insurance rates outside city limits were somewhat higher than those rates within cities. Feedlot insurance costs are given in Table 7.

Through consultation with an insurance agent necessary conditions and rates were determined. As this study's primary concern was cattle feedlots, information on other phases of the farm operation have been omitted, however, in some cases it becomes necessary to include parts of these operations. Insurance was one of these cases. Farmers in general, obtain some type of blanket coverage when purchasing insurance.

The blanket coverage used as a representative sample for this study was Farm Bureau's "Form 2 Master Plan". This plan is broken down and different rates applied to six major categories. These categories are: (1) home, (2) household goods, (3) outbuildings, (4) personal property, (5) liability on farm and (6) cattle. Insurance costs on cattle will be considered as a variable cost in this study. Licensed vehicles were insured under a separate policy.

To be insured under the particular master plan discussed here, the following conditions must be met to receive the indicated rates:

1) Outbuildings; approved lightning rods certified with a master label number from the United Underwriters Laboratory, net premium \$.73 per \$100 insured.

2) Personal property; includes all emplements, tools, grains, hay, silage and all other personal property excluding livestock, licensed vehicles and household goods, net premium \$.34 per \$100 insured.

TABLE 7

INSURANCE COSTS FOR FIVE MODEL FEEDLOTS, KANSAS, 1961

Item	Model I	Model II	Model III	Model IV	Model V
	(dollars)				
Insured value of outbuildings[a]	1360	2000	3694	6284	8800
Insured value of personal property[b]	2240	3960	5020	9320	19634
Insured value of licensed vehicles	750[f]	900[g]	1850[g]	2250[g]	4500[g]
Insured value of outbuildings, personal property and vehicles	4350	6860	10564	17854	32934
Annual insurance costs on outbuildings	9.93	14.60	26.97	45.87	64.24
Annual insurance costs on personal property	7.62	13.36	17.07	31.69	66.76
Annual insurance costs on licensed vehicles[c]	16.40	32.80	32.80	32.80	32.80
Annual insurance costs on liability coverage of feedlot[d]	10.00	10.00	10.00	10.00	10.00
Total fixed annual insurance cost	43.95	70.86	86.84	102.36	173.80
Total fixed insurance cost per head	1.10	.62	.39	.23	.19
Daily total fixed insurance cost[e]	.29	.47	.58	.68	1.16
Daily total fixed insurance cost per head	.0073	.0041	.0026	.0015	.0013

[a]Outbuildings and personal property insured at 80 per cent of actual value.

[b]Excludes cattle and household goods.

[c]Liability coverage only on trucks and pickups.

[d]Costs equals approximately one-half of liability coverage for

3) Liability; $100,000 covering up to and including 320 acres, net premium $20.25 per year.

4) Cattle; under broad form animals are covered against every type of death excluding natural death and being killed by a vehicle owned and operated by the insured or a tenant to the insured, net premium $.64 per $100 insured.[12]

The minimum liability coverage for the state of Kansas of $5,000, $25,000 and $50,000 was assumed on licensed vehicles used in the feeding operation. Net premium for this minimum requirement was $16.40 per year per vehicle.[13]

The Form 2 Master Plan and the policy on licensed vehicles hold no deductables against hail and storms. Trench silos were not insured, only silage contained within.[14] For purposes of convenience, only $10 of liability coverage costs for the farm will be charged to the cattle feeding program of each model.[15]

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320 acres.

[e]Based on 150 working days required to prepare cattle for market.

[f]One vehicle.

[g]Two vehicles.

[12]Interview with Jean Clark, general agent for Farm Bureau Mutual Insurance Co., Inc., August 8, 1963.

[13]Ibid.

[14]Ibid.

[15]The amount of variation from schedule to schedule make it impossible to determine what part of the farming operation the feedlot represented, therefore, it was arbitrarily decided to charge $10 of the liability coverage costs ($20.25) to the feeding operation.

IV VARIABLE COSTS

Variable costs are those costs which either increase or decrease as total output of the plant increases or decreases.[1] As the period under consideration increases in length the number of factors associated with variable costs also increase. This process is a continuing one until in the long-run all costs are variable. In general, variable costs refer to such factors of production as labor, electricity, etc., i.e., input factors that vary with output and may not be used at all at the zero level. Not many variable costs are completely variable.[2] For example, veterinary expense for 40 head of cattle will not be one-half as much as for 80 head. There is some degree of fixity, therefore. This may be accounted for by fees charged for the farm call; i.e., the Veterinarian would charge just as much to drive from his office to the farm, before he began work, for 40 cattle as for 80. Also the practice of using lumpy inputs decreases variability of a given factor. This may be shown in the area of labor where one man is usually the smallest unit considered.[3] However, in spite of these elements of fixity, some costs were considered to vary with volume of output and, were therefore, classified as variable costs.

Variable costs under consideration in this study were; insurance on cattle, taxes on cattle, veterinary, electricity, insecticides, fuel,

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[1] Sloan and Zurcher, p. 347.

[2] Baum, Faris and Walkup, p. 19.

[3] Bressler, p. 24.

hired labor, buying cattle, selling cattle, trucking cattle and death losses. The following variable costs were excluded; bedding, stilbestrol, other trucking expense and miscellaneous expense (such as telephone, wires, travel, etc.).

Miscellaneous expenses were omited because they contributed only a small portion to total variable costs.[4] In some cases they were less than 1 per cent of total variable costs. For this reason attention has been directed to those costs of greater magnitude. The survey indicated a majority of feedlots administered stilbestrol as a feed additive. This study was concerned with non-feed costs, therefore, stilbestrol, as a cost of feeding, was not included in this report. For the most part, feedlot operators, as shown by the survey, did not use bedding in their fat cattle feeding program, therefore, it has been omited here as a variable cost item.

Insurance Expense

Information pertaining to insurance on cattle was obtained from the survey of feeders. Supplemental information was obtained from the Farm Bureau Mutual Insurance Company.[5] Insurance for cattle on farms was written as part of the "Master Plan" cited earlier in connection with insurance as a fixed cost. Under this plan cattle were insured against all death losses, excluding natural death and death resulting from a vehicle owned and operated by the insured or a tenant to the insured. The net premium was $.54 per $100 insured value.

Variable insurance costs increase or decrease in direct proportion

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[4] Ibid., p. 40.

[5] Jean Clark, Farm Bureau Insurance.

to increases or decreases in numbers, valuation or both numbers and valuation of cattle being fed. The general practice of feedlot operators was to estimate; (1) the average number of cattle to be fed at any one time, (2) the average age of the cattle and (3) the average valuation of these cattle for the year. Yearly premiums were then set up and paid on these average estimates.

For example, a feeder estimates he will have, on the average, 200 cattle on feed at any one time, their age will average between one and two years and average valuation is $200 per head. Therefore, this feedlot operator must pay $.64 X 400 or $256 per year premiums.

In this study an average valuation of $200 per animal and an average age between one and two years was assumed for all five models (Table 8). Economies of scale do not exist for this variable cost factor. Per unit costs were constant, i.e., they neither increased nor decreased as output was increased or decreased. However, it still remains a variable costs factor because at zero output no costs were incurred and as soon as production started costs began.[6]

Tax Expense

Close study with a Kansas State University economist and county tax officials,[7] revealed the following information on taxation of cattle. Meetings are held each year by county tax officials at which time assessed valuations and levies are decided upon. These vary from county to county and year to year but an average figure can be computed which adequately represents the

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[6]Baum, Faris and Walkup, p. 19.

[7]Interview with Wilfred Pine, Kansas State University agricultural economist, August 7, 1963.

TABLE 8

INSURANCE COSTS[a] PER DAY[b] FOR CATTLE IN FIVE MODEL FEEDLOTS, KANSAS, 1961

	Model				
	I	II	III	IV	V
Percent of Capacity Utilized	40 head	115 head	225 head	450 head	925 head
			(dollars)		
150 per cent	.507	1.476	2.880	5.760	11.840
125 per cent	.427	1.227	2.400	4.800	9.867
100 per cent	.340	.980	1.920	3.840	7.893
75 per cent	.253	.733	1.440	2.880	5.920
50 per cent	.167	.487	.960	1.920	3.947
25 per cent	.087	.247	.480	.960	1.973

[a]Net premium of $.64 per $100 insured was used. Average valuation was $200 per animal and average age was 1 to 2 years.

[b]150 days assumed as the time required to finish cattle for market.

state as a whole for any given year.

As personal property, cattle were assessed at approximately 33 per cent of current value and taxed at 50 mills per dollar assessed valuation (figures represent Kansas average). Variable tax costs, as variable insurance costs, vary in direct proportion to increases or decreases in number of cattle on hand January 1.

Two options were available to Kansas Cattle feeders.

1) They may be assessed on average yearly inventory of all livestock

on hand. This was the long form and for this and other reasons was not too popular.

2) The short and most frequently used form assesses livestock on the farm as of January 1.

The actual assessed valuation varies throughout the state, however, as indicated above one-third of present valuation seems to be an average for the state.[8] Feeder cattle over one year and under two years of age were assessed, on the average, at $47 per head (Table 9). This assumes an average purchase price of $140.

TABLE 9

TAX COSTS[a] PER DAY[b] FOR CATTLE IN FIVE MODEL FEEDLOTS, KANSAS, 1961

	Model				
	I	II	III	IV	V
Percent of Capacity Utilized	40 head	115 head	225 head	450 head	925 head
			(dollars)		
150 per cent	.940	2.703	2.288	10.575	21.738
125 per cent	.783	2.252	4.406	8.813	18.114
100 per cent	.627	1.802	3.525	7.050	14.492
75 per cent	.470	1.351	2.644	5.288	10.869
50 per cent	.313	.901	1.763	3.525	7.246
25 per cent	.157	.450	.881	1.763	3.623

[a]Rough fed feeder cattle greater than one but less than two years of age were assessed at $47 per head and taxed at 50 mills per dollar assessed valuation (figures are assumed Kansas average).

[b]150 days assumed as the time required to finish cattle for market.

Other Variable Costs

Relationships of the remaining nine variable costs to size of herd and to percentage utilization of feedlot capacity were determined from survey data, from four relevant survey questions.

The first of these four questions requested the operator to furnish 1961 costs for each of the nine variables. The second established the "normal" or 100 per cent capacity of the feedlot. The third asked for number of head fed during the 1961 feeding period; the fourth, specifically asked operators to estimate what percentage of variable costs, incurred at "normal" capacity, would be applicable, if their feedlots were operated at capacities of 25, 50, 75, 100, 125 and 150 per cent of "normal". Answers to the second and third questions permitted computation of the percentage of "normal" capacity the feedlots were operated in 1961. Because costs of the nine variables covered animals fed in 1961, it was necessary to adjust these to a 100 per cent or "normal" capacity basis.

This procedure can best be explained in the following manner. For example, let us say that one particular operator estimated his 1961, feedlot fuel cost to be $525. He also stated that the "normal" capacity of his feedlot was 100 head and that he fed 85 head during the 1961, feeding period. His lot was operated at 85 per cent of capacity and his fuel bill (one of the nine variables) for 85 per cent capacity was $525. To adjust this cost to a 100 per cent or "normal" capacity basis, it was revised upward by the equation .85X $525, i.e., X $617.65 where X is fuel cost at 100 per cent or "normal" capacity.

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[8] *Ibid.*

Before attempts were made to fit an equation to the survey data, checks were made to determine if the data appeared linear or curvilinear. Scatter diagrams were plotted using the survey information. The wide dispersion of data on the diagrams made observational analysis checking for linearity or curvilinearity difficult. However, economic logic reasons that total costs increase at a decreasing rate as scale of operation expands, thereby, producing curvilinearity.

The above expectation then, led to a trial of various quadratic functions. Only one such equation tried produced usable information. An equation of the form $Y = a + b_1X_1^2 + b_2X_2^2 + b_3X_1X_2 + b_4X_1 + b_5X_2$ produced some usable answers, i.e., usable from a logical viewpoint. In the above equation (Y) equals the total cost of any variable cost item, (X_1) equals the number of cattle per feedlot and (X_2) equals the per cent of "normal" capacity at which a feedlot is operated. The multiple correlation coefficients squared (R^2) were low for most of the nine variable costs considered (Appendix B). This, in turn, led to high standard errors (Appendix B). For example, fuel had an (R^2) of (.23102) and a standard error of $612.90 (compared to a mean of $672.70). No studies using similar analyses could be found for comparisons. Therefore, there was no basis for considering these results good, bad, or typical for these type data, so logic had to suffice.

The estimated costs derived from the quadratic equation resulted in negative values for some variable items on all five hypothetical models in this study. These negative values were scattered throughout the various levels of capacity utilization with a concentration at the 25 per cent level. No logical justification could be formulated to account for these negative costs at all scales of feedlot operation. Costs for a particular item may be zero on some feedlots but negative costs in feedlot operations are impossible, so fitting for curvilinearity was abandoned. The set of linear equations used produced negative costs also, however, there were fewer of them (for a more complete discussion see page 63).

The next step was to try to fit linear equations to the data. One such equation of the form $Y = a + b_1X_1 + b_2X_2$, where variables equal the same as in the above quadratic equation, was tried. Results obtained from this equation relative to the above quadratic function were equally poor and unrealistic (Appendix B). Using fuel as an example again, values computed were: $R^2 = .20977$ and standard error $617.39 compared to a mean of $672.70. Therefore, a final attempt was made in which the two independent variables were separated. First a function of the form $Y = a + bX$ was derived where (Y) equals the total cost of any variable cost item for a given feedlot operating at 100 per cent of capacity and (X) equals the number of cattle per feedlot. Thus an equation was designed to give an estimate of the relationship between a particular variable cost (Y) and size of a feedlot (X) operating at a given capacity (100 per cent in this case as explained by the example on page 60).

A second equation of the same form (i.e., $Y = a + bX$), where (Y) equals the percentage of variable costs, relative to "normal" capacity and (X) equals the degree of capacity utilized. This equation estimates the relationship of a particular percentage of costs at "normal" capacity (Y) to level of operation (X).

Thus for each variable cost item two equations were formulated. One, an estimating equation for deriving the cost of various sizes of lots operated at "normal" (i.e., 100 per cent) capacity. The other, an equation for determining the cost of each size lot operated at various levels of capacity. Through this combination of equations average variable short-run cost data may be computed for each cost item and summed for each of the five hypothetical feedlots.

The estimated costs derived from this set of linear equations resulted in negative values for some variable items. However, relative to the other equations tried, there were fewer negative costs estimated and those that were estimated by this set of equations were confined to one model (the smallest or 40 head size). Negative costs estimated for the smallest model were adjusted to zero where they could be explained with some degree of certainty. (For further explanation see the individual variable cost items.)

Coefficients of determination and standard errors for the first of the two equations were little better than those obtained on other examples, (Appendix B). Values for (R^2) ranged from 16 to 52 per cent and standard errors ranged from $85 for insecticides (compared to a mean of $109) to $2950 for hired trucking cattle expenses (compared to a mean of $2118). Coefficients of determination for the second equation were improved, however, ranging from 20 to 99 per cent for the nine variables (Appendix B). The two equations combined produced, on the whole, much more realistic answers than did the discarded equations.

Veterinary Expense

Medicine and the administering of it was an important factor in cattle feeding operations. This importance increased as the feedlot was filled beyond normal capacity, i.e., cattle not treated properly were subjected to diseases on an increasing scale as feedlots were overcrowded. The operators interviewed indicated veterinary expenses increased as herd size increased but at a more rapid rate when feedlots were overcrowded. Feedlots of the smallest size treat most of their own cattle, calling the veterinarian only on extreme emergencies. As feedlot size increases quantity of treatments also increase and feedlot operators, as indicated by the survey, tend to have professional Veterinarians do most of the veterinary work. Most feedlots, especially the larger ones, endorsed the use of mass vaccination either at the place of purchase or as soon as cattle were delivered to the feedlot. This, they said, increased veterinary expense but the increase was more than offset in the long-run by decreased death losses. Veterinary costs ranged from 36 cents per day for Model I to $4.57 per day for Model V (Table 10) when feedlots were assumed to operate at 100 per cent of capacity for 150 days. Veterinary costs were among the lowest of the eleven variables considered (Tables 20-25).

TABLE 10

VETERINARY COSTS PER DAY[a] FOR CATTLE IN FIVE MODEL FEEDLOTS, KANSAS, 1961

	Model				
	I	II	III	IV	V
Percent of Capacity Utilized	40 head	115 head	225 head	450 head	925 head
			(dollars)		
150 per cent	.497	.991	1.715	3.198	6.327
125 per cent	.431	.860	1.489	2.776	5.494
100 per cent	.359	.716	1.240	2.311	4.573
75 per cent	.300	.599	1.037	1.934	3.827
50 per cent	.235	.469	.811	1.513	2.993
25 per cent	.170	.338	.586	1.091	2.160

[a]150 days assumed as the time required to finish cattle for market.

Electricity Expense

Electricity costs were lower than veterinary costs in most cases, exceeding only that of insecticides on a few feedlots at different levels of capacity (Tables 20-25). Electrical expense for Model I was zero (Table 11). However, this low cost does nothing to hinder the importance of electricity on feedlots. It was used to run motors for pumping water, grinding feed, moving feed, feeding silage and grain, lights, etc. on most feedlots. As feedlots increased in size and more automation was experienced electricity became more significant.

TABLE 11

ELECTRICITY COSTS PER DAY[a] FOR CATTLE IN FIVE MODEL FEEDLOTS, KANSAS, 1961

	Model				
	I	II	III	IV	V
Percent of Capacity Utilized	40 head	115 head	225 head	450 head	925 head
			(dollars)		
150 per cent	.000	.102	.726	2.003	4.699
125 per cent	.000	.093	.666	1.837	4.310
100 per cent	.000	.085	.606	1.671	3.920
75 per cent	.000	.076	.546	1.505	3.531
50 per cent	.000	.068	.485	1.339	3.142
25 per cent	.000	.060	.425	1.173	2.752

[a]150 days assumed as the time required to finish cattle for market.

The estimating equations used for this variable (Appendix B) gave a small negative value for the smallest model. This was inconsistent with survey data from the small lots and illogical from a realistic viewpoint. It is probable that the amount of electricity used on the smallest feedlots was so nominal the operators simply did not give reliable estimates. In the absence of a satisfactory explanation for negative electricity costs on the smallest lot the estimating equation results were ignored and zero costs were arbitrarily entered in the tabulation.

Fuel Expense

Costs for fuel was one of the major variable costs in this study (Tables 20-25). Fuel was consumed on all models with quantity used increasing as capacity expanded. Largest fuel consumption was through the tractors and feed trucks. Prices paid per gallon for fuel were fairly uniform throughout the state. Costs per day operating at "normal" capacity for 150 days ranged from $2.29 to $7.12 (Table 12).

Insecticide Expense

Insecticides were one of the lowest costs groups on all feedlots interviewed (Tables 20-25). Every feedlot interviewed indicated the use of insecticides, however, per day costs were nominal ranging from 3.8 cents in Model I to $1.558 in Model V (Table 13) when operated at 100 per cent capacity. Models were assumed operating for 150 days. Insecticides were applied in various ways; through sprayers, commercially produced cattle rubs and farmer made cattle rubs. Percentage of effectiveness varied within each method, therefore, a definite statement as to the most effective method was impossible.

TABLE 12

FUEL COSTS PER DAY[a] FOR CATTLE IN FIVE MODEL FEEDLOTS, KANSAS, 1961

	Model				
	I	II	III	IV	V
Percent of Capacity Utilized	40 head	115 head	225 head	450 head	925 head
			(dollars)		
150 per cent	2.804	3.307	4.044	5.551	8.733
125 per cent	2.545	3.001	3.669	5.037	7.925
100 per cent	2.288	2.698	3.299	4.528	7.124
75 per cent	2.026	2.388	2.921	4.010	6.308
50 per cent	1.766	2.082	2.546	3.496	5.500
25 per cent	1.506	1.776	2.172	2.982	4.691

[a]150 days assumed as the time required to finish cattle for market.

TABLE 13

INSECTICIDE COSTS PER DAY[a] FOR CATTLE IN FIVE MODEL FEEDLOTS, KANSAS, 1961

	Model				
	I	II	III	IV	V
Percent of Capacity Utilized	40 head	115 head	225 head	450 head	925 head
			(dollars)		
150 per cent	.057	.251	.535	1.116	2.342
125 per cent	.048	.209	.446	.931	1.953
100 per cent	.038	.167	.356	.742	1.558
75 per cent	.029	.126	.268	.560	1.175
50 per cent	.019	.084	.179	.374	.786
25 per cent	.010	.043	.091	.189	.397

[a]150 days assumed as the time required to finish cattle for market.

Hired Labor

Hired labor was the highest group on almost all feedlots operating at all levels. Only as the per cent of capacity operation reached 125 and 150 in the larger feedlots were hired labor costs surpassed. In these larger lots the expense of trucking cattle overshadowed hired labor costs at the 125 and 150 per cent levels (Tables 20-25). Labor here does not include that contributed by the operator and his family but all other labor that was hired and paid for was included in this category. Labor costs for the smaller feedlots were not too high representing outlays only at peak times, such as, harvest. Small feedlot operators implied they were able to supply a sufficient quantity of their own and family labor to handle the feeding operation. The need for hired help came only at harvest time. As size expanded a full time employee was hired with his cost split between different enterprises. Finally in the largest lots the survey indicated one or more men were hired full time for the feeding operation. Costs ranged from $3.91 per day for Model I to $17.24 per day for Model V (Table 14).

TABLE 14

HIRED LABOR COSTS PER DAY[a] FOR CATTLE IN FIVE MODEL FEEDLOTS, KANSAS, 1961

	Model				
	I	II	III	IV	V
Percent of Capacity Utilized	40 head	115 head	225 head	450 head	925 head
			(dollars)		
150 per cent	4.230	5.450	7.240	10.900	18.629
125 per cent	4.053	5.222	6.937	10.445	17.851
100 per cent	3.914	5.043	6.699	10.086	17.237
75 per cent	3.670	4.767	6.333	9.535	16.295
50 per cent	3.523	4.540	6.031	9.080	15.518
25 per cent	3.347	4.312	5.728	8.625	14.740

[a]150 days assumed as the time required to finish cattle for market.

Expense Buying Cattle

Cattle feedlots must purchase replacements or raise their own. Very few feedlots indicated they grew their own replacements. Therefore, the five models within this study were assumed to purchase their replacement cattle. However, the methods by which they purchase replacements may not always result in a cost to the feedlot operator. As indicated on the survey questionnaires, some operators especially those in the smaller feedlots chose to list the period during which they purchased cattle as a vacation with no expenses charged to the cattle program. Others purchased cattle from adjoining ranches or ranches not to far distant on standing contracts from year to year. Some, again primarily the smaller operators, indicated they went to auctions each week anyway and would not charge any of this expense to their feeding operation.

Linear equations used to compute these costs (Appendix B) produced negative values for the smallest model. This was treated much the same as electricity costs, i.e., adjusted to zero. For the reasons stated above this seemed justifiable. As feedlots expanded and feeding became a more prominate enterprise on the farm a cost was charged to the cattle (Table 15).

Expense Selling Cattle

Selling cattle, as buying cattle, may be accomplished on the feedlot premises. Standing contracts with a particular packer buyer may prevail from year to year. Finally there are many places to sell cattle other than the feedlot. Some of these are; (1) auctions and (2) terminals. A majority of operators interviewed, indicated they usually incurred some selling expense chargeable to the cattle program. These costs ranged from $1.91 per day for

TABLE 15

BUYING CATTLE COSTS PER DAY[a] FOR CATTLE IN FIVE MODEL FEEDLOTS, KANSAS, 1961

	Model				
	I	II	III	IV	V
Percent of Capacity Utilized	40 head	115 head	225 head	450 head	925 head
			(dollars)		
150 per cent	.000	.434	1.823	4.663	10.658
125 per cent	.000	.382	1.605	4.106	9.385
100 per cent	.000	.337	1.414	3.618	8.271
75 per cent	.000	.279	1.169	2.992	6.838
50 per cent	.000	.227	.952	2.435	5.565
25 per cent	.000	.175	.734	1.878	4.292

[a]150 days assumed as the time required to finish cattle for market.

Model I to $13.46 per day for Model V (Table 16). Feedlots were assumed operating at 100 per cent of capacity for a 150 day feeding period. Selling costs were among the higher cost variables (Tables 20-25).

TABLE 16

SELLING CATTLE COSTS PER DAY[a] FOR CATTLE ON FIVE MODEL FEEDLOTS, KANSAS, 1961

	Model				
	I	II	III	IV	V
Percent of Capacity Utilized	40 head	115 head	225 head	450 head	925 head
			(dollars)		
150 percent	2.851	4.310	6.430	10.928	20.051
125 percent	2.184	3.601	5.373	9.048	16.754
100 percent	1.914	2.893	4.317	7.269	13.460
75 percent	1.444	2.184	3.258	5.487	10.160
50 percent	.976	1.475	2.201	3.706	6.863
25 percent	.507	.767	1.144	1.936	3.566

[a]150 days assumed as the time required to finish cattle for market.

Hired Trucking Expense - Cattle

This item covers only that trucking actually hired and includes both trucking in and trucking out of cattle. Any truck hauling the operator did with his own vehicle was not considered here but was included in expense to truck depreciation, interest on investment, fuel, etc. The set of linear equations produced negative values for the smallest model here as in electricity and buying cattle expenses. The negative values were again arbitrarily adjusted to zero. Some reasons for this adjustment are:

1) Many small feedlot operators implied they hauled most of their own

cattle to and from market.

2) Some operators, as stated before, purchased cattle on ranches very close to their own and drove the cattle from one place to the other.

As feedlots expanded hiring commercial truckers became a more common practice. Along with this came rapid increases in per day costs to the feedlot. Trucking costs jumped from zero in Model I to $33.38 per day for Model V (Table 17). Again 100 per cent capacity and 150 days were assumed. Trucking cattle costs were also among the higher costs groups increasing in importance as feedlots expanded (Tables 20-25).

TABLE 17

HIRED TRUCKING CATTLE COSTS PER DAY[a] FOR CATTLE ON FIVE MODEL FEEDLOTS, KANSAS, 1961

	Model				
	I	II	III	IV	V
Percent of Capacity Utilized	40 head	115 head	225 head	450 head	925 head
			(dollars)		
150 per cent	.000	.280	7.024	20.817	49.935
125 per cent	.000	.234	5.853	17.348	41.614
100 per cent	.000	.187	4.695	13.914	33.378
75 per cent	.000	.140	3.512	10.401	24.972
50 per cent	.000	.094	2.342	6.937	16.641
25 per cent	.000	.047	1.172	3.472	8.329

[a]150 days assumed as the time required to finish cattle for market.

Death Loss Expense

Costs for death losses were an expense incurred on farmer feedlots but not on commercial feedlots which were custom feeding.[9] In custom feeding the owner of the cattle incurres losses through death, however, in farmer feedlots the operator owns all cattle being fed, therefore, he must assume all costs. Death losses in the smaller feedlots, as indicated by the survey, were very few and usually a period of some years expired between losses on any given feedlot. For the year 1961, the period for which this data applies, a majority of small feedlot operators interviewed listed no death losses, therefore, a cost of zero was assigned to Model I (Table 18). Death losses on larger feedlots placed this cost as approximately average in the variable cost categories (Tables 20-25).

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[9] King, p. 16.

TABLE 18

DEATH LOSS COSTS PER DAY[a] FOR CATTLE IN FIVE MODEL FEEDLOTS, KANSAS, 1961

	I	II	III	IV	V
Percent of Capacity Utilized	40 head	115 head	225 head	450 head	925 head
			(dollars)		
150 per cent	.000	1.406	3.838	7.798	16.862
125 per cent	.000	1.289	3.212	7.146	15.451
100 per cent	.000	1.157	2.885	6.419	13.879
75 per cent	.000	1.053	2.625	5.841	12.629
50 per cent	.000	.936	2.332	5.188	11.219
25 per cent	.000	.818	2.039	4.536	9.808

[a] 150 days assumed as the time required to finish cattle for market.

V THE EFFECT OF PLANT VOLUME AND SCALE ON OPERATING COSTS

Large feedlots have lower per unit nonfeed costs than small feedlots at all volumes of output. This is indicated by Figure 2 showing the five hypothetical models compared as each is operated at a given level of capacity utilization. Daily costs per head ranged from $1.43 in the smallest model operating at 25 per cent of capacity to $.17 in the largest model operating at 150 per cent of capacity (Tables 20-25). Table 19 indicates the number of cattle per model as the models were operated at the six levels of capacity utilization discussed in this study. Depreciation, taxes, interest and insurance all show economies of scale for the larger plants. Depreciation exhibits the greatest reduction in average per head costs as scale increases, followed by interest, taxes and insurance. Veterinary, fuel, hired labor and selling cattle expenses also produced economies of scale for larger feedlots. Insurance and taxes on cattle were constant on a per head basis because total costs varied in direct proportion to cattle numbers. Electricity, insecticides, buying cattle, hired trucking of cattle and death loss expenses indicate diseconomies of scale.

Daily per head nonfeed costs and nonfeed costs per pound of gain for the five models operating at 150, 125, 100, 75, 50 and 25 per cent of feedlot utilization are presented in Tables 20 through 25. These two methods of expressing costs were developed since both were commonly used in the feeding industry. When percentage of utilization decreases, operating costs increase at a more rapid rate for smaller lots than for larger lots. The largest feedlots have the least cost increase as output decreases.

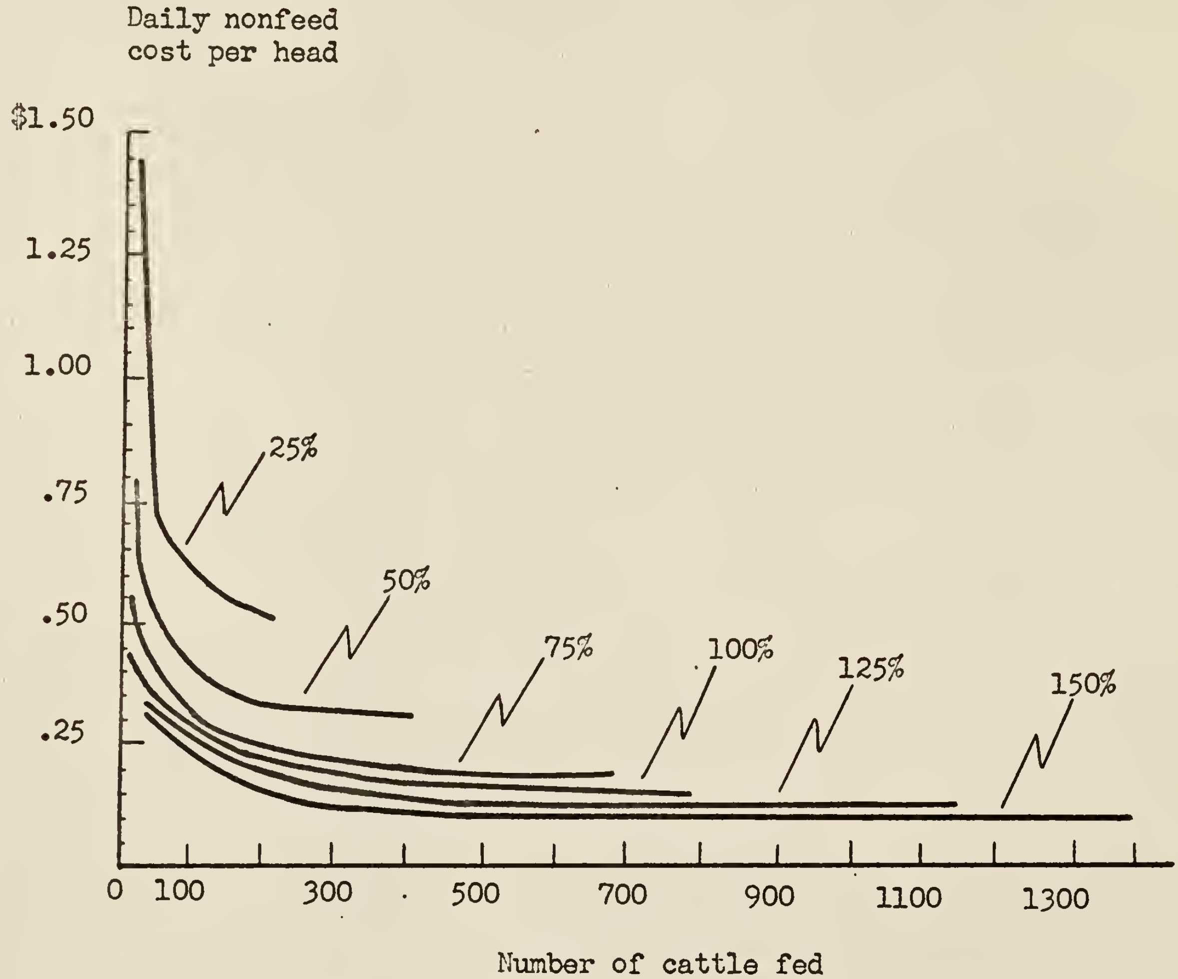

Fig. 2. — Relation between daily nonfeed costs per head and size of lot at given degrees of utilization.

TABLE 19

VOLUME OF CATTLE PER MODEL OPERATED
AT THE FOLLOWING PERCENTAGE OF CAPACITY

	Per Cent of Capacity					
Model :	25	50	75	100	125	150
			(number of cattle)			
I	10	20	30	40	50	60
II	29	58	86	115	144	173
III	56	113	169	225	281	338
IV	113	225	338	450	563	675
V	231	463	694	925	1156	1388

Total daily fixed costs remain constant for any given feedlot throughout all levels of capacity utilization, therefore, any increase in total costs must come from an increase in variable costs as feedlot capacity increases. Since total costs are equal to the sum of fixed costs and variable costs, total per unit costs must equal the sum of average variable unit costs and average fixed unit costs. The average total unit cost curve for each model is comprised of a series of points each point representing the sum of fixed and variable costs per unit at various levels of capacity utilization.[1]

Short-run average total unit cost curves for the five models are illustrated in Figure 3. For each hypothetical model, costs decline sharply

[1]Baum, Riley and Weeks, p. 42.

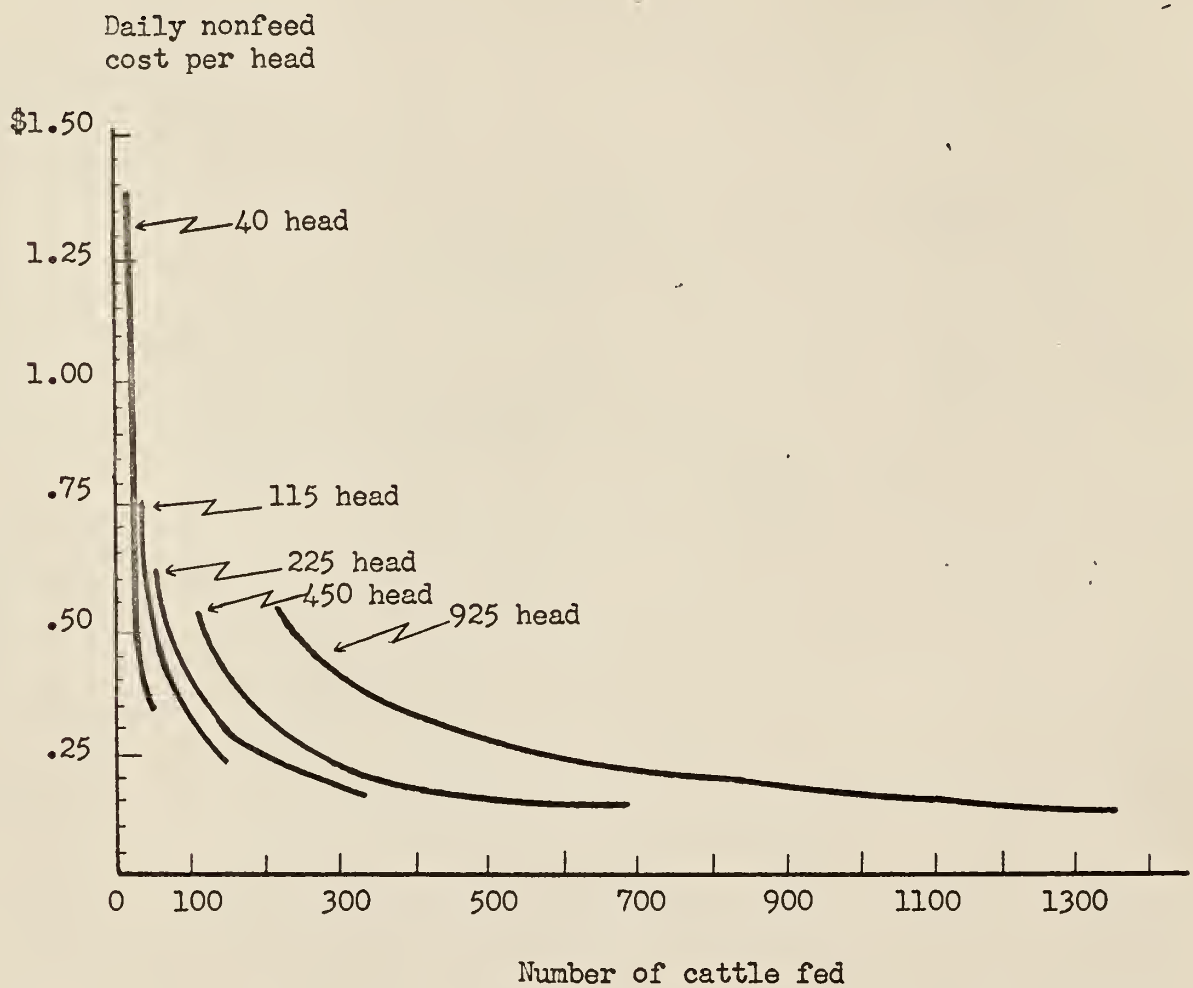

Fig. 3. — Short-run average nonfeed cost curves for five model feedlots, Kansas, 1961.

TABLE 20

SUMMARY OF NONFEED COSTS FOR FIVE MODEL CATTLE FEEDLOTS OPERATING AT 150 PER CENT OF FEEDLOT CAPACITY, KANSAS, 1961.

Item :	Model I	Model II	Model III	Model IV	Model V
Total Volume of Cattle Fed At 150 Per Cent of Capacity	60	173	338	675	1388
			(dollars)		
Fixed costs per day :					
Depreciation	6.00	9.60	14.32	24.28	48.06
Taxes	.51	.81	1.23	1.94	3.64
Interest	1.79	2.82	4.31	7.33	13.85
Insurance	.29	.47	.58	.68	1.16
Total fixed	8.59	13.70	20.44	34.23	66.71
Variable costs per day :					
Insurance on cattle	.507	1.467	2.880	5.760	11.840
Taxes on cattle	.700	2.013	3.940	7.880	16.187
Veterinary	.497	.991	1.715	3.198	6.327
Electricity	.000	.102	.726	2.003	4.699
Fuel	2.804	3.307	4.044	5.551	8.733
Insecticides	.057	.251	.535	1.116	2.342
Hired labor	4.230	5.450	7.240	10.900	18.629
Buying cattle	.000	.434	1.823	4.663	10.658
Selling cattle	2.851	4.310	6.430	10.928	20.051
Trucking cattle	.000	.280	7.024	20.817	49.935
Death loss	.000	1.406	3.838	7.798	16.862
Total variable	11.646	20.001	40.195	80.614	166.263
Total fixed and variable costs per day	20.236	33.711	60.635	114.844	232.973
Daily cost per head	.337	.195	.179	.170	.168
Cost per pound of gain[a]	.126	.073	.067	.064	.063

[a]Assuming 400 pounds gain per animal in 150 days.

TABLE 21

SUMMARY OF NONFEED COSTS FOR FIVE MODEL CATTLE FEEDLOTS OPERATING AT 125 PER CENT OF FEEDLOT CAPACITY, KANSAS, 1961.

Item	Model I	Model II	Model III	Model IV	Model V
Total Volume of Cattle Fed At 125 Per Cent of Capacity	50	144	281	563	1156
			(dollars)		
Total fixed costs per day	8.59	13.70	20.44	34.23	66.71
Variable costs per day:					
Insurance on cattle	.427	1.227	2.400	4.800	9.867
Taxes on cattle	.587	1.673	3.287	6.567	13.493
Veterinary	.431	.860	1.489	2.776	5.494
Electricity	.000	.093	.666	1.837	4.310
Fuel	2.545	3.001	3.669	5.037	7.925
Insecticides	.048	.209	.446	.931	1.953
Hired labor	4.053	5.222	6.937	10.445	17.851
Buying cattle	.000	.382	1.605	4.106	9.385
Selling cattle	2.184	3.601	5.373	9.048	16.754
Trucking cattle	.000	.234	5.853	17.348	41.614
Death loss	.000	1.289	3.212	7.146	15.451
Total variable	10.275	17.791	34.937	70.041	144.097
Total fixed and variable costs per day	18.865	31.491	55.377	104.271	210.807
Daily cost per head	.377	.219	.197	.185	.182
Cost per pound of gain[a]	.141	.082	.074	.069	.068

[a]Assuming 400 pounds gain per animal in 150 days.

TABLE 22

SUMMARY OF NONFEED COSTS FOR FIVE MODEL CATTLE FEEDLOTS OPERATING AT 100 PER CENT OF FEEDLOT CAPACITY, KANSAS, 1961.

	Model				
Item :	I	II	III	IV	V
Total Volume of Cattle Fed At 100 Per Cent of Capacity	40	115	225	450	925
			(dollars)		
Total fixed costs per day	8.59	13.70	20.44	34.23	66.71
Variable costs per day :					
Insurance on cattle	.340	.980	1.920	3.840	7.893
Taxes on cattle	.467	1.340	2.627	5.253	10.793
Veterinary	.359	.716	1.240	2.311	4.573
Electricity	.000	.085	.609	1.679	3.938
Fuel	2.288	2.698	3.299	4.528	7.124
Insecticides	.038	.167	.356	.742	1.558
Hired labor	3.914	5.043	6.699	10.086	17.237
Buying cattle	.000	.337	1.414	3.618	8.271
Selling cattle	1.914	2.893	4.317	7.269	13.460
Trucking cattle	.000	.187	4.695	13.914	33.378
Death loss	.000	1.157	2.885	6.419	13.879
Total variable	9.320	15.603	30.061	59.659	122.104
Total fixed and variable costs per day	17.910	29.303	50.501	93.889	188.814
Daily cost per head	.448	.255	.224	.209	.204
Cost per pound of gain[a]	.168	.096	.084	.078	.077

[a]Assuming 400 pounds gain per animal in 150 days.

TABLE 23

SUMMARY OF NONFEED COSTS FOR FIVE MODEL CATTLE FEEDLOTS OPERATING AT 75 PER CENT OF FEEDLOT CAPACITY, KANSAS, 1961.

	Model				
Item :	I	II	III	IV	V
Total Volume of Cattle Fed At 75 Per Cent of Capacity	30	86	169	338	694
			(dollars)		
Total fixed costs per day	8.59	13.70	20.44	34.23	66.71
Variable costs per day :					
Insurance on cattle	.253	.733	1.440	2.880	5.920
Taxes on cattle	.353	1.007	1.973	3.940	8.093
Veterinary	.300	.599	1.037	1.934	3.827
Electricity	.000	.076	.546	1.505	3.531
Fuel	2.026	2.388	2.921	4.010	6.308
Insecticides	.029	.126	.268	.560	1.175
Hired labor	3.670	4.767	6.333	9.535	16.295
Buying cattle	.000	.279	1.169	2.992	6.838
Selling cattle	1.444	2.184	3.258	5.487	10.160
Trucking cattle	.000	.140	3.512	10.410	24.972
Death loss	.000	1.053	2.625	5.841	12.629
Total variable	8.075	13.352	25.082	49.094	99.748
Total fixed and variable costs per day	16.665	27.052	45.522	83.324	166.458
Daily cost per head	.556	.315	.269	.247	.240
Cost per pound of gain[a]	.208	.118	.101	.092	.090

[a]Assuming 400 pounds gain per animal in 150 days.

TABLE 24

SUMMARY OF NONFEED COSTS FOR FIVE MODEL CATTLE FEEDLOTS OPERATING AT 50 PER CENT OF FEEDLOT CAPACITY, KANSAS, 1961.

	Model				
Item	I	II	III	IV	V
Total Volume of Cattle Fed At 50 Per Cent of Capacity	20	58	113	225	463
			(dollars)		
Total fixed costs per day	8.59	13.70	20.44	34.23	66.71
Variable costs per day :					
Insurance on cattle	.167	.487	.960	1.920	3.947
Taxes on cattle	.233	.673	1.313	2.627	5.393
Veterinary	.235	.469	.811	1.513	2.993
Electricity	.000	.068	.485	1.339	3.142
Fuel	1.766	2.082	2.546	3.496	5.500
Insecticides	.019	.084	.179	.374	.786
Hired labor	3.523	4.540	6.031	9.080	15.518
Buying cattle	.000	.227	.952	2.435	5.565
Selling cattle	.976	1.475	2.201	3.706	6.863
Trucking cattle	.000	.094	2.342	6.937	16.641
Death loss	.000	.936	2.332	5.188	11.219
Total variable	6.919	11.135	20.152	38.615	77.567
Total fixed and variable costs per day	15.509	24.835	40.592	72.845	144.277
Daily cost per head	.775	.428	.359	.324	.312
Cost per pound of gain[a]	.291	.161	.135	.121	.117

[a]Assuming 400 pounds gain per animal in 150 days.

TABLE 25

SUMMARY OF NONFEED COSTS FOR FIVE MODEL CATTLE FEEDLOTS OPERATING AT 25 PER CENT OF FEEDLOT CAPACITY, KANSAS, 1961.

	Model				
Item :	I	II	III	IV	V
Total Volume of Cattle Fed At 25 Per Cent of Capacity	10	29	56	113	231
			(dollars)		
Total fixed costs per day	8.59	13.70	20.44	34.23	66.71
Variable costs per day :					
Insurance on cattle	.087	.247	.480	.960	1.973
Taxes on cattle	.120	.333	.660	1.313	2.700
Veterinary	.170	.338	.586	1.091	2.160
Electricity	.000	.060	.425	1.173	2.752
Fuel	1.506	1.776	2.172	2.982	4.691
Insecticides	.010	.043	.091	.189	.397
Hired labor	3.347	4.312	5.728	8.625	14.740
Buying cattle	.000	.175	.734	1.878	4.292
Selling cattle	.507	.767	1.144	1.936	3.566
Trucking cattle	.000	.047	1.172	3.472	8.329
Death loss	.000	.818	2.039	4.536	9.808
Total variable	5.747	8.916	15.261	28.155	55.408
Total fixed and variable costs per day	14.337	22.616	35.671	62.385	122.118
Daily cost per head	1.434	.780	.637	.552	.529
Cost per pound of gain[a]	.538	.292	.239	.207	.198

[a]Assuming 400 pounds gain per animal in 150 days.

with increased utilization of the fixed plant. As scale of the operation increases slope of the average cost curve decreases, because fixed costs become a smaller and smaller proportion of total unit costs. This points to the greater utilization of fixed plant facilities.

The economies of scale or long-run cost curve decreases rapidly at the smaller models and gradually levels out as scale of operation expands. The long-run cost or economies of scale curve is illustrated in Figure 4. Declining per unit costs prevail throughout all increases in scale for this study, however, the rate of decrease is quite slow for feedlots with capacities above 225 head. The shape of the long-run cost curve is dependent upon the short-run average total cost curves. In the short-run, average fixed unit costs continue to decrease. Average variable unit costs level out and begin to rise as inputs demanded by increased scale of operation become more inefficient. Theoretically when the rise in average variable unit costs becomes great enough to offset the decrease in average fixed unit costs the average total unit cost curve for feedlots levels out and begins to rise. However, in this study the point of increasing unit costs was not reached. The least-cost point of production will be the lowest point on the average total unit cost curve in the short-run.[2]

The long-run economies of scale cost curve is drawn tangent to the individual short-run cost curves of the feedlots when feedlot capacities form a continuous series. Theoretically the economies of scale curve is drawn tangent to the least-cost point of only one short-run cost curve. This point is the least-cost point of production for all feedlots in the long-run. Tangencies of the long-run curve to other short-run curves are to the left of

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[2]Baum, Faris and Walkup, p. 32.

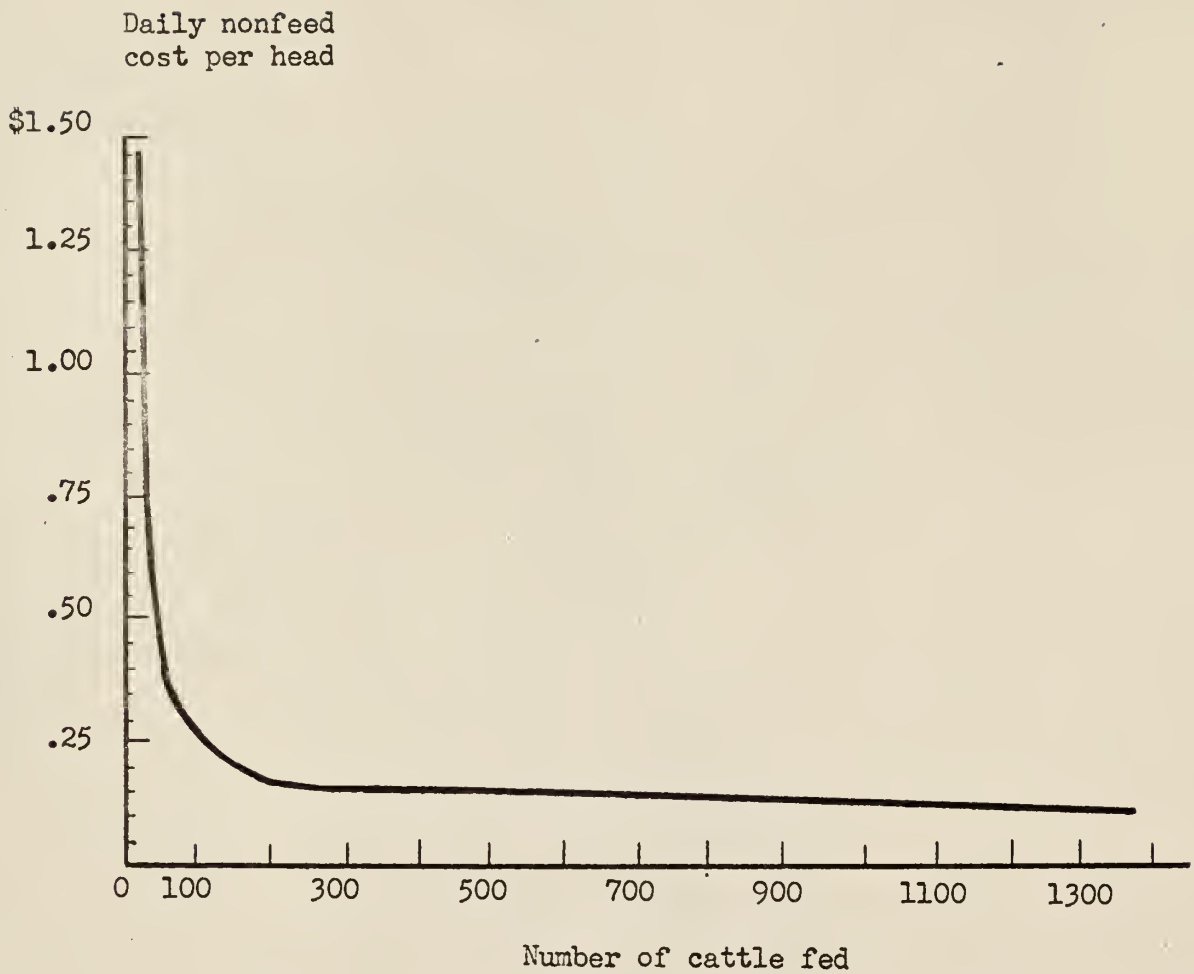

Fig. 4. -- Economies of scale curve (nonfeed cost) for five model feedlots, Kansas, 1961.

short-run least-cost combinations when the long-run curve is negatively sloped and to the right of short-run least-cost combinations when the long-run curve is positively sloped.[3] Short-run cost curves did not turn up in the traditional "U" shape in this study, therefore, the economies of scale curve was drawn tangent to the lowest point on all short-run cost curves. This situation seems to compare favorably with other studies on economies of scale.[4]

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[3]Bressler, p. 21

[4]King, p. 4.
Bressler, p. 64.
Baum, Riley and Weeks, pp. 41-42.

VI SUMMARY AND CONCLUSIONS

Five model feedlots with designed capacities of 40, 115, 225, 450 and 925 head, respectively, were developed to determine the behavior of average costs associated with scale of operation and with level of capacity at which individual feedlots were operated. A survey was conducted asking feedlot operators to indicate, among other things, their capital investments, fixed costs and variable costs. These costs and investments were then analyzed statistically, to establish standards from which the study could proceed. Using the budget or "synthetic" approach, secondary sources of information (such as, dealers, manufacturers and contractors) were asked to supply costs data which were then correlated to the standards set by the survey. For each feedlot size, average unit costs were calculated for feedlots operated between 25 and 150 per cent of "normal" capacity. These short-run plant cost curves were then used to develop an economies of scale curve for farmer feedlot operations.

Costs analyses, for this study, indicate a sharp rise in unit costs for operations at low levels of capacity. Feedlots operated at 100 per cent of capacity have per head costs less than half those costs of a feedlot operated at 25 per cent of capacity. Also, nonfeed costs per head decline as feedlots operated at a given per cent of "normal" capacity expand output. For example, feedlots operated at 125 per cent of "normal" capacity had nonfeed costs per head of $.18 for a capacity of 1156 head compared to $.38 per head for a capacity of 50 head (Table 26).

From information presented, it appears that farmer feedlots can

TABLE 26

SUMMARY OF DAILY AVERAGE TOTAL NONFEED COSTS PER HEAD FOR FIVE HYPOTHETICAL FEEDLOTS OPERATED AT GIVEN DEGREES OF CAPACITY UTILIZATION

	Number of Head at "Normal" Capacity				
Degree of Capacity Utilization	40	115	225	450	925
			(dollars)		
25 per cent	1.434	.780	.637	.552	.529
50 per cent	.775	.428	.359	.324	.312
75 per cent	.556	.315	.269	.247	.240
100 per cent	.448	.255	.224	.209	.204
125 per cent	.377	.219	.197	.185	.182
150 per cent	.337	.195	.179	.170	.168

continue to operate. That is, as long as they expand output to its maximum and continually increase scale to keep pace with modern technology.

Statistical data indicate that larger feedlots are justified by the economies of scale of feedlot operations. It also implies that costs advantages can be fully attained only if feedlots are used at capacity or even somewhat beyond what farmers consider "normal" capacity. However, due to the relatively large standard errors compared to the means and the low coefficients of determination; statistical analyses would suggest a larger sample should be drawn in future surveys of similar data, thereby, increasing the chance for greater accuracy.

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APPENDIX A

BREAKDOWN OF CAPITAL INVESTMENTS

TABLE 27

EQUIPMENT, BUILDINGS AND MACHINERY FOR A 40 HEAD CAPACITY FEEDLOT, MODEL I

Item	Costs Chargable to Cattle	Depreciation
Grain bins	$ 750	$ 75
Upright silo	800	80
Trench silo	100	20
Total feed storage	$1650	$175
Machine shed	$ 150	$ 15
Tractor	750	150
Manure spreader	300	60
Roller-crimper	300	60
Total machinery and buildings	$1500	$285
Feed bunks	$ 100	$ 20
Fence	150	30
Windbreaker	50	10
Cattle chute	100	20
Oilers	50	10
Water facilities	150	30
Total feed yard	$ 600	$120
Pickup	$ 750	$150
Wagon	300	60
Loader, tractor	250	50
Portable auger	200	40
Cattle spray equipment	100	20
Total feeding and miscellaneous equipment	$1600	$320
Total	$5350	$900

TABLE 28

EQUIPMENT, BUILDINGS AND MACHINERY FOR A 115 HEAD CAPACITY FEEDLOT, MODEL II

Item	Costs Chargable to Cattle	Depreciation
Grain bins	$ 1500	$150
Upright silo	800	80
Trench silo	100	20
Total feed storage	$ 2400	$250
Machine shed	$ 200	$ 20
Tractor	1000	200
Silage cutter	750	150
Manure spreader	400	80
Roller-crimper	300	60
Total machinery and buildings	$ 2650	$510
Feed bunks	$ 300	$ 60
Fence	300	60
Windbreaks	100	20
Cattle chute	100	20
Oilers	100	20
Water facilities	200	40
Total feed yard	$ 1100	$220
Wagon, power box	$ 800	$160
Truck	500	100
Pickup	400	80
Loader, tractor	250	50
Portable auger	250	50
Cattle spray equipment	100	20
Total feeding and miscellaneous equipment	$ 2300	$460
Total	$ 8450	$1440

TABLE 29

EQUIPMENT, BUILDINGS AND MACHINERY FOR A 225 HEAD CAPACITY FEEDLOT, MODEL III

Item	Costs Chargable to Cattle	Depreciation
Grain bins	$ 1500	$150
Hay shed	1000	100
Upright silo	1500	150
Trench silo	200	40
Feed tank	217	44
Total feed storage	$ 4417	$484
Machine shed	$ 400	$ 40
Tractor	1250	250
Silage cutter	900	180
Manure spreader	400	80
Roller crimper	300	60
Total machinery and buildings	$ 3250	$610
Feed bunks	$ 550	$110
Fence	400	80
Windbreaks	100	20
Cattle chute	100	20
Oilers	250	50
Water facilities	400	80
Total feed yard	$ 1800	$360
Wagon power box	$ 1000	$200
Truck	1250	250
Pickup	600	120
Loader, tractor	250	50
Portable auger	250	50
Cattle spray equipment	125	25
Total feeding and miscellaneous equipment	$ 3475	$695
Total	$12942	$2149

TABLE 30

EQUIPMENT, BUILDINGS AND MACHINERY FOR A 450 HEAD CAPACITY FEEDLOT, MODEL IV

Item	Costs Chargable to Cattle	Depreciation
Grain bins	$ 2500	$250
Hay shed	2000	200
Upright silo	2500	250
Trench silo	250	50
Feed tank	255	51
Total feed storage	$ 7505	$801
Machine sheds	$ 600	$ 60
Tractor	1500	300
Silage cutter	1250	250
Manure spreader	500	100
Roller-crimper	400	80
Total machinery and buildings	$ 4250	$790
Fence line bunks	$ 1650	$330
Fence	1000	200
Windbreaks	200	40
Concrete aprons	1650	330
Cattle chute	100	20
Oilers	450	90
Water facilities	750	150
Total feed yard	$ 5800	$1160
Wagon, power box	$ 1000	$ 200
Truck	1500	300
Pickup	750	150
Loader tractor	300	60
Portable elevator	300	60
Portable auger	400	80
Cattle spray equipment	200	40
Total feeding and miscellaneous equipment	$ 4450	$ 890
Total	$ 22005	$3641

TABLE 31

EQUIPMENT, BUILDINGS AND MACHINERY FOR A 925 HEAD CAPACITY FEEDLOT, MODEL V

Item	Costs Chargable to Cattle	Depreciation
Grain bins	$ 7500	$ 750
Hay shed	2500	250
Trench silos	1500	300
Feed tank	493	98
Total feed storage	$11993	$1398
Machine shed	$ 1000	$ 100
Tractor	5000	1000
Silage cutter	2250	450
Roller-crimper	800	160
Total machinery and buildings	$ 9050	$1710
Fence line bunks	$ 3300	$ 660
Fence	2500	500
Windbreaks	300	60
Concrete aprons	3300	660
Cattle chute	200	40
Oilers	1000	200
Water facilities	2500	500
Total feed yard	$13100	$2620
Truck, power box	$ 1500	$ 300
Truck	3000	600
Pickup	1500	300
Loader tractor	500	100
Portable elevator	300	60
Portable auger	400	80
Cattle spray equipment	200	40
Total feeding and miscellaneous equipment	$ 7400	$1580
Total	$41543	$7308

TABLE 32

CAPITAL INVESTMENT ITEMS CLASSIFIED AS EITHER REAL OR PERSONAL PROPERTY AND THE VALUATION OF EACH CHARGED TO THE FEEDLOT OPERATION

Real Property	I	II	III	IV	V	Personal Property	I	II	III	IV	V
	Model						Model				
	(dollars)						(dollars)				
Grain bins	750	1500	1500	2500	7500	Feed tank	-	-	217	255	493
Machine shed	150	200	400	600	1000	Feed bunks	100	300	550	-	-
Hay shed	-	-	1000	2000	2500	Truck-power box	-	-	-	-	1500
Upright silo	800	800	1500	2500	-	Wagon-power box	-	800	1000	1000	-
Trench silo	100	100	200	250	1500	Truck	-	500	1250	1500	3000
Fence line bunks	-	-	-	1650	3300	Cattle chute	100	100	100	100	200
Fence	150	300	400	1000	2500	Oilers	50	100	250	450	1000
Windbreaks	50	100	100	200	300	Pickup	750	400	600	750	1500
Water facilities	150	200	400	750	2500	Wagon	300	-	-	-	-
Concrete aprons	-	-	-	1650	3300	Tractor	750	1000	1250	1500	5000
						Silage cutter	-	750	900	250	2250
						Loader-tractor	250	250	250	300	500
						Portable auger	200	250	250	400	400
						Cattle spray equipment	100	100	125	200	200
						Manure spreader	300	400	400	500	-
						Roller-crimper	300	300	300	400	800
						Portable elevator	-	-	-	300	300
Present Valuation	2150	3200	5500	13100	24400	Present valuation	3200	5250	7442	8905	17143
Total assessed valuation	472[a]	704[a]	1210[a]	2882[a]	5268[a]	Total assessed valuation	1056[b]	1733[b]	2456[b]	2939[b]	5657[b]
Total taxes[c]	24	35	61	144	263	Total taxes[c]	53	87	123	147	283

[a]Twenty two per cent of present valuation equals the assessed valuation of real property.

[b]Thirty three per cent of present valuation equals the assessed valuation of personal property.

[c]An average state levy of 50 mills per dollar assessed valuation was used to figure taxes.

APPENDIX B

EQUATIONS AND RELATED STATISTICS USED IN THIS REPORT

Several equations were fitted to the survey data. Four of these were selected for further discussion in this study. They are:

A) $Y = a + b_1X_1^2 + b_2X_2^2 + b_3X_1X_2 + b_4X_1 + b_5X_2$

B) $Y = b_1X_1 + b_2X_2$

C) $Y = a + bX$

D) $Y = a + bX$

Equations (A) is a quadratic function and (B), (C) and (D) are linear functions. For equations (A) and (B) the variables are the same.

Y = the total cost of any variable item for a given feedlot operated at a given level of capacity.

X_1 = the number of cattle per feedlot.

X_2 = the per cent of "normal" capacity at which a feedlot is operated.

Equation (C) was designed to give an estimate of the relationship between a particular variable cost (Y) and size of a feedlot (X) operating at a given capacity (100 per cent in this case). The variables in this equation are:

Y = the total cost of any variable cost item for a given feedlot operating at 100 per cent of capacity.

X = the number of cattle per feedlot

Equation (D) estimates the relationship of a particular percentage of costs at "normal" capacity (Y) to level of operation (X). The variables for this equation are:

Y = the percentage of variable costs, incurred at "normal" capacity that would be applicable if the feedlot were operated at capacities of 25, 50, 75, 125 or 150 per cent.

X = the various levels a feedlot may be operated at, i.e., 25, 50, 75, 100, 125 and 150 per cent

See Table 33 for related statistics to the above equations.

The nine variable cost items and set of linear equations used to compute the cost of each are:

Veterinary expense;	equation (C)	$Y = 25.27 + .7142X$
	equation (D)	$Y = 29 + .7291X$
Electricity expense;	equation (C)	$Y = -69.26 + .7135X$
	equation (D)	$Y = 60 + .3955X$
Fuel expense;	equation (C)	$Y = 310.35 + .8198X$
	equation (D)	$Y = 54.5 + .4539X$
Insecticide expense;	equation (C)	$Y = -4.6 + .2577X$
	equation (D)	$Y = .5 + .9987X$
Hired labor expense;	equation (C)	$Y = 496.71 + 2.2582X$
	equation (D)	$Y = 81 + .1805X$
Buying cattle expense;	equation (C)	$Y = -118.42 + 1.4693X$
	equation (D)	$Y = 36.5 + .6157X$
Selling cattle expense;	equation (C)	$Y = 208.67 + 1.9592X$
	equation (D)	$Y = 2 + .9798X$
Hired trucking expense;	equation (C)	$Y = -675.90 + 6.1402X$
	equation (D)	$Y = .025 + .9972X$
Death loss expense;	equation (C)	$Y = -97.31 + 2.3559X$
	equation (D)	$Y = 60.5 + .4066X$

These equations were used to compute the total cost of each variable item on the five hypothetical models operated at the six levels of capacity utilization.

TABLE 33

CORRELATION AND REGRESSION COEFFICIENTS AND THEIR RELATED STATISTICS FOR EQUATIONS CONSIDERED FOR NINE VARIABLE COST ITEMS IN THIS STUDY.

Variable 1 - Veterinary Expenses

	Equations			
Related Statistics	A	B	C	D
Standard error of the equation	427.40	435.35	441.52	16.05
Correlation coefficient (R)	.53038	.49469	.4862	.9045
Level of significance (F)	17.84902	37.42306	..	..
Coefficient of determination (R^2)	.28131	.24471	.23639	.8181
Constant (a)	.00320	-235.0376	25.27	29.000
Regression coefficient (b_1)	-.00002	.62549	.7142	.7291
Standard deviation of (b_1)	.00026	.08493	.2110	.1390
Level of significance (t) for (b_1)	-.09162	7.36472	..	..
Regression coefficient (b_2)	.00157	3.03764	..	..
Standard deviation of (b_2)	.01792	.66657	..	..
Level of significance (t) for (b_2)	.08762	4.53949	..	..
Regression coefficient (b_3)	.00665	..	..	..
Standard deviation of (b_3)	.00195	..	..	..

TABLE 33 Continued

Related Statistics	Equations A	B	C	D
Level of significance (t) for (b_3)	3.40490	..	..	..
Regression coefficient (b_4)	.07213	..	..	..
Standard deviation of (b_4)	.36491	..	..	..
Level of significance (t) for (b_4)	.19766	..	..	..
Regression coefficient (b_5)	-.25694	..	..	..
Standard deviation of (b_5)	3.32376	..	..	..
Level of significance (t) for (b_5)	-.07730	..	..	..
Variable 2 - Electricity Expense				
Standard error of the equation	352.70	366.98	387.56	13.50
Correlation coefficient (R)	.59497	.54003	.5377	.8072
Level of significance (F)	24.98780	47.55167	..	..
Coefficient of determination (R^2)	.35399	.29163	.28912	.6516
Constant (a)	.01182	-184.3763	-69.260	60.000
Regression coefficient (b_1)	.00091	.67287	.7135	.3955

TABLE 33 Continued

	Equations			
Related Statistics	A	B	C	D
Standard deviation of (b_1)	.00021	.07111	.1840	.1150
Level of significance (t) for (b_1)	4.35338	9.46229	..	..
Regression coefficient (b_2)	-.00087	1.32588	..	..
Standard deviation of (b_2)	.01479	.56188	..	..
Level of significance (t) for (b_2)	-.05888	2.35971	..	..
Regression coefficient (b_3)	.00279	..	..	..
Standard deviation of (b_3)	.00160	..	..	..
Level of significance (t) for (b_3)	1.74761	..	..	..
Regression coefficient (b_4)	-.65609	..	..	..
Standard deviation of (b_4)	.29379	..	..	..
Level of significance (t) for (b_4)	-2.23317	..	..	..
Regression coefficient (b_5)	.21854	..	..	..
Standard deviation of (b_5)	2.74068	..	..	..
Level of significance (t) for (b_5)	.07974	..	..	..

TABLE 33 Continued

Variable 3 - Insecticide Expense				
	Equations			
Related Statistics	A	B	C	D
Standard error of the equation	78.30	88.90	84.46	3.44
Correlation coefficient (R)	.78733	.71046	.7259	.9973
Level of significance (F)	76.32407	120.78139	..	..
Coefficient of determination (R^2)	.61989	.50476	.52693	.9946
Constant (a)	.00405	-99.6952	-4.600	.500
Regression coefficient (b_1)	.00019	.22537	.2577	.9987
Standard deviation of (b_1)	.00004	.01702	.0396	.0295
Level of significance (t) for (b_1)	4.14295	13.23787	..	..
Regression coefficient (b_2)	.00001	1.09459	..	..
Standard deviation of (b_2)	.00324	.13440	..	..
Level of significance (t) for (b_2)	.00557	8.14380	..	..
Regression coefficient (b_3)	.00257	..	..	..
Standard deviation of (b_3)	.00035	..	..	..
Level of significance (t) for (b_3)	7.32881	..	..	..

TABLE 33 Continued

	Equations			
Related Statistics	A	B	C	D
Regression coefficient (b_4)	-.22636	..	..	..
Standard deviation of (b_4)	.06445	..	..	..
Level of significance (t) for (b_4)	-3.51178	..	..	..
Regression coefficient (b_5)	-.04740	..	..	..
Standard deviation of (b_5)	.60062	..	..	..
Level of significance (t) for (b_5)	-.07892	..	..	..

Variable 4 - Fuel Expense

Standard error of the equation	612.90	617.39	641.46	13.65
Correlation coefficient (R)	.48065	.45800	.4043	.8405
Level of significance (F)	14.06033	31.45685	..	..
Coefficient of determination (R^2)	.23102	.20977	.16346	.7064
Constant (a)	-.01304	-80.9402	310.350[illegible]	54.500
Regression coefficient (b_1)	-.00081	.78413	.8198	.4539
Standard deviation of (b_1)	.00036	.11822	.3009	.1165

TABLE 33 Continued

	Equations			
Related Statistics	A	B	C	D
Level of significance (t) for (b_1)	-2.23085	6.63229	..	..
Regression coefficient (b_2)	-.00149	4.06075	..	..
Standard deviation of (b_2)	.02537	.93341	..	..
Level of significance (t) for (b_2)	-.05898	4.35044	..	..
Regression coefficient (b_3)	.00335	..	..	..
Standard deviation of (b_3)	.00274	..	..	..
Level of significance (t) for (b_3)	1.21955	..	..	..
Regression coefficient (b_4)	1.44356	..	..	..
Standard deviation of (b_4)	.50403	..	..	..
Level of significance (t) for (b_4)	2.86402	..	..	..
Regression coefficient (b_5)	2.84084	..	..	..
Standard deviation of (b_5)	4.69659	..	..	..
Level of significance (t) for (b_5)	.60487	..	..	..

TABLE 33 Continued

Variable 5 - Hired Labor Expense				
	Equations			
Related Statistics	A	B	C	D
Standard error of the equation	947.80	940.13	936.92	17.15
Correlation coefficient (R)	.66637	.66495	.6572	.4418
Level of significance (F)	23.96240	60.63703	..	..
Coefficient of determination (R^2)	.44405	.44216	.43191	.1952
Constant (a)	-.00287	-78.6697	496.710	81.000
Regression coefficient (b_1)	.00039	2.30258	2.2582	.1805
Standard deviation of (b_1)	.00067	.21714	.5286	.1765
Level of significance (t) for (b_1)	.58885	10.60384	..	..
Regression coefficient (b_2)	.00628	5.44438	..	..
Standard deviation of (b_2)	.04867	1.76306	..	..
Level of significance (t) for (b_2)	.12920	3.08802	..	..
Regression coefficient (b_3)	-.00195	..	..	..
Standard deviation of (b_3)	.00512	..	..	..
Level of significance (t) for (b_3)	-.38101	..	..	..

TABLE 33 Continued

	Equations			
Related Statistics	A	B	C	D
Regression coefficient (b_4)	1.98490	..	..	..
Standard deviation of (b_4)	.97127	..	..	..
Level of significance (t) for (b_4)	2.04360	..	..	..
Regression coefficient (b_5)	5.28743	..	..	..
Standard deviation of (b_5)	9.05112	..	..	..
Level of significance (t) for (b_5)	.58417	..	..	..
Variable 6 - Buying Cattle Expense				
Standard error of the equation	854.90	869.31	887.97	18.95
Correlation coefficient (R)	.52169	.48682	.4966	.8345
Level of significance (F)	16.15380	34.01214	..	..
Coefficient of determination (R^2)	.27216	.23699	.24661	.6956
Constant (a)	-.01633	-512.7368	-118.420	36.500
Regression coefficient (b_1)	-.00056	1.30253	1.4693	.6157
Standard deviation of (b_1)	.00052	.17351	.4341	.1640

TABLE 33 Continued

	Equations			
Related Statistics	A	B	C	D
Level of significance (t) for (b_1)	-1.08445	7.50683	..	..
Regression coefficient (b_2)	-.00322	4.66852	..	..
Standard deviation of (b_2)	.03680	1.36651	..	..
Level of significance (t) for (b_2	-.08774	3.41637	..	..
Regression coefficient (b_3)	.01215	..	..	..
Standard deviation of (b_3)	.00399	..	..	..
Level of significance (t) for (b_3)	3.04163	..	..	..
Regression coefficient (b_4)	.92194	..	..	..
Standard deviation of (b_4)	.74039	..	..	..
Level of significance (t) for (b_4)	1.24522	..	..	..
Regression coefficient (b_5)	-.46831	..	..	..
Standard deviation of (b_5)	6.84121	..	..	..
Level of significance (t) for (b_5)	-.06845	..	..	..

TABLE 33 Continued

Variable 7 - Selling Cattle Expense				
	Equations			
Related Statistics	A	B	C	D
Standard error of the equation	1439.30	1460.40	1279.22	5.65
Correlation coefficient (R)	.51503	.48309	.4658	.9926
Level of significance (F)	16.02985	34.24859	..	..
Coefficient of determination (R^2)	.26526	.23338	.17733	.9853
Constant (a)	-.01368	-817.8892	208.673	2.000
Regression coefficient (b_1)	-.00059	1.77390	1.9592	.9798
Standard deviation of (b_1)	.00089	.28914	.6204	.0490
Level of significance (t) for (b_1)	-.66580	6.13490	..	..
Regression coefficient (b_2)	.00002	12.58436	..	..
Standard deviation of (b_2)	.06114	2.26533	..	..
Level of significance (t) for (b_2)	.00037	5.55519	..	..
Regression coefficient (b_3)	.02023	..	..	..
Standard deviation of (b_3)	.00667	..	..	..
Level of significance (t) for (b_3)	.71812	..	..	..

TABLE 33 Continued

	Equations			
Related Statistics	A	B	C	D
Regression coefficient (b_4)	1.25479	..	..	..
Standard deviation of (b_4)	3.03142	..	..	..
Level of significance (t) for (b_4)	3.24090	..	..	..
Regression coefficient (b_5)	11.35644	..	..	..
Standard deviation of (b_5)	.57230	..	..	..
Level of significance (t) for (b_5)	.28538	..	..	..
Variable 8 - Hired Trucking Expense — Cattle				
Standard error of the equation	2901.70	3125.04	2951.94	1.23
Correlation coefficient (R)	.64170	.55474	.5867	.9997
Level of significance (F)	28.56301	46.00982	..	..
Coefficient of determination (R^2)	.41179	.30773	.34141	.9994
Constant (a)	.14634	-2400.3270	-675.901	.025
Regression coefficient (b_1)	.00731	5.28929	6.1402	.9972
Standard deviation of (b_1)	.00186	.61630	1.14124	.0110

TABLE 33 Continued

	Equations			
Related Statistics	A	B	C	D
Level of significance (t) for (b_1)	3.92421	8.58233	..	..
Regression coefficient (b_2)	-.02412	21.64395	..	..
Standard deviation of (b_2)	.12843	5.05082	..	..
Level of significance (t) for (b_2)	-.18784	4.28522	..	..
Regression coefficient (b_3)	.06091	..	..	..
Standard deviation of (b_3)	.01340	..	..	..
Level of significance (t) for (b_3)	4.54447	..	..	..
Regression coefficient (b_4)	-8.78638	..	..	..
Standard deviation of (b_4)	2.58265	..	..	..
Level of significance (t) for (b_4)	-3.40207	..	..	..
Regression coefficient (b_5)	-1.94401	..	..	..
Standard deviation of (b_5)	23.76210	..	..	..
Level of significance (t) for (b_5)	-.08181	..	..	..

TABLE 33 Continued

Variable 9 - Death Loss Expense				
	Equations			
Related Statistics	A	B	C	D
Standard error of the equation	939.80	967.67	953.00	21.45
Correlation coefficient (R)	.67579	.64375	.6637	.6627
Level of significance (F)	30.26156	64.75484	..	..
Coefficient of determination (R^2)	.45669	.41441	.44050	.4392
Constant (a)	.03537	-635.6197	-97.310	60.500
Regression coefficient (b_1)	.00115	2.19308	2.3559	.4066
Standard deviation of (b_1)	.00064	.20438	.4931	.1920
Level of significance (t) for (b_1)	1.78867	10.72994	..	..
Regression coefficient (b_2)	.00528	6.30137	..	..
Standard deviation of (b_2)	.04420	1.66182	..	..
Level of significance (t) for (b_2)	.11958	3.79183	..	..
Regression coefficient (b_3)	.01527	..	..	..
Standard deviation of (b_3)	.00464	..	..	..
Level of significance (t) for (b_3)	3.28543	..	..	..

TABLE 33 Continued

	Equations			
Related Statistics	A	B	C	D
Regression coefficient (b_4)	-.56370	..	..	..
Standard deviation of (b_4)	-.91398	..	..	..
Level of significance (t) for (b_4)	2.86402	..	..	..
Regression coefficient (b_5)	2.84084	..	..	..
Standard deviation of (b_5)	4.69659	..	..	..
Level of significance (t) for (b_5)	.60487	..	..	..

ECONOMIES OF SCALE IN FARMER OPERATED CATTLE FEEDLOTS, KANSAS

by

HENRY D. WAKEFIELD

B. S., Kansas State University, 1962

AN ABSTRACT OF A MASTER'S REPORT

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The lack of cost information on farmer operated cattle feedlots in Kansas prompted this study. A desire for information of this type was expressed through Kansas State University farm management specialists, economists, and Kansas farmers. The study was thus designed to help aid in future studies, feedlot expansions and commencement of new feedlots. This phase of the study was limited to nonfeed costs.

A sample was drawn from members of the Kansas Farm Management Association who were known to feed cattle. This sample was stratified into five different size groups. A simple average of each group gave the five hypothetical models used in this study, i.e., 40, 115, 225, 450 and 925 head, respectively. Feedlot operators were contacted and personally interviewed. The survey attempted to find, among other things; capital investments of each feedlot, fixed and variable costs incurred by operators, "normal" capacity of the lot, number of head fed in 1961, and some of the operators personal background in cattle feeding. Statistical analyses were applied to the answers where practical and standards derived from which to proceed. Secondary sources of information were obtained and correlated to this set of derived standards (budget approach). The standards and ensuing cost data were applied to the five hypothetical models. Inferences were then made from each model as they applied to the population, i.e., each model was assumed representative for one of five size groups of Kansas farmer operated cattle feedlots. For each model, average total nonfeed costs per head were calculated for feedlots operated between 25 and 150 per cent of "normal" capacity. These short-run plant cost curves were then used to develop a long-run planning or economies of scale curve for farmer feedlot operations in Kansas.

A summary of total nonfeed costs indicated that per head nonfeed costs decline as a feedlot increases plant utilization. For example, a 115 head feedlot operated at 50 per cent of 'normal' capacity has daily total nonfeed costs per head of $.428 compared to $.219 per head for the same feedlot operating at 125 per cent of 'normal' capacity. Statistical data reveal that larger feedlots are justified by the economies of scale of feedlot operations. Analysis of total nonfeed cost data for feedlots operating at 100 per cent of plant utilization disclosed daily total nonfeed costs per head ranging from $.448 for 40 head to $.203 for 925 head. From the proceeding two conclusions, evidence was presented in this study indicating that, feedlots can continue to achieve costs advantages as they progress from 25 to 150 per cent of plant utilization. However, costs advantages are reduced to small decreases in daily nonfeed costs per head as plant utilization exceeds 100 per cent. For example, a 225 head feedlot has daily nonfeed costs per head of $.637, $.359, $.269, $.224, $.197 and $.179 as it operates from 25 to 150 per cent of plant utilization, respectively.

Large standard errors relative to the means and relatively small coefficients of determination computed for those equations used in the analyses indicate that; costs concluded in this study may deviate considerably from the actual mean daily total nonfeed costs per head of Kansas farmer operated cattle feedlots. Statistical implication concludes that a larger sample size may have produced answers with less variance.