Economic opportunities for on-the-farm feed processing in Montana
by Arne Degn

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE in Agricultural Economics
Montana State University

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Processing costs and other relevant data were obtained from twenty-five feeders in Montana who were processing their own feeds in the year 1962. These costs were then compared to commercial processing charges found to be prevalent at the time of the survey.

According to this analysis, those feeders feeding 1,000 head of cattle or more per year will nearly always find it profitable to process their own feed. Those feeding less than 1,000 head per year must consider factors such as, distance from feedlot to commercial processing plant, commercial processing rates and service, management ability of farmer, capital availability, seasonality of feeding, etc., in determining feasibility of on-the-farm feed processing for their individual farms.

This thesis should serve as an efficiency measurement for existing farm feed plants, and as a planning guide for farmers and feeders contemplating the addition of a feed processing enterprise.

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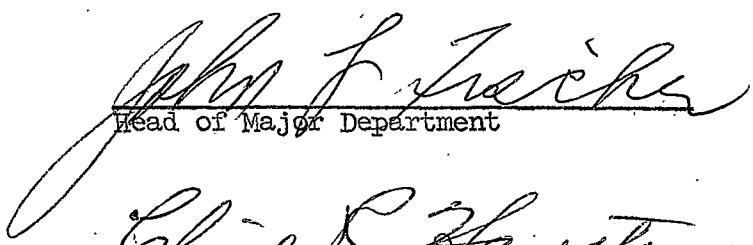

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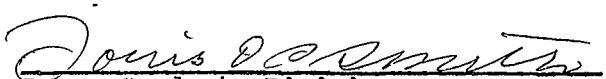

Dean, Graduate Division

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The author accepts full responsibility for any omissions or errors in this paper.

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ABSTRACT

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CHAPTER I

INTRODUCTION

The Problem Situation

Montana's increased barley production over the past decade has contributed to an expansion in livestock feeding. The purpose of this thesis is to determine the feasibility of feed processing on the farm as a means of reducing feeding costs and expanding the in-state market for Montana barley.

Barley Production Up

With increased wheat acreage controls came an increase in barley production in Montana. Barley production expansion has also been influenced by varietal improvements and cultural advancements.

Montana barley production increased 109 percent from 1951 to 1961. There have been year to year fluctuations due to climatic variations and changing governmental policy during these years but a definite increase in production has prevailed. Table I reveals this past trend together with the estimated production for 1962 and 1963.

Nationally, feed grain production has also increased but at a slower rate than in Montana. The increased national population and the increased per capita consumption of animal products has enabled livestock feeders and other livestock producers throughout the nation to utilize this accelerated feed grain production to a great extent.

Montana Feedlot Expansion

Since barley is the principal feed ingredient in cattle feeding operations throughout Montana, the tremendous production expansion of barley in the state in recent years has been a determining factor in the expansion of Montana's livestock feeding industry. Cattle feeding in

Montana has expanded continuously during the period from 1950 to 1963. On January 1, 1963 there were a total of 71,000 head of cattle and calves on feed in the state compared with 25,000 on feed January 1, 1950. 1/ This is an increase of 184 percent for this 14 year period.

TABLE I. MONTANA BARLEY PRODUCTION AND U. S. FEED GRAIN PRODUCTION

Date	Acres Harvested a/	Montana Barley Production In Tons a/	U.S. Total Feed Grain In Tons b/
1951	460,000	303,600	
1952	744,000	324,216	
1953	550,000	356,400	
1954	1,265,000	759,000	
1955	1,354,000	975,000	
1956	1,043,000	713,424	119,308,000
1957	1,721,000	1,094,000	132,424,000
1958	1,583,000	1,291,728	144,121,000
1959	1,852,000	1,222,320	149,605,000
1960	1,704,000	961,056	155,618,000
1961	1,465,000	632,880	140,626,000
1962 c/	1,802,000	1,319,064	143,093,000
1963 d/	1,550,000	1,116,000	

a/ Statistical Reporting Service, Montana Agricultural Statistics, Vol. IX, Montana Department of Agriculture, cooperating with United States Department of Agriculture, Helena, Montana, December, 1962, P. 20.

b/ Economic Research Service, 1962 Grain and Feed Statistics - Supplement to Statistical Bulletin No. 159: USDA, Washington, D. C., July, 1963, Table VII, P. 5.

c/ Preliminary

d/ Estimated

1/ The number on feed on any specific date is an indicator of trend but it does not give total annual numbers fed. See discussion on page 4 for this estimate.

Table II shows the increase in cattle feeding in Montana and in the nation.

The increase for the United States during the period 1950 to 1962 was 76 percent while Montana's increase for the same period was 176 percent. Montana has truly increased her cattle feeding but still only feeds approximately 1 percent of the nations fed cattle.

TABLE II. CATTLE ON FEED JANUARY 1. a/

Year	Montana	U. S. Total
1950	25,000	4,448,000
1951	26,000	
1952	32,000	
1953	45,000	
1954	54,000	
1955	49,000	
1956	68,000	
1957	75,000	
1958	73,000	
1959	72,000	
1960	70,000	
1961	77,000	
1962	69,000	7,833,000
1963	71,000	

a/ Derived from files of the Statistical Reporting Service, United States Department of Agriculture, Helena, Montana, July 25, 1963.

Montana Feedlot Size Distribution

According to an "armchair" estimate made in 1960 by the Montana Crop and Livestock Reporting Service, Montana has about 600 feedlots. An accurate estimate of feeders is difficult to obtain because of the "in-and-outers" in the feeding industry and because of the difficulty in defining "feedlot". This 1960 estimate is shown in Table III.

Montana now has about 600 feedlots with only 23 (or 4 percent) of them feeding over 1,000 head per year. This group had on feed January 1, 1963, 24,000 cattle or 34 percent of the total cattle on feed in the state on that date. 2/

TABLE III. DISTRIBUTION OF CATTLE FEEDLOTS CLASSIFIED AS TO SIZE ON JANUARY 1, 1960. a/

Number of Cattle in Feedlot	Number of Feedlots in Size Group
1 - 49	192
50 - 99	194
100 - 199	119
200 - 299	46
300 - 399	11
400 - 499	16
500 - 999	16
1,000 - 1,999	5
2,000 - 2,999	1
3,000 - and over	2
TOTAL	603

a/ Statistical Reporting Service, op. cit.

Total Montana Cattle Marketed Compared With Number Fed

Montana had a net marketing of 1,139,913 cattle of all classes in 1960 and 1,101,506 in 1961. 3/ Fed Cattle numbers for the same two years can be determined from the marketings during the quarters. (See Table IV). Approximately 115,000 head were fed in 1960 and 113,000 in 1961.

2/ This is a revised estimate made by the Montana Crop and Livestock Reporting Service and reported in "Cattle on Feed", USDA Statistical Reporting Service, July, 1963.

3/ Montana Agricultural Statistics, op. cit., pp. 84-85.

By comparing the number of fed cattle marketed with the total number of cattle of all classes marketed, we find that Montana feeders were only feeding about 10 percent of the cattle that are marketed each year in and from the state, the remainder leave the state as stockers or feeders.

The surplus barley production, together with the small percentage of Montana's cattle fed in the state, would indicate that future feedlot expansion is feasible, if Montana feeds are suitable as feed ingredients.

TABLE IV. FED CATTLE MARKETED--BY YEAR. a/

Quarter	1960	1961	1962
1st	34,000	34,000	35,000
2nd	30,000	29,000	27,000
3rd	28,000	28,000	23,000
4th	23,000	22,000	15,000
TOTAL	115,000	113,000	100,000

a/ Statistical Reporting Service, op. cit.

Montana Feeds Substitute For Corn

Present Montana feeders, meat packers and retailers feel that Montana barley-fed beef is entirely acceptable in the meat trade.

Barley, especially Montana's high quality barley, is considered to be worth at least 90 percent of an equal weight of number two corn when fed to beef cattle. Dried molasses beet pulp, another feed available in large quantities and at prices comparable to feed grains, is worth 88-95 percent of an equal weight of number two corn when fed to cattle at not over 50 percent of the ration. 4/ These feeds used in conjunction with roughages

4/ S. H. Morrison, "Estimated Feed Value Table of Various Ingredients for Fattening Cattle and Sheep", Feedlot (magazine) November, 1962, pp. 21-30

make up a satisfactory ration requiring almost no protein supplementation. Table V exhibits the exceptional complementarity between barley and beet pulp.

The beet pulp provides the "roughage effect" in the rumen (from fiber which is more readily digested in the rumen than is most fibrous material) as well as providing high TDN, calcium and readily available sugar for the rumen microorganisms. Barley provides a good source of TDN, phosphorous, and a higher percentage of protein than is needed for an ideal fattening ration. 5/ The ration resulting from the blending of these Montana ingredients is one with a high percentage of TDN to give fast, efficient gains as well as one which has a "roughage effect" to stimulate rumen microbial activity.

5/ Dr. W. H. Hale of Arizona reported in the May 11, 1963 issue of Feedlot magazine that barley rations with 10-11 percent crude protein gave significantly better results than those at the 13-14 percent level.

Morrison, in his Feeds and Feeding book recommends that fattening cattle be fed rations containing 8.1 to 8.7 percent digestable protein.

Montana (high quality) barley has 12-14 percent crude protein (10-11 percent digestable protein), therefore a ration composed of barley and about 20 percent to 25 percent beet pulp should meet the protein requirements of fattening beef cattle.

Montana Feeds Need To Be Processed

Present day demands for lighter weight and more uniformly finished carcasses of beef necessitates rapid fattening of beef animals. High energy rations become essential to this accomplishment.

If high energy rations are to be built up of barley alone, without the use of beet pulp or other roughage or roughage-like ingredients, it becomes necessary to retain as much of the barley fiber and in effect make the barley itself act as a roughage upon entering the rumen. This can be done by flaking or steam-rolling, by dry-rolling or by coarse grinding. There is much dispute among nutritionists as to the relative desirability of these various processing methods. Dr. A. T. Ralston of Oregon State University, indicates that there is no significant nutritional difference between dry rolled and steam rolled barley for feeding to beef cattle. Table VI shows results of another study at the University of Arizona on dry vs. steam-rolled barley.

It therefore seems safe to assume that there is no appreciable difference between steam-rolled barley and dry-rolled barley especially if some dry beet pulp or roughage is fed in conjunction with the barley.

Processing other than barley grinding or rolling may be desirable. Cattle feeding is now in a period of rapid change, with new and improved feed additives coming onto the market almost daily. These micro-ingredients must be uniformally dispersed throughout the ration by some method. A feed industry spokesman warns prospective farm feed processors of the danger of improperly mixed rations. "The mixing phase of processing becomes especially critical with the addition of micro-ingredients such as, vermifuge drugs, trace minerals, vitamins, hormones, urea, etc." 6/

6/ Oakley M. Roy, American Feed Manufacturers Association, "On-The-Farm Milling", paper presented at the Feed Manufacturing School, September, 1960.

TABLE V. COMPARISON ON FEED INGREDIENTS

Feed Ingredient	Total Dry Matter	Crude Protein	Fat	Fiber	Digestable Protein	Total Digestable Nutrients	Calcium	Phosphorus
Barley, common feed grade, not including Pacific Coast States a/	89.3%	11.8%	1.9%	6.2%	10.0%	75.6%	0.06%	0.39%
Barley, High Grade b/	90.3	13.5	3.5	8.7	10.8	73.2	0.03	0.40
Beet pulp, with molasses, dried a/	92.2	8.9	0.5	15.2	5.9	72.4	0.57	0.07
Corn, #2 yellow a/	85.0	8.7	3.9	2.0	6.7	80.1	0.02	0.27

a/ S. H. Morrison, "Estimated Feed Value Table of Various Ingredients for Fattening Cattle and Sheep", Feedlot (magazine), November, 1962, pp. 21-30.

b/ Frank B. Morrison, Feeds and Feeding, 22nd Edition, The Morrison Publishing Co., Ithaca, N. Y., 1957, pp. 1114-1115.

TABLE VI. COMPARISON OF DRY AND STEAM ROLLED BARLEY.

Trail	Days	Percent Grain in Ration	DRY ROLLED Steers	Average Daily Feed, Lb.	Average Daily Gain, Lb.	Feed/100 Lb. Gain Lb.	STEAM ROLLED Steers	Average Daily Feed Lb.	Average Daily Gain Lb.	Feed/100 Lb. Gain Lb.
1 a/	126	53	14	22.7	2.91	780	14	23.0	3.10	742
2	97	56	16	21.6	2.60	833	16	21.8	2.34	934
3	97	46	16	21.4	2.26	946	16	21.2	2.40	884
4	112	56	16	23.8	3.19	741	16	23.2	3.15	728
AVERAGE				22.4	2.74	825		22.3	2.75	822

a/ Results of Experimental work done at the University of Arizona reported by Dr. W. H. Hale in the May 11, 1963 issue of Feedstuffs, p. 84.

The need for careful mixing lies in the fact that even a small overdose of any of these additives might prove harmful or even fatal to the livestock. Mixing or blending is therefore an exacting and critical stage of feed processing.

Other feed processing stages that should be considered are grinding or chopping hay to facilitate feed handling and increase feed efficiency, and molasses blending which is quite commonly used to increase feed palatibility.

Pelleting, though economically feasible for feeding other classes of livestock, does not prove to be so for cattle fattening. Therefore, it will be omitted from the study.

Alternatives For Getting Complete Ration To Farm

When livestock feeding developed in an area, expansion of feed manufacturing inevitably follows. Proper feed processing is becoming more important as the individuals in the feeding industry become acquainted with new feeding technology and strive to put these advances to practice. Montana now has about 90 commercial feed plants. 7/ There are also an increasing number of farm feed processing plants that are capable of grinding or rolling and mixing or blending. Many other feeders have plants that will do a partial job of processing, often leaving out the increasingly important mixing step.

7/ Kenneth Eubanks, "The Feed Manufacturing Industry in Montana", unpublished thesis, Montana State College: Bozeman, Montana, p. 15.

The alternative methods whereby a farmer or feeder might acquire a complete ration are:

1. Buy a complete mixed feed from a feed manufacturer or dealer.
2. Buy only a supplement or premix and have his own grain commercially ground and mixed together with this supplement.
3. Hire a portable custom mill to come to his farm and process his feed.
4. Buy a premix and add it to his own on-the-farm processed grain.
5. Purchase a small power-take-off feed mill and process his own feed.
6. Build a complete on-the-farm plant consisting of a roller or grinding mill, mixer or metering system, a molasses blender, and possibly a pellet mill.

The last three methods are considered to be on-the-farm processing.

Practical Processing Methods For Montana

All of the foregoing methods of obtaining complete rations are not practical for every farm because of special problems. Conditions in Montana that affect these alternatives include the following:

1. The distance from the commercial feed processing plants to the farm feedlots is greater in Montana than for most areas in the nation. Additional transportation charges therefore must be considered.
2. Montana feeders or potential feeders often have their own feed grain supply on the farm.
3. The existing Montana commercial feed plants have efficiency problems related to seasonal demand, low volume, variable demand from year to year and a variety of competitive situations.
4. The cost of transportation is usually too great to transport commercial feeds economically from those out-of-state areas with large, efficient, feed processing plants.
5. The commercially prepared feeds from these efficient but distant plants would likely not be suitable for Montana feeders, though proper for the area where produced.

The Research Problem

The specific research problem is to determine the economic feasibility of on-the-farm feed processing for different types and scales of feeding operations. Distance from commercial feed plants to feedlots will be given consideration.

Objectives

The objectives of the study are:

1. To study the type of existing on-the-fam feed processing equipment in relation to area and type of feeding being done.
2. To determine the operating costs of farm feed plants, including costs of depreciation, interest and all other fixed and variable costs, so that cost of on-the-fam feed processing can be determined.
3. To compare the cost of feed processing on the farm with the costs of commercially processed feeds.
4. To determine the economic position of feed processing on the farm with the following variables:
   (a) Size of feedlot.
   (b) Type of plant.
   (c) Distance from commercial processing plant.

Hypotheses

To guide the study, the following hypotheses are projected:

1. On-the-farm feed processing is economically feasible on some Montana farms.
2. The size of the feedlot is positively related to the economic feasibility of on farm feed processing.

Limitations

Because of limited research resources and the necessity to keep the

study from becoming too cumbersome, it becomes necessary to establish certain limitations and assumptions.

1. The study will be directed toward on-the-farm feed processors rather than all feeders in the state.
2. The study will be limited primarily to cattle feeders since the expansion has been in this type of feeding.
3. The assumption will be made that rations prepared by the on-the-farm plants are nutritionally sound and comparable to a commercially prepared ration.
4. The relatively small population makes random sampling impractical.
5. Incomplete farm records make cost allocation to a particular enterprise on farms extremely difficult.

Procedure For Phase I-Survey of Existing Plants

Virtually all of the complete on-the-farm feed processors in Montana were interviewed. 8/ An initial list of feeders falling into this category was obtained from a state-wide feed ingredient supplier. This list was then verified and expanded upon by contacts with county agents and interviewed feeders.

Personal interviews were made of on-the-farm processors in an effort to arrive at both fixed and variable operating costs. Total investment, number of head of livestock fed per year, number of tons of feed processed per year and mileage to the nearest or most desirable commercial feed processor were also obtained. Questions relative to why the feeders installed their own processing equipment were asked to gain knowledge of the motivating variables.

8/ In this study a complete feed processing plant will be considered to be one that mixes or blends the ration as well as grinds or rolls.

Commercial processors supplied information on commercial processing services available and on the processing charges.

In an effort to isolate the trends of on-the-farm feed processing, visits were made to the three counties having the largest concentration of feeding in the state. These counties are Cascade, Yellowstone, and Richland. Since a complete population of all feeders is difficult to obtain, a visit with the county agent and selected feeders provided a list of a few key operators in each county. Included in this list were unusual or new operations that might give some clue to trends in feed processing. Visits with equipment dealers gave added information for this phase as well as the following Phase II. Relatively large feeders who were successfully using the services of the commercial processors were interviewed. Also included in this phase were visits with feeders who were partially processing their own feeds.

Trends recognized in these three counties are presented as representative of the trends throughout the state.

Fixed Costs

Plant Investment Determination.--Total investment for each plant was determined by taking the reported actual investment as stated by the respondent. The questions were asked in such a way as to include purchase price of all equipment, value of any old buildings or equipment that were included in the complete plant, and all installation and construction expenses including the value of farm labor in construction. In the two cases of small partial plants that were already fully depreciated, an estimate was made of the present market value and this value was used in determining depreciation and interest (or opportunity cost). No land value was assigned to the plant evaluation since in most cases plant site values were negligible.

Depreciation Allowance.--Each interviewee was asked to express his opinion as to the expected life of his plant. These life expectancies were then used in the determination of the annual depreciation. The plant life estimates varied, but the quality of the plants varied as well. Expected life ranged from five years for the reappraised, fully depreciated plants to 25 years for one plant of exceptional quality. Ten, fifteen and twenty years were more frequent estimates of mill life with the shorter life being assigned to plants with lighter quality equipment.

The depreciation was calculated by the straight-line method. No salvage value was deducted.

Plant Insurance and Property Taxes.--Difficulty was encountered in getting reliable costs for taxes and insurance. The county tax statements do not include a separate evaluation or tax statement for the feed plants and the operators usually had not made an estimate of tax on the plant prior to this interview. A percentage of the total tax bill was used by the feedlot operators in determining a share to apply to the plant.

Insurance on the plants varied a great deal because of different coverages and different company policy and rates. In many cases the whole farmstead was covered by one policy and the total insurance cost had to be multiplied by the percentage of farmstead value assigned to the feed plant.

Interest or Opportunity Cost.--To make interest costs more comparable, a uniform procedure was used in determining the interest cost for all plants.

An interest rate of 7 percent was selected as a compromise between a long term loan rate of 6 percent, short term rates of between 7 percent and 8 percent and equipment contract rates which often exceed 12 percent actual interest rate.

An average interest was used because annual depreciation allowance lowers the remaining plant investment. The average annual interest cost was determined by multiplying the initial investment by 7 percent and dividing the product by two.

In applying this method of deriving an interest charge, a $40,000.00 investment results in an average annual interest cost of $1,400.00 ($40,000.00 x 3½%).

Tractor Fixed Costs.--When a tractor was used as power for processing feed at the farm plant the tractor fixed costs were separated from the total costs so that a better comparison of variable power costs could be obtained for data analysis.

The tractor fixed cost was calculated by using rates set up in a California bulletin entitled, "Machinery Costs and Related Data", and recorded in Appendix A of this thesis. The costs were based on a total of 800 hours per year tractor use on the farm and in the feed plant.

Variable Costs

Labor Costs.--The labor cost for feed processing is a major portion of the total cost. The questionnaire was designed to determine the actual amount of labor required to operate and maintain the feed processing plant. The amount of hired labor was differentiated from the owner's labor and an attempt was made to have respondents evaluate their time by setting a wage rate. Respondent reply consistency for owners' salary was hard to maintain.

In an attempt to set a somewhat uniform wage rate it was assumed that a plant operator must be above average in skill and reliability with some knowledge of animal nutrition as well. It was therefore decided that the relatively high farm wage rates of $300 per month, including house and other"fringe" benefits, for hired help and $400 per month for owners' labor should be used in determining hourly wage rates. It was further

assumed that a 48-hour work week and a 50-week work year prevailed. This results in a $1.50 per hour wage rate for hired labor and $2.00 per hour for owner salary. These wage rates corresponded with those of the larger operators who had calculated labor costs for their plants. In the few cases requiring assistants for such jobs as hay grinding, a lower wage rate was used for the helper.

There was difficulty in distinguishing processing time from feeding time since in almost all instances the same worker accomplished both tasks. Upon asking the feedlot operator to estimate the actual labor required to operate the plant, the first reply was often, "the plant is automatic and requires almost no labor". This seemed to be true in many cases.

Power Costs.--On-the-farm processing power requirements were determined from the interviews. The only adjustment needed in the power cost estimates was to apply a standard per hour variable tractor cost to the hours of tractor use reported by the respondents who used tractor power for part of their processing. These costs were taken from the same California bulletin from which the fixed tractor costs were obtained and appear in Appendix A.

Electric power costs were estimated without a great deal of variation by the respondents. The reported electric costs were compared with a theoretical power requirement for grain processing and were found to be within reason.

Repair and Upkeep.--These costs were based entirely upon the operators records or his estimated annual cost of repair and maintenance. A small amount of upkeep might be required to maintain an idle plant but these costs would certainly be negligible. Therefore all repair and maintenance costs were considered as variable costs in the analysis.

Additional Factors Related to Cost Analysis

Annual Feed Production.--The tons of feed processed per year were reported with apparent knowledge by the respondents. Reported output was compared with tonnage computed by multiplying Morrison's feeding standards times the number of cattle fed per year, times the average number of days the cattle were on feed. This latter method was used as data in a few cases where the feeder had little idea of the annual feed tonnage processed.

There appears to be some discrepancy in the data reported but it must be borne in mind that varying amounts of silage and unprocessed hay were fed in conjunction with the processed feeds.

Number of Cattle Fed Per Year.--Numbers of different species and classes of livestock were reduced to a common unit to facilitate stratification of the observations into size groups. The unit can be defined as equal to the following:

1 yearling steer or heifer carried to choice grade, or
1½ calves wintered, or
3/4 calf carried to choice grade, or
5 ewes wintered, or
6 lambs fattened, or
1 cow wintered (provided she was fed processed feed throughout the winter).

Commercial Processing Rates.--Custom charges were obtained by asking feedlot operators what they would be required to pay at the commercial processing plant of their choice for a similarly processed feed. These data were then verified by interviews with elevator operators in the area.

Trucking Charges.--The cost of hauling home grown feed ingredients to and from the commercial processing plant was determined by multiplying the reported mileage to the plant, times the rate per mile as shown in Appendix B. Mileage on paved roads was calculated at 21 cents per mile total operating costs and the per mile rate for gravelled roads was estimated at

29 cents per mile. Trucks were considered loaded both ways since the assumption was made that feed ingredients were on the farm. Five ton loads were assumed in arriving at per ton cost.

Waiting Time.--Farmers cannot afford to spend long periods of time waiting for grain to be processed and mixed. As farm labor becomes more productive and expensive, and volume of processing per farm increases, the waiting time becomes more of a consideration.

The waiting and hauling time reported by respondents was multiplied by $2.50, of which $1.75 is for average hourly wage rate and $.75 is for truck fixed costs which was split off from the per mile derivation to make a more realistic comparison between those feeders hauling short and long distances.

The total cost of delivering the commercially processed feed to the feedlot was determined by mileage, times rate per mile; plus waiting and hauling hours, times $2.50 per hour.

Four of the respondents who had taken the pains to calculate a hauling and waiting cost for their own operations gave credence to the procedure and rates used in this phase of the study.

Data Analysis in Total Cost Determination

To facilitate analysis of data, the observations were broken down into three size groups. Stratification was made according to number of head fed per year rather than lot capacity or mill capacity.

Nine feedlots fall into the size category of 2,000 head and over fed per year. Seven of these nine feedlots had cost data that were usable in the cost per ton analysis, while the remaining two were included in the plant type comparison in Table VIII. The reported number of head fed per year was well dispersed from 2,000 to 8,000 in this size group.