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A Structural Analysis of the Beef Slaughtering Industry in South Dakota

Haven L. Stuck

A STRUCTURAL ANALYSIS OF THE BEEF SLAUGHTERING INDUSTRY IN SOUTH DAKOTA

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HAVEN L. STUCK

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A STRUCTURAL ANALYSIS

OF THE BEEF SLAUGHTERING INDUSTRY

IN SOUTH DAKOTA

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

Thesis Advisor / Date

Thesis Advisor Date

Head, Economics Department Date

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CHAPTER I

INTRODUCTION

The beef industry in South Dakota and in the United States has experienced considerable growth during the past decade. The demand for beef has also increased rapidly during this period. Per capita consumption of beef increased from 87.8 pounds in 1961 to 113.3 pounds in 1971.[1/] Consumers have shown a greater preference for beef as their disposable incomes have gone up. The increase in per capita consumption together with the increase in population has led to a greatly expanded cattle industry.

The sale of cattle and calves accounted for 52.2 percent of the cash farm income in South Dakota in 1970. This figure has shown a marked increase from the 1958-62 average of 43.6 percent.[2/] The income potential of the beef industry in South Dakota is considerably greater than that received at present. Statistics indicate that only about one-half of the calves produced in the state are being fed in South Dakota.[3/] This is true in spite of the fact that South Dakota

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1/ South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture, 1961, p. 67, and South Dakota Agriculture, 1971, p. 48, Sioux Falls, South Dakota.

2/ South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture, 1961, p. 76, South Dakota Agriculture, 1963, p. 47, and South Dakota Agriculture, 1971, p. 55, Sioux Falls, South Dakota.

3/ South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture, 1971, Sioux Falls, South Dakota, pp. 39, 47.

has a surplus of feed grains. In addition, it is estimated that less than sixty percent of the cattle available for slaughter are actually slaughtered in the state.

The structure of the meat packing industry has also changed significantly during the last two decades. The industry has become more decentralized with the shift from plants located near major consumption areas to plants operating near major production areas. This has been due primarily to changes in transportation technology which have reduced the costs of transporting meat relative to live animals. Also, improved refrigeration equipment and interstate highways have facilitated more rapid transportation and receipt of a higher quality product. The new production oriented plants tend to be smaller and more specialized than the old plants and make use of recent technological developments to facilitate efficient operation.

PURPOSE OF STUDY

The income received from the production of beef, South Dakota's most important product, could be greatly expanded by an increase in cattle slaughter. The main objective of this study is to analyze the beef packing industry in the state in an attempt to determine the optimum number, location and size of specialized beef slaughter plants in South Dakota.

Recent structural changes in the meat packing industry should be beneficial to the meat packing industry in South Dakota. It is hoped that this study will provide useful information to industry personnel

for making investment decisions. This information could also be used by area development groups to determine the relative competitive position of their area as a potential site for a beef packing plant. This study has in addition the following associated objectives:

1. Review trends and recent developments in the beef production and slaughter industries and their implications for South Dakota.

2. Estimate operating costs for selected sizes of beef slaughter plants in South Dakota.

3. Estimate optimum patterns of shipment of live cattle to packing plants and meat to demand centers.

SCOPE OF STUDY AND METHODOLOGY

This study divides the state into eleven potential beef supply areas and considers eight demand centers located throughout the United States. The beef industry in South Dakota is analyzed with respect to production patterns, slaughter numbers and marketing patterns. Trends in the beef slaughter industry are reviewed and implications are made as to their application to the situation in South Dakota. Estimates of operating costs are made for different sized plants in the state, and transportation costs are synthesized for assembling the cattle at the potential plants and transporting the meat to the demand centers. A simplex transportation model was used to simulate the optimum location and size of potential packing plants. The model considers the presence of economies of scale in plant operations and various assembly and distribution costs associated with different transportation distances.

REVIEW OF LITERATURE

Samuel H. Logan and Gordon A. King[4/] studied the economies of scale in cattle slaughtering operations for California plants. Costs were synthesized for the then conventional bed type plants and for five on-the-rail plants with rated capacities of 20, 40, 60, 75 and 120 head per hour. The plants were designed to slaughter only cattle. They sold the hides green and did not perform rendering, sausage making, boning or breaking operations.

An article by Logan[5/] presents an analysis of the effects of weekly variations in the supplies of slaughter cattle on the costs of operating beef packing plants in California. It is pointed out that the nature of the supply flow of live animals is an important consideration in the location and construction of a slaughter plant.

King and Logan[6/] use a transshipment model of linear programming to consider simultaneously the costs of shipping raw materials, processing, and shipping the final product. The location and quantity

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[4/] Samuel H. Logan and Gordon A. King, "Economies of Scale in Beef Slaughter Plants," Giannini Foundation Res. Rep. No. 260, Berkeley: California Agricultural Experiment Station, 1962.

[5/] Samuel H. Logan, "The Effects of Short-run Variations in Supplies of Cattle and Costs of Slaughtering in California," Journal of Farm Economics, August 1963, Vol. 45, pp. 625-630.

[6/] Gordon A. King and Samuel H. Logan, "Optimum Location, Number and Size of Processing Plants with Raw Product and Final Product Shipments," Journal of Farm Economics, February 1964, Vol. 46, pp. 94-108.

of slaughter animals and the final product demand are taken as given. Within the framework stated, the questions which are answered are: (1) Where should processing plants be located?, and (2) What should be the optimum number and size of plants needed to move the animals through slaughter plants and to consumers at the least aggregate cost? An iterative procedure is used to incorporate economies of scale in processing in addition to transportation costs to obtain a minimum cost solution. The solution indicated an optimum of 12 plants for California in the original 32 supply and demand regions. This demonstrates the importance of assembly and distribution costs as well as economies of scale in processing in determining the optimum size of plant.

In a publication Logan[7/] reviewed the importance of economies of scale in cattle slaughtering operations. The original Logan and King costs estimates were revised using 1965 costs that were relevant for Omaha, Nebraska. As in the original study, economies of scale were found to exist throughout the range of plant sizes considered, which varied from 20 to 120 head per hour.

7/ Samuel H. Logan, "Economies of Scale in Cattle Slaughtering Plants" (National Commission on Food Marketing, Supplement No. 2 to Technical Study No. 1, "Organization and Competition in the Livestock and Meat Industry") June, 1966.

An article by Ben C. French[8/] examines some considerations in estimating assembly cost functions for agricultural processing operations. It is noted that procurement costs increase with plant volume and must be considered along with internal plant costs and distribution costs in evaluating the efficiency of alternative plant sizes and locations. Consideration is given to the general relation between assembly cost and plant volumes.

John F. Stollsteimer[9/] studied the problem of simultaneously determining the number, size and location of plants that minimize the combined transportation and processing costs involved in assembling and processing any given quantity of raw material produced in varying amounts at scattered production points. The procedure used is an extension of the basic linear programming transportation model with the exception that the Stollsteimer model includes plant numbers and locations as variables and reflects economies of scale in plant costs.

Franzmann and Kuntz[10/] made a study of economies of scale in slaughtering operations for Southwestern cattle slaughtering plants.

8/ Ben C. French, "Some Considerations in Estimating Assembly Cost Functions for Agricultural Processing Operations," Journal of Farm Economics, November 1960, Vol. 42, pp. 767-778.

9/ John F. Stollsteimer, "A Working Model for Plant Numbers and Locations," Journal of Farm Economics, August 1963, Vol. 45, pp. 631-645.

10/ John R. Franzmann and B. T. Kuntz, "Economies of Size in Southwestern Beef Slaughter Plants," Department of Agricultural Economics, Oklahoma State University, Bulletin B-648, April 1966.

They synthesized long-run average costs for plants using on-the-rail slaughtering systems with designed kill capacities of 20, 40, 60, 75, 90 and 120 head per hour. Diseconomies of scale were found to exist in labor and utility costs.

David L. Langemeier[11/] studied the optimum number, size and location of beef slaughtering plants in Eastern Nebraska. Costs and requirements were obtained from Logan and King, and Franzmann and Kuntz. Economies of scale were evident over the entire range of plant sizes with average costs per head declining from $10.90 for a plant with an output of 20 head per hour to $8.72 for a plant slaughtering 120 head per hour. Average costs per head decreased at a slower rate when plants increased from 75 to 120 head per hour than when plants increased from 20 to 60 head per hour.

Cox and Taylor[12/] analyzed the factors that should be considered by those who are advocating the establishment or expansion of slaughtering plants. They studied the feasibility of expanding existing slaughtering plants and organizing new ones in the state of North Dakota. Labor and capital requirements were estimated for various sizes of plants.

11/ David L. Langemeier, "The Optimum Number, Size and Location of Beef Slaughtering Plants in Eastern Nebraska" (Unpublished Master's Thesis, University of Nebraska, 1965).

12/ Rex W. Cox and Fred R. Taylor, "Feasibility of Cooperatively Owned Slaughtering Plants," Department of Agricultural Economics, North Dakota State University, Agricultural Economics Report No. 39, Fargo, January 1965.

John M. Huie[13/] studied the number, size and location of beef slaughter plants in Michigan. A main objective was to estimate the number, size and location of plants which would minimize the total cost of cattle assembly, in-plant processing, and meat distribution for projected 1980 cattle production and beef consumption. Average total cost per head from this study ranged from $11.34 in the 20 head per hour plant down to $8.85 per head for the 120 head per hour plant.

13/ John M. Huie, "Number, Size and Location of Beef Slaughter Plants in Michigan," Department of Agricultural Economics, Michigan State University, Agricultural Economics Report No. 161, East Lansing, April 1970.

CHAPTER II

THE BEEF PACKING INDUSTRY

Commercial cattle slaughter in the United States has nearly doubled since 1950, increasing from 18.6 million head in that year to 35.9 million head in 1971.[14/] South Dakota's share of commercial cattle slaughter increased from 1.2 percent in 1950 to 1.7 percent in 1960 and 1.9 percent in 1970. Slaughter in the state dropped 24 percent in 1971 primarily because of an employee strike. This reduced South Dakota's share of the nation's commercial beef slaughter to 1.2 percent. Figure 8 shows the increase in beef slaughter in South Dakota during the past twenty years in relation to slaughter growth for the nation. Cattle slaughter in the state reached an all time high in 1967 when 729,500 head were slaughtered.[15/] During the next three years the state experienced small decreases before the large drop in 1971.

[14/] South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture, 1956, p. 69, and South Dakota Agriculture, 1971, p. 46, Sioux Falls, South Dakota.

[15/] South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture, 1971, Sioux Falls, South Dakota, p. 46.

LOCATIONAL CHANGES IN THE MEAT PACKING INDUSTRY

Livestock slaughter has had three distinct centers in this country. The industry began in the populated areas of the East and then moved to the large terminal markets, located mainly in the Midwest. In recent years the industry has shifted to the fed beef production areas. New and improved technology together with a need to increase efficiency caused these location changes. Refrigerated railroad cars and trucks made it possible to ship meat long distances to the demand centers. Transportation rate changes have made it more economical to ship carcasses and cuts of beef than live animals.

National trends in commercial cattle slaughter show a movement toward the major cattle producing areas. As a result of this trend state and regional slaughter volumes are likely to be dependent on local production of cattle for slaughter. South Dakota experienced a decline in the numbers of cattle on feed from 1969-1971 which would explain in part the decline in slaughter volume during these same years.

The numbers of cattle slaughtered in various regions of the country show a large difference in regional slaughter growth. These changes reflect the decentralization of beef slaughtering toward the production areas. Regional growth in cattle slaughter coincides with regional increases in cattle feeding. Table 1 shows the number and percentage of total cattle slaughtered by region for selected years. Growth in cattle slaughter since 1960 has been the greatest in the Northern Plains, High Plains, and in Colorado and Arizona.

Table 1. Number and Percentage of Total Cattle Slaughtered by Region and Selected States, 1950, 1960 and 1971 and Percentage Change, 1950-1971 and 1960-1971.

Region[1/]	Number Slaughtered			As Percentage of Total			Percentage Change	
	1950	1960	1971	1950	1960	1971	1950-1971	1960-1971
	----thousand head---			-------percent-------			-------percent---------	
Northeast	1860	2072	1578	10	8	4	- 15	- 24
Lake States	2404	3120	3443	13	12	10	+ 43	+ 10
Corn Belt	5350	6884	8335	30	27	23	+ 56	+ 21
Southeastern	1683	2557	2688	9	10	8	+ 60	+ 5
Northern Plains	2498	3739	7475	14	15	21	+199	+100
High Plains	1284	1902	4527	7	8	13	+253	+138
Mountain	192	363	518	1	1	1	+170	+ 43
Colorado	490	1046	2311	3	4	6	+372	+121
Arizona	75	161	521	1	1	1	+595	+224
Pacific Northwest	583	905	1336	3	4	4	+129	+ 48
California	1482	2476	2654	8	10	8	+ 93	+ 15
48 States	17901	25225	35585	100	100	100	+ 99	+ 41

Source: "Livestock and Meat Statistics," USDA, Statistical Reporting Service, 1950 and 1960; "Livestock Slaughter," USDA, Statistical Reporting Service, 1971.

1/ States included in regions are as follows: Northeast - New England, N.Y., N.J., Pa., Del., Md.; Lake States - Mich., Wis., Minn.; Corn Belt - Ohio, Ind., Ill., Ia., Mo.; Southeastern - Va., W. Va., N.C., S.C., Ga., Fla., Ky., Tenn., Ala., Miss., Ark., La.; Northern Plains - N.D., S.D., Neb., Kan.; High Plains - Tex., Okla., N.M.; Mountain - Mont., Wyo., Utah, Nev.; Pacific Northwest - Wash., Ore., Ida.

NUMBER OF SLAUGHTER PLANTS

The number of commercial slaughtering plants has been declining rapidly during the past few years. In spite of this decline in total plant numbers, the number of federally inspected plants has shown a sharp increase (Table 2). The proportion of cattle slaughtered under federal inspection has risen to 88 percent of the nation's commercial cattle slaughter.[16/] The Wholesome Meat Act of 1968, which covers a wide variety of other items, requires that virtually all meat entering commercial trade channels be inspected. A federal-state cooperative arrangement was provided for by the Act under which states could obtain financial assistance as well as technical assistance to improve their programs. States were required to have inspection programs in operation by the end of 1969 that were at least equivalent to the federal program or else the federal government would assume the inspection responsibility for all of that state's plants. Under this law all slaughtering operations must meet requirements that are at least equal to federal inspection requirements. Thus, many large non-federally inspected plants were prompted to seek federal inspection. A large number of small firms have discontinued operation rather than incur the expense of meeting the more stringent inspection requirements.

As of March 1, 1972 there were 121 licensed slaughter plants in South Dakota.[17/] Eight of these plants were federally inspected,

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16/ Ibid.

17/ United States Department of Agriculture, Statistical Reporting Service, Livestock Slaughter 1971, Washington, D. C., p. 35.

Table 2. Number of Federally and Non-federally Inspected Livestock Slaughtering Plants and Percentage Change by Regions and Selected States, 1967 and 1972.

Region[1/]	Federally Inspected			Non-federally Inspected		
	1967	1972	Change 67-72	1967	1972	Change 67-72
	number	number	percent	number	number	percent
Northeast	88	100	+ 14	1566	674	- 57
Lake States	41	102	+149	1065	638	- 40
Corn Belt	132	166	+ 26	2192	1321	- 40
Southeastern	72	151	+110	1794	1141	- 36
Northern Plains	65	181	+178	783	456	- 42
High Plains	56	104	+ 86	1086	595	- 45
Mountain	14	38	+171	161	95	- 41
Colorado	19	23	+ 21	86	61	- 29
Arizona	1	5	+400	41	26	- 37
Pacific Northwest	33	45	+ 36	188	130	- 31
California	63	68	+ 8	43	14	- 67
48 States	584	983	+ 68	9005	5151	- 43

Source: Livestock Slaughter, USDA, Statistical Reporting Service, 1971, p. 35, and 1968, p. 35.

1/ States included in regions listed in previous table.

including six plants which slaughtered cattle. These six plants slaughtered an estimated 86 percent of the total commercial beef slaughter in the state. The majority of the 113 plants under state inspection had a volume of less than 300,000 pounds of live weight annually. Many of these plants are local operations specializing in custom slaughtering or slaughtering for a local retail grocery. The number of federally inspected slaughter plants in the state has been relatively constant in recent years totalling either eight or nine plants as of March 1 in the years 1967 through 1972. The number of state inspected plants averaged 149 for the years 1967 through 1970. The total dropped sharply to 113 in 1971 and held constant in 1972.[18/]

CONCENTRATION AND SPECIALIZATION IN MEAT PACKING

The large national meat packers have lost a significant share of the market since 1920. The regional packers showed large gains during the first part of this period but are now losing part of their share to a growing number of relatively small firms. Much of the recent increase in slaughter has been taken by these relatively small firms. Concentration of federally inspected and total commercial slaughter in the hands of the largest firms has decreased sharply in the past twenty years.

Horizontal specialization or the degree to which plants specialize in the slaughtering of a single specie of livestock, has been

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18/ United States Department of Agriculture, Statistical Reporting Service, Livestock Slaughter 1968, p. 35, and Livestock Slaughter 1971, p. 35, Washington, D. C.

increasing in most regions of the nation. Federally inspected slaughter plants which slaughter only one specie have increased from 16 percent in 1950 to 34 percent in 1962 and 52 percent in 1969. Federally inspected plants slaughtering only cattle and calves numbered 268 out of 725 total plants in 1969 or 37 percent.[19] Four of the six federally inspected plants in South Dakota that slaughter cattle do not slaughter any other specie.

Additional reasons which have been given for the decentralization and increased specialization in the meat packing industry include: (1) less reliance on rail transportation; (2) wide use of federal grade standards which has permitted new firms to compete with older, established firms; and (3) local development groups have attracted industry by offering special concessions.

WAGES IN THE MEAT PACKING INDUSTRY

Wages paid by meat packers vary somewhat across the country. In January 1969 the Bureau of Labor Statistics compiled an industry wage survey for the meat products industry.[20] Table 3 gives hourly earnings for the United States and the Middle West Region with regard to six characteristics. Figures for the Middle West Region are considerably above the national average and in a few cases are higher than any other region. These wage figures would seem to indicate a

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[19] United States Department of Agriculture, Statistical Reporting Service, Number of Livestock Slaughter Plants, March 1, 1970, Washington, D. C., pp. 1-2.

[20] United States Department of Labor, Bureau of Labor Statistics, "Industry Wage Survey--Meat Products," Washington, D. C., 1970.

Table 3. Average Hourly Earnings in the Meat Packing Industry by Selected Characteristics, 1969.

Item	United States		Middle West	
	Number of Workers	Average hourly Earnings	Number of Workers	Average hourly Earnings
All production workers	128,645	$3.30	48,446	$3.76
Men	113,061	3.34	43,023	3.76
Women	15,584	2.96	5,423	3.69
Type of company				
Multi-plant	76,181	3.59	40,485	3.83
Single-plant	52,464	2.86	7,961	3.11
Federal inspection status				
Federally inspected	111,649	3.45	47,468	3.79
Not federally inspected	16,996	2.29	-	-
Size of community				
Metropolitan areas	93,634	3.39	33,806	3.73
Nonmetropolitan areas	35,011	3.05	14,640	3.82
Size of establishment				
20-499 workers	67,291	2.89	12,122	3.17
500 workers or more	61,354	3.74	36,324	3.95
Labor-management contracts				
Establishments with —				
Majority of workers covered	108,159	3.51	44,760	3.83
Minority of workers covered	20,486	2.17	3,686	2.84

Source: United States Department of Labor, Bureau of Labor Statistics, "Industry Wage Survey - Meat Products, January 1969," p. 8.

Note: Dashes indicate no data reported or data that do not meet publication criteria.

disadvantage in locating slaughtering plants in the Middle West. This wage disadvantage, however, is offset by other factors, such as transportation economies, which are influencing the locational changes that are taking place.

CHAPTER III

THE SOUTH DAKOTA BEEF INDUSTRY

Receipts from the sale of cattle and calves in the U. S. in 1971 totaled nearly 15 billion dollars, up nine percent from a year earlier.[21] Cattle and calf sales constitute more than half of the total cash receipts from farm marketings in South Dakota. Crop and livestock sales from farms totaled $1.04 billion in 1970 of which $.53 billion was cattle and calf sales.[22]

The total live weight production of meat animals in the United States set a record high in 1971. Cattle and calf production was a record 40.6 billion pounds, a three percent increase over 1970. South Dakota ranked sixth among the states in the number of beef cows and 11th in the number of cattle on feed as of January 1, 1972.[23] The beef cow herd in the state has been growing steadily during the past decade reaching 1,829,000 head on January 1, 1972.[24] South Dakota's

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[21] United States Department of Agriculture, Statistical Reporting Service, Meat Animals 1970-1971, Washington, D. C., p. 3.

[22] South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture 1971, Sioux Falls, South Dakota, p. 55.

[23] Ibid., p. 38.

[24] Ibid.

production of cattle and calves was 1.81 billion pounds in 1971 as compared with 1.77 billion pounds a year earlier.[25/]

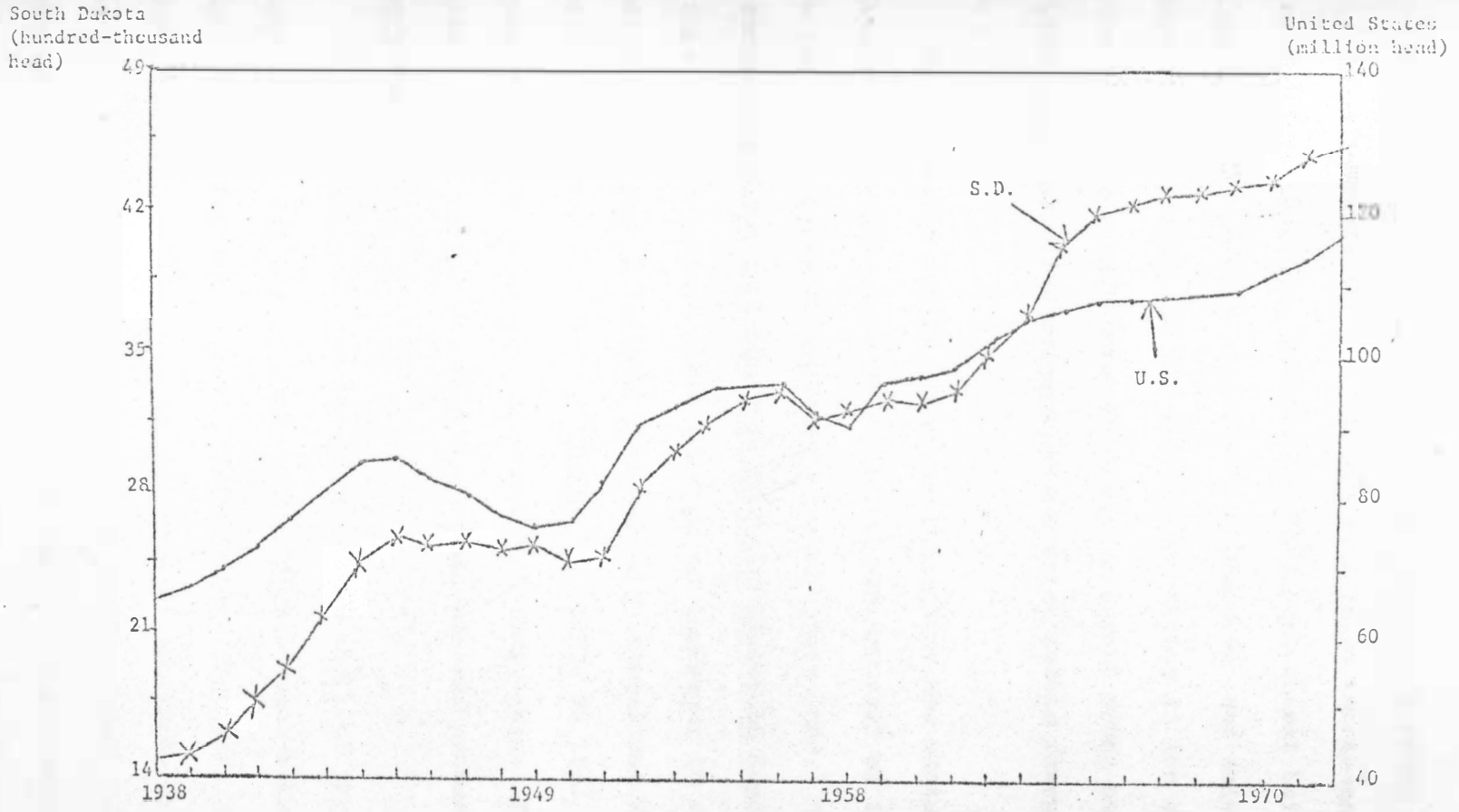
CATTLE INVENTORIES

Cattle numbers on farms move in cycles as demonstrated in Figure 1 which shows cattle numbers for the United States and South Dakota from 1938-1972. This period contains three complete cycles and a fourth beginning in 1969. The third cycle beginning in 1958 and ending in 1969 was unusual as it did not show a decline toward the end of the cycle. This may be attributed to the large increase in the demand for beef during the late 1960's. The complete cycles shown in Figure 1 lasted 11, 9, and 11 years, respectively. The downswings in the cycles have become shorter, and in the last cycle the downswing was virtually nonexistent.

Figure 1 also illustrates the growth in cattle inventories in South Dakota and in the United States since 1933. During this period cattle numbers have fluctuated but have maintained a general upward trend. The rate of growth has been greater for South Dakota than for the United States. In 1938 South Dakota accounted for about 2.3 percent of the nation's cattle inventory. This figure rose to 3.9 percent on January 1, 1972.

[25/] USDA, op. cit., pp. 5-7.

Figure 1. All Cattle on Farms in South Dakota and in the United States, 1938-1972.



Source: South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture 1971, and earlier issues.

The composition of South Dakota's cattle inventory in 1970 and 1972 is shown in Table 4. The figures show large increases in beef cows and heifers that have calved, and beef replacement heifers. These categories represent potential producers of beef animals and are important indicators of future beef production in the state. Milk cow inventories have been declining in recent years and now constitute less than five percent of the total cattle inventory in the state.

Beef cows are widely dispersed throughout the state. The population is generally more dense in the eastern half of the state due to the higher carrying capacity of the pasture land. All cattle inventories are shown in Table 5 by Crop and Livestock Reporting Districts. All areas have shown substantial increases in cattle numbers over the past 10 years. But the East Central and Southeast Districts, which had the largest numbers of cattle in 1967, showed virtually no growth in numbers over the past five years. This would indicate a change in the relative importance of beef producing areas in South Dakota.

Cattle numbers should be considered in light of the phase of the cattle cycle. Cycles in South Dakota cattle numbers have been similar to those for the nation. State numbers, however, have shown greater relative increases during the cyclical uptrends, particularly toward the end of the uptrend. This would indicate that South Dakota may see substantial increases in cattle numbers in the next three to five years as the nation is in the third year of a cyclical uptrend.

Table 4. Composition of South Dakota's Cattle and Calf Inventory, January 1, 1970 and 1972.

	1970		1972		1972 as a percent of 1970
	No. of head (thousand)	Percent of total	No. of head (thousand)	Percent of total	
Milk cows and heifers that have calved	186	4.2	174	3.8	93.5
Milk cow replacement heifers 500 lbs.+	49	1.1	45	1.0	91.8
Beef cows and heifers that have calved	1685	38.2	1829	40.3	108.5
Beef cow replacement heifers 500 lbs.+	238	5.4	291	6.4	122.3
Other heifers and steers 500 lbs.+	665	15.1	559	12.3	84.1
Bulls 500 lbs.+	95	2.2	100	2.2	105.3
Steers, heifers and bulls under 500 lbs.	1492	33.8	1545	34.0	103.6
Total all cattle	4410	100.0	4543	100.0	103.0

Source: South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture 1971, p. 39.

Table 5. All Cattle Inventories by Crop and Livestock Reporting Districts for Selected Years.

District	Number of Head 1962	1967	1972	Percent Change 1962-72	Percent Change 1967-72
	------thousand------				
1. Northwest	282	376	375	+33	0
2. North Central	412	570	631	+53	+11
3. Northeast	377	490	507	+34	+ 3
4. West Central	276	349	371	+34	+ 6
5. Central	479	596	661	+38	+11
6. East Central	550	679	686	+25	+ 1
7. Southwest	162	196	228	+41	+16
8. South Central	415	441	464	+12	+ 5
9. Southeast	540	626	620	+15	- 1
State	3493	4323	4543	+30	+ 5

Source: South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture 1966, p. 69, 1967, p. 41, and 1971, p. 40.

CATTLE FEEDING

South Dakota ranked 11th among the states in cattle on feed as of January 1, 1972. Cattle feeding has not increased as fast in the state as it has for the nation as a whole, especially during the past four years. Cattle feeding and fed cattle marketed reached peaks in 1968 with 406,000 head on feed January 1, 1968 and 656,000 head of fed cattle marketed during that year.[26/] The decline in cattle feeding since 1968 was reversed in 1971. Figure 2 shows cattle and calves on feed in South Dakota and the United States from 1953 to 1972.

Calves in the western range area are for the most part shipped out-of-state or to the eastern part of the state to be fed. The Southeastern and East Central areas of the state have traditionally been the major cattle feeding areas in South Dakota. In recent years, however, these areas have experienced a decrease in numbers of cattle on feed. Cattle feeding has increased in the Northeast, North Central, Central and Southwest Districts.

Cattle feeding in some of the leading states has followed a trend toward larger feedlots. The large feedlots are producing a larger percentage of the fed cattle marketed. South Dakota has not as yet followed this trend to any great degree, although some increase

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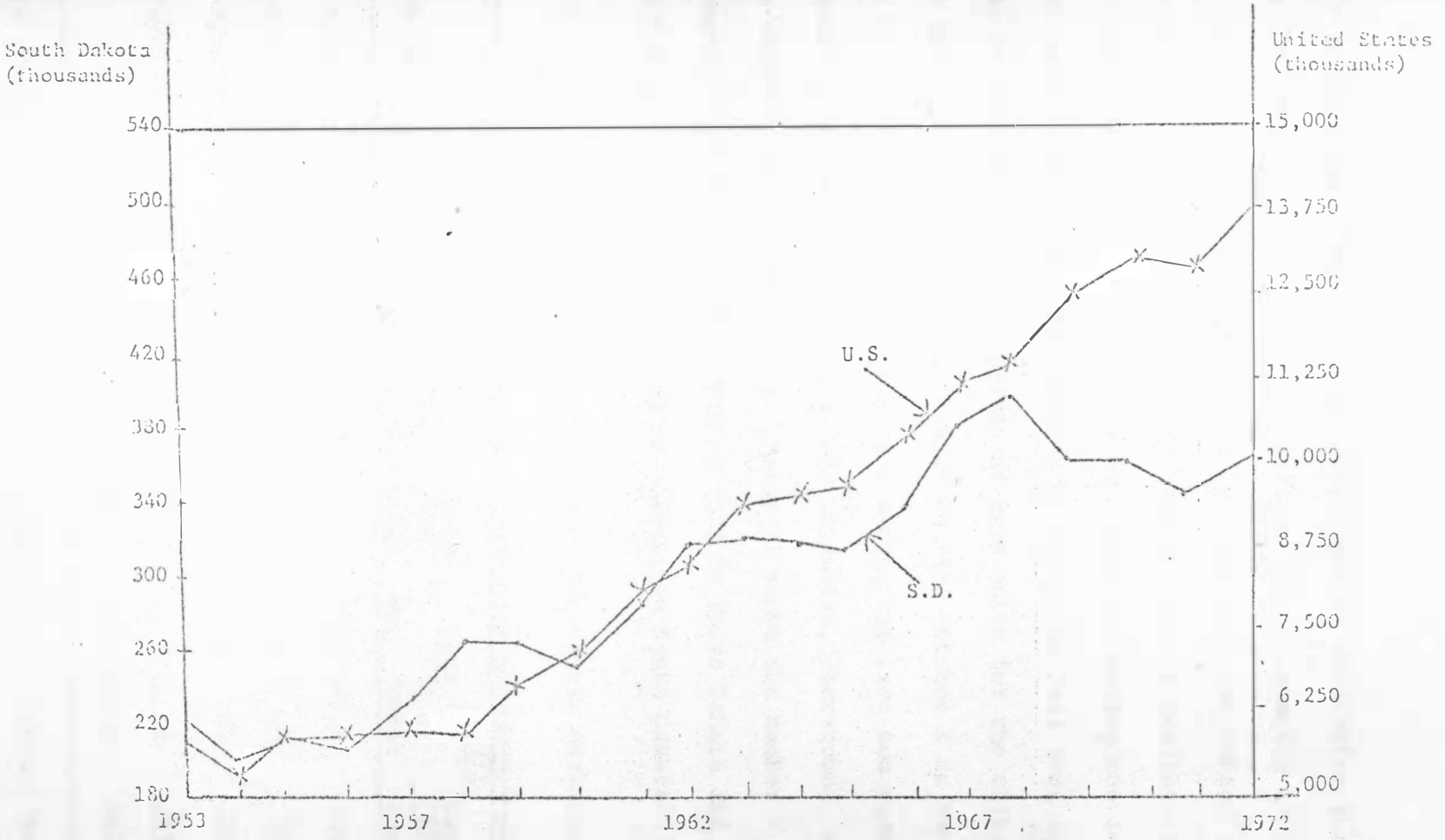
[26/] South Dakota Crop and Livestock Reporting Service, op. cit., p. 46.

Figure 2. Cattle and Calves on Feed, January 1, in South Dakota and the United States, 1953-1972.



Source: South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture 1971, and earlier issues.

in size is evident. Table 6 shows cattle feedlot statistics for South Dakota for 1969 and 1971. In 1971 feedlots with a capacity of over 1,000 head marketed 58 percent of the fed cattle in the United States as compared to 20.4 percent for South Dakota. Larger feedlots tend to be less seasonal as more emphasis is placed on keeping the lots full throughout the year. The numbers of cattle on feed tend to be largest on January 1 with a significant drop shown for the third and fourth quarter inventory dates. Cattle on feed October 1 in South Dakota has shown a substantial increase during the last ten years. This would indicate a trend toward more intensive, year-round, use of the state's feeding facilities. Table 21 shows the number and seasonal distribution of cattle on feed in South Dakota and Figure 9 shows fed cattle marketed by quarter in South Dakota.

Table 6. Size of Feedlots and Percentage of Fed Cattle Marketed in South Dakota, 1969 and 1971.

Feedlot Capacity	1969 Lots No.	1969 Lots % of total	1969 Cattle Mkted ,000 head	1969 Cattle Mkted % of total	1971 Lots No.	1971 Lots % of total	1971 Cattle Mkted ,000 head	1971 Cattle Mkted % of total
Under 1,000 head	9346	99.4	459	83.3	9049	99.4	475	79.6
1,000-1,999 head	37	.4	37	6.7	33	.4	46	7.7
2,000-3,999 head	12	.1	25	4.5	13	.1	28	4.7
Over 4,000 head	5	.1	30	5.5	5	.1	48	8.0
	9400	100.0	551	100.0	9100	100.0	552	100.0

Source: United States Department of Agriculture, Statistical Reporting Service, Livestock and Meat Statistics.

CATTLE MARKETING

Auctions have been the fastest growing method of marketing livestock in South Dakota. Table 7 illustrates the growth in auction market business, which has primarily been at the expense of the public stockyards. The increase in auction market sales has been due mainly to an increase in feeder calf volume.

Table 7. Percentage of all South Dakota Cattle and Calves Sold by Indicated Marketing Outlet, 1957, 1964, 1970.

Marketing Outlet	Year 1957	1964	1970
	----------percent----------		
Direct to Packers	6	11	12
Public Stockyards	38	29	12
Auction Markets	34	48	64
Farm to Farm and other	22	12	12

Sources: South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture 1965, p. 45; USDA, Packers and Stockyards Resume, November 9, 1971; Annual Report for Sioux Falls Stockyards Company, December 31, 1971; South Dakota Livestock Sanitary Board Report, fiscal year 1970-71.

Figures showing packer purchases of slaughter cattle from different market outlets are quite different from the above figures. The packers rely mainly on direct marketings and country dealers to fill their demand for cattle. This is especially true with regard to fed cattle as 71 percent of the South Dakota packer purchases of

steers and heifers were from direct sales or through country dealers. Terminal markets ranked second in importance and were the source of 22 percent of total slaughter purchases, about twice the total of auction markets. Table 8 shows the sources of United States and South Dakota packer purchases of cattle and calves.

BEEF CONSUMPTION

Annual consumption of red meat per capita rose from about 125 pounds in the 1930's to 192 pounds in 1971. The trends in pork and lamb and mutton consumption remained fairly steady while beef and veal consumption rose from about 60 pounds in the 1930's to 113.3 pounds in 1971. The increase in total meat consumption resulted almost entirely from this increase in beef consumption. The trend in meat consumption per capita is shown in Figure 3.

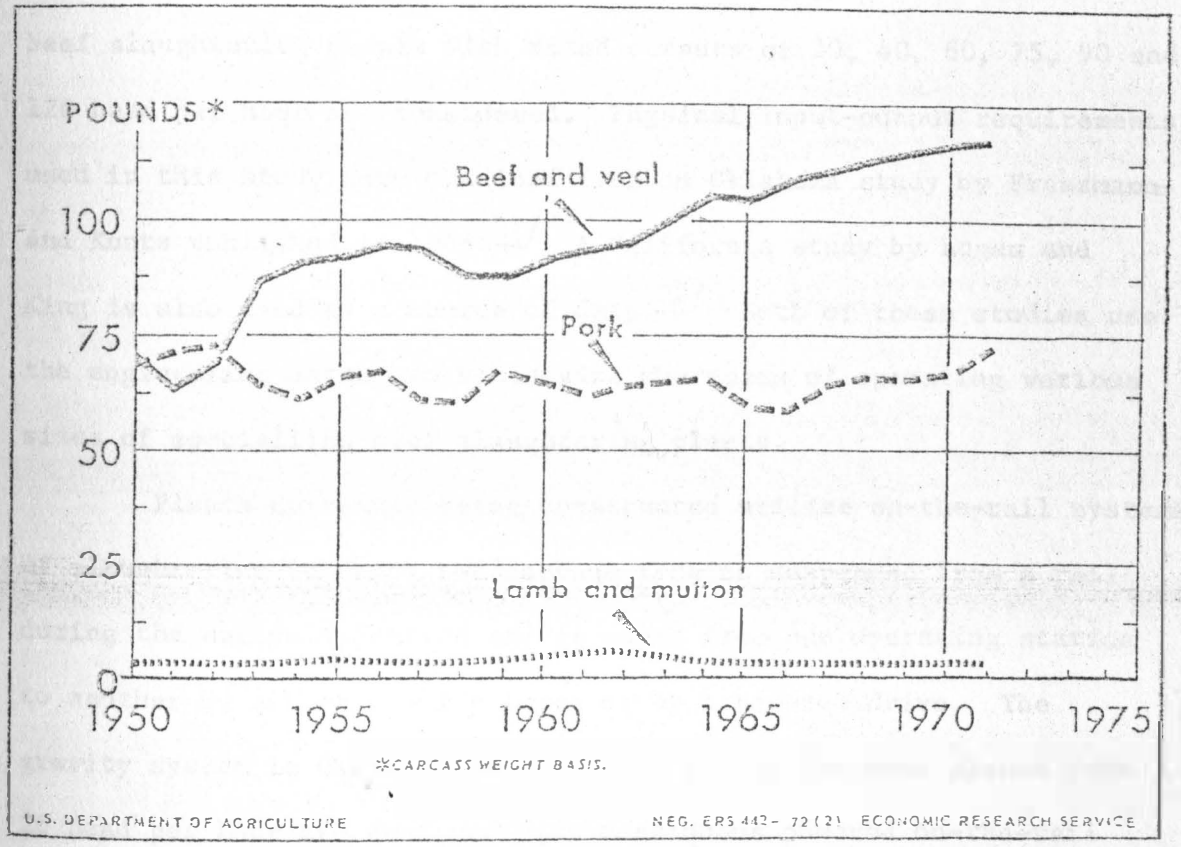
Table 8. United States and South Dakota Packer Purchases of Cattle and Calves; Percentages of Total by Class of Livestock and Market Source, 1970.

Source	South Dakota[1/]			United States			
	Steers and Heifers	Cows and Bulls	All Cattle	Steers and Heifers	Cows and Bulls	All Cattle	Calves
	percent			percent			
Direct, Country Dealers, etc.	71.0	44.8	66.7	72.8	33.4	65.3	34.0
Terminal Markets	24.1	11.4	22.0	17.7	21.3	18.4	11.4
Auction Markets	4.9	43.8	11.3	9.5	45.2	16.4	54.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number of Head (1,000)	523	104	626	26,038	6,160	32,198	3,920
Percent of All Cattle	83	17	100	81	19	100	---
Percent of All Cattle and Calves	83	17	100	72	17	---	11

Source: USDA, Packers and Stockyards Resume, Statistical Issue, November 29, 1971.

[1/] Very few calves are slaughtered in South Dakota.

Figure 3. Meat Consumption Per Person.



CHAPTER IV

ESTIMATED SLAUGHTER COSTS

This chapter contains an analysis of the costs incurred in the operation of specialized beef slaughtering plants. Six model beef slaughtering plants with rated outputs of 20, 40, 60, 75, 90 and 120 head per hour are considered. Physical input-output requirements used in this study were obtained from an Oklahoma study by Franzmann and Kuntz published in 1966.[27] A California study by Logan and King is also used as a source of data.[28] Both of these studies use the engineering method to synthesize the costs of operating various sizes of specialized beef slaughtering plants.

Plants currently being constructed utilize on-the-rail systems of slaughtering in which the carcass remains suspended from a rail during the entire operation and is moved from one operating station to another by either gravity force or by a powered drive. The gravity system is used in certain small plants but most plants over 20 head per hour are equipped with continuous powered on-the-rail systems. Other small plants may be equipped with intermittent on-the-rail systems which can be stopped at the operating stations.

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[27] John R. Franzmann and B. T. Kuntz, "Economies of Size in Southwestern Beef Slaughter Plants," Department of Agricultural Economics, Oklahoma State University, Bulletin B-648, April 1966.

[28] Samuel H. Logan and Gordon A. King, "Economies of Scale in Beef Slaughter Plants," Giannini Foundation Res. Rep. No. 260, Berkeley: California Agricultural Experiment Station, 1962.

Labor and investment requirements were based on several time and observational studies done on beef slaughtering plants. Plants were designed to meet the regulations issued by the Meat Inspection Division of the United States Department of Agriculture. The plants are operated primarily as kill and chill operations and do not break down the carcasses. Supporting operations are limited to hot offal work-up and a small rendering facility. Each plant was assumed to sell all of its hides green. The synthesized plants consist of corral facilities, a kill and dressing area, chill and holding coolers, an offal work-up area, an equipment clean-up area, an employee dressing area, a rendering department, office space, and sufficient parking space for employees and visitors.

The plants are assumed to operate at the rated number of head per hour for seven and one-half hours per day, allowing 30 minutes per day for breaks, and 252 days per year. Labor is paid on the basis of 260 eight-hour days.

The cost estimates obtained in this study are intended to be representative of current conditions in South Dakota. Estimates are designed to reflect plant costs through 1972. The procedures used in obtaining the cost estimates will be explained in the following discussion. Cost estimates are divided into the following categories: (1) labor, (2) buildings, corrals and parking area, (3) land, (4) equipment, (5) property taxes, (6) utilities, (7) miscellaneous supplies and services, and (8) interest on operating capital.

LABOR

Labor costs represent the largest single expense item for beef slaughter plants, excluding the cost of livestock. Thus, small changes in the hourly wage rate have a significant effect on total cost. Wage rates and wage practices for this study were obtained from a current union contract agreement.[29] Interviews with other federally inspected beef slaughtering plants that employ union labor revealed that three have a base wage below the $4.03 used in this study. The base wage paid at each of the other four companies, though, falls within 10 percent of $4.03. One interview at a non-union, federally inspected plant revealed a wage rate considerably below the rates found in the union plants. In January, 1969, the Bureau of Labor Statistics found the average hourly earnings of workers in plants with labor contracts in the Midwest to be $3.83.

Labor requirements were adapted from the Oklahoma study. Job descriptions from the union contract were applied to the specifications listed in that study. Annual costs for each job were determined by assuming a total of 2080 hours paid per year. This was based on 260 eight-hour days including eight paid holidays. When one worker performed more than one job he was always paid at the wage rate of the higher paying job.

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[29] Spencer Foods, Inc., Sioux Falls, South Dakota plant and the Amalgamated Meat Cutters and Butcher Workmen of North America, AFL-CIO and Local 304, September 7, 1971 through December 6, 1974.

Several adjustments were made in the requirements for labor as published by Franzmann and Kuntz. In formulating the requirements for supporting labor, Franzmann and Kuntz indicated that as the plant size increased the plants would do additional processing of the offal. Because of the larger volume it may be economically feasible for the larger plants to hire more workers to do this additional processing. However, because it would be difficult to estimate the additional plant income it was assumed that all plants would engage in only a minimal amount of offal processing and the extent of processing would be the same in each size of plant. Therefore, this study excludes the requirements for cold offal labor included in the Oklahoma study and allows for increases in hot offal labor requirements approximately proportional to increases in plant size. In addition the requirements for yardmen are taken from the California study. Tables 24 and 25 show a complete breakdown of the operations, labor requirements and annual costs for union labor. Table 26 specifies the hourly wage rate assigned to each job description. In determining total annual cost per worker, vacation pay and sick leave are added to the workers' wages. Total annual labor cost per worker at each hourly wage rate is shown in Table 27. Vacation and sick leave benefits increase with length of employment. Vacation benefits were estimated

to average two weeks per year which, according to the union contract, is the time allotted employees with from three to ten years of service. Vacation benefits under the contract varied from one to four weeks. Sick leave was assumed to average two weeks per year per employee with the payment the first week equal to 50 percent of the regular weekly wage and payment the second week equal to 55 percent of the regular weekly wage. The union contract guaranteed workers a 40-hour week, thus labor costs were virtually fixed in the short-run.

Packing plants employ a sizeable work force which does not come under union contract. Salaries for these supervisory and office personnel vary greatly among plants and are quite difficult to obtain. Because of this the salaries found in the Oklahoma study were inflated by an average of four percent per year to arrive at the annual cost of salaried personnel. A detailed breakdown of estimated salaried personnel requirements and costs is given in Table 28.

Social security tax, health and life insurance, workmen's compensation insurance and pension costs are also included in total labor costs. The cost of social security tax was computed at the present rate of 5.2 percent to a maximum of $9,000 per employee. Many companies pay the cost of health and life insurance policies for their employees. This cost was estimated at $180 per year per employee. The cost of workmen's compensation insurance was estimated at 2.5 percent on the first $4200 of wages per union employee

or $105 per year per employee. For salaried personnel the rate used was .5 percent on the first $4200 of salary. These estimates were obtained from the local Employment Security Department. Pension costs were estimated to be 4.9 percent of the total wages and salaries.[30] Estimated annual total costs for labor by plant size are shown in Table 9.

BUILDING, CORRALS AND PARKING AREA

A detailed breakdown of the requirements and costs for building, corrals and parking area is given in Tables 29, 30, 31 and 32. Cost estimates for the building including coolers and parking lots from the Oklahoma study were inflated by 5.6 percent per year from January 1964 through the end of 1972. This figure was derived from the commercial and factory building construction index.[31] Corral construction costs from the same study were inflated by 5.37 percent per year according to the composite construction cost index.[32]

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[30] American Meat Institute, "Financial Facts About the Meat Packing Industry, 1970," Chicago, p. 11.

[31] United States Department of Commerce, Survey of Current Business, Washington, D. C., April 1965, p. S-10, August 1968, p. S-10, May 1972, p. S-10.

[32] Ibid.

Table 9. Estimated Annual Total Costs for Labor by Plant Size, South Dakota, 1972.[1/]

Labor cost	Plant size, in head killed per hour					
	20	40	60	75	90	120
	dollars					
Kill floor[2/]	113,909	192,939	309,447	377,841	463,213	587,053
Supporting operations[2/]	98,099	219,407	238,146	294,473	356,262	475,477
Salaried personnel[2/]	71,325	145,935	206,035	269,556	309,394	404,676
Social security tax[3/]	13,064	25,912	35,003	42,478	51,185	67,526
Insurance cost[4/]	7,593	14,985	20,181	24,489	29,652	39,072
Pension cost[5/]	13,883	27,356	36,928	46,152	55,315	71,894
Total	317,873	626,534	845,740	1,054,989	1,265,021	1,645,698

1/ All items rounded to nearest dollar.

2/ See Tables 24, 25 and 28.

3/ Computed at the present rate of 5.2% to a maximum of $9,000 per employee.

4/ Company cost for health and life insurance estimated at $180.00 per year per employee. Workmen's compensation insurance cost was 2.5% on the first $4,200 per employee or $105 per year per employee. For salaried personnel the rate used was .5% on the first $4,200.

5/ A figure of 4.9% times the total wages and salaries was used.

Corral space sufficient to handle 2.5 times one day's kill was specified for each size plant. The corral area included sets of pens ten feet wide and twenty feet deep which would hold eleven head of cattle. One-fifth of the total pen area was covered with a weather tight roof to facilitate ante mortem inspection in inclement weather.

Area for parking was included in the total area required for the plants. An estimate of the total area needed was obtained by allocating an area of 9 feet by 30 feet, including driveways, for each employee. In addition, an area equal to 10 percent of the employee parking area was provided for visitor parking.

The annual cost for building, corrals and parking area was calculated by depreciating them over a 25 year period.

LAND

Land requirements were estimated by summing the area requirements for the building, parking lots, corrals and a small additional area for expansion. Area requirements were explained in the previous section. Additional land was provided to allow for expansion in chill cooler facilities equal in size to the original chill cooler. Estimates for land requirements do not include additional area around the facility which varies considerably among plants.

Values of land vary greatly throughout the state. It was assumed that the land being considered would be near a town or city of some size and utilities would be provided to the site. Interviews

with local realtors revealed an estimate of the cost of industrial land of $.05 per square foot. This results in a cost of $2,178 per acre. Annual land costs were estimated by assigning an interest rate of seven percent to the total cost of the land. These costs are presented in Table 10.

Table 10. Estimated Land Requirements and Costs for the Six Model Plants, South Dakota, 1972.

Plant Size in head per hour	Plant area	Future expansion area	Total area	Total land cost[1/]	Annual cost of interest[2/]
	(sq. ft.)	(sq. ft.)	(sq. ft.)	(dollars)	(dollars)
20	28,788	1,710	30,498	1524.90	106.74
40	53,077	3,132	56,209	2810.45	196.73
60	76,120	4,692	80,812	4040.60	282.84
75	92,632	5,712	98,344	4917.20	344.20
90	111,627	7,490	119,117	5955.85	416.91
120	148,700	13,200	161,900	7872.70	551.09

Source: Adapted from Franzmann and Kuntz, Economies of Size in Southwestern Beef Slaughter Plants, 1966, p. 11.

1/ Cost of land was estimated at $0.05 per square foot.

2/ An interest rate of seven percent was applied to the total land cost.

EQUIPMENT

Equipment requirements were divided into four general categories: (1) refrigeration, (2) kill floor and supporting operations, (3) inedible rendering, and (4) office. The costs found in the Oklahoma study were inflated by appropriate indices published by the Department of Commerce. The estimating procedure, total equipment costs, and equipment depreciation costs are shown in Table 11. The Allbright-Nell Company was consulted concerning the kill floor equipment costs.[33/] Actual blueprints obtained from the company for the kill floor layout showed that their equipment costs were virtually the same as those estimated by the procedure used in this study.

TOTAL INVESTMENT COSTS

Building, equipment and land constitute the initial investment costs for a beef packing plant. These costs are summarized in Table 12.

PROPERTY TAXES

Property taxes are a significant expense item for beef packing plants in South Dakota. The South Dakota Tax Reporter was used as a source to determine the average assessment ratio and property tax rate. Aggregate property tax rates were given for 25 cities in South Dakota for 1971.[34/] These 25 rates were averaged and a tax rate of

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[33/] Allbright-Nell Company, 5323 S. Western Blvd., Chicago, Illinois, 60609.

[34/] Commerce Clearing House, Inc., South Dakota Tax Reporter, pp. 7011-7012.

Table 11. Estimated Equipment Costs and Annual Equipment Depreciation Costs for the Six Model Plants, South Dakota, 1972.

Plant size in head per hour	Tons of Refrigeration equipment required			Refrigeration equipment cost[1]		Kill Floor equipment cost[2]	Rendering equipment cost[2]	Office equipment cost[3]	Total equipment cost[4]	Equipment salvage value[5]	Balance for depreciation[6]	Annual depreciation[7]
	Chill cooler	Holding cooler	Total	Per ton	Total							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	tons			dollars								
20	43	12	55	1,082	59,510	45,115	88,863	7,143	200,631	20,063	180,568	9,350
40	84	22	106	1,042	110,452	84,762	155,852	11,398	362,464	36,246	326,218	16,824
60	125	30	155	1,002	155,310	102,534	172,258	15,761	445,863	44,586	401,277	20,773
75	157	41	198	982	194,436	164,055	205,069	19,693	583,253	58,325	524,928	27,133
90	210	50	260	949	246,742	177,726	205,069	23,487	653,024	65,302	587,722	30,443
120	248	66	314	922	289,511	191,397	352,718	31,414	865,040	86,504	778,536	40,340

Source: Adapted from Franzmann & Kuntz, Economies of Size in Southwestern Beef Slaughter Plants, 1966, p. 13.

1/ Refrigeration costs inflated by 3.83% per year according to Wholesale Price Index for Special Industry Machinery and Equipment.

2/ Kill floor and rendering equipment costs inflated 3.57% per year according to Wholesale Price Index for Special Industry Machinery and Equipment and Industrial Material Handling Equipment.

3/ Office equipment cost inflated by 1.1% per year according to Wholesale Price Index for Office and Store Machines and Equipment.

4/ Sum of columns 6, 7, 8, 9.

5/ 10% of column 10.

6/ Column 10 less column 11.

7/ Sum of columns 6, 7 and 8 less 10 percent salvage value divided by 20 years, plus column 9 less 10% salvage value divided by 10 years.

Table 12. Total Investment Costs for the Six Plant Sizes, 1972.

Item	Plant size in head per hour					
	20	40	60	75	90	120
	dollars					
Building	256,577	410,494	554,905	667,864	806,305	1,096,795
Equipment	200,631	362,464	445,863	583,253	653,024	865,040
Land	1,525	2,810	4,041	4,917	5,956	7,873
Total	458,733	775,768	1,004,809	1,256,034	1,465,285	1,969,708

$77.60 per $1,000 of assessed valuation was obtained. County assessment ratios from the 25 counties in which the cities were located were averaged and yielded an assessment ratio of 45 percent rounded to the nearest percent.[35/] The Brookings County Treasurer was consulted to estimate the tax cost for cattle inventory. Cattle are assessed uniformly across the state and packing plants pay tax on both live and dressed beef. This study assumes two days normal kill to be the average on hand. The assessment rate for South Dakota in 1972 was $85 for cows and $100 for fat cattle over 850 pounds. For the purposes of this study the inventory was assessed at an average rate of $95 per animal and a tax rate of $77.60 per $1,000 of assessed valuation was used. A breakdown of the total annual tax cost is given in Table 13.

35/ Ibid., pp. 7101-7102.

Table 13. Estimated Real Estate and Property Tax Costs for the Six Model Plants, South Dakota, 1972.

Plant size in head per hour (1)	Assessed land value1/ (2)	Average assessed improvement value2/ (3)	Assessed salvage value3/ (4)	Average assessed equipment value4/ (5)	Assessed value of cattle inventory5/ (6)	Total assessed value6/ (7)	Annual tax cost7/ (8)
	dollars						
20	686	57,730	9,029	40,628	28,500	136,572	10,598
40	1,265	92,361	16,311	73,399	57,000	240,336	18,650
60	1,818	124,854	20,064	90,287	85,500	322,523	25,023
75	2,213	150,269	26,246	118,109	106,875	403,712	31,328
90	2,680	181,419	29,386	132,237	128,250	473,972	36,780
120	3,543	246,779	38,927	175,171	171,000	635,419	49,309

1/ 45 percent of total land cost from Table 10.

2/ Since the improvements are being depreciated over time, one-half of the building costs were taken times 45 percent.

3/ 45 percent of the equipment salvage value from previous table.

4/ The equipment is also being depreciated over time. One-half of the depreciable equipment value from Table 11 was taken times an assessment rate of 45 percent.

5/ This study assumes two days normal kill to be average on hand and an average assessment rate of $95 per head.

6/ Sum of columns 2, 3, 4, 5, 6.

7/ A tax rate of $77.60 per $1,000 of assessed value in column 7 was used.

ANNUAL FIXED COSTS

The initial costs of investment in buildings and equipment can be amortized over a period of years to obtain an estimate of annual costs. In addition, total annual fixed investment costs include interest, insurance and taxes. Table 14 shows annual depreciation, insurance and interest costs for buildings and equipment.

Architectural costs are added to the building costs to obtain an estimate of total building costs. Architectural costs were estimated at eight percent of building costs. This figure was verified in an interview with an architectural firm with experience in packing house construction.[36/]

A summary of total annual fixed costs is given in Table 15.

UTILITIES

Requirements for utilities were obtained from the California study by Logan and King. Detailed requirements and costs for electricity, water, sewage and natural gas are outlined in Tables 33, 34 and 35. Rate schedules were obtained from South Dakota sources as noted in each table. Table 16 was formulated from these three tables in the Appendix.

36/ Willis Regier, Inc., Stockyards Building, Omaha, Nebraska.

Table 14. Estimated Annual Depreciation, Insurance, and Interest Costs for Buildings and Equipment, South Dakota, 1972.

Plant size in head per hour (1)	Building costs1/ (2)	Architectural costs2/ (3)	Total building costs3/ (4)	Building depreciation costs4/ (5)	Total cost of buildings and equipment5/ (6)	Insured value of buildings and equipment6/ (7)	Annual insurance cost7/ (8)	Annual interest cost8/ (9)	Equipment depreciation cost9/ (10)	Total annual cost10/ (11)
	dollars									
30	237,571	19,006	256,577	10,263	457,208	365,766	585	16,002	9,350	36,200
40	380,087									
40	380,087	30,407	410,494	16,420	772,958	618,366	989	27,054	16,824	61,287
60	513,801	41,104	554,905	22,196	1,000,768	800,614	1,281	35,027	20,773	79,277
75	618,393	49,471	667,864	26,715	1,251,117	1,000,894	1,601	43,799	27,133	99,248
90	746,579	59,726	806,305	32,252	1,459,329	1,167,463	1,868	51,077	30,443	115,640
120	1,015,351	81,244	1,096,795	43,872	1,961,835	1,569,468	2,511	68,664	40,340	155,387

1/ Taken from Table 29.

2/ Eight percent of the building cost.

3/ Column 2 plus column 3.

4/ Column 4 divided by 25 years.

5/ Column 4 plus total equipment cost from previous table.

6/ 80 percent of column 6 verified by local insurance agency.

7/ An estimated fire insurance rate of $.16 per $100.00 was obtained from local insurance agency.

8/ An interest rate of seven percent was applied to one-half of column 6.

9/ Taken from Table 11.

10/ Sum of columns 5, 8, 9 and 10.

Table 15. Estimated Annual Fixed Costs for Specialized Beef Slaughtering Plants, South Dakota, 1972.

Cost Items	Plant size in head per hour					
	20	40	60	75	90	120
	dollars					
Depreciation[1/]	19,613	33,244	42,969	53,848	62,695	84,212
Interest						
Building & Equipment[2/]	16,002	27,054	35,027	43,789	51,077	68,664
Land[3/]	107	197	283	344	417	551
Insurance[4/]	585	989	1,281	1,601	1,868	2,511
Taxes[5/]	10,598	18,650	25,028	31,328	36,780	49,309
Total	46,905	80,134	104,588	130,910	152,837	205,247

1/ Column 13, Table 11 and Column 5, Table 14

2/ Column 9, Table 14

3/ Column 6, Table 10

4/ Column 8, Table 14

5/ Column 8, Table 13

MISCELLANEOUS SUPPLIES AND SERVICES

Six additional items were included in the total cost of operating a beef packing plant. These items included: (1) repair and maintenance, (2) killing supplies, (3) office supplies, (4) telephone, (5) laundry, and (6) feed. Estimates of the total costs of these items and the sources are shown in Table 17.

Table 16. Estimated Total Annual Utility Costs by Size of Plant, South Dakota, 1972.

Plant size in head per hour	Electricity	Water	Sewage	Natural gas	Total
			--dollars--		
20	12,901	2,810	843	1,634	18,189
40	22,176	5,172	1,552	2,398	31,298
60	30,911	7,532	2,260	3,039	43,742
75	37,376	9,293	2,788	3,529	52,986
90	43,829	11,072	3,322	4,037	62,260
120	56,402	14,538	4,361	5,053	80,354

Source: Tables 33, 34 and 35.

INTEREST ON OPERATING CAPITAL

Because of the large dollar volume involved in purchasing livestock, interest on operating capital is an important cost item. For example a 60 head per hour plant operating at full capacity will slaughter 450 head per day. At an average weight of 1061 pounds and an average price of $32 per cwt. it would require $152,784 to purchase one day's kill. This study assumes that a sufficient amount of operating capital is needed to purchase one week's kill plus an additional ten percent for other transactions. It was also assumed that operating capital could be generated from both external and internal sources which would result in lowering, somewhat, the effective interest rate charged. The interest rate used was six percent. Interest costs for operating capital for each size of plant can be found in Table 18.

Table 17. Estimated Annual Cost of Miscellaneous Supplies and Services, South Dakota, 1972.

Plant size in head per hour	Repair and maintenance	Killing supplies	Office supplies	Telephone	Laundry	Feed	Total cost
	dollars						
20	16,178	14,293	6,836	10,182	10,779	3,780	62,048
40	32,357	19,760	9,174	20,364	21,559	7,560	110,774
60	48,535	25,215	11,512	30,546	32,338	11,340	159,486
75	60,669	29,237	13,260	38,217	40,459	14,162	196,004
90	72,803	33,311	15,006	45,820	48,506	17,010	232,456
120	97,070	41,496	18,529	61,093	64,510	22,680	305,378

Source: Repair and maintenance, telephone and laundry costs obtained from Franzmann and Kuntz, Economies of Size in Southwestern Beef Slaughter Plants, 1966, p. 21. Repair and maintenance and laundry costs were inflated by 2.65 percent per year according to the index for industrial commodities in the Wholesale Price Index. Telephone costs were left unadjusted. Rates used for these costs were: $.428 per head for repair and maintenance, $.2662 per head per year for telephone, and $.285 per head per year for laundry.
Killing supplies, office supplies and feed costs obtained from Logan and King, Economies of Scale in Beef Slaughter Plants, 1961, p. 90. Killing supply and office supply costs were inflated by 2.65 percent per year according to the index for industrial commodities in the Wholesale Price Index. Feed costs were left unadjusted. Rates used for these costs were: $8851.38 + $.1439$_x$ per head per year for killing supplies, $4496.86 + $.0619$_x$ per head per year for office supplies, and $.10 per head per year for feed.

TOTAL AND PER UNIT COSTS

Tables 18, 19 and 20 present total annual costs, average costs per head, and cost components as a percentage of total annual costs. Figure 4 shows graphically average total processing costs per head for the six model plants. Costs per head declined from $12.22 in the smallest plant to $10.31 in the largest, with economies of scale present over the entire range of plant sizes studied. However, as noted in the graph, plants of the 60 head per hour size have obtained most of the cost economies found within the limits of the study. Average cost per head decreased 13 percent in moving from the 20 to the 60 head per hour plant, but only a three percent drop was observed when plant size was increased from 60 to 120 head per hour.

The cost estimates obtained in this study are representative of plant sizes which were previously specified and which operate at their rated capacity. The sizes considered were selected because they represent sizes of plants often constructed in the industry. Figure 4 was constructed by connecting average total processing costs for the six model plants. Variation in the scale of plants synthesized in this study was necessarily discontinuous. Thus, in actuality only six points were estimated on the industry economies of scale curve. The curve formed by connecting these points may be considered as an approximation of the long run economies of scale curve for the beef packing industry. Figure 4 approximates average total cost per head at various capacity levels assuming continuous variation in plant size is possible.

Table 18. Estimated Total Annual Costs for the Six Model Plants, South Dakota, 1972.

Cost Items	Plant size, head killed per hour					
	20	40	60	75	90	120
	dollars					
Annual fixed costs	46,905	80,133	104,588	130,910	152,837	205,247
Depreciation	19,613	33,244	42,969	53,848	62,695	84,212
Interest	16,109	27,250	35,310	44,133	51,493	69,215
Taxes & insurance	11,183	19,639	26,309	32,930	38,648	51,820
Labor	317,873	626,534	845,740	1,054,989	1,265,021	1,645,698
Kill floor	113,909	192,939	309,447	377,841	463,213	587,053
Supporting operations	98,099	219,407	238,146	294,473	356,262	475,477
Salaried personnel	71,325	145,935	206,035	269,556	309,394	404,676
Tax and welfare	34,540	68,253	92,112	113,119	136,152	178,492
Utilities	18,189	31,298	43,742	52,986	62,260	80,354
Other supplies	62,047	110,774	159,486	196,003	232,456	305,378
Interest on operating capital	16,806	33,612	50,419	63,023	75,628	100,837
Total annual cost	461,820	882,351	1,203,975	1,497,911	1,788,202	2,337,514

Table 19. Estimated Average Costs per Head for the Six Model Plants, South Dakota, 1972.

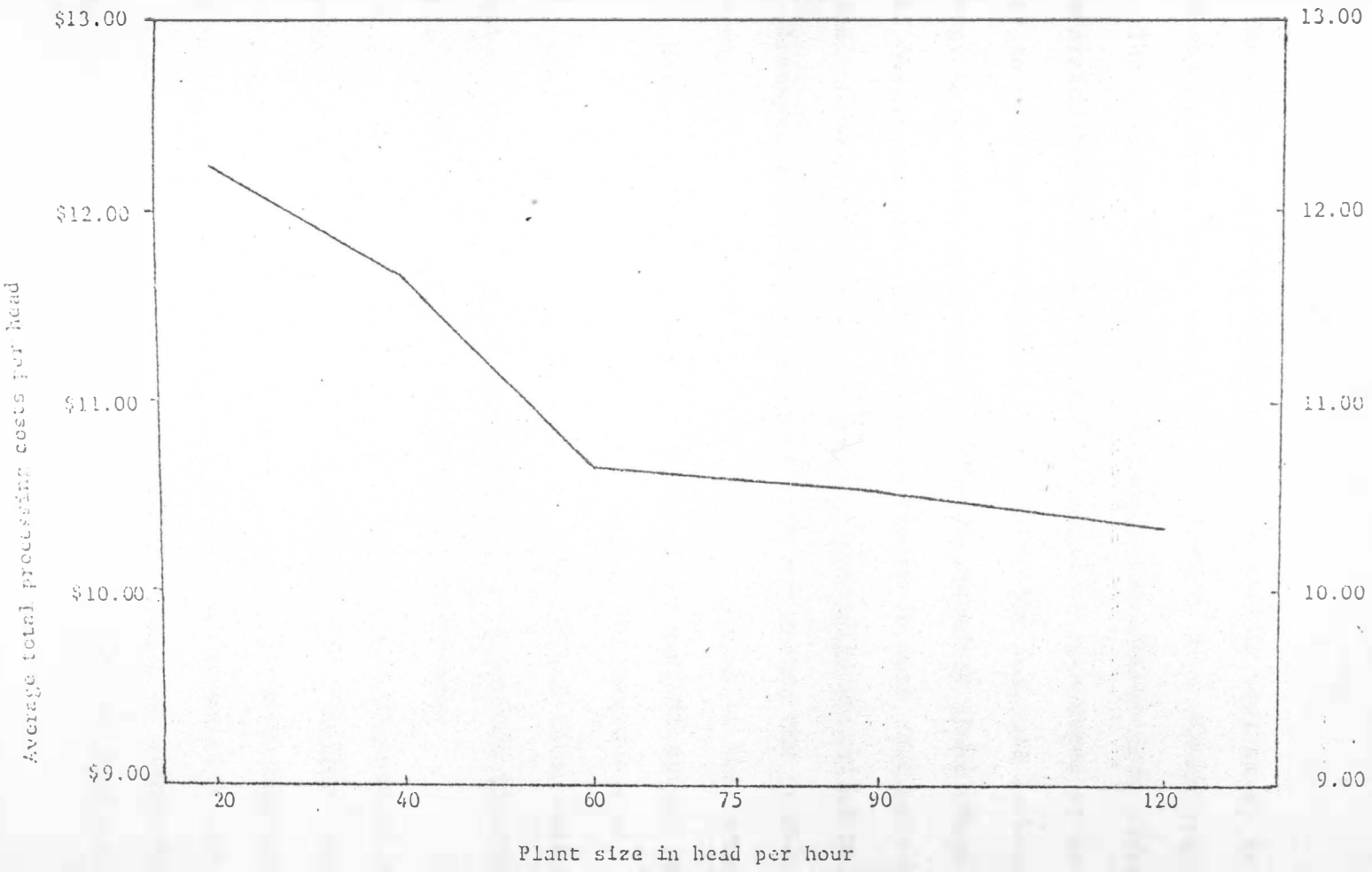
Cost Items	Plant size, head killed per hour					
	20	40	60	75	90	120
	(Cost per head in dollars)					
Annual fixed costs	1.24	1.06	.92	.92	.90	.90
Depreciation	.52	.44	.38	.38	.37	.37
Interest	.43	.36	.31	.31	.30	.31
Taxes & insurance	.30	.26	.23	.23	.23	.23
Labor	8.41	8.29	7.46	7.44	7.44	7.26
Kill floor	3.01	2.55	2.73	2.67	2.72	2.59
Supporting operations	2.60	2.90	2.10	2.08	2.09	2.10
Salaried personnel	1.89	1.93	1.82	1.90	1.82	1.78
Tax and welfare	.91	.90	.81	.80	.80	.79
Utilities	.48	.41	.39	.37	.37	.35
Other supplies and services	1.64	1.47	1.41	1.38	1.37	1.35
Interest on operating capital	.44	.44	.44	.44	.44	.44
Totals	12.22	11.67	10.62	10.57	10.51	10.31

Table 20. Cost Components as a Percentage of Total Annual Cost for the Six Model Plants, South Dakota, 1972.

Cost items	Plant size, head killed per hour					
	20	40	60	75	90	120
	percent					
Annual fixed costs	10.16	9.08	8.69	8.74	8.55	8.78
Depreciation	4.25	3.77	3.57	3.59	3.51	3.60
Interest	3.49	3.09	2.93	2.95	2.88	2.96
Taxes & insurance	2.42	2.23	2.18	2.20	2.16	2.22
Labor	68.82	71.00	70.23	70.42	70.73	70.39
Kill floor	24.66	21.86	25.70	25.22	25.90	25.11
Supporting operations	21.24	24.86	19.78	19.66	19.92	20.34
Salaried personnel	15.44	16.54	17.11	17.99	17.30	17.31
Tax and welfare	7.48	7.73	7.65	7.55	7.61	7.63
Utilities	3.94	3.55	3.63	3.54	3.48	3.44
Other supplies	13.43	12.55	13.24	13.08	13.00	13.06
Interest on operating capital	3.64	3.31	4.19	4.21	4.23	4.31
Total[1/]	100.0	100.0	100.0	100.0	100.0	100.0

1/ Columns may not sum to 100 because of rounding.

Figure 4. Estimated Average Total Processing Costs per Head for the Six Model Plants, South Dakota, 1972.



CHAPTER V

OPTIMUM SIZE, NUMBER AND LOCATION OF BEEF SLAUGHTERING PLANTS IN SOUTH DAKOTA

The simplex transportation model was used in this study to estimate the optimum size, number and location of beef slaughtering plants. The solution to the model indicates the minimum cost pattern of transferring the product. Before the model is introduced it is necessary to outline specifications upon which the analysis is based. Supply regions must be delineated as well as potential plant sites and final demand centers. The available supply in each area must be determined. Demand centers are allocated a specified amount of the supply. Transportation costs are calculated for moving the product from the supply area to the plants and from the plants to the demand centers. Plant costs are included with the above specifications to arrive at a solution which will estimate optimum product movement patterns, plant size, and plant locations. The optimum size, number and location of plants considering assembly, processing and distribution costs will be where the combined total cost is a minimum.

The total cost of assembling the supply at the processing plants will decrease as the number of plants increases. This results because the total distance required for assembly is reduced. Given economies of scale in processing cost over the range of plant capacities considered, total processing cost increases as the number of plants is increased given a fixed amount of supply. Average distribution costs

do not vary with plant size, thus total distribution costs are not changed by varying the number of plants. However, the location of plants will affect total distribution costs. The optimum size, number and location of plants results when the counteracting effects of reduced assembly costs with increasing plant numbers, increased processing costs with increasing plant numbers, and distribution costs that vary with the distance from the demand center just offset each other.

It is necessary to make certain assumptions in order to arrive at the solution. A list of these assumptions follows:

1. Given:
   a. supply regions
   b. demand centers
   c. potential plant sites
   d. transportation costs per unit for assembling the cattle and distributing the meat.
2. Transportation costs per unit do not vary with quantity shipped.
3. Local consumption is estimated at 12 percent of available supply.
4. Products are homogenous and consumers are indifferent as to the source of supply.
5. All movement of the product originates or terminates at a single point in each of the respective supply regions.
6. Points of origin and potential plant sites are selected to approximate the center of beef production in each supply region.
7. Demand centers are selected to coincide with present shipment patterns.

ASSEMBLY COSTS

Assembly costs involve the shipment of live cattle to the packing plants. Total assembly costs depend upon the transportation rates and the distance traveled. The South Dakota Public Utilities Commission issues a rate schedule for intrastate traffic by motor carriers.[37] Interviews with several trucking companies revealed that the majority followed the rate schedule issued by the P.U.C., and indicated that they would transport cattle from the farm to a packing plant at the P.U.C. rate for a minimum load of 37,000 pounds. The P.U.C. rates as published were used to determine assembly costs in this study and are shown in Table 36.

The approximate center of beef production in each supply region was used to measure the distance from each supply region to each processing plant. The distance found from each supply region to each plant outside that supply region was multiplied by a factor of 1.2 to convert air distance to road distance. To determine the average length of haul from a supply region to a plant location within that region a

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[37] South Dakota Public Utilities Commission, "South Dakota Class B Motor Carriers Tariff No. 42," March 24, 1972, Pierre, South Dakota.

formula developed by Ben C. French[38] was used. The formula used considered a circular supply area with the square road grid which is prevalant in South Dakota. The formula was

$$D = \frac{8}{3} \frac{\text{No. of slaughter cattle in region}}{(\pi)^2 \text{ (density of slaughter cattle per sq. mi.)}}$$

where D is the average length of haul in miles.

The estimated road distances are applied to the P.U.C. rate schedule to obtain transportation costs per hundredweight from the supply regions to the processing plants. The costs were then converted to a dressed weight basis by dividing by an average dressing percentage of 59.5 percent.

DISTRIBUTION COSTS

Distribution costs involve the transportation cost of shipping meat from South Dakota packing plants to eight demand centers. The Interstate Commerce Commission regulates transportation rates for interstate shipment of meat products by commercial carriers. Some of the plants interviewed operated their own fleet of trucks to transport a large share of the final product. Because the costs of shipping in company-owned trucks varies considerably this study assumed that all plants would utilize commercial carriers at the rates specified by the I.C.C. Rates were obtained from two South Dakota cities to the eight

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[38] Ben C. French, "Some Considerations in Estimating Assembly Cost Functions for Agricultural Processing Operations," Journal of Farm Economics, November 1960, Vol. 42, pp. 772-773.

demand centers selected and a linear function was formulated. Rates from the other potential plant sites to the demand centers were estimated from the variable term in the linear function.

The I.C.C. rates used in this study were for either semi-truck or "piggy-back" with a minimum load of 38,000 pounds. Plants interviewed indicated that railroad cars were not used for meat shipments. "Piggy-back" shipments were somewhat limited with the majority being shipped by semi-truck.

DEMAND

Interviews were conducted with the federally inspected plants in the state to determine the destination of meat shipments. The statistics obtained were aggregated to determine the percent of total supply in South Dakota being shipped to the various demand centers. Local consumption was determined to be 12 percent of the total supply. This figure was obtained by taking the United States per capita consumption figure of 113 pounds times the population of the state divided by the estimated total supply. Thus the amount allocated to each demand center represents a percent of the supply which is shipped out of the state. The demand centers, the percent of supply shipped out of the state allocated to each demand center, and the number of units shipped are shown in Table 37.

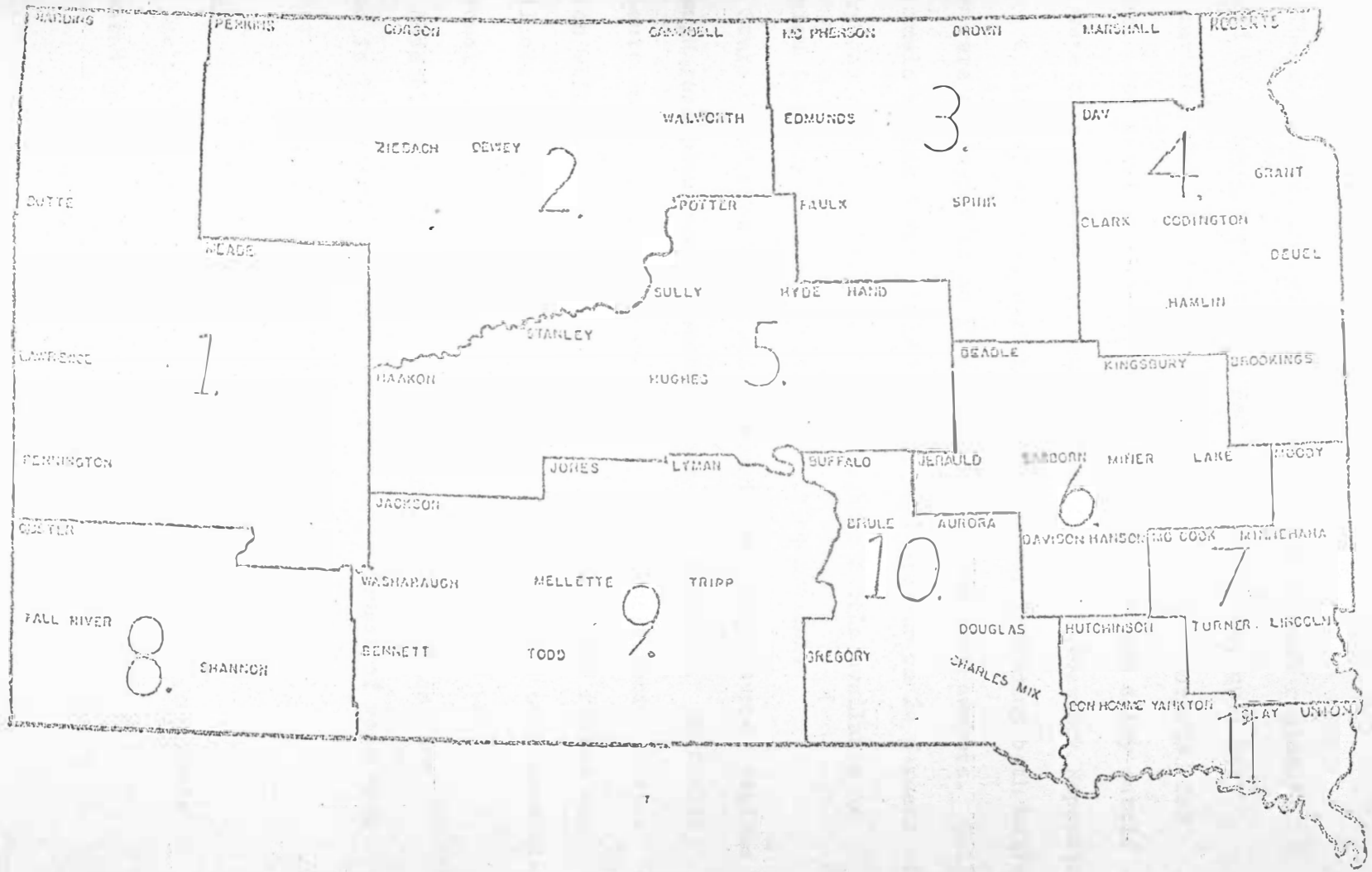
DATA SUMMARY

In the previous discussion assembly cost, plant cost, distribution cost, and demand quantities have been explained. In addition, it is necessary to specify the supply regions and the plant capacities.

In this study the 67 counties in the state are grouped into 11 supply regions. Minimum requirements for the supply areas were that they contain at least the supply required for capacity operation of the smallest plant size considered. Areas in the Eastern part of the state, where cattle density is greater, contain considerably more than the minimum supply requirement. The supply areas are shown in Figure 5. Specific boundaries of the supply regions are not necessary but are nevertheless shown so as not to divide counties. Table 38 lists the counties included in each region and the total dressed weight supply in each region. Dressed weight is determined by assuming an average live weight of 1061 pounds and an average dressing percentage of 59.5 percent.[39/] The plant capacities are converted from a per head basis to a dressed weight equivalent by multiplying the number of head by 631.3 pounds, the assumed dressed weight per head. Processing costs are also converted to a dressed weight equivalent. In all cases supply is expressed in 10,000 pound units to facilitate calculations. Slaughter plant capacities and processing costs are shown in Table 39.

39/ South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture 1971, p. 46, Sioux Falls, South Dakota.

Figure 5. Beef Supply Areas in South Dakota.



The available supply of slaughter cattle in each region is determined by summing estimates of fed cattle marketed, cull beef animals marketed for slaughter, and cull dairy animals marketed for slaughter. Fed cattle marketed, beef cattle numbers and dairy cattle numbers were obtained from the South Dakota Crop and Livestock Reporting Service. Cull beef animals marketed for slaughter including both bulls and cows were estimated to be 16 percent of the beef cow numbers. Cull dairy animals marketed for slaughter were estimated to be 24 percent of the dairy cow numbers. The number of slaughter cattle available in each region is converted to a dressed weight equivalent.

State boundaries were used as boundaries of the supply regions even though some plants were located close to the border. In reality these plants may draw part of their supply from a neighboring state. Statistics which show flows of cattle in and out of South Dakota are not available, therefore, it was assumed that inshipments were approximately equal to outshipments.

Assembly costs from each supply region to each plant are presented in Table 40. Distribution costs for shipment of meat from the plants to the demand centers are shown in Table 41.

THE MODEL

The initial cost matrix for assembling and processing costs is presented in Table 42. The rows indicate supply region

designations and the columns are plant designations. Row 12 contains the column totals which are the plant capacities designated for the initial run. Plant designations correspond to the supply region designations. In the initial run each region was assigned a plant with a capacity closest to the supply within the region. Column 12 contains the row totals or the total supply available in each supply region. The entries within the matrix represent the total cost in dollars of shipping 10,000 pounds of dressed weight from each supply region to each plant plus the cost of processing 10,000 pounds given the plant size designated. Thus the entry in row 1, column 1 is the cost of assembling the cattle (on a dressed weight basis) from Supply Region 1 to Plant 1 plus the cost of processing in Plant 1.

The same procedure is used to construct the distribution cost matrix with the exception that the entries in the distribution cost matrix represent transportation costs per 10,000 pounds of meat from the plants to the demand centers. Column totals in this matrix represent the total amount allocated to each demand center and the row totals show the total amount of dressed beef shipped to out-of-state demand centers from each plant. Row totals or available supplies of meat at the plants are calculated at 88 percent of plant capacity to adjust for local consumption.

CONCLUSION

The first feasible solution is shown in Table 42. The initial plan was computed by filling successively the least-cost routes available. Available supply exceeded the initial potential plant capacity which resulted in all plants operating at capacity. Plants operating in Regions 1, 2 and 9 were eliminated because of high unit costs.

Through the process of inspection it is possible to make successive improvements by inspection of the cost table and the border rows. Flows from the high cost cells are reassigned to lower overall costs. Obvious improvements can be made by inspection. To distinguish small variations the modi or stepping stone method can be used to be sure the optimum result is reached. An alternative is to test variations by computer runs which will show total cost figures and demand flows for the various possible plants. Failure to lower total cost and to improve capacity allocation will indicate that further adjustments are unnecessary.

For the final solution it became necessary to consider the effects of distribution costs on plant location. This resulted in increasing the capacity of the plant in Region 10 to handle the largest share of the supply in Region 9. In addition, the supply allocated to demand centers west of the state made it most economical to operate at capacity a 60 head per hour plant in Region 8. The final solution matrix including assembling and processing costs is presented in

Table 43. The final solution matrix for distribution, given the plant sizes specified in Table 43, is shown in Table 44.

In the final solution all of the plants are operating at capacity. In Region 2 there was 141 units of excess supply which did not get slaughtered. The total cost was $23,275,828 or $24.09 per head slaughtered.

The final solution pattern for assembling and processing is shown in Table 45. The solution indicates that plants slaughtering 60 head per hour should be located in Regions 4, 5, 6, 7, 8 and 11. Plants slaughtering 75 head per hour are recommended for Regions 3 and 10. It is logical that the 60 head per hour plant would be most prevalant because its processing costs are considerably lower than the smaller plants and it enjoys most of the economies of scale found in the larger plants. Increasing the plant size above the 60 head per hour level would cause increases in assembly costs which would not be offset by decreases in processing costs.

Table 46 contains the final solution pattern for distribution of South Dakota beef. Shipments are allocated to each demand center according to present shipments of beef from South Dakota.

The estimated supply of slaughter cattle available in the state is considerably higher than the number that is actually being slaughtered in South Dakota. In order to determine what the optimum pattern would be if slaughter was maintained at current levels the estimated total supply in each region was reduced by 40 percent. Thus the row totals

in the assembling and processing matrix were reduced and the plant sizes were adjusted using the inspection procedure which was explained previously. Because of the reduction in the amount of meat available for distribution the amount allocated to each demand center was also reduced accordingly. The final solution with the reduced supply decreased the number of plants to five. A plant slaughtering 40 head per hour was recommended for Region 8, plants slaughtering 60 head per hour were suggested for Regions 3 and 6, and 75 head per hour plants were located in Regions 7 and 11. The plant in Region 7 was operating at 98 percent of capacity and the plant in Region 8 was operating at 96 percent of capacity. The cost per head for assembling, processing and distributing increased to $24.66 per head slaughtered.

The final solution pattern for the reduced supply is shown in Tables 47 and 48.

Chapter VI

SUMMARY

This study contains an analysis of the beef and meat packing industries. The objective of the analysis was to formulate a basis from which conclusions could be drawn concerning the beef packing industry in South Dakota.

The discussion of the beef packing industry in Chapter II revealed that the locational trend in the industry is toward the major cattle producing areas. Plants are also becoming more specialized with over half of the federally inspected plants slaughtering only one specie of livestock. The industry in South Dakota has shown considerable growth in the past two decades but it has declined since 1967.

A description of South Dakota's beef industry was presented in Chapter III and revealed that South Dakota ranked as one of the leading states in beef production. The beef cow herd in the state has grown steadily during the past decade. Cattle feeding declined from 1967 to 1970 but in 1971 the upward trend was resumed.

An analysis of slaughter costs for specialized beef slaughtering plants was included in Chapter IV. Investment and operating costs were estimated for plants slaughtering 20, 40, 60, 75, 90 and 120 head per hour.

The simplex transportation model was introduced in Chapter V to estimate the optimum size, number and location of beef slaughtering plants. Costs of assembling, processing and distributing were determined and the supply of beef available was estimated for the specified supply regions. The final solution indicated that plants slaughtering 60 head per hour should be located in Regions 4, 5, 6, 7, 8 and 11. Plants slaughtering 75 head per hour were recommended for Regions 3 and 10. When the supply available was reduced to 60 percent of the total estimated, the number of plants recommended decreased to five. Plants slaughtering 75 head per hour were indicated for Regions 7 and 11. Regions 3 and 6 were recommended locations for 60 head per hour plants and a 40 head per hour plant was recommended for Region 8.

IMPLICATIONS OF RESULTS

The model was employed in an attempt to arrive at an optimum solution for the structure of the beef packing industry in South Dakota. Estimates of number of cattle available for slaughter in the state make it appear that beef slaughter could be expanded, especially in certain areas. This study necessarily only included the state of South Dakota. Factors outside of the state, though, may have implications with regards to the practicality of slaughter plant location. Statistics relating inshipments and outshipments of market cattle were not available and for the purposes of data for the model were considered

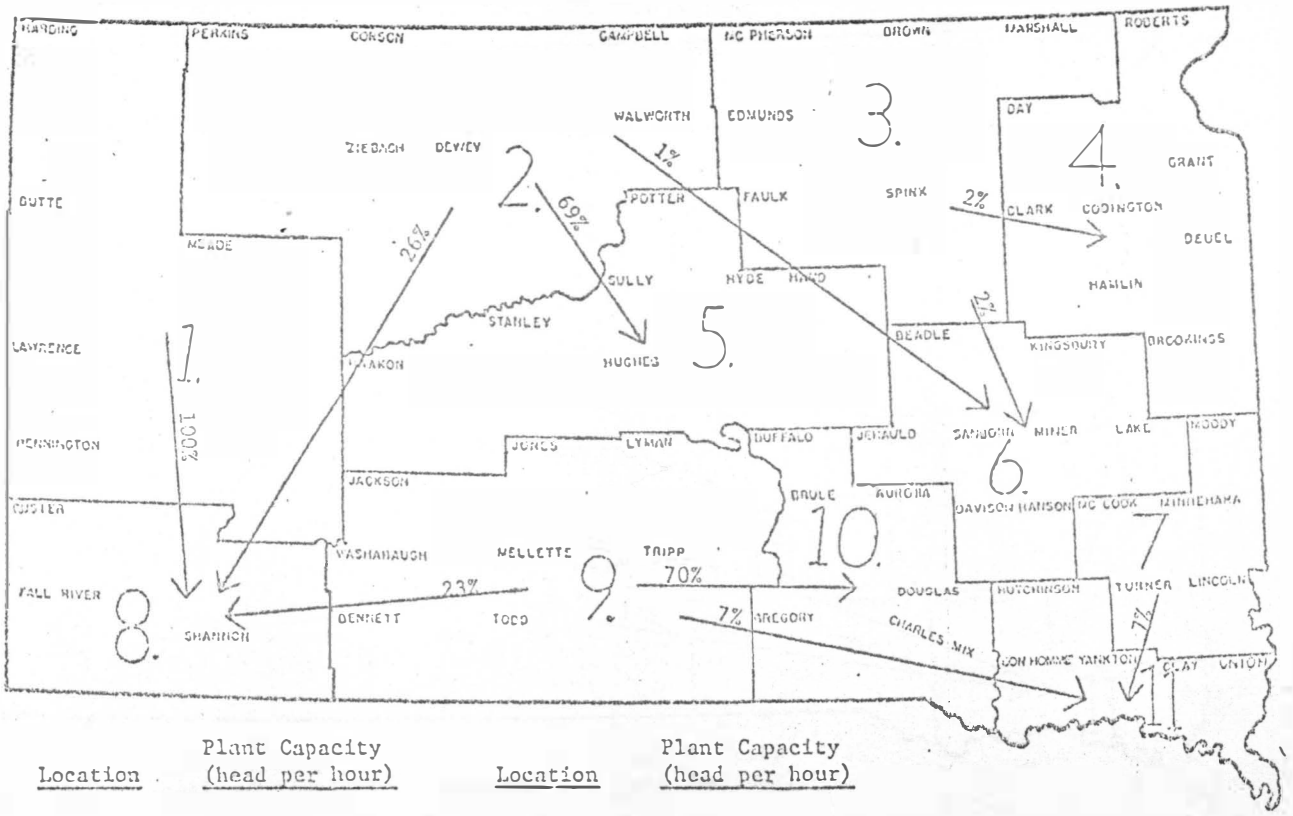
equal. Large plants located near the South Dakota border in Minnesota and Nebraska are drawing a substantial share of their cattle from South Dakota. Thus, out-of-state plants as well as certain factors within the state, such as the availability of utilities, transportation and labor, must be considered in analyzing the practical implications of the results of the model.

Recommended size and location of slaughter plants and estimated flows of slaughter cattle are presented in Figure 6. Estimated supply in each region is as shown in Table 38. The total supply for the state represents about 966,000 head of which approximately 65 percent are fed cattle. This percentage varies from about 25 percent in the Western counties to over 80 percent in the Southeastern counties.

The total estimated supply of available cattle is considerably above the number of cattle slaughtered in the state. Because of this a second analysis was made with supply in each area reduced to 60 percent of the original estimate. The results are shown in Figure 7.

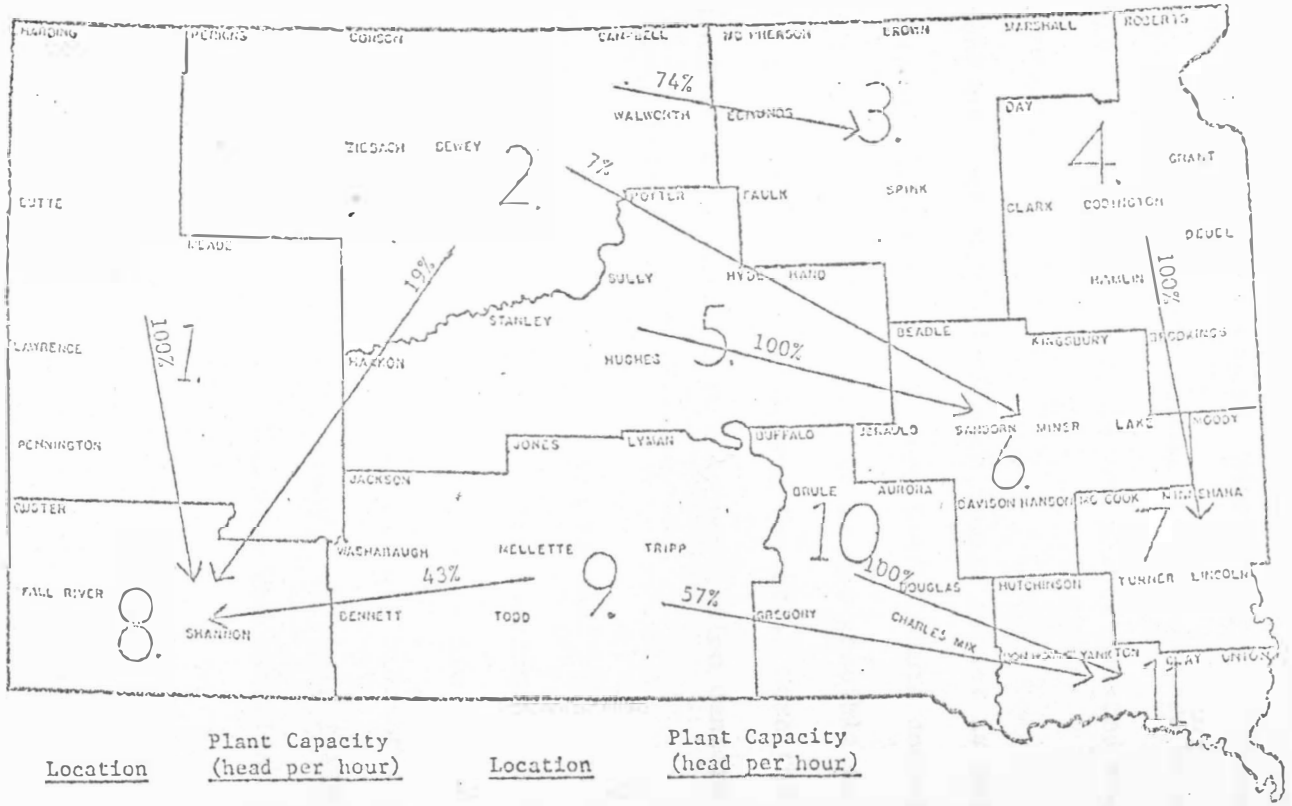
A comparison of Figures 6 and 7 shows the effect of variations in supply on slaughter plant locations. Flows of market cattle tend to be toward the final demand area. This is evident from the location of the plant in Region 8 with cattle being shipped to this plant from Regions 1, 2 and 9. Meat from this plant is shipped west to satisfy the demand allocated to demand centers west of the state.

Figure 6. Plant Sites and Capacities with Optimum Flows of Slaughter Cattle in South Dakota with an Estimated Supply of 966,000 Head.



Location	Plant Capacity (head per hour)	Location	Plant Capacity (head per hour)
3.	75	7.	60
4.	60	8.	60
5.	60	10.	75
6.	60	11.	60

Figure 7. Plant Sites and Capacities with Optimum Flows of Slaughter Cattle in South Dakota with an Estimated Supply of 580,000 Head.



Location	Plant Capacity (head per hour)	Location	Plant Capacity (head per hour)
3.	60	8.	60
6.	60	11.	75
7.	75		

Cattle from other supply regions move east and south to the respective packing plants. Meat from these plants is then allocated to demand centers east and south of the state. When supply was reduced plants in Regions 4, 5 and 10 were eliminated. It became more economical to ship supply from these areas to larger plants located nearer to the demand centers.

The amount of meat shipped to each demand center is determined by present shipment patterns. Beef from South Dakota competes with beef shipped from other states. Thus it is not possible to ship the entire supply to one or two close demand centers. More than one-half of South Dakota's beef is distributed to population centers on the East Coast.

The data presented in this study can be used by industry personnel faced with investment decisions. The conclusions suggest general areas of the state where the location of new or expanded beef slaughter operations should be considered. Present plant locations were not considered in the study, but their influence must be taken into account when recommending the establishment or expansion of plants.

Local development groups can use the data provided by this study to develop the resources of their area. The data provide an indication of the general areas of the state where beef slaughtering has a competitive advantage. The locations specified in the study are intended to be representative of an area and not a specific location. Special input cost advantages, access to markets, variations in supply density, and other conditions

will affect the exact location of plants. Careful consideration should be given to all relevant factors before investments are made. Areas not indicated in the solutions obtained by this study may be considered for plant locations but increases in costs are likely to result. A competitive advantage exists near the center of production in the areas specified provided that the supply of slaughter cattle can be realized. A detailed study of local input costs and flows of slaughter cattle would be necessary to determine the exact plant location.

The optimum solution was determined by the interaction of several variables and it recommended locations for plants with specified volumes. The minimization aspect of the solution is valid only with the plant locations and sizes which resulted. However, in competitive situations it does indicate the areas in which plants are likely to locate. The location decisions of firms over time are likely to be reflected in the model results and viewed in this light it simulates the competitive relationships that firms will face in the future.

South Dakota has been a major exporter of both feeder cattle and feed grain. These resources provide a great potential for expanding cattle feeding and thereby meat packing within the state. The necessary feed and feeder cattle are available within the state to double the number of cattle fed.[40/] An increase

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40/ Raymond O. Gaarder, Trends, Developments, and Potentials for Growth South Dakota's Beef Industry, Economics Department, South Dakota State University, Revised Bulletin 585, December, 1971.

in density of production, holding the volume assembled constant, results in lower assembly costs. Processing costs could also be reduced by greater production density if it resulted in larger plant sizes. Farm income could be increased by expanding feeding operations which in turn would lower costs and increase the profitability of packing plant operations.

Total slaughtering costs per head increased to $24.66 when the number slaughtered was reduced to 60 percent of the supply available. Thus if the beef slaughtering industry in the state could be expanded to obtain all of the available cattle, there would be a savings of approximately $300,000 annually on the number of cattle presently slaughtered.

This analysis is not directly concerned with the impact of increased beef slaughtering on a community or on the state. However, the impact of the additional employment and income resulting from the addition of slaughtering facilities would far exceed the direct savings noted above. For example, the addition of two 60 head per hour and two 75 head per hour packing plants in the state would create approximately 340 jobs and generate an estimated $1,695,498 in wages and salaries. The initial investment would also provide construction opportunities for local contractors. Multiplier effects would further increase the resulting impact.

LIMITATIONS AND NEEDED RESEARCH

The model and the data presented in this study can be used to answer several additional questions which, because of

limitations of time, were not answered by this study. A few of these are listed below.

1. How much would total costs be increased by forcing a plant at a certain location into the solution?
2. Which of the present plants should be phased out to achieve lower total costs?
3. What would be the effect of an increase in processing costs?
4. How would changes in transportation rates affect the optimum solution?
5. In which areas of the state would increases in production be most profitable?

In applying the results of this study the limitations and scope of the analysis should be kept in mind. The influence of seasonal variations in cattle marketing was not considered. Seasonal variations will cause over and under capacity to exist during some periods as the supply fluctuates. No attempt was made to determine plant costs at levels of operation other than the rated capacity. In actuality plants may be forced to vary output as the supply varies. Further research in this area could consider multi-shift and larger capacity slaughtering plants.

Wages and salaries constitute the largest portion of operating costs. Data gathered revealed significant variations among plants as to wage rates and administrative organization. Research on available labor supply and wage rates in a potential site area would be necessary prior to establishing a packing plant. Other factors

such as taxes, utilities, interest, insurance, supplies and services used in the study can be modified to fit local conditions.

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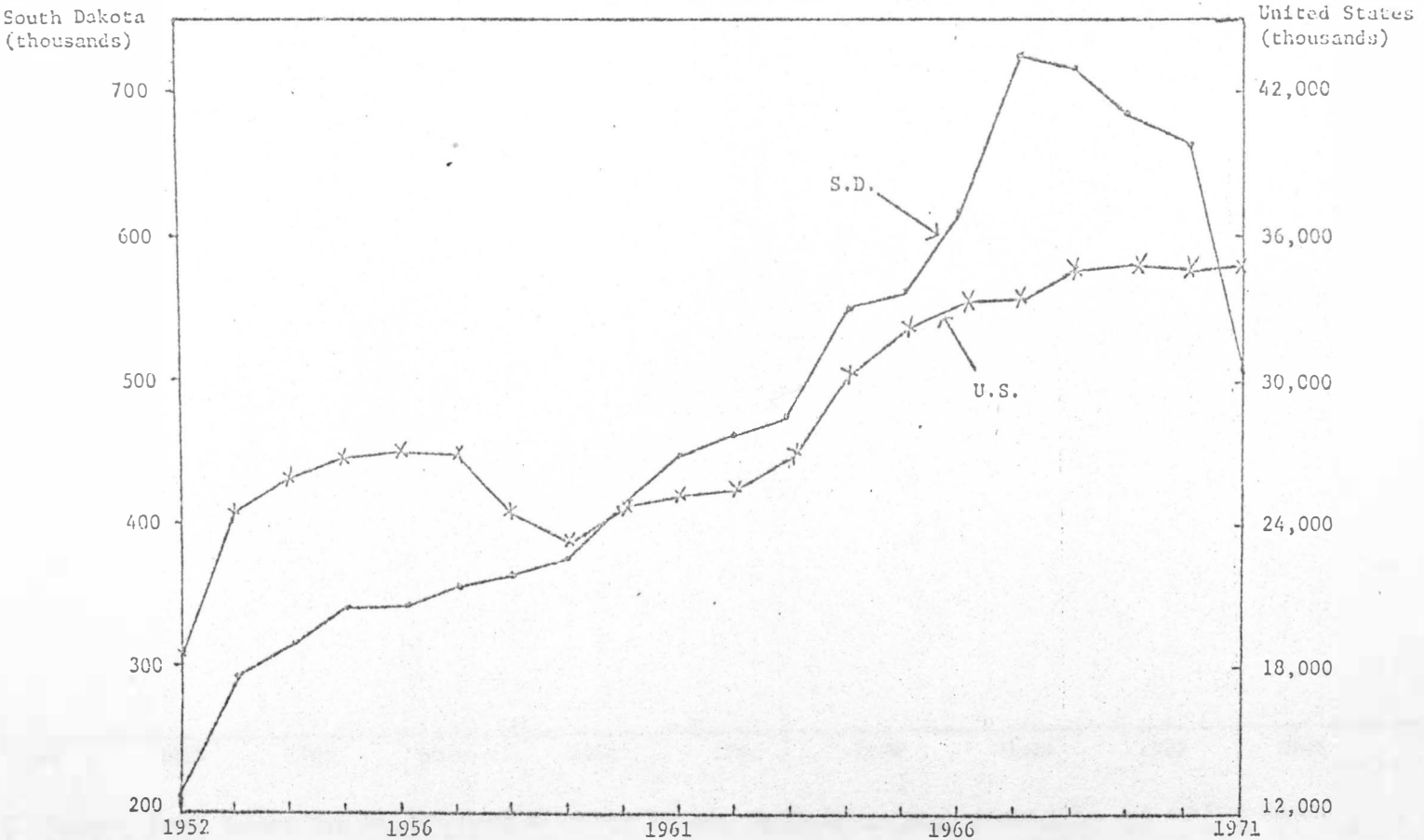
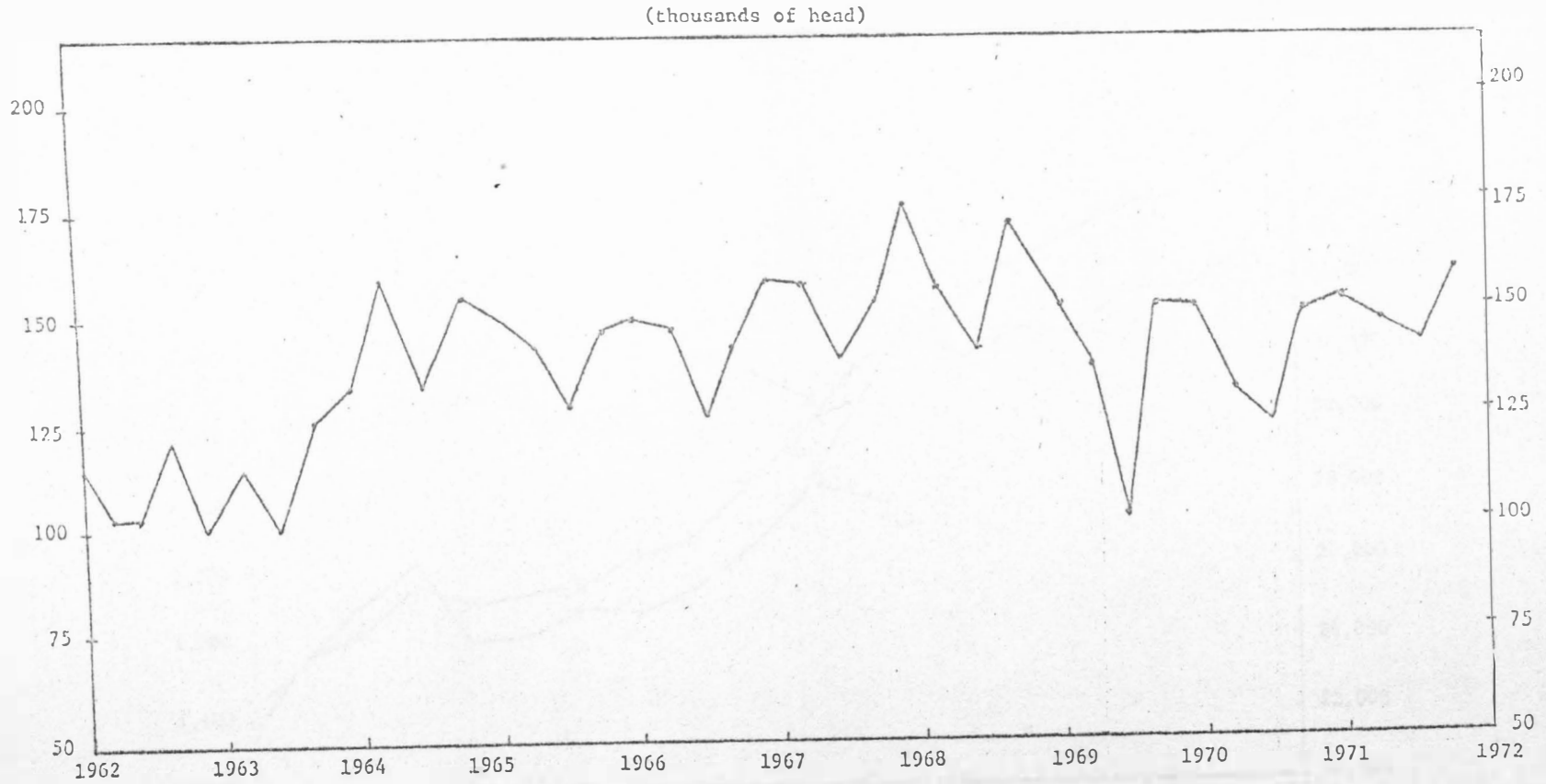
APPENDIX

Figure 8. Cattle Slaughter in South Dakota and in the United States, 1952-1971.



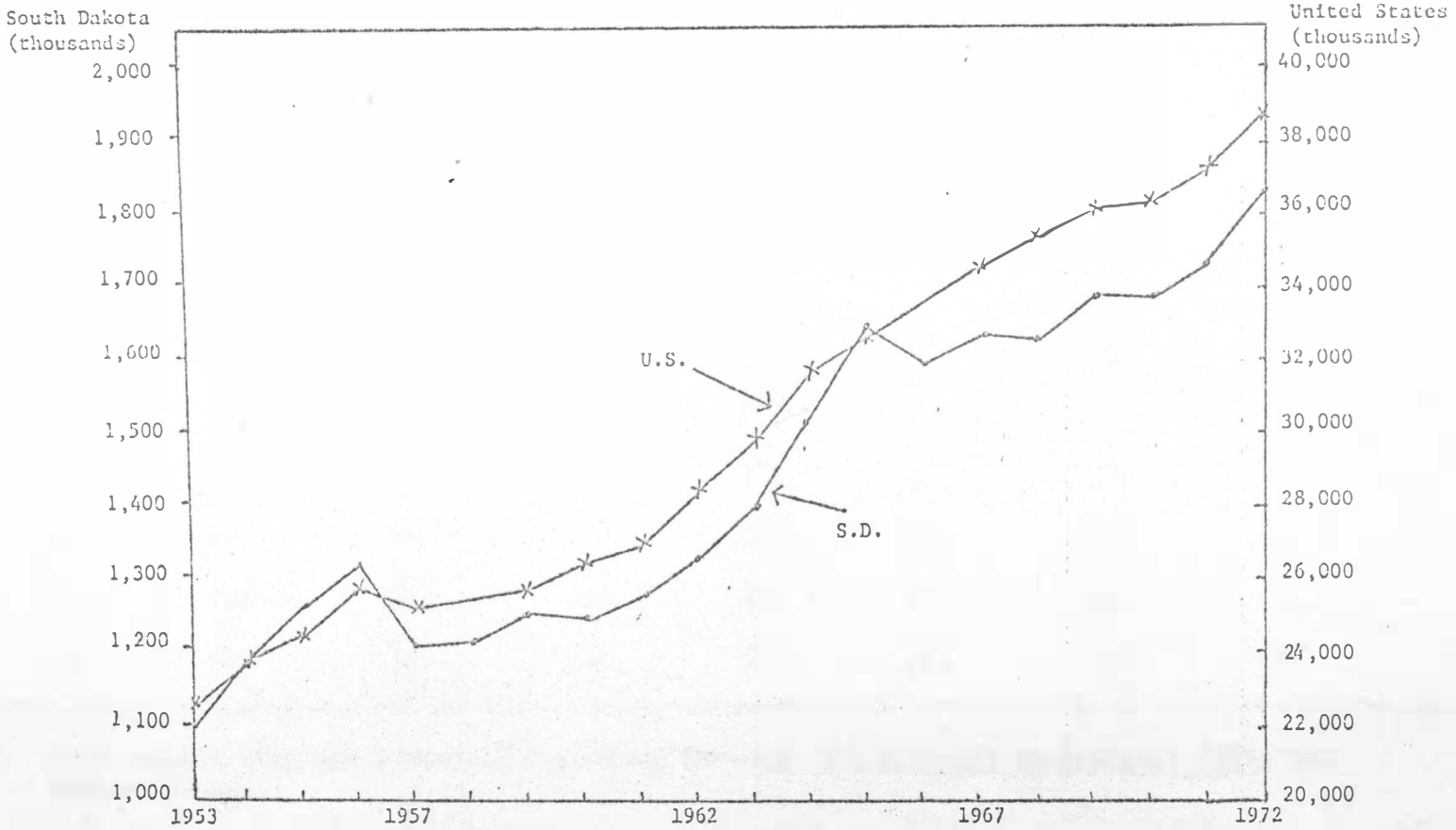
Source: South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture 1971, and earlier issues.

Figure 9. Fed Cattle Marketed by Quarter, South Dakota, 1962-1971.



Source: South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture 1971, and earlier issues.

Figure 10. Beef Cows 2+[1/], South Dakota and the United States, 1953-1972.



Source: South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture 1971, and earlier issues.

1/ Changed to beef cows and heifers that have calved in 1970.

Table 21. Number and Seasonal Distribution of Cattle on Feed in South Dakota by Quarters, 1962-1971.

	January 1		April 1		July 1		October 1	
	1,000 Head	Index Jan. 1=100	1,000 Head	Index Jan. 1=100	1,000 Head	Index Jan. 1=100	1,000 Head	Index Jan. 1=100
1962	325	100	305	94	246	76	198	61
1963	332	100	314	95	258	78	220	66
1964	329	100	342	104	255	78	196	60
1965	322	100	321	100	245	76	235	73
1966	348	100	343	99	270	78	230	66
1967	390	100	364	93	256	66	223	57
1968	406	100	346	85	276	68	230	57
1969	361	100	332	92	270	75	276	76
1970	361	100	342	95	275	76	282	78
1971	339	100	342	101	281	83	285	84

Source: South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture 1971, and earlier issues.

Table 22. Number and Seasonal Distribution of Fed Cattle Marketed in South Dakota by Quarters, 1962-1971.

	January 1		April 1		July 1		October 1	
	1,000 Head	Index Jan. 1-Mar. 31=100	1,000 Head	Index Jan. 1-Mar. 31=100	1,000 Head	Index Jan. 1-Mar. 31=100	1,000 Head	Index Jan. 1-Mar. 31=100
1962	116	100	106	91	106	91	123	106
1963	101	100	116	115	106	105	127	126
1964	135	100	163	121	136	101	156	116
1965	149	100	142	95	126	85	144	97
1966	149	100	146	98	127	85	141	95
1967	164	100	162	99	137	84	155	95
1968	180	100	156	87	145	81	175	97
1969	153	100	138	90	105	69	155	101
1970	152	100	130	86	120	79	150	99
1971	154	100	146	95	140	91	162	105

Source: South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture 1971, and earlier issues.

Table 23. Cash Farm Income from Farm Marketings, South Dakota, 1955-1971.

Year	All crops	All livestock	Cattle and calves	Cattle and calves as percent of total marketings
	million dollars			
1955	167.2	363.9	188.1	35.4
1956	124.9	363.6	197.4	40.4
1957	147.1	389.7	208.9	37.7
1958	195.5	479.1	273.2	40.5
1959	120.1	501.5	304.1	48.9
1960	149.5	451.3	267.9	44.6
1961	171.3	478.9	270.5	41.6
1962	169.4	499.6	290.0	43.3
1963	171.0	488.9	284.3	43.1
1964	150.4	511.6	297.6	45.0
1965	158.8	598.3	356.3	47.1
1966	198.9	682.7	398.6	45.2
1967	203.8	704.9	454.8	50.0
1968	189.3	749.7	487.7	51.9
1969	196.2	779.3	484.5	49.7
1970	200.5	811.5	528.5	52.2
1971	247.7	866.7	1/	1/

Source: South Dakota Crop and Livestock Reporting Service, South Dakota Agriculture 1971, and earlier issues. 1971 figures obtained from Farm Income Situation, U.S.D.A., Economic Research Service, July, 1972.

1/ Figures not available.

Table 24. Synthesized Kill Floor Crews and Annual Labor Costs for the Six Model Plants.

Labor Category	Hourly wages	Output per hour, in number of head: 20 — Number of workers[1]	20 — Annual cost per worker[2]	40 — Number of workers[1]	40 — Annual cost per worker[2]	60 — Number of workers[1]	60 — Annual cost per worker[2]
Drive	4.13			1	9,204.36	1	9,204.36
Pen	4.18					1	9,204.36
Knock	4.18	1	10,085.16				
Shackle and hoist	4.58			1	10,085.16	1	10,085.16
Sticking	4.58						
Scalping	4.13	1 (1)	9,204.36	2 (1)	9,204.36	2	10,085.16
Remove right hind leg	4.28					1	9,424.56
Open right butt	4.83					1	10,635.66
Transfer	4.28	2 (2)	11,296.26	2	10,635.66	1	9,424.56
Remove left hind leg	4.28						
Open left butt	4.83					1	10,635.66
Remove front legs	4.18	1 (1)		2 (1)		1	9,204.36
Rim over	5.13			1 (2)	11,296.26	2	11,296.26
Open shanks, clear out	4.43						
Skin pit of shanks	4.43	1 (3)	11,296.26	2 (3)	10,745.76	1	9,754.86
Clear rosette	4.18						
Clear flanks	5.13	2 (2)		1	11,296.26	1	11,296.26
Open aitch bone	4.83						
Rump	4.83			1 (4)	10,635.66		
Drop bungs	5.13			1 (5)	11,296.26	2	11,296.26
Open and pull tails	4.83	1	11,296.26	1 (4)			
Pull hide	5.13			1	11,296.26	1 (1)	11,296.26
Pull fells	5.13			1 (5)		1 (2)	11,296.26
Saw brisket	4.23	1 (3)		1 (2)		1 (2)	
Back	4.88	1 (4)	10,745.76	2 (3)		1 (2)	
Drop hides	4.23						
Eviscerate	4.33	1 (5)	9,534.66	1 (6)	9,534.66	2	9,534.66
Saw or split carcass	4.93	1	10,855.86	1	10,855.86	2	10,855.86
Trim bruises	4.23	1 (4)		1 (6) 1 (7)	9,314.46		
Scribe and trim neck	4.23	1 (5)		1 (7)		2	9,314.46
Scale	4.23	1 (6)	9,314.46			1	9,314.46
High wash	4.08					1	8,984.16
Low wash	4.08	1	8,984.16			1	8,984.16
High shroud	4.08			3	8,984.16	1	8,984.16
Low shroud	4.08					1	8,984.16
Push into cooler	4.08	1 (6)				2	8,984.16
TOTAL		11	113,909.46	19	192,939.24	31	309,447.06

Table 24 (continued).

Labor category	Hourly wages	Output per hour, in number of head: 75 — Number of workers 1/	75 — Annual cost per worker 2/	90 — Number of workers 1/	90 — Annual cost per worker 2/	120 — Number of workers 1/	120 — Annual cost per worker 2/
Drive	4.18	1	9,204.36	1	9,204.36	3	9,204.36
Pen	4.18	1	9,204.36	1	9,204.36		
Knock	4.18						
Shackle and hoist	4.58	2	10,085.16	2	10,085.16	2	10,085.16
Sticking	4.58	3	10,085.16	1	10,085.16	1	10,085.16
Scalping	4.13			3	9,094.26	4	9,094.26
Remove right hind leg	4.28	1	9,424.56	2	9,424.56	2	9,424.56
Open right butt	4.83	1	10,635.66	1	10,635.66	1	10,635.66
Transfer	4.28	1	9,424.56	1	9,424.56	4	9,424.56
Remove left hind leg	4.28	1	9,424.56	1	9,424.56		
Open left butt	4.83	1	10,635.66	1	10,635.66	1	10,635.66
Remove front legs	4.18	2	9,204.36	2	9,204.36	2	9,204.36
Kick over	5.13	3	11,296.26	3	11,296.26	3	11,296.26
Open shanks, clear out	4.43			2	9,754.86	2	9,754.86
Skin pit of shanks	4.43						
Clear rosette	4.18	1	9,204.36	1	9,204.36	1	9,204.36
Clear flanks	5.13	1	11,296.26	1	11,296.26	2	11,296.26
Open aitch bone	4.83			1	10,635.66		
Hump	4.83	1	10,635.66	1	10,635.66	2	10,635.66
Drop bungs	5.13	1	11,296.26	1	11,296.26	1	11,296.26
Open and pull tails	4.83			1	10,635.66	1	10,635.66
Pull hide	5.13	1	11,296.26	2 (1)	11,296.26	2	11,296.26
Pull tails	5.13						
Saw brisket	4.23	2	10,745.76	2 (1) 1 (2)	10,745.76	1	10,745.76
Back	4.88						
Drop hides	4.23			1 (2)		4	9,314.46
Eviscerate	4.33	2	9,534.66	3	9,534.66	3	9,534.66
Saw or split carcass	4.93	2	10,855.86	2	10,855.86	3	10,855.86
Trim bruises	4.23	3	9,314.46	3	9,314.46	3	9,314.46
Scribe and trim neck	4.23						
Scale	4.23	1	9,314.46	1	9,314.46	2	9,314.46
High wash	4.08	1	8,984.16	2	8,984.16	2	8,984.16
Low wash	4.08	1	8,984.16	1	8,984.16	2	8,984.16
High shroud	4.08	1	8,984.16	1	8,984.16	2	8,984.16
Low shroud	4.08	1	8,984.16	2	8,984.16	2	8,984.16
Push into cooler	4.08	2	8,984.16	2	8,984.16	2	8,984.16
TOTAL		38	377,841.18	47	463,212.72	60	587,053.20

Source: Adapted from Franzmann and Kuntz, Economies of Size in Southwestern Beef Slaughter Plants, 1966, p. 34.

1/ Similar figures in parentheses indicate that the operations are being performed by the same man or men.

2/ The worker will always be paid the wage rate of the highest skill he is performing (Table 28).

Table 25. Synthesized Crews and Annual Labor Costs for the Supporting Operations in the Six Model Plants.

Operation	Hourly wages	Output per hour, in number of head: 20 — Number of workers	20 — Annual cost per worker 1/	40 — Number of workers	40 — Annual cost per worker 1/	60 — Number of workers	60 — Annual cost per worker 1/
Hog Offal Labor							
Foreman	4.38			1	9,644.76	1	9,644.76
Separate, open and flush paunches	4.18	1	9,644.76	1	9,314.46	3	9,314.46
Bone heads, save brains	4.23						
Trim plucks, hang offal	4.18	1	9,314.46	1	9,204.36		
Wash hang, brand edible offal	4.23			1	9,314.46	1	9,314.46
Cooler Labor							
Foreman	4.58	1	10,035.16	1	10,035.16	1	10,035.16
Remove shrouds, push carcasses	4.13			3	9,094.26	3	9,094.26
Dock Labor							
Foreman	4.58			1	10,035.16	1	10,035.16
Roll beef, hook cars and trucks	4.13	1	10,035.16	1	9,094.26	1	9,094.26
Push to scale	4.13						
Scale	4.23			1	9,314.46	1	9,314.46
Dock pusher	4.13	3	9,864.96	6	9,864.96	6	9,864.96
Luggers	4.48						
Rendering Labor							
Foreman	4.38	1	9,644.76	1	9,644.76	1	9,644.76
Helper	4.13			1	9,094.26	1	9,094.26
Maintenance Labor							
Foreman	4.83	1	10,635.66	1	10,635.66	1	10,635.66
Helper	4.23			1	9,314.46	2	9,314.46
Yardmen	4.13	1	9,094.26	2	9,094.26	2	9,094.26
TOTAL		10	98,099.10	23	219,407.28	25	238,146.30

Table 25 (continued).

Operation	Hourly wages	Output per hour, in number of head: 75 — Number of workers	75 — Annual cost per worker 1/	90 — Number of workers	90 — Annual cost per worker 1/	120 — Number of workers	120 — Annual cost per worker 1/
Pot Offal Labor							
Foreman	4.38	1	9,644.76	1	9,644.76	1	9,644.76
Separate, open and flush paunches	4.13	2	9,314.46	3	9,314.46	5	9,314.46
Bone heads, save brains	4.23						
Trim plucks, hang offal	4.18	2	9,204.36	2	9,204.36	3	9,204.36
Wash hang, brand edible offal	4.23	1	9,314.46	1	9,314.46	2	9,314.46
Cooler Labor							
Foreman	4.58	1	10,085.16	1	10,085.16	1	10,085.16
Remove shrouds, push carcasses	4.13	4	9,094.26	6	9,094.26	12	9,094.26
Dock Labor							
Foreman	4.58	1	10,085.16	1	10,085.16	1	10,085.16
Roll beef, hook cars and trucks	4.13	1	9,094.26	1	9,094.26	1	9,094.26
Push to scale	4.13			1	9,094.26	1	9,094.26
Scale	4.23	1	9,314.46	1	9,314.46	1	9,314.46
Dock pusher	4.13			4	9,094.26	5	9,094.26
Loggers	4.48	8	9,864.96	5	9,864.96	5	9,864.96
Rendering Labor							
Foreman	4.38	1	9,644.76	1	9,644.76	1	9,644.76
Helper	4.13	2	9,094.26	2	9,094.26	3	9,094.26
Maintenance Labor							
Foreman	4.83	1	10,635.66	1	10,635.66	1	10,635.66
Helper	4.23	3	9,314.46	4	9,314.46	5	9,314.46
Yardmen	4.13	2	9,094.26	3	9,094.26	3	9,094.26
TOTAL		31	294,473.46	38	356,261.58	51	475,477.86

Source: Adapted from Franzmann and Kuntz, Economies of Size in Southwestern Beef Slaughter Plants, 1966, p. 35.

1/ The worker will always be paid the wage rate of the highest skill he is performing (Table 28).

Table 26. Job Descriptions and Typical Union Hourly Wage Rates for Kill Floor and Supporting Operations Personnel.

Operation	Bracket	Hourly Wage (dollars)
1. Utility	22	5.13
2. Briskets, Rim Over	22	5.13
3. Skin Sides	22	5.13
4. Open Bellies, Bung Out, Skin Flank around Udder or Cod, Cut Bags	22	5.13
5. Splitter	18	4.93
6. Back and Neck	17	4.88
7. Rump, Open Tail to Pattern	16	4.83
8. Stick and Face Cattle, Shackle	11	4.58
9. Header	8	4.43
10. Skin Shanks and Neck Area	8	4.43
11. Gutter	6	4.33
12. Hind Legger and Hang-off	5	4.28
13. Hide Stripper	4	4.23
14. Saw Briskets, Pull and Tie Weasands	4	4.23
15. Bruise Trimmer, Cut Flanks, Open Kidneys	4	4.23
16. Scribe, Plug, Trim Neck, Trim Skirt, Tip and Remove Tail	4	4.23
17. Clean-up and Knocks	4	4.23
18. Scaler	4	4.23
19. Bone Heads	4	4.23
20. Saving Edible Fat	4	4.23
21. Running Ruffle Fat and Rounds	4	4.23
22. Tongue Trimmer	4	4.23
23. Scrape Heads, Strip Weasands	4	4.23
24. Cattle Driver, Shackler and Knocker	3	4.18
25. Front Legger, Cut Head Off, Put on Wash Stand, Remove Horns	3	4.18
26. Clean Bungs, Tie Bungs, Rip Tail	3	4.18
27. Hot Offal Table	3	4.18
28. Head Washer and Drop Tongues, Remove Horns	2	4.13
29. Shrouder	2	4.13
30. Tripe Cleaner	2	4.13
31. Wash Tails, Dump Fat, Brand	2	4.13
32. High Wash	1	4.08
33. Low Wash	1	4.08
34. High Shrouds	1	4.08
35. Low Shrouds and Push in Cooler	1	4.08
36. Clean Floor, Offal Racks, Trolleys	1	4.08
37. Labor	0	4.03

Source: Local 304, The Amalgamated Meat Cutters and Butcher Workmen of North America, AFL-CIO, Sioux Falls, agreement with Spencer Foods, Inc., Sioux Falls, So. Dak. plant. Wage rates effective September 7, 1972.

Table 27. Estimated Annual Wage Schedule of Hourly Employees.[1/]

Hourly wage	Annual wage[2/]	Vacation pay[3/]	Sick leave[4/]	Total Annual wage[5/]
		dollars		
4.03	8,382.40	322.40	169.26	8,874.06
4.08	8,486.40	326.40	171.36	8,984.16
4.13	8,590.40	330.40	173.46	9,094.26
4.18	8,694.40	334.40	175.56	9,204.36
4.23	8,798.40	338.40	177.66	9,314.46
4.28	8,902.40	342.40	179.76	9,424.56
4.33	9,006.40	346.40	181.86	9,534.66
4.38	9,110.40	350.40	183.96	9,644.76
4.43	9,214.40	354.40	186.06	9,754.86
4.48	9,318.40	358.40	188.16	9,864.96
4.58	9,526.40	366.40	192.36	10,085.16
4.63	9,630.40	370.40	194.46	10,195.26
4.83	10,046.40	386.40	202.86	10,635.66
4.88	10,150.40	390.40	204.96	10,745.76
4.93	10,254.40	394.40	207.06	10,855.86
5.13	10,670.40	410.40	215.46	11,296.26

1/ Wage rate and wage practices (vacation pay, sick leave and holidays) based on an agreement between Spencer Foods, Inc. and the Amalgamated Meat Cutters and Butcher Workmen of North America, AFL-CIO, Local No. 304.

2/ Hourly wage times 2,080 hours.

3/ Based on two weeks of vacation with full pay (40 hours per week).

4/ Based on two weeks of payment--the first equal to 50 percent of the regular weekly wage and the second equal to 55 percent.

5/ Sum of columns 2, 3 and 4.

Table 28. Estimated Salaried Personnel Requirements and Annual Personnel Costs of the Six Model Plants, South Dakota, 1972.

		Plant size in head per hour					
		20	40	60	75	90	120
General Manager	salary	13,006	15,744	19,850	23,958	34,225	34,225
	no.	(1)	(1)	(1)	(1)	(1)	(1)
Senior buyer	salary		12,321	12,321	15,744	15,744	15,744
	no.		(1)	(1)	(1)	(1)	(1)
Sales manager	salary		12,321	12,321	15,744	15,744	15,744
	no.		(1)	(1)	(1)	(1)	(1)
Plant superintendent	salary		10,268	12,321	15,744	15,744	15,744
	no.		(1)	(1)	(1)	(1)	(1)
Assistant plant superintendent	salary			7,119	7,666	8,214	8,214
	no.			(1)	(1)	(1)	(1)
Buyers	salary	10,268	10,268	10,268	11,637	11,637	11,637
	no.	(2)	(3)	(5)	(6)	(7)	(10)
Sellers	salary	10,268	10,268	10,268	11,637	11,637	11,637
	no.	(2)	(3)	(5)	(6)	(7)	(10)
Office manager	salary		12,321	12,321	15,744	15,744	15,744
	no.		(1)	(1)	(1)	(1)	(1)
Switchboard	salary		4,107	4,107	4,107	4,107	4,107
	no.		(1)	(1)	(1)	(1)	(1)
Secretary	salary	4,107	4,107	4,928	4,928	4,928	4,928
	no.	(1)	(1)	(2)	(2)	(3)	(5)
Bookkeeper	salary	8,214	8,214	8,214	8,214	8,214	8,214
	no.	(1)	(1)	(1)	(2)	(2)	(4)
Payroll & billing clerk	salary	4,928	4,928	4,928	4,928	4,928	4,928
	no.	(1)	(1)	(1)	(1)	(1)	(1)
Total	salary	71,325	145,935	206,035	269,556	309,394	404,676
	no.	(8)	(15)	(21)	(24)	(27)	(37)

Source: Adapted from Franzmann & Kuntz, Economies of Size in Southwestern Beef Slaughter Plants, 1966, p. 33. Salaries inflated by a factor of 4% per year from 1964-1972.

Table 29. Estimated Building Requirements and Construction Costs for the Six Model Plants, South Dakota, 1972.

		20		40		60	
	Cost per sq. ft.	Floor area (sq. ft.)	Total cost (dollars)	Floor area (sq. ft.)	Total cost (dollars)	Floor area (sq. ft.)	Total cost (dollars)
Kill floor	29.46	1,750	51,555.00	2,990	88,085.40	3,280	96,628.80
Chill cooler		1,710	37,889.24	3,132	64,325.80	4,692	91,871.23
Holding cooler		2,247	49,400.99	3,782	76,722.51	5,472	108,177.06
Rendering	24.55	1,500	36,825.00	1,800	44,190.00	2,825	69,353.75
Corrals		8,800	13,544.52	17,800	27,040.41	27,800	42,481.83
Employee dressing	9.82	391	3,839.62	765	7,512.30	1,054	10,350.28
Equipment clean-up	9.82	224	2,199.68	224	2,199.68	224	2,199.68
Dock	24.55	420	10,311.00	620	15,221.00	720	17,676.00
Dock apron	.82	840	688.80	1,240	1,016.80	1,440	1,180.80
Dry storage	9.82	100	982.00	150	1,473.00	344	3,378.08
Office	16.37	1,320	21,608.40	2,160	35,359.20	2,880	47,145.60
Parking lots	.92	9,486	8,727.12	18,414	16,940.88	25,389	23,357.88
Totals		28,788	237,571.37	53,077	380,086.98	76,120	513,800.99

Table 29 (continued).

		75		90		120	
	Cost per sq. ft.	Floor area (sq. ft.)	Total cost (dollars)	Floor area (sq. ft.)	Total cost (dollars)	Floor area (sq. ft.)	Total cost (dollars)
Kill floor	29.46	4,260	125,499.60	5,247	154,576.62	8,970	264,256.20
Chill cooler		5,712	110,503.49	7,490	140,721.66	8,964	168,562.84
Holding cooler		6,912	128,119.63	7,917	151,645.05	10,527	201,145.03
Rendering	24.55	3,425	84,083.75	4,040	99,182.00	5,000	122,750.00
Corrals		33,400	49,685.13	39,800	59,539.94	52,300	78,021.70
Employee dressing	9.82	1,343	13,188.26	1,683	16,527.06	2,346	23,037.72
Equipment clean-up	9.82	224	2,199.68	224	2,199.68	224	2,199.68
Dock	24.55	720	17,676.00	870	21,358.50	870	21,358.50
Dock apron	.82	1,440	1,180.80	1,740	1,426.80	1,740	1,426.80
Dry storage	9.82	429	4,212.78	514	5,047.48	639	6,274.98
Office	16.37	3,240	53,038.80	3,600	58,932.00	4,800	78,576.00
Parking lots	.92	31,527	29,004.84	38,502	35,421.84	52,110	47,941.20
Totals		92,632	618,392.76	111,627	746,578.63	148,490	1,015,550.65

Source: Adapted from Franzmann and Kuntz, Economies of Size in Southwestern Beef Slaughter Plants, 1966, p. 8. Construction costs inflated 5.6 percent per year according to the Department of Commerce Commercial and Factory Building Construction Index. Cooler and corral costs detailed in following tables.

Table 30. Estimated Cost of Chill Coolers, South Dakota, 1972.

Plant size in head per hour	Area	Exterior wall	Construction cost of exterior wall[1/]	Number of floor drains	Cost of floor drains[2/]	Number of doors	Cost of doors[3/]	Feet of rail	Cost of rail installed[4/]	Total cost
	(sq. ft.)	(sq. ft.)	(dollars)		(dollars)		(dollars)		(dollars)	(dollars)
20	1,710	5,084	33,300.20	4	157.16	1	893.80	432	3,538.08	37,889.24
40	3,132	8,422	55,164.10	8	314.32	2	1,787.60	862	7,059.78	64,325.80
60	4,692	12,062	79,006.10	12	471.48	2	1,787.60	1,295	10,606.05	91,871.23
75	5,712	14,492	94,922.60	14	550.06	2	1,787.60	1,617	13,243.23	110,503.49
90	7,470	18,359	120,251.45	19	746.51	2	1,787.60	2,190	17,936.10	140,721.66
120	8,964	21,815	142,888.25	23	903.67	4	3,575.20	2,588	21,195.72	168,562.84

Source: Adapted from Franzmann & Kuntz, Economies of Size in Southwestern Beef Slaughter Plants, 1966, p. 30. Costs inflated 5.6 percent per year according to the Department of Commerce Commercial and Factory Building Construction Index.

1/ Column 3 times $6.55 per square foot.

2/ Column 5 times $39.29 each.

3/ Column 7 times $893.80 each.

4/ Column 9 times $8.19.

Table 31. Estimated Cost of Holding Coolers, South Dakota, 1972.

Plant size in head per hour	Area	Exterior wall	Construction cost of exterior wall 1/	Number of floor drains	Cost of floor drains 2/	Number of doors	Cost of doors 3/	Feet of rail	Cost of rail installed 4/	Total cost
	(sq. ft.)	(sq. ft.)	(dollars)		(dollars)		(dollars)		(dollars)	(dollars)
20	2,247	6,483	42,463.65	6	235.74	2	1,787.60	600	4,914.00	49,400.99
40	3,782	9,886	64,753.30	9	353.61	2	1,787.60	1,200	9,828.00	76,722.51
60	5,472	13,908	91,097.40	14	550.06	2	1,787.60	1,800	14,742.00	108,177.06
75	6,912	16,372	107,236.60	17	667.93	2	1,787.60	2,250	18,427.50	128,119.63
90	7,917	19,383	126,958.65	20	785.80	2	1,787.60	2,700	22,113.00	151,645.05
120	10,527	25,500	167,025.00	27	1,060.83	4	3,575.20	3,600	29,484.00	201,145.03

Source: Adapted from Franzmann & Kuntz, Economies of Size in Southwestern Beef Slaughter Plants, 1966, p. 30. Costs inflated 5.6 percent per year according to Department of Commerce Commercial and Factory Building Construction Index.

1/ Column 3 times $6.55 per square foot.

2/ Column 5 times $39.29 each.

3/ Column 7 times $893.80 each.

4/ Column 9 times $8.19.

Table 32. Estimated Cost of Corral Flooring and Roofing, South Dakota, 1972.

Plant size in head per hour	Pens needed 10' x 20'	Area in pens	Area in alleys	Total area	Cost of pen and alley floor 1/	Gates	Length of fencing	Cost of gates and fencing 2/	Area cover by weathertight roof	Cost of weathertight roof 3/	Total cost
	(number)	square feet			(dollars)	(number)	(feet)	(dollars)	(sq. ft.)	(dollars)	(dollars)
20	32	6,400	2,400	8,800	7,211.88	36	1,120	3,516.64	1,760	2,816.00	13,544.52
40	66	13,200	4,600	17,800	14,490.09	73	2,140	6,854.32	3,560	5,696.00	27,040.41
60	104	20,800	7,000	27,800	22,706.91	113	3,440	10,878.92	5,560	8,896.00	42,481.83
75	128	25,600	7,800	33,400	26,906.15	137	3,650	12,090.98	6,680	10,688.00	49,685.13
90	152	30,400	9,400	39,800	32,171.60	161	4,490	14,632.34	7,960	12,736.00	59,539.94
120	200	40,000	12,300	52,300	42,213.02	212	5,820	19,072.68	10,460	16,736.00	78,021.70

Source: Adapted from Franzmann & Kuntz, Economies of Size in Southwestern Beef Slaughter Plants, 1966, p. 28. Costs inflated 5.37 percent per year according to the Department of Commerce Composite Construction Cost Index.

1/ $.72 per sq. ft. for total area of alleys and pens plus area for posts and curbs separating pens.

2/ Fencing cost estimated at $2.11 per linear foot, gates (10 feet wide) estimated at $32.04.

3/ Cost of roof estimated at $1.60 per sq. ft.

Table 33. Estimated Electrical Requirements and Costs by Size of Plant, South Dakota, 1972.

Plant size in head per hour	Average monthly electrical requirements	Billing demand per month	Monthly demand charge	Monthly energy charge	Total monthly electrical cost	Total yearly electrical cost
	kwh	kw	$	$	$	$
20	61,760	247	427	648	1,075	12,901
40	110,421	442	739	1,109	1,848	22,176
60	159,082	636	1,029	1,547	2,576	30,911
75	195,416	782	1,241	1,374	3,115	37,376
90	232,200	929	1,454	2,198	3,652	43,829
120	305,066	1,220	1,861	2,840	4,700	56,402

Source: Electrical requirements obtained from Logan and King, Economies of Scale in Beef Slaughter Plants, 1961, p. 84. Requirements for 90 head per hour plant were estimated by linear projection. Billing demand was estimated to be 4 kw for every 1,000 kwh from Logan and King, Economies of Scale in Beef Slaughter Plants, 1961, p. 83.
Industrial electricity rates were obtained from four public utilities, three cooperatives and one municipality in South Dakota. These rates were averaged to formulate the following schedule.

Demand Charge: $1.92 per kw for the first 100 kw of billing demand per month
$1.60 per kw for the next 400 kw of billing demand per month
$1.45 per kw for the next 500 kw of billing demand per month
$1.38 per kw for all over 1000 kw of billing demand per month

Energy Charge: 1.07¢ per kwh for the first 50,000 kwh used per month
.96¢ per kwh for the next 50,000 kwh used per month
.90¢ per kwh for the next 100,000 kwh used per month
.88¢ per kwh for all over 200,000 kwh used per month

Table 34. Estimated Water Requirements and Water and Sewage Costs by Size of Plant, South Dakota, 1972.

Plant size in head per hour	Average monthly water requirements	Water costs		Sewage costs		Total water and sewage costs	
		Monthly	Yearly	Monthly	Yearly	Monthly	Yearly
	(thou. gal.)	dollars					
20	855	234	2,810	70	843	304	3,653
40	1,711	431	5,172	129	1,552	560	6,724
60	2,566	628	7,532	188	2,260	816	9,791
75	3,204	774	9,293	232	2,788	1,007	12,081
90	3,848	923	11,072	277	3,322	1,199	14,394
120	5,132	1,211	14,538	363	4,361	1,575	18,899

Source: Water requirements obtained from Logan and King, Economies of Scale in Beef Slaughter Plants, 1961, p. 85. Requirements are 36.2 cubic feet per head slaughtered. Rates were obtained from five cities in South Dakota and averaged. Rate schedule was as follows:

$3.39 for the first 1,000 gal. per month
$0.96 per 1,000 gal. for the next 4,000 gal. used per month
$0.41 per 1,000 gal. for the next 10,000 gal. used per month
$0.32 per 1,000 gal. for the next 135,000 gal. used per month
$0.28 per 1,000 gal. for the next 350,000 gal. used per month
$0.23 per 1,000 gal. for the next 4,000,000 gal. used per month
$0.22 per 1,000 gal. for all over 4,500,000 gal. used per month

Annual requirements and costs are 12 times the monthly figures.
Sewage costs were averaged for the five cities. The rate obtained was 30 percent of the water bill.

Table 35. Estimated Requirements and Cost of Natural Gas by Size of Plant, South Dakota, 1972.

Plant size in head per hour	Monthly gas requirements	Gas costs	
		Monthly	Annually
	Thou. cu. ft.	dollars	
20	222.6	136	1,634
40	342.7	200	2,398
60	443.5	253	3,039
75	524.2	294	3,529
90	618.3	336	4,037
120	806.4	421	5,053

Source: Gas requirements obtained from Logan and King, Economies of Scale in Beef Slaughter Plants, 1961, p. 88. Requirements for the 90 head per hour plant were estimated by linear projection. Rates from two power companies servicing South Dakota were averaged. Rates used were for interruptible service. The following rate schedule resulted:

$.82 per Mcf for the first 10 Mcf used per month
$.70 per Mcf for the next 90 Mcf used per month
$.53 per Mcf for the next 400 Mcf per month
$.45 per Mcf for all over 500 Mcf used per month

Table 36. Intrastate Transportation Rates for Livestock, South Dakota.[1/]

Miles	Rate in cents per cwt. for minimum load weight of 37,000 pounds	Miles	Rate in cents per cwt. for minimum load weight of 37,000 pounds
0-5	6	211-220	46
6-10	9	221-230	47
11-20	13	231-240	48
21-25	14	241-250	49
26-30	15	251-260	50
31-35	16	261-270	51
36-40	17	271-280	53
41-45	18	281-290	54
46-50	20	291-300	55
51-55	21	301-310	56
56-60	22	311-320	57
61-65	23	321-330	58
66-70	24	331-340	59
71-75	25	341-350	61
76-80	26	351-360	63
81-85	27	361-370	65
86-90	29	371-380	66
91-95	31	381-390	68
96-100	32	391-400	70
101-110	33	401-410	71
111-120	34	411-420	72
121-130	35	421-430	73
131-140	36	431-440	74
141-150	37	441-450	76
151-160	38	451-460	77
161-170	39	461-470	79
171-180	41	471-480	81
181-190	43	481-490	83
191-200	44	491-500	85
201-210	45		

1/ Applicable on South Dakota Intrastate traffic by all Class B Motor Carriers operating under permits issued by the state Public Utilities Commission. Rates effective April 3, 1972.

Table 37. Estimated Quantities of South Dakota Beef Shipped to Demand Centers.

Demand center	Percent of total demand	Units (10,000 pounds)
1. Minneapolis, Minnesota	10	5,367
2. Chicago, Illinois	20	10,735
3. Baltimore, Maryland	10	5,367
4. New York, New York	17	9,124
5. Boston, Massachusetts	25	13,418
6. Atlanta, Georgia	6	3,220
7. Denver, Colorado	6	3,220
8. Los Angeles, California	6	3,220

Table 38. Estimated Annual Supply Available in Each Supply Region.

Supply region	Counties included	Supply (10,000 lbs.) 1/
1	Harding, Butte, Lawrence, Meade, Pennington	2449
2	Perkins, Corson, Ziebach, Dewey, Campbell Walworth	3548
3	McPherson, Edmunds, Faulk, Brown, Spink, Marshall	9299
4	Roberts, Day, Grant, Clark, Codington, Deuel, Hamlin, Brookings	6953
5	Haakon, Stanley, Potter, Sully, Hughes, Hyde Hand	4728
6	Beadle, Kingsbury, Jerauld, Sanborn, Miner, Lake, Davison, Hanson	6968
7	Moody, McCook, Minnehaha, Turner, Lincoln	7660
8	Custer, Fall River, Shannon	2981
9	Jackson, Washabaugh, Bennett, Jones, Mellette Todd, Lyman, Tripp	3464
10	Buffalo, Brule, Aurora, Gregory, Charles Mix, Douglas	6515
11	Hutchinson, Bon Homme, Yankton, Clay, Union	6428
		60,993

1/ Dressed weight

Table 39. Slaughter Plant Capacities and Processing Costs.

Size of plant in head per hour	Annual volume in dressed weight[1/] (10,000 pounds)	Estimated processing cost per 10,000 pounds of dressed weight (dollars)
20	2,386	194
40	4,773	185
60	7,159	168
75	8,949	167
90	10,738	166
120	14,318	163

1/ Based on average weight of live animal of 1,061 pounds obtained from the South Dakota Crop and Livestock Reporting Service for South Dakota from 1966-1971 and average dressing percent for U. S. from 1966-1971 of 59.5% (S. D. Crop and Livestock Reporting Service).

Table 40. Estimated South Dakota Transportation Costs from the Supply Regions to the Plants.

Supply region	Plants										
	1	2	3	4	5	6	7	8	9	10	11
	dollars per 10,000 pounds of dressed weight										
1	35	59	86	109	72	96	113	55	69	86	109
2	59	34	62	84	55	77	96	74	66	76	92
3	86	62	30	57	57	57	76	96	76	66	77
4	109	84	57	29	72	49	59	118	84	69	66
5	72	55	57	72	30	59	77	76	52	55	74
6	96	77	57	49	59	27	52	96	72	49	55
7	118	96	76	59	77	52	25	114	82	61	40
8	55	74	96	118	76	96	114	27	62	84	103
9	69	66	76	84	52	72	82	62	34	55	74
10	86	76	66	69	55	49	61	84	55	27	52
11	109	92	77	66	74	55	40	103	74	52	24

Table 41. Estimated Transportation Rates from South Dakota Plants to Demand Centers.

Plants	Demand Centers							
	1	2	3	4	5	6	7	8
	dollars per 10,000 pounds							
1	127	170	307	324	348	265	99	258
2	105	155	292	309	333	250	119	278
3	80	136	273	290	314	231	139	298
4	62	121	258	275	299	216	153	312
5	93	138	275	292	316	233	120	279
6	72	117	254	271	295	212	140	299
7	63	100	237	254	278	195	136	295
8	131	168	305	322	346	251	84	243
9	106	143	280	297	321	226	109	268
10	87	113	250	267	291	208	128	287
11	75	96	233	250	274	191	128	287

Table 42. Initial Cost Matrix Including Assembling and Processing Costs.

Row Number	Designation	Column Numbers 1 P1	2 P2	3 P3	4 P4	5 P5	6 P6	7 P7	8 P8	9 P9	10 P10	11 P11	12 Totals
1	S1	229	253	277	257	257	264	286	249	263	254	277	2449
2	S2	253	228	229	252	240	245	264	268	260	244	260	3548
3	S3	280	256	197	225	242	225	244	290	270	234	245	9299
4	S4	303	278	224	197	257	217	227	312	278	237	234	6953
5	S5	266	249	224	240	215	227	245	270	246	223	242	4728
6	S6	290	271	224	217	244	195	220	290	266	217	223	6968
7	S7	312	290	243	227	262	220	193	303	276	229	208	7660
8	S8	249	268	263	286	261	264	282	221	256	252	271	2931
9	S9	263	260	243	252	237	240	250	256	228	223	242	3464
10	S10	280	270	233	237	240	217	229	278	249	195	220	6515
11	S11	303	286	244	234	259	223	208	297	268	220	192	6428
12	Totals	2386	2386	8949	7159	4773	7159	7159	2386	2386	7159	7159	

Table 43. Matrix for Final Solution Including Assembling and Processing Costs.

Row Number	Desig-nation	Column Number 1 P3	2 P4	3 P5	4 P6	5 P7	6 P8	7 P10	8 P11	9 Totals
1	S1	253	277	240	264	286	223	253	277	2449
2	S2	229	252	223	245	264	242	243	260	3548
3	S3	197	225	225	225	244	264	233	245	9299
4	S4	224	197	240	217	227	286	236	234	6953
5	S5	224	240	198	227	245	244	222	242	4728
6	S6	224	217	227	195	220	264	216	223	6968
7	S7	243	227	245	220	193	282	228	208	7660
8	S8	263	286	244	264	282	195	251	271	2981
9	S9	243	252	220	240	250	230	222	242	3464
10	S10	233	237	223	217	229	252	194	220	6515
11	S11	244	234	242	223	208	271	219	192	6428
12	Totals	8949	7159	7159	7159	7159	7159	8949	7159	

Table 44. Distribution Cost Matrix for Final Solution.

Row Number	Desig-nation	Column Number 1 D1	2 D2	3 D3	4 D4	5 D5	6 D6	7 D7	8 D8	9 Totals
1	P3	80	136	273	290	314	231	139	298	7875
2	P4	62	121	258	275	299	216	153	312	6300
3	P5	93	138	275	292	316	233	120	279	6300
4	P6	72	117	254	271	295	212	140	299	6300
5	P7	63	100	237	254	278	195	136	295	6300
6	P8	131	168	305	322	346	251	84	243	6300
7	P10	87	113	250	267	291	208	128	287	7875
8	P11	75	96	233	250	274	191	128	287	6300
9	Totals	5367	10735	5367	9124	13418	3220	3220	3220	

Table 45. Final Solution Pattern for Assembling and Processing South Dakota Beef (10,000 pound units of dressed weight).

Supply Region	Plant Designations								Totals
	P3	P4	P5	P6	P7	P8	P10	P11	
S1						2449			2449
S2			2431	47		929			3548
S3	8949	206		144					9299
S4		6953							6953
S5			4728						4728
S6				6968					6968
S7					7159			501	7660
S8						2981			2981
S9						800	2434	230	3464
S10							6515		6515
S11								6428	6428
Totals	8949	7159	7159	7159	7159	7159	8949	7159	

Table 46. Final Solution Pattern for Distribution of South Dakota Beef.

Plant Designation	Demand Centers								Totals
	D1	D2	D3	D4	D5	D6	D7	D8	
P3					7875				7875
P4	5367				933				6300
P5					2940	3220		140	6300
P6				4751	1549				6300
P7		4435	1865						6300
P8							3220	3080	6300
P10			3502	4373					7875
P11		6300							6300
Totals	5367	10735	5367	9124	13297	3220	3220	3220	

Table 47. Final Solution Pattern for Assembling and Processing South Dakota Beef, Assuming Plants Slaughter 60 Percent of Estimated Supply Available (10,000 Pound Units of Dressed Weight).

Supply Region	Plant Designations					Totals
	P3	P6	P7	P8	P11	
S1				1469		1469
S2	1580	141		408		2129
S3	5579					5579
S4			4172			4172
S5		2837				2837
S6		4181				4181
S7			4596			4596
S8				1789		1789
S9				895	1183	2078
S10					3909	3909
S11					3857	3857
Totals	7159	7159	8949	4773	8949	

Table 48. Final Solution Pattern for Distribution of South Dakota Beef, Assuming Plants Slaughter 60 Percent of Estimated Supply Available (10,000 Pound Units of Dressed Weight).

Plant Designation	Demand Centers								Totals
	D1	D2	D3	D4	D5	D6	D7	D8	
P3	3255				1383	1662			6300
P6					6300				6300
P7			1889	5532	454				7875
P8						292	1954	1954	4200
P11		6509	1366						7875
Totals	3255	6509	3255	5532	8137	1954	1954	1954	