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Feasibility of Establishing Small Livestock Slaughter Plants in North Dakota

By
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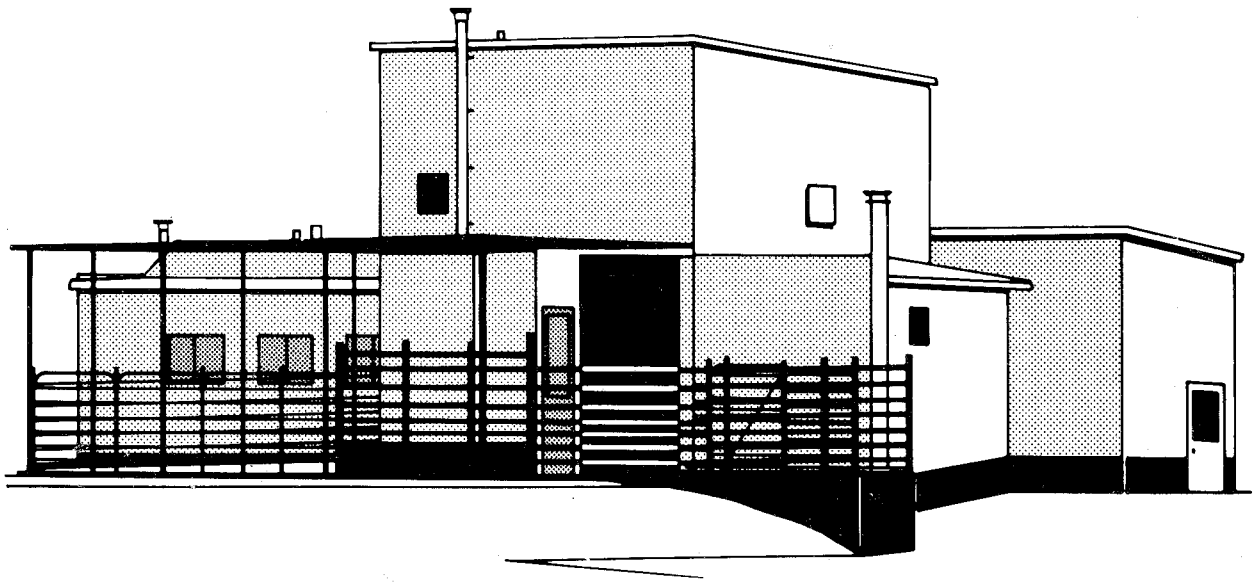

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Preface

The authors are indebted to numerous private businesses and governmental agencies who provided information and data for this study. Special appreciation is given to Mr. Alvin Whitmer, Vice-President, Facilities Division of Koch Supplies, Inc., Kansas City, Missouri, for assistance in developing specific investment cost data. North Dakota meat plant owners are also acknowledged for helpful assistance in supplying and verifying certain operational data.

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Highlights

An economic feasibility analysis of small multi-species slaughter plants was conducted to determine the costs and returns associated with construction and operations. Three model plants were developed ranging in size from an annual slaughter capacity of 1,200 head of cattle and 743 hogs to 3,750 head of cattle and 2,321 hogs. Detailed plant investment costs and operating budgets were developed. Different plant utilization levels were considered as well as plant size to evaluate how each influenced the final operating results. The smallest plant (using an opportunity cost of 12.55 percent) was marginally profitable when operating at 85 percent of capacity, the middle sized plant at 70 percent of capacity, and the largest plant at 55 percent of capacity. A high level of plant utilization must be achieved throughout the year if the smallest plants are to be profitable. The larger plant can be operated profitably at slightly lower levels of plant utilization because of the ability to capture certain economies of size that serve to lower per unit costs.

Small meat plants were found to be economically feasible based on research assumptions. However, a high degree of management expertise would be required to operate plants profitably given the seasonality in livestock production and demand for meat products and services that exist in the industry.

The direct economic impact of these plants was not large, but would be substantial for smaller cities within the state. Total business activity resulting from annual slaughter plant expenditures would amount to an estimated $498,000 for the smallest plant, $892,000 for the middle sized plant, and $1,354,000 for the largest plant. Direct slaughter plant employment was estimated at 7, 12, and 18 employees for each of three sizes of plants. These employment levels would be a significant economic development force for the rural areas of the state.

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Many rural communities in North Dakota attempt to solve problems of unemployment and population decline by increasing economic development. One potential economic development project considered by North Dakota communities is the establishment of new small slaughter and meat processing plants.

This study's primary objective was to determine the costs and returns associated with the construction and operation of small multi-species slaughter and meat processing plants in North Dakota. These estimated costs and returns can be used by state developers, city planners, financial institutions, and potential investors in their respective decision-making processes.

Specific objectives of this study include (1) review of legislation regarding meat inspection, (2) identification of present slaughter and meat processing plants in North Dakota, (3) overview of the current livestock supply in North Dakota, (4) identification of the capital investment and operating costs for a North Dakota based plant, (5) analysis of the economic profitability of a North Dakota plant, and (6) projection of the economic benefits of a new livestock slaughter and meat processing plant on local and state economies.

Regulation of the Meat Industry

Legislation regarding meat inspection has existed for over 85 years. The first comprehensive Federal Meat Inspection Act was passed in 1891 (Williams 1969). This act became necessary due to the increasing animal disease problems in the United States. It provided for inspection of the animal and meat prior to and after slaughter.

The Meat Inspection Act of 1906 extended the provisions of the 1891 Act to include sanitation standards for slaughter and processing plants trading in interstate commerce. It became the basis for all federal meat inspection until December 15, 1967, when the Wholesome Meat Act of 1967 became law. The Wholesome Meat Act of 1967 amended the Meat Inspection Act of 1906 to include the inspection of meat plants that formerly sold meat only within the state (USDA 1969).

The 1967 law gave state legislatures until December 15, 1969, to initiate state inspection of livestock slaughter and meat processing plants that were not previously federally inspected (Dunn 1970). Federal inspection was to become mandatory in those states not having an acceptable state inspection program prior to December 15, 1969. Individual states were allowed an additional year beyond the December 15 deadline, if the state could

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demonstrate satisfactory progress in establishing a meat inspection program which met federal standards.

The North Dakota Legislature passed a state inspection bill. However, because of insufficient funds allocated by the state legislature to implement the inspection program, federal inspection was initiated in North Dakota on April 16, 1970.

The Curtis Amendment, passed on July 16, 1970, amended the Wholesome Meat Law of 1967 to allow retail firms which sold federally inspected meat and custom firms involved in slaughter and processing of meat for the customers' own consumption to be exempt from federal inspection status.

Federal Inspection Regulations

According to present meat acts and regulations (Wholesome Meat Act, Sections 1-10; Poultry Products Inspection Act, Sections 1-9; and Meat Inspection Regulations, Part 301.2) the term "federally inspected" refers to:

> Any meat product or poultry product that is identified by an official mark or official inspection legend, as prescribed by regulation of the Secretary of Agriculture, has been inspected and passed by inspectors appointed for that purpose in establishments at which inspection is maintained. At the time the product is prepared it is inspected, passed and identified, and found to be wholesome, not adulterated, and not mislabeled.
>
> To assure that the meat and poultry products are distributed into commerce as wholesome, not adulterated or misbranded, these products are subjected to examination and inspection during antemortem, postmortem, upon entry into any department wherein the products shall be treated or prepared for meat food and poultry products (processing).
>
> The establishment at which inspection is maintained shall maintain sanitation according to the prescribed rules and regulations of sanitation, and permit access by inspectors at all times to every part of said establishment for the purposes of any examination and inspection.

Custom Exempt Regulations

The Wholesome Meat Act (Section 23) and Federal Meat Inspection Regulations (Part 303.1) define provisions for plants operating under custom exempt status in the following terms:

> The provisions for "federally inspected" requiring the inspection of the slaughter of animals and the preparation of the carcasses, parts thereof, meat and meat food products at establishments conducting such operations for commerce shall not apply to the slaughtering by any person of animals of his own raising, and the preparation by him and transportation in commerce in the carcasses, parts thereof, meat and meat food products of

such animals exclusively for use by him and members of his household and his nonpaying guests and employees; not to the custom slaughter by any person, firm or corporation of cattle, sheep, swine or goats delivered by the owner thereof for such slaughter, and the preparation by such slaughter and transportation in commerce of the carcasses, parts thereof, meat and meat food products of such animals, exclusively for use, in the household of such owner by him, and members of his household and his nonpaying guests and employees.

The adulteration and misbranding provisions, other than the requirement of the inspection legend, shall apply to the articles which are exempted from inspection.

The custom prepared products are plainly marked "NOT FOR SALE" immediately after being prepared by the custom operator and are kept so identified until delivered to the owner.

Retail Exempt Regulations

Meat plants subject to retail exempt status are to follow the prescribed guidelines and definitions as set forth by the Wholesome Meat Act (Section 301c) and the Meat Inspection Regulations (Part 303.1d):

The provisions of this act requiring inspection of the slaughter of animals and the preparation of carcasses, parts thereof, meat and meat food products shall not apply to operations of types traditionally and usually conducted at retail stores and restaurants, when conducted at any retail store or restaurant or similar retail-type establishment for sale in normal retail quantities or service of such articles to consumers at such establishments.

Operations of types traditionally and usually conducted at retail stores and restaurants are the following:

(a) cutting up, slicing, and trimming carcasses, halves, quarters, or wholesale cuts into retail cuts such as steaks, chops, and roasts, and freezing such cuts;

(b) grinding and freezing products, made from meat;

(c) curing, cooking, smoking, rendering or refining of livestock fat, or other preparation of products, except slaughtering or the retort processing of canned products;

(d) breaking bulk shipments of products;

(e) wrapping or rewrapping products.

Any quantity or product purchased by the consumer from a particular retail supplier shall be deemed to be a normal retail quantity if the quantity so purchased does not in the aggregate exceed one-half carcass.

A retail store is any place of business where the sales of product are made to consumers only; at least 75 percent, in terms of dollar value, of total dollar value of sales of product to household consumers and the total dollar value of sales of product to consumers other than household consumers does not exceed $28,000[1] per calendar year (January 1 through December 31); only federally or state inspected and passed product is handled or used in the preparation of any retail product.

A restaurant is an establishment where product is prepared only for sale or service, in meals, or in entrees, directly to individual consumers or such product prepared at a retail exempt store is handled or used in the preparation of any product.

North Dakota Slaughter and Processing Plants

North Dakota is characterized by a large number (143) of smaller custom exempt plants, 26 federally inspected slaughter and processing plants, and 11 federally inspected nonslaughter processing plants for a total of 180 plants in 1985. This represents a reduction of 25 plants, a 13.9 percent decrease since 1977 (the completion date of the last slaughter plant study).

This reduction was not consistent between federally inspected and custom exempt plants. Federally inspected plants, declined from 50 in 1977 to 37 in 1985, a 26 percent decrease. The reduction in the number of custom exempt plants was not as severe, decreasing from a total of 155 in 1977 to 143 in 1985, a 7.7 percent decrease.

The distribution of federally inspected and custom exempt slaughter and meat processing plants in North Dakota in 1985 is presented in Figure 1. Mandan and the Fargo-West Fargo communities were the only two locations that had more than one federally inspected slaughter plant. One of the plants in the Fargo-West Fargo community was located on the North Dakota State University campus. Twenty-six communities had more than one custom exempt plant and 84 communities had only one custom exempt plant. Thirty-four communities had more than one meat slaughter and/or processing plant of either inspection status.

The number of federally inspected and custom exempt plants in North Dakota by county and changes in numbers are presented in Table 1. Fourteen counties had a net decrease in federally inspected plants. Two counties, Emmons and Walsh, gained a federally inspected plant. Twenty-one counties had a net decrease in custom exempt plants, while only 13 counties experienced an increase. Although documentation is not available, it could be assumed that in those 13 counties the increase in custom exempt plants was not only construction of new plants but also former federally inspected plants currently under custom exempt status.

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[1]This dollar limitation is adjusted annually whenever the Consumer Price Index published by the Bureau of Labor Statistics, Department of Labor, indicates a change in the price of same volume exceeds $500. Twenty-eight thousand was the limitation in effect for 1985.

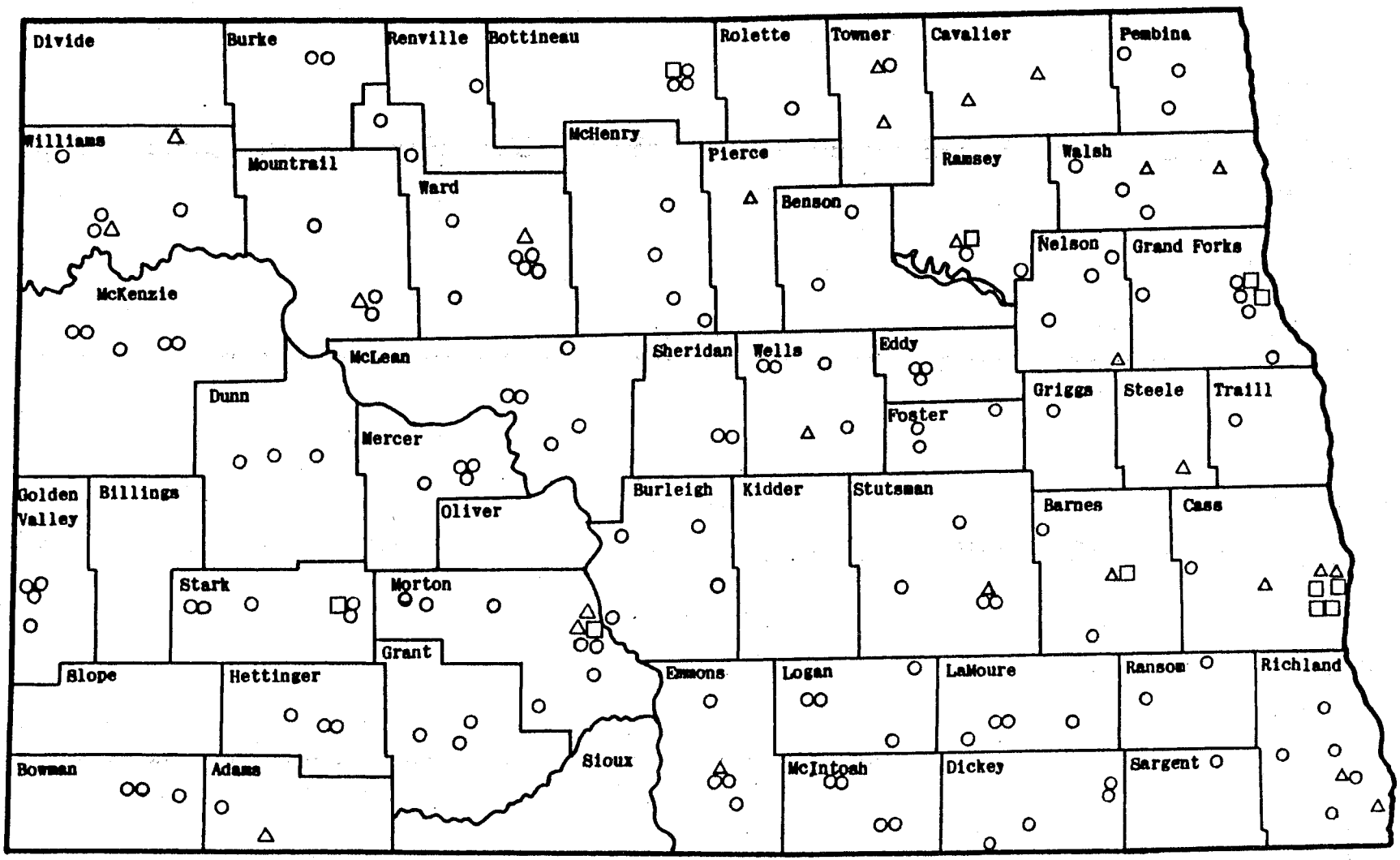


Figure 1. Distribution of Federally Inspected and Custom Exempt Slaughter and Meat Processing Plants, North Dakota, 1985

TABLE 1. NUMBER OF NORTH DAKOTA FEDERALLY INSPECTED AND CUSTOM EXEMPT SLAUGHTER AND PROCESSING MEAT PLANTS BY COUNTY IN 1985 AND CHANGES FROM 1977

County	Federally Inspected		Custom Exempt	
	Number	Change from 1977	Number	Change from 1977
Adams	1	-	1	(1)
Barnes	2	-	2	(1)
Benson	0	-	2	-
Billings	0	-	0	(1)
Bottineau	1	(1)[a]	3	-
Bowman	0	(1)	3	(1)
Burke	0	-	2	(1)
Burleigh	0	(1)	4	-
Cass	7	(1)	1	-
Cavalier	2	-	0	(1)
Dickey	0	-	4	(1)
Divide	0	-	0	-
Dunn	0	(1)	3	1
Eddy	0	-	3	2
Emmons	1	1	4	(1)
Foster	0	-	3	1
Golden Valley	0	-	4	1
Grand Forks	2	(1)	5	3
Grant	0	-	3	(1)
Griggs	0	(1)	1	1
Hettinger	0	-	3	(2)
Kidder	0	(1)	0	-
LaMoure	0	-	4	1
Logan	0	-	4	-
McHenry	0	-	4	-
McIntosh	0	-	4	(2)
McKenzie	0	-	5	2
McLean	0	-	6	(2)
Mercer	0	-	4	1
Morton	3	-	7	(2)
Mountrail	1	(1)	3	1
Nelson	1	-	3	-
Oliver	0	-	0	(1)
Pembina	0	-	3	(3)
Pierce	1	-	0	-
Ramsey	2	(1)	2	1
Ransom	0	-	2	(1)
Renville	0	-	1	-
Richland	2	(1)	5	1
Rolette	0	(1)	1	-
Sargent	0	-	1	-
Sheridan	0	-	2	-
Sioux	0	-	0	-
Slope	0	-	0	-
Stark	1	-	5	(2)
Steele	1	-	0	-
Stutsman	1	-	4	-
Towner	2	-	1	1
Traill	0	-	1	(1)
Walsh	2	1	3	(2)
Ward	1	(2)	8	-
Wells	1	-	4	(1)
Williams	2	(1)	4	(1)
N.D. Total	37	(13)	143	(12)

[a]Numbers enclosed in parentheses ( ) signify a decrease.

The distribution of federally inspected slaughter plants in North Dakota reflects the competitiveness of the industry. Results from a 1985 survey of federally inspected slaughter plant managers reported an average utilization of 54.75 percent of plant capacity. This demonstrates the problem of insufficient demand that many small slaughter plants face. Such a low level of utilization for small slaughter plants is also national in scope. Baker (1976) reported that United States federally inspected plants, slaughtering cattle with a design capacity of up to 9,562 head annually, were utilizing only 38.8 percent of their engineered capacity in 1973.

North Dakota Livestock Supply and Commercial Slaughter

North Dakota meat processors have been generally facing a decline in livestock marketings. Data taken from the 1982 Census of Agriculture for North Dakota indicate a reduction in cattle and calf marketings of 7.4 percent, an increase in fed cattle of 9.2 percent, a reduction of 16.9 percent in the number of hogs and pigs marketed, and a 16.4 percent reduction in marketings of hogs and pigs other than feeder pigs, for the period from 1978 to 1982 (Table 2). The categories cattle fattened on grain; and hogs and pigs sold, other than feeder pigs; were included to more fully reflect the livestock supply a slaughter or processing plant would encounter.

TABLE 2. LIVESTOCK MARKETINGS IN NORTH DAKOTA, 1978 AND 1982

Classification	Marketings		% Change From 1978
	1978	1982	
Cattle and calves sold	1,099,421	1,018,516	(7.4)
Cattle fattened on grain	99,669	108,854	9.2
Hogs and pigs sold	538,492	447,738	(16.9)
Hogs and pigs sold, other than feeder pigs	371,477	310,501	(16.4)

SOURCE: 1982 Census of Agriculture.

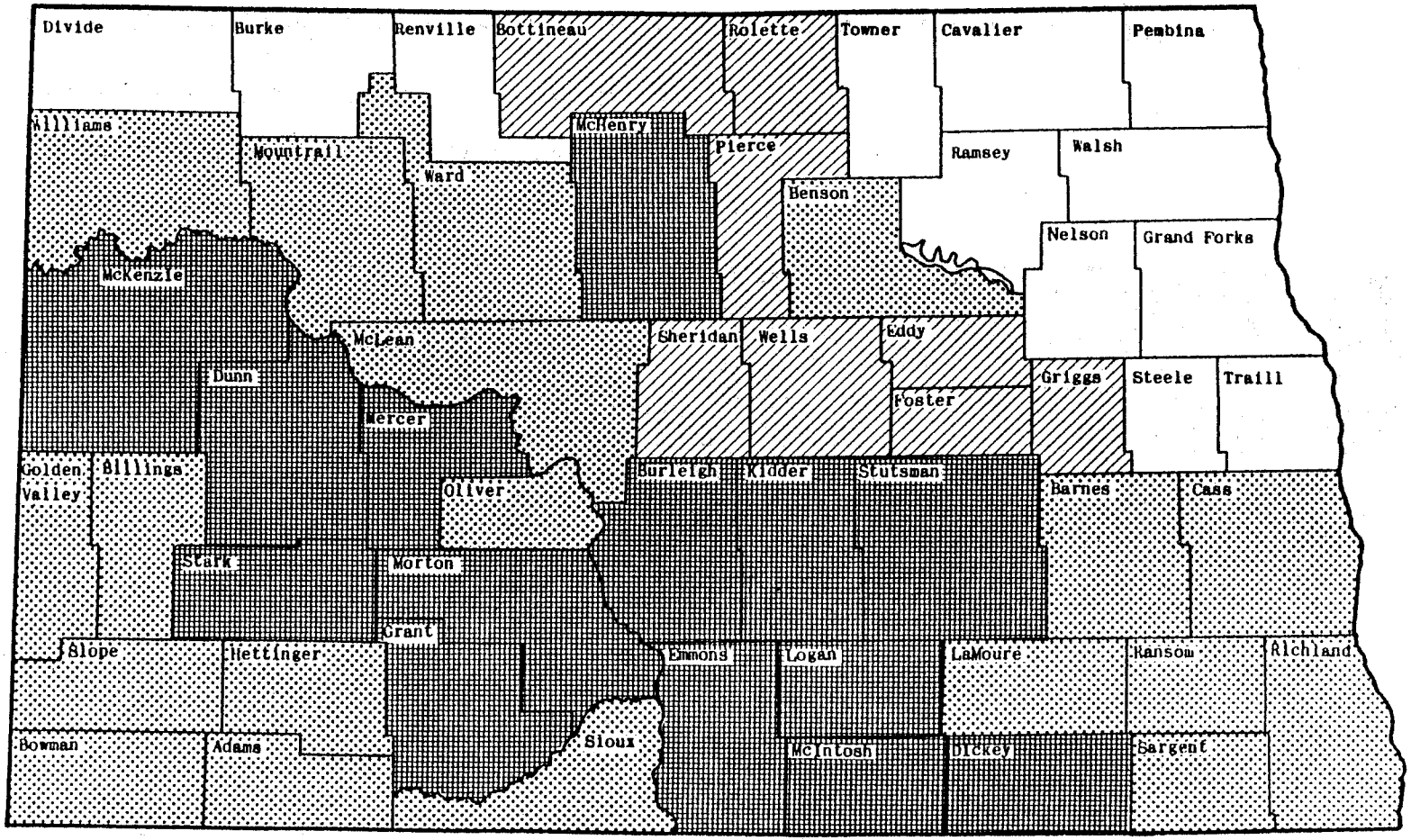
County marketing data are presented in Table 3. The relative increase and decrease in state marketings were not consistent across all counties. Only 15, 32, 13, and 9 out of a total of 53 counties reported increases in marketings, respectively, for all cattle, fed cattle, all hogs, and hogs and pigs other than feeder pigs. The number of counties reporting a decrease in marketings were 38, 20, 38, and 35, respectively.

North Dakota's January 1, 1985, inventory of all cattle was 2,050,000 head and the December 1, 1984, inventory of all hogs was 255,000 head (North Dakota Agricultural Statistics 1985). County concentrations of cattle and hogs are presented in Figures 2 and 3, respectively. Cattle production was concentrated in the south central areas of the state and hog production in the southeastern areas of the state.

TABLE 3. LIVESTOCK MARKETED BY COUNTY, NORTH DAKOTA, 1982

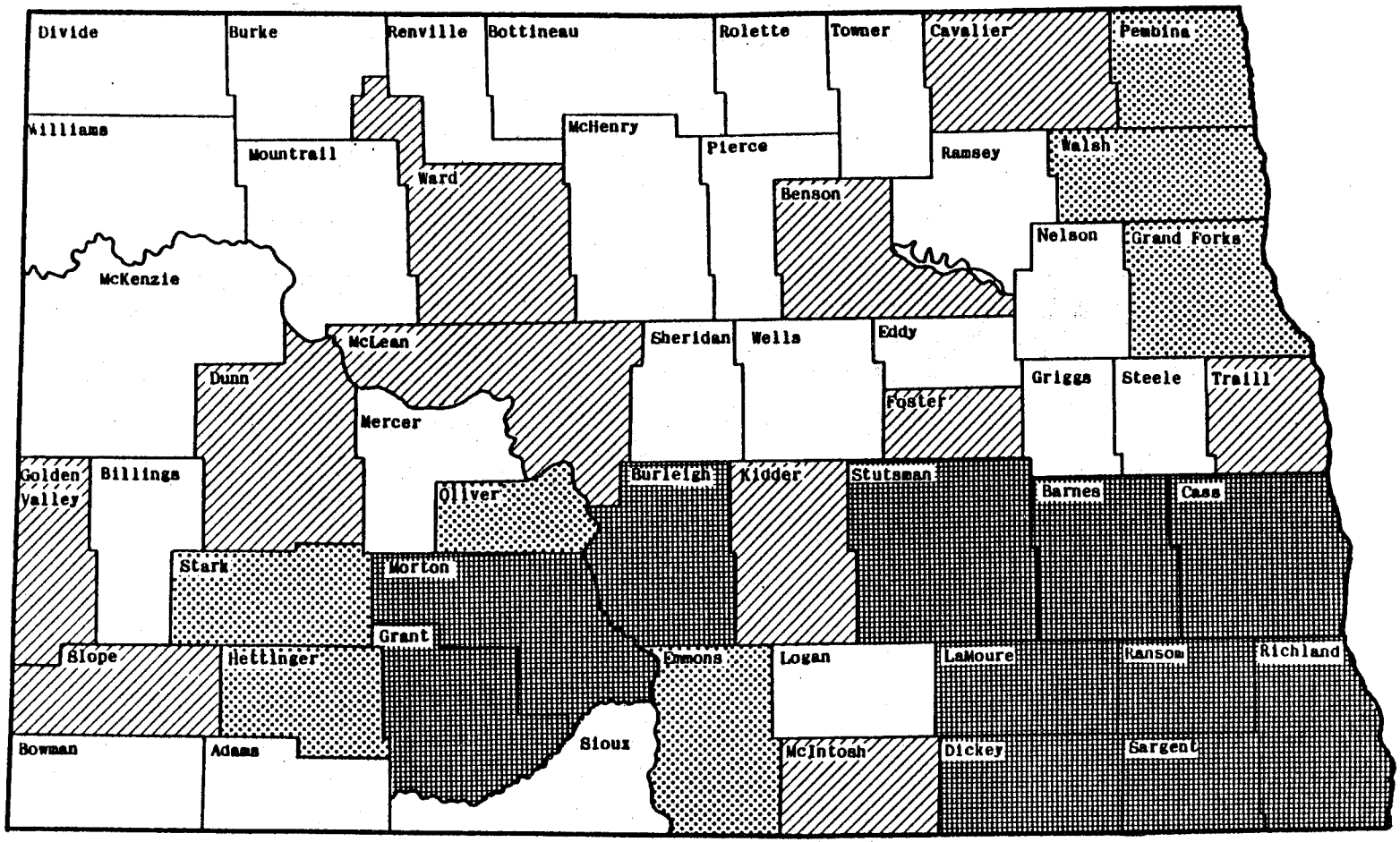
County	Cattle & Calves Sold	Cattle Fattened on Grain	Hogs and Pigs Sold	Hogs & Pigs Sold Other Than Feeder Pigs
	numbers			
Adams	16,386	1,060*	4,877	2,880
Barnes	17,771	2,796*	17,162	11,820
Benson	18,067*	1,010*	3,853	NA
Billings	13,342	597*	653*	599*
Bottineau	9,755	558	2,693	2,290
Bowman	16,029	804	2,692	1,926*
Burke	8,203	323	1,348	900*
Burleigh	34,745*	2,123*	13,018	10,935
Cass	20,391	11,555*	38,144*	28,670*
Cavalier	4,133	440	8,095	7,203*
Dickey	29,326	7,935*	25,481*	19,920
Divide	8,210	536	2,448	2,286
Dunn	42,297	2,965*	4,877	3,293
Eddy	10,565	703*	1,730	1,615
Emmons	36,956*	1,854*	9,130	7,221
Foster	9,107	1,440	5,422*	3,312*
Golden Valley	19,681*	1,597*	4,810	NA
Grand Forks	10,301	4,277*	10,753*	7,750*
Grant	32,842	1,737*	20,142	11,570
Griggs	12,274*	1,209	3,137	1,094
Hettinger	14,387	1,666*	14,237*	8,137
Kidder	32,844	1,667*	5,026	884
LaMoure	20,019	2,887*	20,462*	9,933
Logan	32,040*	792*	4,140	788
McHenry	35,330	1,859*	3,655	2,794
McIntosh	28,188*	1,581	5,034	3,034
McKenzie	37,446	1,829*	4,890	4,295
McLean	27,223*	1,997	4,124	NA
Mercer	26,717*	1,074	2,779	NA
Morton	50,408	4,078*	10,829	6,714
Mountrail	20,210	1,644*	1,160	564
Nelson	8,779*	840*	4,321	2,280
Oliver	14,605	547	11,173*	3,274
Pembina	5,368	1,251	15,289	11,463
Pierce	15,425*	455	1,224	NA
Ramsey	3,949	728	4,679	3,273
Ransom	16,494	2,324*	12,338	9,727
Renville	4,752	250	1,800*	NA
Richland	22,393*	6,043*	41,915	28,494
Rolette	11,098	866	1,929	NA
Sargent	18,588	4,062	25,468*	19,788
Sheridan	13,863	869*	1,924	1,426
Sioux	21,578*	NA	NA	1,446
Slope	14,001	762*	9,499*	8,792*
Stark	30,503	1,972*	8,261	5,045
Steele	3,178	556	1,368*	NA
Stutsman	38,365	3,911*	9,955	6,567
Towner	4,198*	323	3,267*	3,096
Traill	2,787	892	10,056	NA
Walsh	8,442	2,080	14,270*	9,403*
Ward	21,380	1,281*	5,820	4,702
Wells	25,419*	NA	2,291	2,148
Williams	17,160	591	1,834	1,183
N.D. Total	1,018,516	108,854*	447,738	310,501

*Indicates an increase from 1978.
Note: NA indicates data not available.
SOURCE: 1982 Census of Agriculture.



SOURCE: North Dakota Agricultural Statistics.

Figure 2. Distribution of All Cattle by Counties, North Dakota, January 1, 1985



SOURCE: North Dakota Agricultural Statistics.

Figure 3. Distribution of All Hogs by Counties, North Dakota, December 1, 1984

Contrary to marketing data, actual commercial slaughter in North Dakota has been increasing since the late 1970s (Table 4). Commercial cattle

TABLE 4. ANNUAL NORTH DAKOTA COMMERCIAL SLAUGHTER, 1975-1985

Year	Cattle	Calves	Sheep	Hogs
	thousand head			
1975	283.2	.4	1.3	21.9
1976	273.6	.4	1.2	22.4
1977	276.0	1.5	.8	20.1
1978	116.9[a]	.4	.6	20.3
1979	57.3[a]	.3	.7	27.4
1980	134.5	.4	.9	50.7
1981	165.7	.4	1.0	57.6
1982	170.0	.3	1.0	49.3
1983	159.0	.4	1.0	70.2
1984	182.3	.4	1.0	78.4
1985	161.4	.3	.9	84.8

[a]A major slaughter plant was not operating during part of 1979.

SOURCE: Crop Reporting Board, Statistical Reporting Service, USDA.

slaughter in North Dakota fell from 283,200 head in 1975 to 116,900 in 1978 but has since recovered to 182,300 in 1984 and 161,400 in 1985. Calf and sheep slaughter have remained relatively constant. Hog slaughter has been steadily increasing from the 20,000 level for most of the 1970s to 84,800 in 1985.

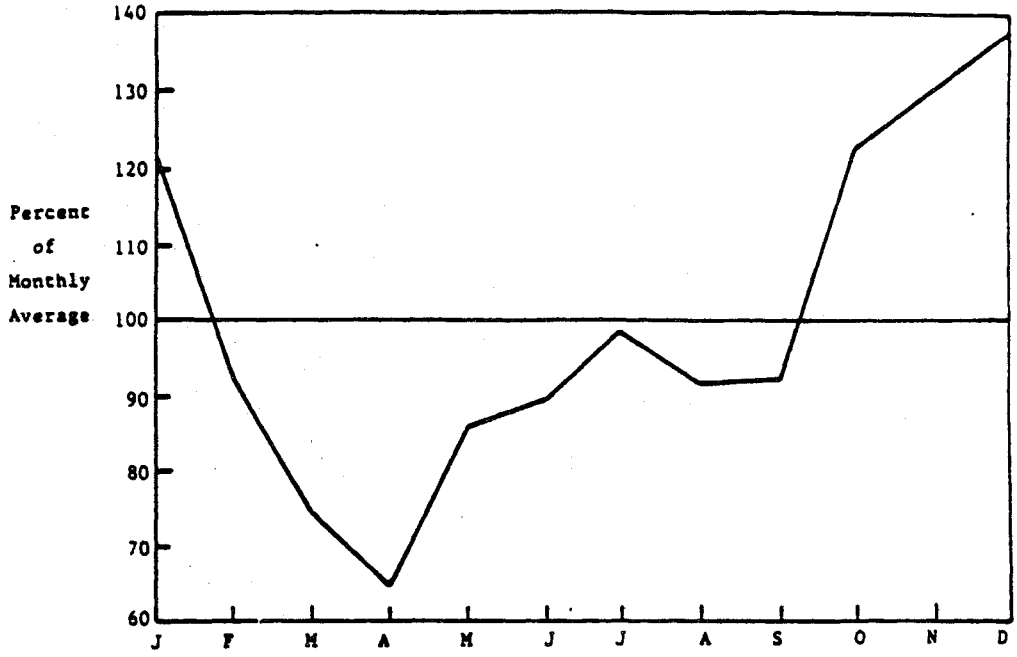
North Dakota slaughter plants also encounter a very volatile monthly livestock slaughter volume. Monthly commercial cattle slaughter, as a percentage of the 1985 average, ranged from 64.7 percent to 137.6 percent in 1985 (Figure 4). Monthly commercial hog slaughter, as a percentage of the 1985 average, ranged from a low of 73.5 percent to a high of 119 percent in 1985 (Figure 5).

Economic Analysis

Economic feasibility analysis of new small slaughter and processing plants in North Dakota will be presented in three sections: (1) model plant characteristics and utilization levels, (2) cost and revenue analysis, and (3) economic profitability. The analysis will be based on operational levels utilizing 55, 70, 85, and 100 percent of model plant capacity.

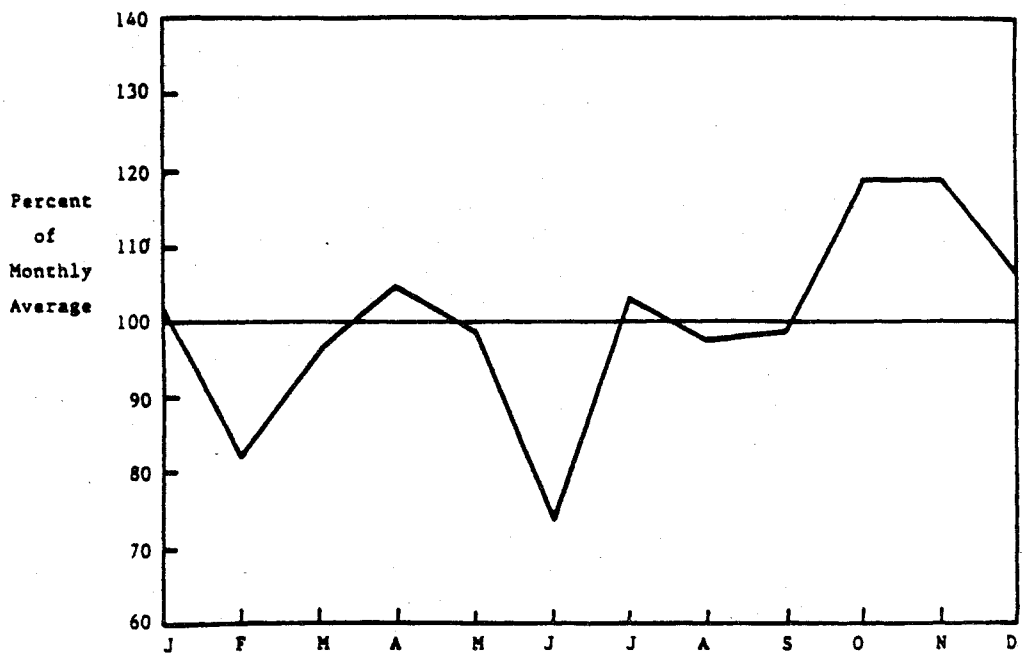
Plant Characteristics and Utilization Levels

Model plants were designed for annual volumes of 1,600, 3,000, and 5,000 head of cattle. These plants will be referred to as Plants A, B, or C, hereafter; Plant A being the smallest, B the medium-sized plant, and C the



SOURCE: USDA Annual Livestock Summary

Figure 4. North Dakota's 1985 Monthly Commercial Cattle Slaughter as a Percentage of the 1985 Average



SOURCE: USDA Annual Livestock Summary

Figure 5. North Dakota's 1985 Monthly Commercial Hog Slaughter as a Percentage of the 1985 Average

largest. A factor of 1.857 hogs per head of cattle is used when converting kill and processing capacity from number of cattle to number of hogs (Stinson et al. 1978).

Annual capacity is based on the daily kill floor capacity, 250 workdays per year, and an institutional constraint factor of .8. The institutional constraint was used to adjust annual capacity due to seasonality of animal supplies and consumer demand, and daily procurement problems. A slaughter and processing plant manager, unlike some other processing industries, does not have the alternative (option) to inventory a supply of raw materials to maintain a constant production process. The factor of .8 was estimated based on the seasonality of the livestock marketings (as discussed earlier) and industry estimates. This factor for annual capacity is considerably higher than the current industry average, but was considered achievable with above average management.

All plants were designed for custom kill, wholesale, and retail operations under federal inspection status. It was assumed one-third of production was devoted to each of the following: (1) custom slaughter and processing, (2) wholesale, and (3) retail markets. Twenty-five percent of the operational time of each model plant was allocated to hog slaughter and processing. Koch Supply, Inc.[2] provided the plant designs with each model design representing actual plant designs of proposed or previously built plants. Model plants were designed to meet all USDA federal inspection standards.

All model plants were equipped with a kill floor, chill cooler, holding cooler, blast freezer, and smokehouse (Table 5). Plants B and C incorporate an additional holding freezer.

TABLE 5. CHARACTERISTICS OF MODEL SLAUGHTER AND PROCESSING PLANTS, NORTH DAKOTA, 1985

Item	Plant Size		
	A	B	C
Annual capacity - animal units[a]	1,600	3,000	5,000
Kill floor capacity - number of cattle per day	8	15	25
Chill cooler capacity - head of cattle	8	15	25
Holding cooler capacity - head of cattle	16	20	35
Blast freezer - 24 hour capacity in lbs.	4,000	4,000	6,000
Holding freezer - lbs. of meat	--	7,500	15,000
Smokehouse - holding capacity in lbs.	500	500	500
Total square footage of building	2,250	2,800	3,475

[a]One animal unit equivalent to one head of cattle or 1.857 hogs.

[2]Koch Supplies, Inc., Kansas City, Missouri, 1985.

Annual slaughter and processing volumes were 1,200 head of cattle and 743 head of hogs for Plant A; 2,250 head of cattle and 1,393 head of hogs for Plant B; and 3,750 head of cattle and 2,321 head of hogs for Plant C. Annual volumes at plant utilization levels of 55, 70, 85, and 100 percent are presented in Table 6.

TABLE 6. ANNUAL SLAUGHTER AND PROCESSING VOLUME FOR MODEL PLANTS, NORTH DAKOTA, 1985

Plant Utilization Level	Plant Size					
	A		B		C	
	Cattle	Hogs	Cattle	Hogs	Cattle	Hogs
(percent)	number of head					
55	660	409	1,238	766	2,063	1,277
70	840	520	1,575	975	2,625	1,625
85	1,020	631	1,913	1,184	3,188	1,973
100	1,200	743	2,250	1,393	3,750	2,321

Cost and Revenue Analysis

Investment Costs

Total investment costs for Model Plants A, B, and C were $235,841; $349,590; and $471,941, respectively (Table 7). Average investment per head

TABLE 7. INVESTMENT COSTS FOR MODEL PLANTS, NORTH DAKOTA, 1985

Item	Plant Size		
	A	B	C
	dollars		
Land	5,165	6,428	7,978
Building and excavation	110,496	146,303	201,883
Drainlines and plumbing	9,000	17,500	38,920
Electric lines and wiring	10,000	19,600	32,900
Kill floor and processing equipment	53,339	78,879	103,663
Refrigeration equipment	43,377	53,391	54,328
Furnace	2,900	3,000	3,100
Office equipment	1,564	1,989	2,469
Delivery: truck	--	16,000	16,000
refrigeration unit	--	4,000	6,000
insulated van	--	2,500	4,700
Total investment costs	235,841	349,590	471,941

of designed daily capacity was $29,480 for Plant A, $23,306 for Plant B, and $18,878 for Plant C (Table 8). Significant economies of size existed for the larger plant. Plant C's average investment per head was 36 percent less than that of Plant A.

TABLE 8. AVERAGE INVESTMENT PER HEAD OF DESIGNED CAPACITY FOR MODEL PLANTS, NORTH DAKOTA, 1985

Item	Plant Size		
	A	B	C
Total plant investment, dollars	235,841	349,590	471,941
Daily designed capacity, animal units[a]	8	15	25
Average investment per animal unit of designed daily capacity, dollars	29,480	23,306	18,878

[a]One animal unit equivalent to one head of cattle or 1.857 head of hogs.

Building Requirements and Costs. All building costs were based on construction estimates of actual plant designs. Specific designs were slightly modified to maintain comparability between the three plants (Table 7). All buildings have an expected life of 20 years with a salvage value of 10 percent.

Land Requirements and Costs. Land requirements were computed at five times the plant's square footage which would provide ample room for plant expansion, employee and customer parking, truck access, and landscaping. Specific locational requirements include availability of city sewer and water. Land value was based on recent sales of industrial park real estate tracts. Values ranged from $16,000 to $25,000 per acre for various North Dakota cities. A value of $20,000 was assumed as reasonable for a North Dakota site.

Equipment Requirements and Costs. Equipment requirements were estimated for slaughter and processing operations, office areas, refrigeration, and heating systems. Interviews and actual price quotes from industrial sources were used to determine equipment requirements and costs.

A refrigerated delivery truck was included to deliver 50 percent of all retail and wholesale meats for Model Plants B and C. Expected life of slaughter and processing equipment, refrigeration equipment, delivery truck, and other equipment was estimated at 10, 15, 5, and 10 years, respectively. All equipment had an expected salvage value of 10 percent except the delivery truck which was set at 40 percent.

Operating Capital Requirements

Operating capital requirements were estimated at $52,157; $97,794; and $162,990 for Plants A, B, and C at full capacity (Table 9). Operating capital

TABLE 9. OPERATING CAPITAL REQUIREMENTS, MODEL PLANTS, NORTH DAKOTA, 1985

Plant Utilization Level	Plant Size		
	A	B	C
(percent)	---------- dollars ----------		
55	28,686	53,787	89,645
70	36,510	68,456	114,093
85	44,333	83,125	138,542
100	52,157	97,794	162,990

requirements were estimated on the basis of a 25-day turnover between purchase of live animals for wholesale and retail sales and the receipt of receivables. The 25-day turnover was estimated as a 5-day slaughter and processing time plus a 20-day turnover in receivables for meat wholesalers as reported by Robert Morris Associates[3] (1985).

Labor Requirements and Costs

Labor requirements were synthesized for each plant size and utilization level. These requirements were based on a USDA publication, Layout Guide for Small Meat Plants (Brasington and Hammons 1976), and interviews with North Dakota plant managers.

Personnel were divided into six departments; slaughter, processing, office and retail, sanitation and maintenance, delivery, and management (Table 10). Labor productivity of slaughter and processing personnel was estimated at 1-1/4 carcasses per man-hour for slaughter and 1,000 lbs. of hanging carcass weight per employee per eight-hour day for processing (Brasington and Hammons 1976). Slaughter and processing labor requirements were considered variable.

Wage rates were estimated from three sources: American Meat Institute (1985); North Dakota Job Service Wage and Benefit Survey for Fargo, Grand Forks, and Bismarck (1985); and interviews of North Dakota slaughter plant

[3]Robert Morris Associates (RMA) is an organization whose members are primarily officers of commercial banks who are concerned with business loans and credit information.

TABLE 10. PERSONNEL REQUIREMENTS FOR MODEL PLANTS AT 100 PERCENT UTILIZATION LEVEL BY DEPARTMENT, NORTH DAKOTA, 1985

Department	Plant Size		
	A	B	C
Slaughter[a]	.78	1.46	2.43
Processing[a]	3.63	6.86	11.35
Office personnel and retail	1.00	1.50	2.00
Delivery	--	.50	.50
Sanitation	.50	.75	1.00
Management	1.00	1.00	1.00
Total number of employees[b]	6.91	12.07	18.28

[a]Slaughter and processing personnel requirements are variable with plant utilization levels and calculated as 1-1/4 carcasses per man-hour for slaughter and 125 lbs. of hanging carcass weight per man-hour for processing.
[b]Fractional employees can be accounted for by part-time and seasonal employees.

managers (Table 11). Wage rates for Plant A, the smallest plant, are generally lower than for Plants B and C. This reflects the probable location

TABLE 11. WAGE RATES FOR MODEL PLANTS, NORTH DAKOTA, 1985

Department	Plant Size		
	A	B	C
	dollars/hour		
Slaughter	6.00[a]	7.20[b]	7.20[b]
Processing	5.50[a]	6.10[c]	6.10[c]
Office personnel and retail	5.50[a]	6.00[d]	6.00[d]
Delivery	--	7.20[d]	7.20[d]
Sanitation	5.50[ae]	4.95[d]	4.95[d]
	annual salary		
Management	$25,900[d]	$28,180[d]	$31,040[d]

[a]Survey of North Dakota Plant Managers, 1985.
[b]Nonunion labor rates for Midwest meat packers as reported by the American Meat Institute (1985).
[c]Nonunion labor rates for Midwest meat processors as reported by the American Meat Institute (1985).
[d]Wage rates for similar occupations as reported by the North Dakota Job Service (1985).
[e]Due to size of plant, sanitation in Plant A was assumed to be done by other personnel, therefore, the same wage rate for processing personnel was used.

of Plant A in a smaller community relative to Plants B and C which, as a result, faces a less competitive labor market. Management salaries for all plants were based on wages reported by the North Dakota Job Service (1985) for managers of wholesale businesses.

Fringe benefits were estimated at 24.3 percent of total wages and salaries. This was the cost of fringe benefits as reported by local packers by the American Meat Institute (1985). Total annual labor costs, including fringe benefits, are summarized in Table 12. Annual labor cost at a 100 percent utilization level for Plant A was $116,603, Plant B was $212,045, and Plant C was $312,608.

TABLE 12. ANNUAL LABOR AND FRINGE BENEFIT COSTS FOR MODEL PLANTS, NORTH DAKOTA, 1985

Plant Utilization Level	Plant Size		
	A	B	C
(percent)	dollars		
55	81,650	136,537	194,834
70	93,301	161,706	234,092
85	104,952	186,875	273,350
100	116,603	212,045	312,608

Utilities

Electrical Requirements and Costs. Electricity was used in each model plant for three purposes: lighting, operation of electric motors, and operation of refrigeration units. Annual electrical consumption at the 100 percent utilization level ranged from 131,343 kwh for Plant A to 187,674 kwh for Plant B and 263,146 kwh for Plant C (Table 13). Energy calculations were

TABLE 13. ANNUAL ELECTRICAL REQUIREMENTS IN KILOWATT-HOURS FOR MODEL PLANTS, NORTH DAKOTA, 1985

Plant Utilization Level	Plant Size		
	A	B	C
(percent)	kilowatt-hours		
55	84,538	121,183	166,546
70	101,829	143,346	198,746
85	116,586	165,510	230,946
100	131,343	187,674	263,146

based on procedures outlined in the American Society of Heating, Refrigeration, and Air Conditioning Engineer's Handbook of Fundamentals (1982). (See Appendix A for detailed electrical usage computational formulas.) Electrical rates were based on the General Service Rate Schedule from the Northern States Power Company, Fargo, North Dakota. The energy charge was $.027 per kilowatt-hour and a demand charge of $5.59 per kilowatt (the weighted average of winter and summer demand charges). Annual electrical costs when operating at a 100 percent utilization level were $6,663, $9,444, and $13,169 for Plants A, B, and C, respectively (Table 14).

TABLE 14. ANNUAL ELECTRICAL COSTS FOR MODEL PLANTS, NORTH DAKOTA, 1985

Plant Utilization Level	Plant Size A		Plant Size B		Plant Size C	
	Energy Charge[a]	Demand Charge[b]	Energy Charge[a]	Demand Charge[b]	Energy Charge[a]	Demand Charge[b]
(percent)	dollars					
55	2,351	2,127	3,272	2,890	4,497	3,904
70	2,749	2,457	3,870	3,385	5,366	4,624
85	3,148	2,787	4,469	3,881	6,236	5,344
100	3,546	3,117	5,067	4,376	7,105	6,064

[a] $.027 per kilowatt-hour.
[b] $5.59 per kilowatt plus a monthly service charge of $15. Monthly demand in kilowatts estimated at 4 kilowatts per 1,000 kilowatt-hours of monthly use (Logan 1962).

Water Requirements and Costs. Water is used primarily for three purposes in a slaughter plant: (1) washing of carcasses, (2) plant cleanup, and (3) employee needs. The schedule in Table 15 was used for determining water usage. Estimated water requirements were based on actual water usage by small slaughter plants as reported in Utility Usage in Small Slaughter Plants (Brasington 1977). Water usage is presented in Table 16. At a 100 percent utilization level water usage was estimated at 377,154 gallons for Plant A, 582,294 gallons for Plant B, and 928,046 gallons for Plant C.

TABLE 15. ESTIMATED WATER USAGE FOR MODEL PLANTS FOR SELECTED FUNCTIONS, NORTH DAKOTA, 1985

Item	Unit	Calculated Usage
Slaughter room:		
Cattle dressing:		
Head washing	gal/head	2.44
Offal-truck washing	gal/head	3.23
Carcass washing	gal/lb	0.03
Total per carcass	gal/lb	0.09
Hog dressing:		
Carcass washing (skin off)[a]	gal/lb	0.07
Carcass washing (skin on)[a]	gal/lb	0.02
Total per carcass (skin off)[a]	gal/lb	0.14
Total per carcass (skin on)[a]	gal/lb	0.35
Plant cleanup:		
Cleanup during slaughter:		
Between species	gal/ft^2	0.07
During work break	gal/ft^2	0.05
At end of day	gal/ft^2	0.27
Holding pens	gal/ft^2	0.19
Inedible-offal room	gal/ft^2	0.21
Chill cooler	gal/ft^2	0.07
Holding cooler	gal/ft^2	0.13
Fabrication room	gal/ft^2	0.27
Employee needs:	gal/day/employee	25
Unaccounted water usage	% of total water usage	25%

[a]All estimators calculated on a live weight basis.

SOURCE: Utility Usage in Small Slaughter Plants (Brasington 1977).

TABLE 16. ANNUAL WATER USAGE FOR MODEL PLANTS, NORTH DAKOTA, 1985

Plant Utilization Level	Plant Size		
	A	B	C
(percent)	---------- gallons ----------		
55	300,484	438,537	688,451
70	326,041	486,456	768,316
85	351,598	534,375	848,181
100	377,154	582,294	928,046

Two charges for water usage are involved in cost calculations. These are a basic water charge and a sewage charge. The average commercial charge for all North Dakota cities larger than 5,000 was used (North Dakota League of Cities 1982). The averages were $1.35 per 1,000 gallons for the basic water charge and $.24 per 1,000 gallons for the sewage charge. Total annual water charges at a 100 percent utilization level were $574 for Plant A, $887 for Plant B, and $1,413 for Plant C (see Table 17 for costs at different utilization levels).

TABLE 17. ANNUAL WATER COSTS FOR MODEL PLANTS, NORTH DAKOTA, 1985

Plant Utilization Level	Plant Size		
	A	B	C
(percent)	---------- dollars ----------		
55	458	668	1048
70	497	741	1170
85	535	814	1292
100	574	887	1413

Natural Gas Requirement and Costs. Natural gas was used for three purposes: (1) heating of water, (2) operation of the smokehouse, and (3) heating of the building. In determining gas usage for heating of water it was assumed that all water used for plant cleanup was heated to 180°F and all other water was tempered to 75°F. A water heater efficiency factor of 75 percent was used. The smokehouse operated at 50,000 BTU per hour, 75 percent efficiency, 500 pound load, and a 12-hour smoking period. It was assumed that 18 percent of the pork carcass, representing hams, was smoked. Natural gas usage for heating of water and operation of the smokehouse was 3,597 ccf (100 cubic feet) for Plant A; 5,030 ccf for Plant B; and 7,787 ccf for Plant C when operating at a 100 percent utilization level (Table 18). Gas costs were based

TABLE 18. ANNUAL NATURAL GAS USAGE IN CCF FOR HOT WATER HEATING AND OPERATION OF SMOKEHOUSE FOR MODEL PLANTS, NORTH DAKOTA, 1985

Plant Utilization Level	Plant Size		
	A	B	C
(percent)	---------- 100 cubic feet (ccf) ----------		
55	3,042	3,990	6,053
70	3,227	4,337	6,631
85	3,412	4,684	7,209
100	3,597	5,030	7,787

on the General Service Schedule from Northern States Power Company, Fargo, North Dakota. Natural gas costs were $1,906; $2,610; and $3,965 for Plants A, B, and C, respectively, operating at a utilization level of 100 percent (Table 19).

TABLE 19. ANNUAL NATURAL GAS COSTS FOR HOT WATER HEATING AND OPERATION OF SMOKEHOUSE FOR MODEL PLANTS, NORTH DAKOTA, 1985[a]

Plant Utilization Level	Plant Size		
	A	B	C
(percent)	---------- dollars ----------		
55	1,633	2,099	3,113
70	1,724	2,269	3,397
85	1,815	2,440	3,681
100	1,906	2,610	3,965

[a]Calculated as: $.54144/ccf up to 30 ccf/month,
$.49144/ccf for usage beyond 30 ccf/month, and
a monthly service charge of $10.

Building heating costs were estimated at $2,050; $2,526; and $3,372 for Plants A, B, and C, respectively, when operating at full capacity (Table 20).

TABLE 20. ANNUAL HEATING COST FOR MODEL PLANTS, NORTH DAKOTA, 1985

Plant Utilization Level	Plant Size		
	A	B	C
(percent)	---------- dollars ----------		
55	1,643	1,991	2,678
70	1,779	2,169	2,910
85	1,914	2,348	3,141
100	2,050	2,526	3,372

The heating requirements were estimated using the computerized North Dakota State University Cooperative Extension Service's AGNET Heating Cost Program (1985). Basic heating costs were assumed to not vary with plant utilization levels but were adjusted for heat loss due to infiltration from meat coolers and freezers which did vary with respect to utilization levels.

Other Costs

Other costs include those that are annual and do not vary with output and those that are variable with the output level. Those that do not vary with output are repairs and maintenance, premise liability, fire insurance, truck insurance, and property tax (see Table 21 for a listing of other costs on an annual basis).

TABLE 21. OTHER NONVARIABLE ANNUAL COSTS FOR MODEL PLANTS, NORTH DAKOTA, 1985

Cost Item	Plant Size A	Plant Size B	Plant Size C
	dollars		
Repairs and maintenance	6,920	9,620	13,118
Premise liability	450	560	695
Fire insurance	3,460	4,810	6,559
Property tax	4,808	6,672	9,087
Truck insurance	--	1,010[a]	1,310[a]

[a]Includes a state license fee of $110.

Repairs and maintenance were estimated at 3 percent of initial plant investment (Schupp and Roy 1973). This figure overestimates repairs and maintenance costs during the first few years of plant operation but underestimates cost in later years. A constant rate of 3 percent was used for budgetary reasons. Premise liability insurance was budgeted at $.20 per square foot of building area. Fire insurance was estimated at $1.50 per $100 value of buildings and equipment. Truck insurance was budgeted at $900 and $1,200 for Model Plants B and C. All insurance estimates were based on interviews with major insurance companies. Property tax was estimated at $410.45 per $1,000 of taxable valuation. Taxable value is 10 percent of assessed value and assessed value is calculated at 50 percent of full and fair market value (North Dakota Tax Department 1984). Full and fair market value is estimated at the total initial investment in buildings and plant equipment. The tax rate of $410.45 was calculated as the state average of county mill rates, $58.64, plus a city mill rate of $351.81. The city mill rate was estimated from the average of Fargo, Jamestown, and Grand Forks rates. Other variable operating costs include commission and trucking fees, delivery expense, product liability, and supplies and other costs.

Commission fees were estimated at $.50 per cwt for the purchase of livestock for noncustom sales and trucking fees were estimated at $.80 per cwt (Table 22). These rates were obtained from interviews of local order buyers and truckers. It was assumed that all livestock processed for retail and wholesale trade are purchased through an order buyer and trucked a distance of 25 to 100 miles.

TABLE 22. ANNUAL COMMISSION AND TRUCKING FEES FOR MODEL PLANTS, NORTH DAKOTA, 1985[a]

Plant Utilization Level	Plant Size		
	A	B	C
(percent)	---------- dollars ----------		
55	6,820	12,787	21,312
70	8,680	16,274	27,124
85	10,540	19,762	32,936
100	12,399	23,249	38,748

[a]Estimated at $.50 per cwt for commission buying and $.80 per cwt for trucking of animals purchased for retail and wholesale sales.

Product liability insurance was calculated at $.51 per $1,000 of wholesale and retail sales (Table 23). The product liability insurance rate was obtained from major insurance companies. Delivery expenses were estimated at 21.45 cents per mile. This estimate was based on a gas cost of $1.25 per

TABLE 23. ANNUAL PRODUCT LIABILITY INSURANCE COSTS FOR MODEL PLANTS, NORTH DAKOTA, 1985

Plant Utilization Level	Plant Size		
	A	B	C
(percent)	---------- dollars ----------		
55	215	402	671
70	273	512	853
85	332	622	1,036
100	390	731	1,219

gallon, average fuel economy of seven miles per gallon, a tire expense of $.01 per mile, and repairs and maintenance at $.026 per mile. These estimates were based on interviews with local trucking firms. It was assumed Plant B's delivery truck would travel 18,000 miles annually and Plant C's truck 24,000 miles annually when operating at a 100 percent utilization level (Table 24).

TABLE 24. ANNUAL VARIABLE DELIVERY EXPENSE FOR MODEL PLANTS, NORTH DAKOTA, 1985

Plant Utilization Level	Plant Size		
	A	B	C
(percent)	---------- dollars ----------		
55	--	2,132	2,843
70	--	2,714	3,618
85	--	3,295	4,394
100	--	3,877	5,169

The category "supplies and other costs" include slaughter and processing supplies, office supplies, condemnations by USDA meat inspector, laundry, telephone, professional dues, and advertising. This variable component was estimated at $.034 per pound of dressed carcass weight (Table 25). The figure of $.034 per pound was the average reported by several North

TABLE 25. ANNUAL COSTS OF SUPPLIES AND OTHER COSTS FOR MODEL PLANTS, NORTH DAKOTA, 1985

Plant Utilization Level	Plant Size		
	A	B	C
(percent)	---------- dollars ----------		
55	16,833	31,562	52,604
70	21,424	40,170	66,951
85	26,015	48,778	81,297
100	30,606	57,386	95,644

Dakota firms in 1985 and is consistent with the figure of 3.26 percent of gross sales as reported by the American Meat Institute (1985) for supplies and containers.

Revenue Analysis

Revenue was calculated on the basis of gross margin per animal slaughtered and processed. Gross margin was defined as the total revenue received per animal slaughtered and processed minus the cost of the live animal purchased. The gross margin is the amount of revenue available to the firm to cover all operating and investment costs for each animal slaughtered. This approach allows use of the USDA's reported farm-retail price spread for cattle and pork in calculating revenues from retail sales. Use of the price spreads eliminates the need to estimate retail prices and livestock prices. These prices tend to be volatile over time. Farm-retail price spreads have been more constant over time than either retail or livestock prices.

The gross margins assumed for custom slaughter and processing were $42.65 per hog and $134.34 per head of cattle. These gross margins were based on a 1985 mail survey of federally inspected North Dakota slaughter plants. Custom charges for hogs were estimated at $8.25 per head for slaughter, $.17 per pound of hanging weight for cutting, wrapping, and freezing, and $.25 per pound charge for smoking hams. Custom charges for cattle were estimated at $11.00 a head for slaughter, $.17 per pound of hanging carcass weight for cutting, wrapping, and freezing, and a by-product value of $12.50 per head for hides. Wholesale gross margins were estimated at $42.65 per hog and $134.34 per head of cattle (Table 26). The wholesale gross margins were estimated at

TABLE 26. GROSS MARGINS PER HEAD BY TYPE OF SALE FOR MODEL SLAUGHTER PLANTS, NORTH DAKOTA, 1985

Type of Sale	Hogs[a]	Cattle[b]
	dollars	
Custom	42.65	134.34
Wholesale	42.65	134.34
Retail	69.42	252.66

[a]Based on 220 pound live weight, a carcass weight of 160 pounds yielding 129 pounds of retail cuts and 28.8 pounds of smoked hams.
[b]Based on 1,050 pounds live weight, a carcass weight of 651 pounds yielding 437.5 pounds of retail cuts and a by-product value of $12.50 per head.

the same gross margin as for custom sales. This was a necessary procedure given an inadequate wholesale pricing mechanism for deriving revenue calculations. It was assumed that the firm would expect to receive the same gross margin for wholesale sales as for their custom sales.

Gross margins for retail sales were estimated at $69.42 per hog and $252.66 per head of cattle (Table 26). Gross margins for retail sales were calculated at 66 percent of the average 1981 to 1985 farm-retail spread net of by-product value as reported by the USDA (Livestock and Poultry Outlook and Situation 1985). The 1981 to 1985 average USDA farm-retail spread net of by-product value was $81.28 per cwt of retail pork cuts and $82.35 per cwt of retail cattle cuts. A by-product value of $12.50 per head of cattle was included for the hide.

The net result of the gross margins for wholesale and retail sales methods, assuming an average hog price of $48.09 per cwt and a cattle price of $63.84 per cwt (these were the 1984 USDA monthly average prices for 200-230 pound US Number 1-2 hogs and USDA Choice 2-4, 900-1,100 pound steers at West Fargo, North Dakota), was an overall markup of 29.3 percent for combined wholesale and retail sales. This compares favorably with the range of the 23 to 35 percent markup reported by several North Dakota slaughter and processing plant operators in 1985.

No allowance was made for by-products other than cattle hides, namely offal, blood, inedible fats, and bone. The market value of these by-products was considered minimal for a small slaughter and processing plant.

Total annual revenue above livestock purchases ranged from $246,883 for Plant A to $771,511 for Plant C when operating at full capacity (Table 27). Values in Table 27 represent total revenues above livestock purchases available to pay for all operating and investment costs incurred by the model plants at various levels of utilization.

TABLE 27. TOTAL ANNUAL REVENUE ABOVE LIVESTOCK PURCHASES FOR MODEL PLANTS, NORTH DAKOTA, 1985

Plant Utilization Level	Plant Size		
	A	B	C
(percent)	---------- dollars ----------		
55	135,786	254,599	424,331
70	172,818	324,035	540,058
85	209,851	393,471	655,784
100	246,883	462,906	771,511

Cost and Revenue Summary

Total investment, operating capital requirements, annual revenues net of livestock purchases, and annual expenses are summarized in Table 28. Total annual costs when operating at full capacity were $223,579; $394,004; and $588,153 for Plants A, B, and C, respectively. Annual net funds generated before state and federal income taxes ranged from $27,386 for Plant A operating at a 55 percent utilization level to $183,358 for Plant C operating at full capacity. These annual revenues and expenses could be used as a basis for estimating a cash flow projection.

Information required to convert the estimated cost and revenue figures presented in Table 28 to a cash flow projection are (1) the amount and terms of debt used to finance the project, (2) the tax status of the investor, and (3) estimates of plant utilization levels during each year. The required adjustments include interest expense, income taxes, principal payment on loan, and changes in working capital requirements (working capital requirements increase when utilization levels increase).

Due to the infinite number of financing options and the tax status of the investment, it is impossible to construct a representative cash flow projection for the model plants. However, a hypothetical cash flow projection for an investment in a size B plant is presented. The cash flow projection illustrates how the estimated cost and revenue figures summarized in Table 28 can be used to evaluate a potential livestock slaughtering and processing investment.

TABLE 28. SUMMARY OF INVESTMENT OUTLAYS, ANNUAL REVENUES, AND ANNUAL COSTS FOR MODEL PLANTS, NORTH DAKOTA, 1985.

Item	Plant Utilization Level											
	Plant Size A				Plant Size B				Plant Size C			
	55	70	85	100	55	70	85	100	55	70	85	100
Total investment	235,851	235,851	235,851	235,851	349,590	349,590	349,590	349,590	471,961	471,961	471,961	471,961
Net working capital	28,686	36,510	44,333	52,157	53,787	68,456	83,125	97,794	89,645	114,093	138,542	162,990
Total capital requirements	264,537	272,361	280,184	288,008	403,277	418,046	432,715	447,384	561,606	586,054	610,503	634,951
Revenue (net of livestock purchases)	135,786	172,818	209,851	246,883	254,599	324,035	393,471	462,906	424,331	540,058	655,784	771,511
Annual depreciation[a]	13,632	13,632	13,632	13,632	21,510	21,510	21,510	21,510	28,292	28,292	28,292	28,292
Interest on average plant investment[b]	16,571	16,571	16,571	16,571	24,795	24,795	24,795	24,795	33,329	33,329	33,329	33,329
Interest on net working capital[c]	3,600	4,582	5,564	6,546	6,750	8,591	10,432	12,273	11,250	14,319	17,387	20,455
Property tax	4,808	4,808	4,808	4,808	6,672	6,672	6,672	6,672	9,087	9,087	9,087	9,087
Fire insurance	3,460	3,460	3,460	3,460	4,810	4,810	4,810	4,810	6,559	6,559	6,559	6,559
Premise liability	450	450	450	450	560	560	560	560	695	695	695	695
Total fixed expenses	42,522	43,504	44,486	45,467	65,096	66,937	68,778	70,619	89,212	92,280	95,349	98,417
Repairs and maintenance	6,920	6,920	6,920	6,920	9,620	9,620	9,620	9,620	13,118	13,118	13,118	13,118
Labor	65,688	75,061	84,434	93,807	109,845	130,094	150,342	170,591	156,745	188,329	219,912	251,495
Fringe benefits	15,962	18,240	20,518	22,795	26,692	31,613	36,533	41,454	38,089	45,764	53,439	61,113
Electricity	4,478	5,206	5,935	6,663	6,162	7,256	8,350	9,444	8,401	9,990	11,579	13,169
Fuel	3,276	3,503	3,729	3,956	4,090	4,439	4,788	5,136	5,791	6,306	6,822	7,337
Water	458	497	535	574	668	741	814	887	1,048	1,170	1,292	1,413
Supplies and other expenses	16,833	21,424	26,015	30,606	31,562	40,170	48,778	57,386	52,604	66,951	81,297	95,644
Truck insurance and fees	0	0	0	0	1,010	1,010	1,010	1,010	1,310	1,310	1,310	1,310
Delivery expenses	0	0	0	0	2,132	2,714	3,295	3,877	2,843	3,618	4,394	5,169
Buyer commission and trucking fees	6,820	8,680	10,540	12,399	12,787	16,274	19,762	23,249	21,312	27,124	32,936	38,748
Product liability insurance	215	273	332	390	402	512	622	731	670	853	1,036	1,219
Total operational expenses	120,650	139,804	158,957	178,111	204,971	244,442	283,913	323,385	301,932	364,533	427,135	489,736
Total annual cost	163,172	183,307	203,443	223,579	270,067	311,379	352,692	394,004	391,144	456,813	522,483	588,153
Annual funds available for principal payments, income taxes, and dividends on equity	(27,386)	(10,489)	6,408	23,304	(15,468)	12,655	40,779	68,903	33,187	83,244	133,301	183,358

[a]Annual depreciation estimated on the straight line depreciation method where depreciable life is equal to useful economic life.
[b]An opportunity cost of 12.55 percent (the 1976-1985 average interest rate for U.S. domestic corporate Baa bonds) was charged against average plant investment. Average plant investment was $132,037; $197,567, and $265,557 for Plant size A, B, and C. (See Appendix B for calculations.)
[c]Calculated at 12.55 percent times net working capital.

The cash flow projections for years one through five for an investment in Model Plant B are presented in Table 29. The following assumptions were made:

1) Fifty percent of the initial plant investment was financed by borrowed capital. Initial loan balance was $174,795. Annual loan payment was $31,636. Loan was amortized over 10 years at 12.55 percent, the 1976-1985 average of United States domestic corporate Baa bonds.

2) Working capital requirements were financed exclusively by borrowed capital. Working capital requirements increased as plant utilization levels increased. Due to yearly changes in working capital requirements the loan was not amortized, but an annual interest charge for borrowed working capital was included in fixed expenses.

3) Plant utilization levels of 55 percent the first year, 70 percent the second, 85 percent the third, and 100 percent the fourth and fifth, were assumed.

4) The investment project was treated as a separate corporate entity for tax purposes.

The project incurs a projected cash flow deficit, before a payment on equity, of $22,309 in year one and $9,613 in year two. Cash flow projection is positive in years three through five. Consequently, in year one and two sufficient equity or borrowed capital must be available to carry the plant forward to year three when a positive return is generated. An income sufficient to cover all costs is not generated from plant operations until year four.

Economies of size are readily apparent when plant size increases. Short-run average production cost curves for the model plants are presented in Figure 6. Average cost of processing decreased dramatically for all plants when utilization levels increased. The inefficiency incurred when plants are incorrectly sized for a given market area is illustrated in Figure 6. For example, Plant B at a 55 percent utilization has significantly higher average cost than Plant A at 100 percent of capacity, even though total output is the same. The costliness of oversizing a plant decreases as plant size increases. The cost difference between Plant B at 100 percent and Plant C at the same volume of output is smaller than the difference between Plant A at 100 percent of capacity and Plant B at the same volume level of output.

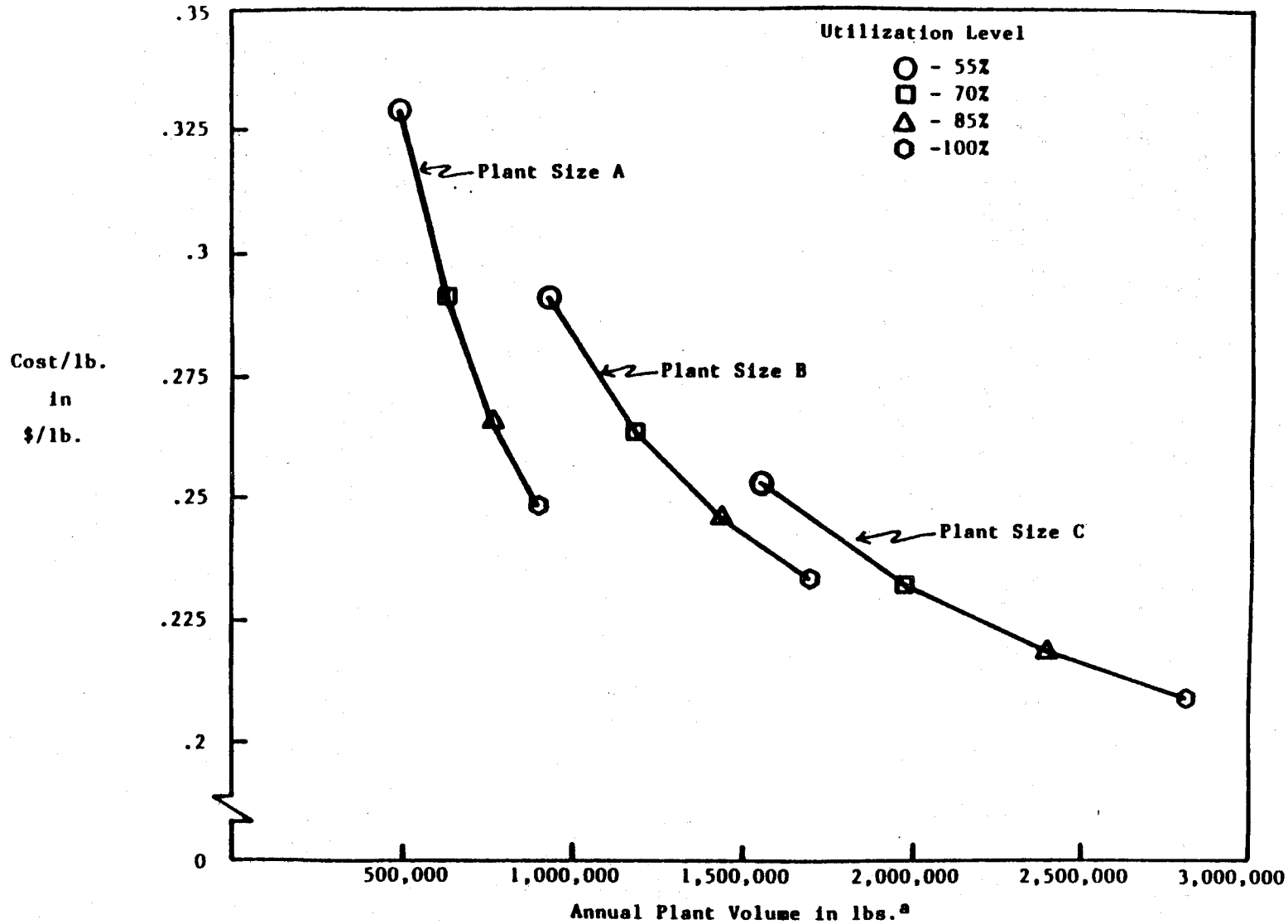
Economic Profitability

The goal of economic profitability analysis is to determine if an investment project will contribute to the overall profits of the investor (Boehlje and Eidman 1984). The investor may be an existing firm, that is a corporation, partnership or single proprietorship, or a newly formed organization entering the business. Consequently, determination of economic profitability is dependent upon the characteristics of the individual investor. The major characteristics that are different among investors are

TABLE 29. HYPOTHETICAL CASH FLOW EXAMPLE FOR A MODEL B SIZE SLAUGHTERING PLANT

	Year				
	1	2	3	4	5
Revenue (net of livestock purchases)	254,599	324,035	393,471	462,906	462,906
Equipment replacement[a]	21,510	21,510	21,510	21,510	21,510
Interest on plant investment loan	21,937	20,720	19,350	17,808	16.072
Interest expense on working capital[b]	6,750	8,491	10,432	12,273	12,273
Property tax	6,672	6,672	6,672	6,672	6,672
Fire insurance	4,810	4,810	4,810	4,810	4,810
Premise liability	560	560	560	560	560
Repairs and maintenance	9,620	9,620	9,620	9,620	9,620
Labor	109,845	130,094	150,342	170,591	170,591
Fringe benefits	26,692	31,613	36,533	41,454	41,454
Electricity	6,162	7,256	8,350	9,444	9,444
Fuel	4,090	4,439	4,788	5,136	5,136
Water	668	741	814	887	887
Supplies and other expenses	31,562	40,170	48,778	57,386	57,386
Truck insurance and fees	1,010	1,010	1,010	1,010	1,010
Delivery expenses	2,132	2,714	3,295	3,877	3,877
Buyer commission and trucking fees	12,787	16,274	19,762	23,249	23,249
Product liability insurance	402	512	622	731	731
Total expenses	267,209	307,304	347,246	387,017	385,282
Taxable income	(12,610)	16,730	46,224	75,890	77,625
Taxable income plus carryover loss from previous year	0	4,120	46,224	75,890	77,625
Income taxes[c]	0	758	10,815	22,409	23,286
Additional net working capital[d]	0	14,669	14,669	14,669	0
Principal payment[e]	9,699	10,916	12,286	13,828	15,563
Surplus (deficit)[f]	(22,309)	(9,613)	8,453	24,983	38,776
Opportunity cost of equity[g]	21,937	21,937	21,937	21,937	21,937
Surplus (deficit) above opportunity cost of equity[h]	(44,246)	(31,550)	(13,484)	3,046	16,839

[a]The budgeted figure for equipment replacement may overstate actual equipment replacement in the early years of the plant's life.
[b]Calculated at an interest rate of 12.55 percent.
[c]Federal and State corporate income taxes.
[d]Additional working capital is required when increasing plant utilization levels.
[e]Principal payment is the balance of the annual loan payment of $31,636 less annual interest expense.
[f]Surplus (deficit) is the funds available for a payment to equity when a surplus occurs or the additional funds required from equity or debt to maintain current loan payments.
[g]Opportunity cost of equity calculated at 12.55 percent (the 1976-1985 average of United States domestic corporate Baa bonds) on an initial investment of $174,795.
[h]Surplus (deficit) is the annual funds generated by the project above all expenses including an opportunity cost charge on equity.



[a]Plant volume in lbs. calculated on a hanging carcass weight of 651#/beef and 160#/hog.

Figure 6. Short-run Average Total Cost, Model Plants Operating at Varying Utilization Levels, North Dakota, 1985

marginal tax rates[4], (which have an impact on tax benefits from depreciation and interest expense) returns from alternative investments, and cost of borrowed funds.

An analysis of the different sized slaughter and processing plants will be illustrated under marginal tax rates of 0, 20, 35, and 50 percent. The internal rate of return (IRR)[5] is the method chosen to calculate the expected returns from the plants under various operational levels and marginal tax rates.

The IRR is superior to other analytical methods because it takes the time value of money into consideration and it allows incorporation of time lags between initial investment and operation of the plant at designed capacity levels.

The criterion for deciding if the IRR is an acceptable return is the investor's after-tax weighted average cost of capital (WACOC). WACOC is defined as:

$$WACOC = KeWe + Kd(1-t)Wd$$

where

We = proportion of equity
Wd = proportion of debt
Ke = the required after tax return on equity
Kd = cost of debt (borrowed funds)
t = marginal tax rate

The project (investment) is economically profitable if the IRR for the proposed investment equals or exceeds the investor's cost of capital. If the preceeding criterion is met the project will generate a return to the investor above the cost of capital.

The IRR for the model plants are presented in Tables 30 through 32. The internal rates of return ranged from 13 percent for Plant A to 25.8 percent for Plant C when operation was at 100 percent of capacity with a marginal tax rate of 35 percent. Impacts of reduced operational levels are significant in all plant sizes. Plant A's pretax IRR fell from 18.5 percent when operating at 100 percent of capacity to only 5.5 percent when operating at 70 percent of capacity. When a new project (business) does not replace an existing business it is rare that the plant is able to start operation at full capacity. This can have a significant impact on the IRR for that investment. The assumption that a plant would not start at full capacity, but begin operation at 55 percent and reach full capacity during the fourth year, would decrease the pretax IRR from 18.5 percent to 14.2 percent for Plant A, 25.3 percent to 20 percent for Plant B, and from 36.2 percent to 28.9 percent for Plant C (Tables 30, 31, and 32).

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[4]Marginal tax rate is the rate additional income is taxed at.

[5]The internal rate of return (IRR) is usually thought of as the rate of return the project (investment) earns during the investment's planning horizon.

TABLE 30. INTERNAL RATE OF RETURN FOR MODEL PLANT A, NORTH DAKOTA, 1985

Plant Utilization Level[a]	Marginal Tax Rate (Percent)			
	0	20	35	50
	percent			
55	(4.8)	(3.8)	(3.0)	(2.3)
70	5.5	4.5	3.7	2.9
85	12.6	10.5	8.7	6.9
100	18.5	15.4	13.0	10.4
55-70[b]	4.9	4.0	3.3	2.6
55-85[c]	10.5	8.9	7.5	6.1
55-100[d]	14.2	12.1	10.4	8.6

[a]A twenty-year planning horizon (the expected life of the building) and a six-month time lag from initial construction and investment outlays to start of operation is assumed.
[b]Utilization level is 55 percent for year one and 70 percent for years 2 through 20.
[c]Utilization level is 55 percent for year one, 70 percent for year two, and 85 percent for years 3 through 20.
[d]Utilization level is 55 percent for year one, 70 percent for year two, 85 percent for year three, and 100 percent for years 4 through 20.

TABLE 31. INTERNAL RATE OF RETURN FOR MODEL PLANT B, NORTH DAKOTA, 1985

Plant Utilization Level[a]	Marginal Tax Rate (Percent)			
	0	20	35	50
	percent			
55	5.6	4.6	3.8	2.9
70	13.4	11.2	9.4	7.4
85	19.9	16.6	14.0	11.2
100	25.3	21.2	17.9	14.4
55-70[b]	12.6	10.5	8.8	7.1
55-85[c]	17.1	14.5	12.4	10.1
55-100[d]	20.0	17.2	14.8	12.2

[a]A twenty-year planning horizon (the expected life of the building) and a six-month time lag from initial construction and investment outlays to start of operation is assumed.
[b]Utilization level is 55 percent for year one and 70 percent for years 2 through 20.
[c]Utilization level is 55 percent for year one, 70 percent for year two, and 85 percent for years 3 through 20.
[d]Utilization level is 55 percent for year one, 70 percent for year two, 85 percent for year three, and 100 percent for years 4 through 20.

TABLE 32. INTERNAL RATE OF RETURN FOR MODEL PLANT C, NORTH DAKOTA, 1985

Plant Utilization Level[a]	Marginal Tax Rate (Percent)			
	0	20	35	50
	percent			
55	16.2	13.6	11.4	9.1
70	24.0	20.0	16.9	13.6
85	30.5	25.5	21.6	17.5
100	36.2	30.4	25.8	20.9
55-70[b]	22.5	19.0	16.2	13.1
55-85[c]	26.4	22.5	19.4	15.9
55-100[d]	28.9	24.8	21.5	17.8

[a]A twenty-year planning horizon (the expected life of the building) and a six-month time lag from initial construction and investment outlays to start of operation is assumed.
[b]Utilization level is 55 percent for year one and 70 percent for years 2 through 20.
[c]Utilization level is 55 percent for year one, 70 percent for year two, and 85 percent for years 3 through 20.
[d]Utilization level is 55 percent for year one, 70 percent for year two, 85 percent for year three, and 100 percent for years 4 through 20.

An example of a specific investor's decision-making process regarding the economic profitability of an investment in a meat slaughter and processing plant is included in Appendix C.

In summary, assuming a pretax opportunity cost of equity capital and cost of debt rate of 12.55 percent (the 10-year, 1976-1985 average of corporate Baa bonds reported by Moody's Investors Service, United States Department of Commerce)[6], Plant A becomes marginally profitable when operating at 85 percent of capacity, Plant B at 70 percent, and Plant C at 55 percent. Taking into consideration lower levels of utilization during the early years, Plant A was not economically profitable until operating at full capacity, and Plant B was only marginally profitable at the 70 percent utilization level. Plant C remained economically profitable at all utilization levels analyzed. Larger plants reached profitability at lower levels of utilization due primarily to lower investment costs per unit of output (Tables 30, 31, and 32).

[6]United States Department of Commerce, Bureau of Economic Analysis. Survey of Current Business. Selected monthly issues. Washington, DC: United States Government Printing Office.

Economic Impacts

The economic impacts resulting from the construction and operation of a livestock slaughter plant in North Dakota can be measured in terms of several key economic variables. Numerous direct, indirect, and induced impacts would occur within the state. These include increased levels of business activity, retail sales, and personal income. Also, additional tax revenue would be generated.

All three sizes of livestock slaughter plants were considered for this analysis; with each assumed to be operating at full capacity (for a description of the capacities associated with each plant size, see the economic analysis section earlier in this report). Because a specific location was not determined for the plant, the impacts will be reported only as occurring in North Dakota. Impacts resulting from the slaughter plant were analyzed in two phases, construction and operational. The construction impact refers to the "one time" business activity generated as a result of the construction of the facility. These impacts would be distributed throughout the duration of the construction, which was assumed to be less than one year for all three sizes of plants. Economic impacts resulting from the operation of a slaughter plant would result each year the plant is in operation. These impacts are annually recurring, but were determined for one year based on the expected expenditures that would result from the operation of the plant. The impact analysis was computed in terms of 1986 dollar values.

Input-Output Model

The impacts resulting from construction and operation of a livestock slaughter plant were analyzed using the North Dakota Input-Output Model. Input-output analysis is a technique for tabulating the linkages or interdependencies between various industrial groups within an economy. For a complete discussion of input-output theory and methodology, as well as a review of the North Dakota Input-Output Model, see Coon et al. (1985).

Economic impacts were calculated by applying the local expenditures for construction and operation to the North Dakota input-output interdependence coefficients. These input-output interdependence coefficients are commonly called multipliers because they measure the number of times a dollar of income "turns over" in the state. The multiplier effect results when each producing sector buys some fraction of its inputs from other sectors of the state's economy and these sectors, in turn, use some fraction of that income to buy some of their inputs from still other sectors, and so on. The multiplier effect is due to the spending and respending within the state's economy of part of each dollar that enters the state. North Dakota's input-output interdependence coefficients are presented in Table 33.

Several tax revenues can also be estimated using the input-output model. These include state personal income tax, corporate income tax, and sales and use tax collections. Tax revenues are based on historic relationships between tax collections and input-output model estimates of gross business volume for selected sectors. Estimating equations were used to calculate North Dakota personal income tax (2.1 percent times the input-output model's personal income estimate), corporate income tax (.31 percent times the model's estimate of total business activity of all business sectors), and

TABLE 33. INPUT-OUTPUT INTERDEPENDENCE COEFFICIENTS, BASED ON TECHNICAL COEFFICIENTS FOR 17-SECTOR MODEL FOR NORTH DAKOTA

Sector	(1) Ag, Lvstk	(2) Ag, Crops	(3) Nonmetallic Mining	(4) Const	(5) Trans	(6) Comm & Pub Util	(7) Ag Proc & Misc Mfg	(8) Retail Trade	(9) FIRE
(1) Ag, Livestock	1.2072	0.0774	0.0445	0.0343	0.0455	0.0379	0.1911	0.0889	0.0617
(2) Ag, Crops	0.3938	1.0921	0.0174	0.0134	0.0178	0.0151	0.6488	0.0317	0.0368
(3) Nonmetallic Mining	0.0083	0.0068	1.0395	0.0302	0.0092	0.0043	0.0063	0.0024	0.0049
(4) Construction	0.0722	0.0794	0.0521	1.0501	0.0496	0.0653	0.0618	0.0347	0.0740
(5) Transportation	0.0151	0.0113	0.0284	0.0105	1.0079	0.0135	0.0128	0.0104	0.0120
(6) Comm & Public Util	0.0921	0.0836	0.1556	0.0604	0.0839	1.1006	0.0766	0.0529	0.1321
(7) Ag Proc & Misc Mfg	0.5730	0.1612	0.0272	0.0207	0.0277	0.0239	1.7401	0.0452	0.0704
(8) Retail Trade	0.7071	0.8130	0.5232	0.4100	0.5475	0.4317	0.6113	1.2734	0.6764
(9) Fin, Ins, Real Estate	0.1526	0.1677	0.1139	0.0837	0.1204	0.1128	0.1322	0.0577	1.1424
(10) Bus & Pers Services	0.0562	0.0684	0.0430	0.0287	0.0461	0.0374	0.0514	0.0194	0.0766
(11) Prof & Soc Services	0.0710	0.0643	0.0559	0.0402	0.0519	0.0526	0.0530	0.0276	0.0816
(12) Households	1.0458	0.9642	0.8424	0.6089	0.7876	0.7951	0.7859	0.4034	1.2018
(13) Government	0.0987	0.0957	0.0853	0.0519	0.2583	0.0999	0.0796	0.0394	0.1071
(14) Coal Mining	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(15) Thermal-Elec Generation	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(16) Pet Exp/Ext	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(17) Pet Refining	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Gross Receipts Multiplier	4.4931	3.6851	3.0284	2.4430	3.0534	2.7901	4.4509	2.0871	3.6778

- continued -

TABLE 33. INPUT-OUTPUT INTERDEPENDENCE COEFFICIENTS, BASED ON TECHNICAL COEFFICIENTS FOR 17-SECTOR MODEL FOR NORTH DAKOTA (CONTINUED)

Sector	(10) Bus & Pers Service	(11) Prof & Soc Service	(12) Households	(13) Govt	(14) Coal Mining	(15) Thermal-Elec Generation	(16) Pet Exp/Ext	(17) Pet Refining
(1) Ag, Livestock	0.0384	0.0571	0.0674	0.0000	0.0376	0.0251	0.0159	0.0145
(2) Ag, Crops	0.0152	0.0229	0.0266	0.0000	0.0285	0.0321	0.0062	0.0057
(3) Nonmetallic Mining	0.0043	0.0050	0.0057	0.0000	0.0032	0.0019	0.0045	0.0037
(4) Construction	0.0546	0.0787	0.0902	0.0000	0.0526	0.0328	0.1148	0.0929
(5) Transportation	0.0118	0.0100	0.0093	0.0000	0.0084	0.0048	0.0180	0.0172
(6) Comm & Public Util	0.1104	0.1192	0.1055	0.0000	0.0712	0.0378	0.0510	0.0444
(7) Ag Proc & Misc Mfg	0.0237	0.0362	0.0417	0.0000	0.0618	0.0782	0.0097	0.0089
(8) Retail Trade	0.4525	0.6668	0.7447	0.0000	0.3995	0.2266	0.1838	0.1675
(9) Fin, Ins, Real Estate	0.1084	0.1401	0.1681	0.0000	0.0771	0.0977	0.0388	0.0358
(10) Bus & Pers Services	1.0509	0.0455	0.0605	0.0000	0.0289	0.0201	0.0139	0.0127
(11) Prof & Soc Services	0.0497	1.1026	0.0982	0.0000	0.0493	0.0301	0.0210	0.0195
(12) Households	0.7160	1.0437	1.5524	0.0000	0.6666	0.3973	0.3205	0.2951
(13) Government	0.0774	0.0881	0.1080	1.0000	0.0511	0.0444	0.0280	0.0285
(14) Coal Mining	0.0000	0.0000	0.0000	0.0000	1.0000	0.1582	0.0003	0.0002
(15) Thermal-Elec Generation	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
(16) Pet Exp/Ext	0.0000	0.0000	0.0000	0.0000	0.0138	0.0084	1.0981	0.8227
(17) Pet Refining	0.0000	0.0000	0.0000	0.0000	0.0168	0.0102	0.0000	1.0000
Gross Receipts Multiplier	2.7133	3.4159	3.0783	1.0000	2.5664	2.2057	1.9245	2.5693

sales and use tax (4.06 percent times the model's retail trade activity) collections attributable to the livestock slaughter plant (Coon et al. 1984). Tax revenues were estimated separately for the construction and operational phases.

Local Expenditures

Local expenditures during the construction phase totaled $129,000, $183,000, and $274,000 for plant sizes A, B, and C, respectively (Table 34).

TABLE 34. ESTIMATED LOCAL CONSTRUCTION AND OPERATIONAL[a] PHASE EXPENDITURES ASSOCIATED WITH THREE SIZES OF LIVESTOCK SLAUGHTER PLANTS, NORTH DAKOTA, 1986

Item	Sector						
	Const	Trans	Comm & Pub Util	Retail	FIRE	House-holds	Total
	thousand dollars						
Construction Phase:							
Size A	129	--	--	--	--	--	129
Size B	183	--	--	--	--	--	183
Size C	274	--	--	--	--	--	274
Operational Phase:							
Size A	--	12	11	38	4	109	174
Size B	--	23	15	71	7	197	313
Size C	--	39	22	114	10	292	477

[a]Excludes livestock purchases.

These outlays were for building and site preparation; all machinery and equipment required to outfit the plant was assumed to be purchased outside of North Dakota. Operational phase expenditures (i.e., annual expenditures to staff and operate the plant) did not include payments for livestock to be slaughtered in the plant. Purchases of livestock do not have an economic impact. The animals would be sold regardless of whether the slaughter plant purchased them or not, because they could be sold to an alternative market. Total annual operational expenditures, excluding out-of-state and tax expenses, for plant size A was $174,000, for plant size B was $313,000, and for plant size C was $477,000 (Table 34). Expenditures during the operational phase were distributed through five sectors of the economy with the household sector receiving the greatest amount. This means that the wages and salaries will be the largest nonlivestock expenditure for the slaughter plant on an annual basis.

Total Business Activity

Applying construction and operational phase expenditures to the multipliers provided estimates of personal income, retail trade, total business activity for all business sectors, and total business activity attributable to the livestock slaughter plant. The construction phase (a one-time injection into the local economy) generated $79,000, $111,000, and $167,000 of personal income for plant sizes A, B, and C, respectively (Table 35). Retail trade activity associated with the construction of Plant A was $53,000, Plant B was $75,000, and Plant C totaled $112,000. Total business activity generated as a result of the construction of plant sizes A, B, and C were $315,000, $447,000, and $669,000, respectively.

TABLE 35. ESTIMATED PERSONAL INCOME, RETAIL SALES, BUSINESS ACTIVITY OF ALL BUSINESS (NONAGRICULTURAL) SECTORS, AND TOTAL BUSINESS ACTIVITY RESULTING FROM CONSTRUCTION AND OPERATION[a] OF THREE SIZES OF LIVESTOCK SLAUGHTER PLANTS, NORTH DAKOTA, 1986

Item	Personal Income	Retail Sales	Business Activity of All Business Sectors	Total Business Activity
	thousand dollars			
Construction Phase:				
Size A	79	53	223	315
Size B	111	75	319	447
Size C	167	112	475	669
Operational Phase:				
Size A	207	144	259	498
Size B	373	261	459	892
Size C	559	399	699	1,354

[a]Excludes meat sales.

Total business activity resulting from annual local expenditures to operate the livestock slaughter plant was $498,000 for plant size A, $892,000 for plant size B, and $1,354,000 for plant size C (Table 35). Personal income attributable to operation was $207,000, $373,000, and $559,000, respectively, for Plants A, B, and C. Retail trade activity occurring as a result of the plant operations amounted to $144,000 for size A, $261,000 for size B, and $399,000 for size C.

For plant size B, total local construction expenditures of $183,000 generate a total level of business activity of $447,000; this means that every dollar spent by the slaughter plant will generate another $1.44 of business activity, giving a total of $2.44. Every dollar spent by the slaughter plant during the operational phase will create another $1.85 in the local economy based on plant size B's annual expenditure patterns. Operational expenditures would generate a total of $2.85 in business activity, a level slightly higher than that of the construction phase.

Tax Collections

Data in Table 35 provided the necessary measures of business activity to estimate tax revenues generated by the livestock slaughter plant. Tax revenues calculated included North Dakota personal income, corporate income, and sales and use. Total tax revenues associated with the construction phase were $5,000, $6,000, and $11,000, respectively, for Plants A, B, and C (Table 36). These revenues were rather small due to the lack of local purchases of

TABLE 36. ESTIMATED TAX REVENUES RESULTING FROM CONSTRUCTION AND OPERATION OF THREE SIZES OF LIVESTOCK SLAUGHTER PLANTS, NORTH DAKOTA, 1986

Item	Sales and Use Tax	Personal Income Tax	Corporate Income Tax	Total
	thousand dollars			
Construction Phase:				
Size A	2	2	1	5
Size B	3	2	1	6
Size C	5	4	2	11
Operational Phase:				
Size A	6	4	1	11
Size B	11	8	1	20
Size C	16	12	2	30

machinery and equipment to outfit the plant. However, tax revenues were considerably larger during the operational phase with total annual collections being $11,000 for plant size A, $20,000 for size B, and $30,000 for size C. Over half of the tax revenues was from sales and use tax for each plant size. Sales and use tax collections amounted to $6,000, $11,000, and $16,000 for Plants A, B, and C, respectively.

Summary and Conclusions

The primary objective of this study was to determine the costs and returns associated with the construction and operation of small multi-species slaughter and meat processing plants in North Dakota. Additional information was provided regarding (1) legislation of the meat industry, (2) present slaughter and meat processing plants in North Dakota, (3) current livestock supply in North Dakota, (4) capital investment requirements, (5) operating cost and revenue information, and (6) the economic impacts of a new plant. Results were intended to apply across the state as opposed to being site specific. Potential investors should use the analysis as a guide for initial assessment of feasibility, and then substitute site specific information to determine the ultimate feasibility for establishing a plant at a specific location.

Three sizes of plants were modeled. They ranged from a small plant slaughtering 1,200 head of cattle and 743 hogs annually to 3,750 head of cattle and 2,321 hogs for the largest plant at full capacity. Employment ranged from seven for the smallest plant to 18 for the largest plant.

Pretax internal rate of returns for the three plant sizes were 18.5 percent, 25.3 percent, and 36.2 percent, respectively, for the small, medium, and large size plants when operating at full capacity. The profitability of all plants was quite dependent on plant utilization levels. If plant utilization fell to 55 percent, the pretax IRR would be -4.8 percent, 5.6 percent, and 16.2 percent for Plants A, B, and C, respectively. A plant utilization level of 55 percent is not uncommon in North Dakota slaughter and meat processing plants.

Small multi-species slaughter and processing plants are economically feasible based on research assumptions. However, a high degree of management expertise would be necessary to successfully operate a small meat processing plant. Of particular concern to potential managers should be the seasonality in livestock production and seasonality in demand for meat plant products and services, especially custom services which may include wild game processing. Although economically feasible, depending on financing arrangements, an investment in a slaughter and meat processing plant may not generate sufficient funds for debt repayment and a cash return to equity during the initial years of operation.

Contractual arrangements with livestock producers to guarantee a source of slaughter livestock could aid managers in dealing with the supply problem. Developing reliable markets for products such as contractual arrangements in the hotel, restaurant, and institutional (HRI) trade (including military installations and USDA bulk purchases) should be considered. Product development such as specialty sausages and unique services and products that promote customer loyalty should be an organizational strategy.

It was assumed that the value of by-products other than cattle hides was minimal. However, meat plant managers may find unique ways to merchandise by-products to increase the competitiveness of the firm.

One of the first steps in identifying the potential for establishing a meat plant in a local community should be an assessment of resources and legal, environmental, and economic factors by community leaders and potential investors. Important factors include the availability of livestock, potential demand for products and services, and the availability of capital, labor, and land including water and sewage disposal facilities.

Identifying methods of financing the initial investment, such as community financial institution cooperation with Small Business Administration or Bank of North Dakota guaranteed loans may be necessary. Issuing Municipal Industrial Development Act (MIDA) bonds, property tax relief, and other areas of community support may be considered. However, caution must be taken so that existing businesses are not treated unfairly.

The economic impact of the model plants was not large when compared to several other economic development projects in the state. However, a small meat plant could have a significant impact on a small community. Annual business activity generated was $450,000; $794,000, and $1,200,000 for the three plants. Direct employment was estimated at 7, 12, and 18 employees.

APPENDIX A

Electrical Computational Formulas

The computational formulas used for determining electrical consumption for lighting and refrigeration are as follows:

Lighting: Determining electrical consumption for lighting incorporates three formulas.

1) Lighting requirements = number of lumens =

$$\frac{\text{footcandles of illumination x floor area in sq. ft.}}{\text{coefficient of utilization x maintenance factor}}$$

2) Number of lamps = $\frac{\text{number of lumens}}{\text{number of lumens/lamp}}$

3) Annual kilowatt-hours = $\frac{\text{number of lamps x bulb wattage}^1 \text{ x hours used}}{\text{1,000 watts per kwh}}$

Refrigeration: Electrical consumption is determined by estimating the heat gain in British thermal units (BTUs) and dividing the heat gain by the efficiency of the refrigeration units in BTUs per kilowatt-hour.

Heat gain for refrigeration purposes is comprised of three major components: 1) product load, 2) transmission load, and 3) infiltration air load.

Product load is the heat removal requirement to reduce product temperature from initial temperature to final storage temperature. The formulas for calculating the heat gain in BTUs are:

1) Heat removal in cooling from the initial temperature to some lower temperature above freezing:

$$q_1 = Mc_1(t_1-t_2)$$

2) Heat removal in cooling from the initial temperature to the freezing point of the product:

$$q_2 = Mc_1(t_1-t_f)$$

3) Heat removal to freeze the product:

$$q_3 = Mh_{if}$$

4) Heat removal in cooling from the freezing point to the final temperature below the freezing point:

$$q_4 = Mc_2(t_f-t_3)$$

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[1]If flourescent lighting is used the wattage of ballist unit must also be included.

where

q_1, q_2, q_3, q_4 = heat removal, BTU
M = mass of the product, lb.
c_1 = specific heat of the product above freezing, BTU/lb. per deg. F.
t_1 = initial temperature of the product above freezing, deg. F.
t_2 = lower temperature of the product above freezing, deg. F.
t_f = freezing temperature of the product, deg. F.
h_{if} = latent heat of fusion of the product, BTU/lb.
c_2 = specific heat of the product below freezing, BTU/lb. per deg. F.
t_3 = final temperature of the product below freezing, F.

Transmission load is the heat gain through walls, floor, and ceiling. It depends on the following factors: type of insulation, thickness of insulation, outside wall areas, and the temperature difference between the refrigerated space and ambient air.

The overall coefficient of heat transfer, U, of a wall, floor, or ceiling can be derived by the following equation:

$$U = \frac{1}{x/k}$$

where

U = overall heat transfer coefficient, BTU/h. x $ft.^2$ per deg. F.
x = wall thickness, in.
k = thermal conductivity of wall material, BTU x in/h x $ft.^2$ per deg. F.

After establishing the coefficient of heat transfer, U, the heat gain in B.T.U./h is given by the equation:

$$Q = UA\Delta t$$

where

Q = heat leakage, BTU/h.
A = outside area of section, $ft.^2$.
Δt = difference between outside air temperature and air temperature of the refrigerated space, deg F.

Infiltration air load is the heat gain due to infiltration of heated air through doors and other openings into the refrigerated space. It is estimated using the following equation:

$$Q_t = VA(h_i - h_r)e_r$$

where

Q_t = average hourly refrigerated load, BTU/lb.
V = volume of refrigerated space, $ft.^3$
A = number of air changes per hour
h_i = enthalpy of infiltration air, BTU/lb.
h_r = enthalpy of refrigerated air, BTU/lb.
e_r = density of refrigerated air, $lb./ft.^3$

APPENDIX B

Average Plant Investment

Average plant investment equals the sum of the average investment of individual assets. Average investment of an asset is estimated using the following formula:

Average Investment = (Initial + Ending Investment)/2

APPENDIX TABLE 1. AVERAGE PLANT INVESTMENT FOR MODEL PLANTS, NORTH DAKOTA 1985

Item	Initial Investment	Ending Investment[a]	Average Investment
Model Plant A			
Buildings & equipment (excluding land and delivery trucks)	230,676	23,068	126,872
Land	5,165	5,165	5,165
Delivery trucks	--	--	--
Total average plant investment			132,037
Model Plant B			
Buildings & equipment (excluding land and delivery trucks)	327,162	32,716	179,939
Land	6,428	6,428	6,428
Delivery trucks	16,000	6,400	11,200
Total average plant investment			197,567
Model Plant C			
Buildings & equipment (excluding land and delivery trucks)	447,963	44,796	246,380
Land	7,978	7,978	7,978
Delivery trucks	16,000	6,400	11,200
Total average plant investment			265,558

[a]Ending investment was estimated as the salvage value of the assets. Salvage value was 10 percent of the initial investment for all assets excluding land and delivery trucks. Land is not a depreciable asset therefore ending investment equals initial investment. Salvage value of delivery trucks is estimated at 40 percent of initial investment.

APPENDIX C

Internal Rate of Return and Weighted Average Cost of Capital Example

This is an example of the procedure an investor would use in determining if a slaughter plant would be profitable based on his source of funds. Essentially the investor will compare his weighted average cost of capital (WACOC) to the estimated internal rate of return (IRR) as presented earlier. If the IRR for the proposed plant equals or exceeds the investor's WACOC, the plant or investment is profitable and will contribute to the investor's overall profit. The example will be based on the following assumptions:

1) The proposed location has sufficient demand to support a plant of size B at a 70 percent utilization level or greater.

2) The project will be financed over the long run equally by debt and equity.

3) Cost of borrowed funds is 12 percent.

4) Required after-tax rate of return on equity is 9 percent.

5) The investor has a marginal tax rate of 35 percent.

Substituting in the following equation:

$$WACOC = KeWe + Kd(1-t)Wd = 9\%(.50) + 12\%(1-.35).50 = 8.35\%$$

where

WE = proportion of equity
Wd = proportion of debt
Ke = the required after tax return on equity
Kd = cost of debt (borrowed funds)
t = marginal tax rate

WACOC is equal to 8.35 percent. A project with an IRR greater than 8.35 percent will be profitable. The proposed plant's IRR is 9.4 percent (Table 31, utilization level of 70 percent and a marginal tax rate of 35 percent) and is consequently determined to be profitable. Taking lower levels of utilization into consideration during the first year, utilization level of 55 percent, the IRR falls from 9.4 percent to 8.8 percent (Table 31). Consequently, the plant is only marginally profitable, an IRR of 8.8 percent versus a WACOC of 8.35 percent.

References

American Meat Institute. 1985. Financial Review of the Meat Packing Industry, 1984. P O. Box 3556, Washington, DC.

ASHRAE. 1985. Handbook of Fundamentals. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. Atlanta, GA.

Baker, Allen J. 1976. Federally Inspected Livestock Slaughter by Size and Type of Plant. Statistical Bulletin No. 549, Economic Research Service, USDA, Washington, DC.

Boehlje, Michael D. and Vernon R. Eidman. 1984. Farm Management. New York, NY: John Wiley & Sons.

Brasington, Clayton F. 1978. Utility Usage in Small Slaughter Plants. Agricultural Research Service, USDA, Washington, DC.

Brasington, Clayton F. and Donald R. Hammons. 1976. Layout Guide for Small Meat Plants. Marketing Research Rept. No. 1057, Agricultural Research Service, USDA, Washington, DC.

Bureau of the Census. 1984. 1982 Census of Agriculture. US Dept. of Commerce.

Bureau of Economic Analysis. Survey of Current Business. Selected annual summaries, US Dept. of Commerce.

Coon, Randal C., F. Larry Leistritz, Thor Hertzgaard, and Arlen G. Leholm. 1985. The North Dakota Input-Output Model: A Tool for Analyzing Economic Linkages. Agr. Econ. Rept. No. 187, Dept. of Agr. Econ., NDSU, Fargo, ND.

Coon, Randal C., Carlena F. Vocke, William Ransom-Nelson, and F. Larry Leistritz. 1984. North Dakota Economic-Demographic Assessment Model (NEDAM): Technical Description of Update and Enhancement. Agr. Econ. Misc. Rept. No. 75, Dept. of Agr. Econ., NDSU, Fargo, ND.

Job Service North Dakota. 1985. Bismarck-Mandan Wage and Benefit Survey 1985. Bismarck, ND.

Job Service North Dakota. 1985. Fargo Wage and Benefit Survey 1985. Bismarck, ND.

Job Service North Dakota. 1985. Grand Forks Wage and Benefit Survey 1985. Bismarck, ND.

Logan, Samuel H. and Gordon A. King. 1962. Economies of Scale in Beef Slaughter Plants. Giannini Foundation Research Rept. No. 260. California Agr. Exp. Sta., University of California, Davis, CA.

North Dakota Crop & Livestock Reporting Service. 1985. North Dakota Agricultural Statistics. Fargo, ND.

North Dakota League of Cities. 1982. Water and Sewer Rate Survey. Economic Development Commission, Bismarck, ND.

North Dakota Tax Department. 1985 Property Tax Statistical Report. Bismarck, ND.

Robert Morris Associates. 1985. Robert Morris Annual Statement Studies. Philadelphia, PA: Robert Morris Associates.

Schupp, Alvin R. and Ewell P. Roy. 1973. Economic Feasibility of Hog Slaughtering and Processing Facilities in Central Louisiana. Dept. of Agr. Econ., Research Rept. No. 455, Louisiana State University, Baton Rouge, LA.

Staroba, Arlyn, G.M. Bedker, and E.V. Dunn. 1977. Costs and Returns for Small Livestock Slaughter Plants in North Dakota. Agr. Econ. Rept. No. 119, Dept. of Agr. Econ., NDSU, Fargo.

Stinson, Robert L., P. Geoffrey Allen, Robert L. Christensen. 1978. The Economic Feasibility of Constructing Additional Livestock Slaughter Facilities in Massachusetts. Research Bulletin No. 660, Dept. of Food and Resource Econ., University of Massachusetts, Amherst, MA.

USDA Economic Research Service. 1985. Livestock and Poultry Outlook and Situation Report. Washington, DC.

USDA Food Safety and Inspection Service. Meat and Poultry Inspection Regulations. Washington, DC.

USDA Food Safety and Inspection Service. 1985. Meat and Poultry Inspection Directory. Washington, DC.

USDA Statistical Reporting Service. 1976-1985. Livestock Slaughter Annual Summary. Washington, DC.