An economic-engineering study of the feed manufacturing industry of Montana
by Kenneth Wayne Eubanks

A dissertation submitted to the Graduate Faculty in partial fulfillment of the requirements for the
degree of DOCTOR OF PHILOSOPHY in Agricultural Economics
Montana State University
© Copyright by Kenneth Wayne Eubanks (1962)

Abstract:
The State of Montana today is faced with the twin considerations of an abundant supply of barley and a
large number of cattle. Further, the feed manufacturing industry has embarked on a general program of
expansion. There is a possibility of greatly expanding the livestock feeding industry in Montana
because of a growing, demand for finished livestock products in Montana and on the Pacific Coast.

The general expansion of the feed manufacturing industry brings to focus three principal problems. The
first problem is related to the supply of barley and the necessity of making an economical disposition
thereof. This disposition can be made through increased feeding operations for livestock, and also, in
the case of the Montana industry, for the wintering of cattle. Then secondly, the feed manufacturing
industry needs to have available the necessary information concerning the location, size, and type of
plant arrangement best suited to the State of Montana. Thirdly, there is a need to make available
detailed cost information so that the managers of plants presently in operation in Montana may better
judge the efficiencies of their own operations.

Most managers of the feed mills possess only a rough approximation as to total cost and little or no
information at all concerning the cost of production at the several stages along the production cycle. In
this research area, the technique employed was to determine the cost of production for six natural
production stages in the manufacture of range cubes.

A break-down of the research area of this study includes a stage-by-stage analysis which will allow
plant managers to properly appraise their own operations in light of those reported. The stage analysis
begins with each element as it enters the feed plant, and follows it through until the finished product is
placed on the vehicle that will take it to the point of consumption.

Perhaps the most interesting and revealing issue may be stated as follows: Within the present structure
and under present operating conditions are economies of size present in the Montana feeding
manufacturing industry? It is generally contended that regardless of the size of the firm in the Montana
industry the economies that will most enhance the profit structure of the firm are all internal
economies. These economies can best be obtained by employing the latest technology available and
constructing the physical plant lay-out in such a way as to maximize the return gained from the
equipment employed in each of the six basic production stages.
AN ECONOMIC-ENGINEERING STUDY OF THE FEED MANUFACTURING INDUSTRY OF MONTANA

by

KENNETH WAYNE EUBANKS

A dissertation submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

Agricultural Economics

Approved:

John L. Fischer
Head, Major Department

Clive R. Hardt
Chairman, Examining Committee

Dean, Graduate Division

MONTANA STATE COLLEGE
Bozeman, Montana

August, 1962
BIOGRAPHICAL

Kenneth W. Eubanks

Candidate for the degree of
Doctor of Philosophy

1926 Born at Booneville, Arkansas
1944 Graduate Georgia Military Academy, College Park, Georgia
1944-1945 United States Army Infantry
1954 B.B.A., Baylor University, Waco, Texas
1955 M.S., Baylor University, Waco, Texas
1955-1958 Lecturer in Economics and Finance, University of Southern California
1958-1960 Graduate Study, Montana State College, Bozeman, Montana
1960-1961 Research Assistant, Montana State College, Bozeman, Montana
1961-1962 Assistant Professor of Commerce, Montana State College, Bozeman, Montana
ACKNOWLEDGEMENTS

The author owes a debt of continuing gratitude to Dr. Clive R. Harston, committee chairman, for his encouragement, guidance and many suggestions that have made this thesis possible. The words of encouragement and suggestion offered by Drs. John L. Fischer, Layton S. Thompson, Clarence W. Jensen, Harold A. Pederson, and Edward H. Ward, have been of untold benefit and shall not be forgotten. Thanks are also extended to each and every member of the staff at Montana State College for their help and co-operation throughout these several years.

Sincere appreciation is extended to the feed manufacturing firms that co-operated in this study. Also to the Mid-West Feed Manufacturer's Association and to each of the engineering and equipment firms that supplied much of the data used sincere gratitude is expressed. Thanks are also due to my wife and family whose co-operation and indulgence have supported this effort.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Methodology</td>
<td>3</td>
</tr>
<tr>
<td>Objectives</td>
<td>7</td>
</tr>
<tr>
<td>Hypothesis</td>
<td>9</td>
</tr>
<tr>
<td>II. REVIEW OF LITERATURE</td>
<td>16</td>
</tr>
<tr>
<td>III. STEAM ROLLING, GRINDING AND MIXING</td>
<td>42</td>
</tr>
<tr>
<td>Source of Barley Supply</td>
<td>49</td>
</tr>
<tr>
<td>Barley Delivery</td>
<td>50</td>
</tr>
<tr>
<td>Expansion Plans</td>
<td>53</td>
</tr>
<tr>
<td>Price Structure</td>
<td>53</td>
</tr>
<tr>
<td>Integrated Operations</td>
<td>55</td>
</tr>
<tr>
<td>The Accounts Receivable Problem</td>
<td>59</td>
</tr>
<tr>
<td>Distribution of Production</td>
<td>61</td>
</tr>
<tr>
<td>Seasonality in Grinding and Mixing and Steam Rolling</td>
<td>64</td>
</tr>
<tr>
<td>Trends in Feed Characteristics</td>
<td>66</td>
</tr>
<tr>
<td>IV. PELLETING FEED PLANTS</td>
<td>74</td>
</tr>
<tr>
<td>Production Considerations</td>
<td>74</td>
</tr>
<tr>
<td>Introduction</td>
<td>74</td>
</tr>
<tr>
<td>Seasonality in Montana's Pellet Production</td>
<td>78</td>
</tr>
<tr>
<td>Expected Future Trends in Feed Manufacturing</td>
<td>79</td>
</tr>
<tr>
<td>CHAPTER</td>
<td>PAGE</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Future Expansion Plans</td>
<td>80</td>
</tr>
<tr>
<td>Barley Supply</td>
<td>84</td>
</tr>
<tr>
<td>Geographic Considerations</td>
<td>90</td>
</tr>
<tr>
<td>Production Volumes</td>
<td>92</td>
</tr>
<tr>
<td>Marketing</td>
<td>102</td>
</tr>
<tr>
<td>Changing Patterns of Demand</td>
<td>102</td>
</tr>
<tr>
<td>Observations of Competitive Structures</td>
<td>105</td>
</tr>
<tr>
<td>Concern for Government Policy</td>
<td>107</td>
</tr>
<tr>
<td>Marketing of Manufactured Feed</td>
<td>110</td>
</tr>
<tr>
<td>Equipment and Plant Layout</td>
<td>115</td>
</tr>
<tr>
<td>Cooling Equipment</td>
<td>118</td>
</tr>
<tr>
<td>Conveying Systems</td>
<td>118</td>
</tr>
<tr>
<td>Boiler</td>
<td>120</td>
</tr>
<tr>
<td>Packing Equipment</td>
<td>121</td>
</tr>
<tr>
<td>Pelleting Equipment</td>
<td>121</td>
</tr>
<tr>
<td>Mixers</td>
<td>123</td>
</tr>
<tr>
<td>Pre-Mixing</td>
<td>127</td>
</tr>
<tr>
<td>Grinding Equipment</td>
<td>128</td>
</tr>
<tr>
<td>Warehouse System</td>
<td>129</td>
</tr>
<tr>
<td>V. A COST ANALYSIS OF SELECTED FIRMS IN THE FEED MANUFACTURING INDUSTRY OF MONTANA</td>
<td>132</td>
</tr>
<tr>
<td>Introduction</td>
<td>132</td>
</tr>
<tr>
<td>CHAPTER</td>
<td>PAGE</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Sales/Net Worth.</td>
<td>169</td>
</tr>
<tr>
<td>Percentage Profits/Worth</td>
<td>170</td>
</tr>
<tr>
<td>Sales/Total Assets</td>
<td>170</td>
</tr>
<tr>
<td>Profits/Total Assets</td>
<td>171</td>
</tr>
<tr>
<td>Model Mills.</td>
<td>171</td>
</tr>
<tr>
<td>Introduction</td>
<td>171</td>
</tr>
<tr>
<td>Model Mill 1</td>
<td>173</td>
</tr>
<tr>
<td>Basic Equipment.</td>
<td>174</td>
</tr>
<tr>
<td>Plant Structure.</td>
<td>178</td>
</tr>
<tr>
<td>Break Even Analysis.</td>
<td>180</td>
</tr>
<tr>
<td>Fixed Costs.</td>
<td>183</td>
</tr>
<tr>
<td>Variable Costs</td>
<td>184</td>
</tr>
<tr>
<td>Model Mill 2</td>
<td>190</td>
</tr>
<tr>
<td>Basic Equipment.</td>
<td>192</td>
</tr>
<tr>
<td>Plant Structure.</td>
<td>192</td>
</tr>
<tr>
<td>Break-Even Analysis.</td>
<td>193</td>
</tr>
<tr>
<td>Fixed Cost.</td>
<td>193</td>
</tr>
<tr>
<td>Variable Costs</td>
<td>193</td>
</tr>
<tr>
<td>Revenue.</td>
<td>194</td>
</tr>
<tr>
<td>VI. SUMMARY.</td>
<td>195</td>
</tr>
<tr>
<td>Steam Rolling, Grinding and Mixing and Pelleting.</td>
<td>195</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Total Production Volumes for Ground, Mixed and Steam Rolled Feed - 1960</td>
<td>44</td>
</tr>
<tr>
<td>II. Principal Use for Steam Rolled Barley</td>
<td>46</td>
</tr>
<tr>
<td>III. Distribution of Ground and Mixed and Steam Rolled Feeds</td>
<td>48</td>
</tr>
<tr>
<td>IV. From Whom Barley Supply is Obtained</td>
<td>51</td>
</tr>
<tr>
<td>V. Expansion Plans</td>
<td>54</td>
</tr>
<tr>
<td>VI. Prices Charged for Custom Services</td>
<td>56</td>
</tr>
<tr>
<td>VII. Integrated Services Furnished by Plants Grinding, Mixing and Steam Rolling</td>
<td>57</td>
</tr>
<tr>
<td>VIII. Credit Conditions in Feed Manufacturing Firms</td>
<td>60</td>
</tr>
<tr>
<td>IX. Radius Output as Distributed by Firm Grinding Mixing and Steam Rolling</td>
<td>62</td>
</tr>
<tr>
<td>X. Percentage of Total Production Sold in Less Than Ton Lots</td>
<td>63</td>
</tr>
<tr>
<td>XI. Seasonality for Grinding Mixing and Steam Rolling Firms</td>
<td>65</td>
</tr>
<tr>
<td>XII. The Use of Molasses by Firms Grinding-Mixing and Steam Rolling</td>
<td>67</td>
</tr>
<tr>
<td>XIII. Integrated Services Provided by Feed Manufacturing Firms</td>
<td>77</td>
</tr>
<tr>
<td>XIV. Plans for Expansion</td>
<td>81</td>
</tr>
<tr>
<td>XV. Source of Barley Supply</td>
<td>85</td>
</tr>
<tr>
<td>XVI. Distance the Barley Supply Moves to Manufacturing Point</td>
<td>88</td>
</tr>
<tr>
<td>TABLE</td>
<td>PAGE</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>XVII. Location Characteristics of Montana's Feed Manufacturing Plants</td>
<td>91</td>
</tr>
<tr>
<td>XVIII. Total Production Volumes for Areas in Montana 1960</td>
<td>93</td>
</tr>
<tr>
<td>XIX. A Breakdown of the Various Production Lines Shown With Reference to the Area of Production</td>
<td>97</td>
</tr>
<tr>
<td>XX. Totals for Steam Rolled and Ground and Mixed, Pelleted, Combined Total Production Volumes in Tons</td>
<td>103</td>
</tr>
<tr>
<td>XXI. Combined Steam Rolled and Ground and Mixed Production in Montana</td>
<td>104</td>
</tr>
<tr>
<td>XXII. Changes That Have Occurred in the Demand for Manufactured Formula Feeds</td>
<td>106</td>
</tr>
<tr>
<td>XXIII. Price Structure for Tagged Range Cubes in the 20 Per Cent Protein Classification</td>
<td>108</td>
</tr>
<tr>
<td>XXIV. Distribution of Manufactured Feed</td>
<td>111</td>
</tr>
<tr>
<td>XXV. Marketing Radius for Manufactured Feed Products</td>
<td>113</td>
</tr>
<tr>
<td>XXVI. Method of Transportation Utilized in the Marketing of Manufactured Feeds</td>
<td>114</td>
</tr>
<tr>
<td>XXVII. Percentage of Total Pelleted Production Marketed by Bag and Bulk</td>
<td>116</td>
</tr>
<tr>
<td>XXVIII. Power Requirements for Mixers of Various Capacities Ranging from 1 to 5 Tons</td>
<td>126</td>
</tr>
<tr>
<td>XXIX. Mills Producing 10,000 Tons and Over Per Year</td>
<td>136</td>
</tr>
<tr>
<td>XXX. Mills Producing 5,000 to 10,000 Tons Per Year</td>
<td>142</td>
</tr>
<tr>
<td>XXXI. Mills Producing 5,000 Tons and Under Per Year</td>
<td>146</td>
</tr>
<tr>
<td>XXXII. Production Cost at Stage 4 for All Mills</td>
<td>151</td>
</tr>
<tr>
<td>TABLE</td>
<td>PAGE</td>
</tr>
<tr>
<td>------------</td>
<td>------</td>
</tr>
<tr>
<td>XXXIII.</td>
<td>Total Cost at Stage 4</td>
</tr>
<tr>
<td>XXXIV.</td>
<td>Total Cost for All Production Stages</td>
</tr>
<tr>
<td>XXXV.</td>
<td>Eleven Financial Ratios Applied to Feed Manufacturing Firms in Montana and Utah</td>
</tr>
</tbody>
</table>
# LIST OF MAPS

<table>
<thead>
<tr>
<th>MAP</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hay Harvested Showing Alfalfa Processing Plants</td>
<td>12</td>
</tr>
<tr>
<td>2. Types of Farming Showing Pellet Mills</td>
<td>13</td>
</tr>
<tr>
<td>3. Population of Montana Showing Pellet Mills</td>
<td>14</td>
</tr>
<tr>
<td>4. Simplified Traffic Flow Showing All Feed Processing Plants</td>
<td>15</td>
</tr>
<tr>
<td>5. Montana Area Divisions</td>
<td>70</td>
</tr>
<tr>
<td>6. All Cattle Showing Pellet Mills</td>
<td>71</td>
</tr>
<tr>
<td>7. Hay Harvested Showing Pellet Mills</td>
<td>72</td>
</tr>
<tr>
<td>8. Barley Harvested Showing Pellet Mills</td>
<td>73</td>
</tr>
<tr>
<td>9. Railroads Showing All Feed Processing Plants</td>
<td>130</td>
</tr>
<tr>
<td>10. Highways Showing All Feed Processing Plants</td>
<td>131</td>
</tr>
</tbody>
</table>
LIST OF DIAGRAMS

<table>
<thead>
<tr>
<th>DIAGRAM</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pelleting Mill, Stage 4</td>
<td>11</td>
</tr>
<tr>
<td>2. Side View Model No. 1</td>
<td>181</td>
</tr>
<tr>
<td>3. Front View Model No. 1</td>
<td>182</td>
</tr>
<tr>
<td>4. Break Even Chart Showing Profit and Cost Relationship For Model Mill No. 1</td>
<td>187</td>
</tr>
<tr>
<td>5. Adjusted Break Even Point, Showing Increase in Fixed Cost</td>
<td>189</td>
</tr>
<tr>
<td>6. Break Even Chart Showing the Results of Removing Depreciation as a Fixed Cost Item</td>
<td>191</td>
</tr>
</tbody>
</table>
ABSTRACT

The State of Montana today is faced with the twin considerations of an abundant supply of barley and a large number of cattle. Further, the feed manufacturing industry has embarked on a general program of expansion. There is a possibility of greatly expanding the livestock feeding industry in Montana because of a growing demand for finished livestock products in Montana and on the Pacific Coast.

The general expansion of the feed manufacturing industry brings to focus three principal problems. The first problem is related to the supply of barley and the necessity of making an economical disposition thereof. This disposition can be made through increased feeding operations for livestock, and also, in the case of the Montana industry, for the wintering of cattle. Then secondly, the feed manufacturing industry needs to have available the necessary information concerning the location, size, and type of plant arrangement best suited to the State of Montana. Thirdly, there is a need to make available detailed cost information so that the managers of plants presently in operation in Montana may better judge the efficiencies of their own operations.

Most managers of the feed mills possess only a rough approximation as to total cost and little or no information at all concerning the cost of production at the several stages along the production cycle. In this research area, the technique employed was to determine the cost of production for six natural production stages in the manufacture of range cubes.

A break-down of the research area of this study includes a stage-by-stage analysis which will allow plant managers to properly appraise their own operations in light of those reported. The stage analysis begins with each element as it enters the feed plant, and follows it through until the finished product is placed on the vehicle that will take it to the point of consumption.

Perhaps the most interesting and revealing issue may be stated as follows: Within the present structure and under present operating conditions are economies of size present in the Montana feed manufacturing industry? It is generally contended that regardless of the size of the firm in the Montana industry the economies that will most enhance the profit structure of the firm are all internal economies. These economies can best be obtained by employing the latest technology available and constructing the physical plant lay-out in such a way as to maximize the return gained from the equipment employed in each of the six basic production stages.
CHAPTER I

INTRODUCTION

The State of Montana today is faced with the twin considerations of an abundant supply of barley and a large number of cattle. Further, the feed manufacturing industry has embarked on a general program of expansion. There is a possibility of greatly expanding the livestock feeding industry in Montana because of a growing demand for finished livestock products in Montana and on the Pacific Coast. Empirical practice has favored shipping to the Midwest for fattening, which, in some cases, entails shipment of the finished product back through Montana and on to the Pacific Coast. There is an obvious transportation advantage in favor of the Montana livestock being fattened here for immediate shipment to the Pacific Coast.

The general expansion of the feed manufacturing industry brings to focus three principal problems. The first problem is related to the supply of barley and the necessity of making an economical disposition thereof. This disposition can be made through increased feeding operations for livestock, and also, in the case of the Montana industry, for the wintering of cattle. Then secondly, the feed manufacturing industry needs to have available the necessary information concerning the location, size, and type of plant arrangement best suited to the State of Montana. Thirdly, there is a need to make available detailed cost information so that the managers of plants presently in operation
in Montana may better judge the efficiencies of their own operations. Montana is unique, to a degree, in that barley is the principle feed ingredient used in the manufacture of pelleted rations. The range cube is generally the most prominent type of pellet produced in the Montana area. As opposed to the Midwest, transportation distances are much greater and therefore the problem of size and location of mills is an important factor.

The research areas of the present study center around the supply of raw ingredients, the necessity of establishing cost standards by which feed manufacturing plants may appraise their operations, and making general information concerning the feed manufacturing industry available to those concerned.

As mentioned above, adequate supplies of barley are present to support the feed manufacturing industry. However, almost all of the micro ingredients such as cottonseed, linseed and soybean products must be obtained from out of state sources. At one time alfalfa meal was not in adequate supply and had to be imported also. In recent years three new alfalfa mills have commenced operations and now can adequately supply the Montana industry. In some fringe areas, because of transportation cost, some alfalfa meal, both dehydrated and sun-cured, is imported (See Map #1).

Generally, mill operators do not have the necessary cost data to make realistic appraisals of their operations relative to those of other enterprises of the same nature within the national industry.
Montana has been divided into three general research areas. This division was based on geographical and operational characteristics. The feed manufacturing firms operating within these three general areas have been placed in the following categories:

1. Those that grind and mix and/or steam roll
2. Those that pellet exclusively
3. Those that combine all the operations of grinding and mixing and/or steam rolling and pelleting.

Grinding and mixing and steam rolling are classified as feed manufacturing endeavors because of the complexity that has been incorporated into these functions. Nearly all of the firms engaged in grinding and mixing and/or steam rolling prepare a pelleted ration, and in most cases, as many as sixteen additives have been blended into the finished steam rolled product. The purpose here is to describe the general characteristics of the grinding and mixing and/or steam rolling enterprises, and to indicate the trend of growth that has been experienced and that expected. The area of detailed cost analysis applies to pelleting, as the Montana industry is characterized by the importance of the production of range cubes.

Most managers of the feed mills possess only a rough approximation of total cost and little or no information at all concerning the cost of production at the several stages along the production cycle. In this
research area, the technique employed was to determine the cost of production for six natural production stages in the manufacture of range cubes. Although cost data has been assembled on a per ton basis for warehousing and pelleting in the Midwest, no complete analysis of all the stages of production has to our knowledge ever been published in the United States. This is partly true because pelleting is a relatively new innovation, and because of the wide differences in the equipment arrangement found in feed manufacturing plants.

A break-down of the research area of this study includes a stage-by-stage analysis which will allow plant managers to appraise their own operations properly in light of those reported. The stage analysis begins with each element as it enters the feed plant, and follows it through until the finished product is placed on the vehicle that will take it to the point of consumption. The cost analysis employed in the various stages will include direct labor, supervision, maintenance, power, depreciation on equipment in the form of machine cost per ton, as well as gas and water where such items are utilized.

(1) Stage Number One includes the unloading, grinding, and elevating of all the raw ingredients that will comprise the finished product. This stage ends when the several ingredients have been processed through Stage One and have come to rest either in their respective holding bins, or at some other position from which they will move into the
next stage of production. For example, barley will be subjected to the analysis from the point of unloading, through the hammer mill, if it moves directly to the hammer mill, up to the elevator and into the holding bins. Each raw ingredient so entering will be analyzed no matter how many separate operations take place until it reaches the point from which it will move into the next stage of production.

(2) Stage Number Two of operations is an integral part of pelleting and is concerned with the pre-mixing of the micro ingredients that are included in nearly all pelleted range feed in Montana. There are several methods employed at this stage by the Montana industry which generally fall into the following three categories:

(a) those mills that maintain a completely separate pre-mixing operation where the many micro ingredients are blended into a pre-mix of the company's own design,

(b) those plants that utilize pre-mixes which are blended and packaged by some other company and are purchased as complete pre-mix units,

(c) those mills that maintain an inventory of raw ingredients and blend them into the general mix without the benefit of pre-mix formulas.

Some mills in Montana have successfully blended Stage Two
into Stage Three, thereby more fully utilizing the labor unit assigned to Stage Three.

(3) Stage Three of operations is referred to as the milling and percentage allocation stage. This stage starts as the raw ingredients are withdrawn from their respective holding bins and delivered into the mixer, i.e., horizontal, vertical, or continuous line. This stage ends when the raw ingredients have been properly mixed and conveyed to the hopper above the pelleting machine, or where special molassitizing equipment or mixers are used, into the surge bins above the pelleting machine. As a general rule in Montana, the miller in most cases is the person upon whom responsibility rests for mill operation, in spite of the role normally expected of a foreman or superintendent.

(4) Stage Number Four is the pelleting and cooling operation. This phase of the study begins when the mixed feed elements enter into the surge bin above the pelleting machine, or in the case of other mixing equipment preceding the pelleting process, when the raw ingredients enter that mixer-blender. This stage of operation ends after the raw ingredients have been compressed into pellets and have been cooled, dried and discharged into the holding bins above the packaging equipment. In the event the pellets
are designated for bulk delivery, the break-off point is determined when the pellets leave the cooler. In addition to the costs previously mentioned, this stage will also include steam cost in the form of gas or other power, water, and die and roller cost. Diagram #1 shows this operation.

(5) Stage Number Five of operations is packaging. This stage begins when the cooled and dried pellets have been discharged into the holding bins above the weighing apparatus, and ends when the packaged pellets are discharged into a delivery chute leading to a warehouse, or when the packaged pellets are moved away by either conveyor belt, hand truck, or forklift.

(6) Stage Number Six is the warehousing operation. It begins when the packaged pellets begin their movement to warehousing from the packaging stage, i.e., Stage Number Five, and includes all movements within the warehouse, and ends when the product is placed on the vehicle that offers the final transportation step.

Objectives

The objectives of this research effort may be classified into three general divisions. The first will report on the characteristics of the Montana feed manufacturing industry. Special emphasis will be
placed on the location of the feed processing plants in relation to
the supply sources of raw ingredients. These raw ingredients will
include both major and secondary materials. The method of transpor-
tation to the plant and the method of unloading will be reported.
The relationship between the geographical location of feed manufac-
turing plants and the type of farming conducted in immediate areas
is shown on Map #2.

Information concerning the location of the firms in relation
to geographical demand considerations will be presented. Map #3 shows
the location of Montana's feed manufacturing plants with reference
to the population dispersion in Montana. Methods of transportation
to points of consumption for the several finished products and the
channels through which distribution is effected are pointed out (Map #4).

The Montana feed manufacturing industry has generally developed
in an integrated industrial area. Observations reflecting this condi-
tion with projections into the future provide useful material. Peculiar-
ities of the Montana industry as compared with other areas observed or
reported will be mentioned where relevant.

The second objective covers the operational costs for a selected
group of feed manufacturing firms in Montana of typical size and plant
arrangement. The selection of these plants was on a purely cooperative
basis.

The third objective will be to construct model mills with
special attention to the problems of the feed manufacturing industry
of Montana. Break-even analysis will be applied under several different operational conditions.

**Hypothesis**

Perhaps the most interesting and revealing issue may be stated as follows: Within the present structure and under present operating conditions are economies of size present in the Montana feed manufacturing industry?

Notwithstanding, whether economies of size are present or not, an attempt will be made to point out methods for increasing interplant efficiencies. Marshall in discussing generally the division of labor and narrowing his frame of reference to external and internal economies has drawn the line of distinction as follows:

We may divide the economies arising from an increase in the scale of production of any kind of goods, into two classes - firstly, those dependent on the general development of the industry; and, secondly, those dependent on the resources of the individual houses of business engaged in it, on their organization and the efficiency of the management. We may call the former 'external economies', and the latter 'internal economies'. In the present chapter we have been chiefly discussing internal economies, but we now proceed to examine those very important external economies which can often be secured by the concentration of many small businesses of a similar character in particular localities, or, as is commonly said, by the localization of industry.*

This paper will present recommendations so that feed manufacturing plants operating within the Montana industry may take advantage of the internal economies as defined by Marshall.
HAY HARVESTED SHOWING ALFALFA PROCESSING PLANTS

Key:
A - ALFALFA PELLET MILL

Used by permission from: MONTANA IN MAP, BY N. HELBURN, M. EDIE AND G. LIGHTFOOT.

SOURCE
U.S.D.C., Census of Agriculture—Preliminary, 1959
KEY
- Cash crop farming: Grain
- Livestock ranching
- Mixed livestock ranching and cash crop farming
- General farming and irrigation
- Forest: Largely ungrazed

TYPES OF FARMING SHOWING PELLET MILLS

Key:
0 = FEED PLANT - PELLETING, STEAM ROLLING AND GRINDING AND MIXING

SOURCES
U.S.D.A., Bureau of Agricultural Economics, 
Farm Adjustments in Montana, 1940.
U.S.D.I., Bureau of Reclamation, Irrigation
Data for the Columbia and Missouri River Basins

Used by permission from: MONTANA IN MAP, BY N. HELBURN, M. EDIE AND G. LIGHTFOOT.
POPULATION OF MONTANA SHOWING PELLET MILLS

Key:
0 - FEED PLANT - PELLETING, STEAM ROLLING AND GRINDING AND MIXING

Used by permission from: MONTANA IN MAP, BY N. HELBURN, M. EDIE AND G. LIGHTFOOT.
Simplified Traffic Flow Showing All Feed Processing Plants

Key:
- O - Feed Plant - Pelleting, Steam Rolling and Grinding and Mixing
- O - Feed Plant - Steam Rolling and Grinding and Mixing
- O - Feed Plant - Grinding and Mixing
- P - Portable Unit
- A - Alfalfa Pellet Mill
- + - Feed Plant - Pelleting Only

Used by permission from: Montana in Map, by N. Helburn, M. Edie and G. Lightfoot
CHAPTER II

REVIEW OF LITERATURE

A series of studies dealing with feed manufacturing were undertaken after 1946. One of the early publications was entitled "Operating Cost of Selected Cooperative Feed Mills and Distributors", and dealt with costs of manufacturing and distribution, and made observations concerning the physical operations of the selected mills.* This study dealt exclusively with feed mixing operations while pointing out that future studies would deal with pelleting operations and would involve time and motion studies, etc. Notwithstanding, some of the selected mills did have pelleting equipment but no actual cost was established. A "reasonably close average" for pelleting costs was set between $1.50 and $1.20 per ton, depending on the size of the cube manufactured.** The mixing operations were classified into four groups: (1) small local mills, (2) large local mills, (3) regional mills, and (4) group mills, with production volumes ranging from 705 tons to 218,253 tons per year.

On the basis of his observations, the author concludes:

*Lacey F. Rickey, Operating Cost of Selected Cooperative Feed Mills and Distributors, Farm Credit Administration, United States Department of Agriculture, Bulletin 56 (Washington: Government Printing Office, 1949).

**Ibid., p. 7.
There was evidence that some economies of scale were present. However, the type of equipment employed, together with its more modern features are important elements regardless of the plant's size. Where economies of scale are found they are generally associated with bulk and handling procedures.

Mr. Rickey points out that a comparison of costs between line-mix mills and the modern batch mix system may favor the latter. The Rickey study was conducted from a strict accounting procedure with reference to both the manufacturing and distribution costs. Each operating expense, i.e., salaries and wages, depreciation, insurance, etc., was divided by the total tons produced during the year so that a total cost, reflecting all of the individual expense items was established.

Where low cost mills were found, several factors were responsible. Among them were: (a) large scale operations, (b) modern equipment, (c) good mill arrangement, i.e., line balance, (d) steady operation at near capacity. On the other hand, high cost mills are generally characterized by antiquated plant arrangement and equipment and production volumes are far below plant capacity.

Other important factors that influence cost differences include: (a) management ability, (b) the quality of labor
and the wage rates, (c) types of feed and proportion manufactured, (d) amount and kind of services rendered, etc.

From the farmer's point of view, the price paid for manufactured feed depends on costs of distribution, buying of ingredients, transportation cost, and others.*

Another landmark publication dealing with problems and general information on a national basis appeared in 1953 under the title, "The Mixed-Feeds Industry."** In the problem area of the seasonality of commercial feed manufacturing, the purchase and storage of ingredients were items of prime importance.

With reference to seasonality in commercial feed manufacturing, the authors report that the number of employees does not change much over the year. This raises three presumptions. First, that there is little seasonality in commercial feed manufacturing; second, that most feed manufacturing firms have other allied enterprises that can absorb the extra labor force during slack periods; and third, that the size of the feed manufacturing firm is such that the presence or absence of employees is generally noticeable, and therefore public

*Ibid., p. 41.

reaction is a factor.* Further, if items two and three are significant factors, then production variation would be greater than variations in employee numbers. They point out that very little data is available concerning seasonality in the feed manufacturing industry and that they have serious doubts that employee variability properly reflects production seasonality. However, they do offer the general rule that "greater seasonality in production tends to occur in regions in which production is relatively large and that seasonality tends to be smaller in low-production areas."**

The purchase and storage of ingredients creates the twin problems of storage and risk-bearing. The more complex formulas require from 12 to 15 major ingredients and any number of additional trace elements.*** To carry large stocks of these ingredients would require large capital outlays both for physical storage and for inventory and, of course, accounting cost would also increase.

Therefore, there is a wide variety of policies among feed manufacturing firms in regard to inventory. Some feed manufacturers will attempt to carry large quantities of raw ingredients; others will

---

*Ibid., p. 20.*

**Ibid., p. 21.*

***Ibid., p. 21.*
not. The general rule seems to be a "hand-to-mouth type of buying" just above minimum levels.* Some of the larger manufacturers use the futures markets to some extent.

For two principle reasons inventories of finished products are held to a minimum. First, there is a tendency for the vitamin quality to deteriorate during storage, and second, the constantly changing demand for different types of feeds allows greater flexibility when raw ingredients are held separately.**

Askew and Brensike pointed out the rapid growth of the feed manufacturing industry, and reported that its two billion dollar sales volume in 1947 make it one of the nation's largest industries.*** In their geographic distribution of feed manufacturing plants, as of 1947, they show Montana in the lowest group, i.e., 0 to 9 plants; however, by 1960, depending on the definition of a feed plant used, Montana will have advanced to the second highest group with from 50 to 99 plants operating in the state.

The size of plant in terms of ingredients used varied substantially in 1947 from 3,000 to 14,000 tons per year, with an average

---

*Ibid., p. 22.

**Ibid., p. 21. This is general practice in Montana and as rule of thumb is a three week supply.

***It was reported at the Midwest Feed Manufacturers' Association Feed Production School in 1959 that sales volume was in excess of 3.5 billion.
production of approximately 7,000 tons per year for the United States. Considerable variation was found from region to region. They report that in the mountain region, the average production per plant was only a third of the national average.*

Askew and Brensike set forth the seven major ingredients used in feed manufacturing, i.e., (1) corn, (2) oats, (3) wheat, (4) barley, (5) mill feeds and screening, (6) soybean meal, and (7) alfalfa meal, and classified the United States into areas of surplus, deficit and borderline states.** Montana is listed in 1947 as being a surplus producer of oats, wheat, barley, mill feeds and screenings, and as a deficit area in the production of corn, soybean meal, and alfalfa meal. Depending on definitions used, some adjustment is necessary to properly reflect 1960 conditions in the Montana area. No state in the United States appeared to be in a surplus position for all seven ingredients in 1947 and no doubt this holds true in 1960. However, Montana now appears to have a surplus in alfalfa meal.

The authors presented aggregate operating cost for the feed manufacturing industry and also dealt briefly with the value added concept from the same point of view.*** It was established that the

---


***Ibid.*, pp. 22-24. Value added is defined as the cost of a manufactured or semi-manufactured product attributable to work performed on the constituent raw materials. See Eric L. Kohler, Dictionary for.
feed manufacturing industry spent $1,736,027,000 in 1947 for ingredients, fuel, electricity and contract work, and that the value added by the manufacturing effort was $394,236,000, of which $143,301,000 was spent on wages and salaries and the balance of $250,935,000 went for profits and other manufacturing costs.* No further break-down was given.

Another report of a general nature but more closely related to Montana problems was published in 1953 under contract with the United States Department of Agriculture, by Foye M. Troute and G. B. Wood.** There it was pointed out that the feed manufacturing manager is per se interested in two general relationships: first, how do operating costs compare in mills of different sizes, and second, how do operating costs compare among mills in the same competitive area? It was accurately observed that feed manufacturing plants are generally more noted for their differences than for their similarities. For this reason, among others, cost standards have been slow to develop. The feed manufacturing industry in Montana is no exception. There are

---


*Ibid.*, p. 24. The data used was collected by the Bureau of the Census and little additional break-down is possible.

wide variations in physical plant arrangement and production patterns. Troute and Wood observed that the production labor cost represents the largest single outlay among cost items, and shows little variation between mills.* However, the administrative labor cost was in some cases nearly as large as direct production labor cost and showed twice the variation between the mills sampled. There is evidence that the same pattern exists for certain feed manufacturing plants operating in Montana.

The authors were concerned with the following cost items in their analysis:

(1) Wages and salaries, which in addition, included estimated wages for non-salaried management. This cost was divided into two categories: production and administrative labor. The production labor cost included all payments for labor directly employed in the production, processing, and handling of ingredients, and also an increment for direct supervision and associated bookkeeping. Whereas, the administrative labor included executive salaries, sales, professional services, etc.

(2) The second cost analyzed was depreciation. Depreciation costs were established for plant facilities and equipment. Where facilities were used for multiple purposes, a pro-

rata assessment was made.

(3) The third item, maintenance and repairs, was established to include all maintenance and repairs of feed manufacturing machinery and buildings, while excluding plant expenses and major plant adjustments.

(4) The fourth cost included taxes and license. This category included all payments except income taxes assessed by the federal and state governments, and those taxes on wages.

(5) A fifth category included heat, lights, power, and water.

(6) A sixth category covered insurance on feed manufacturing equipment and existing buildings.

(7) A miscellaneous category was included to cover the cost of transporting raw ingredients into the feed manufacturing plant, but did not include the cost of delivery to the customer of finished products.*

This type of cost data was obtained from thirty-five feed manufacturing plants which cooperated with the study. The sample included a wide range of sizes with the largest mill producing 100 times as much as the smallest mill. No such wide divergence was found in the Montana industry. The sample included privately owned, corporate and cooperative types of business organizations. The present study relating to Montana includes the same business forms. While Troute and Wood made

*Ibid.
no attempt to compare efficiency between these types, certain observations were made relating to the Montana industry.* While several methods of classification were possible, the authors chose to divide their mills into categories determined by the annual volume of production. The mills were classified into those producing less than 5,000 tons per year, those producing 5,000 to 10,000 tons annually, those producing 10,000 to 20,000 tons annually, those producing from 20,000 to 40,000 tons annually, and those mills which produced over 40,000 tons annually.

The authors made four general observations concerning the various cost items in these size groups:

(1) That administrative cost per ton generally tends to be a larger proportion of total unit cost in similar mills.** They recognize, of course, that their sample was small, and there is serious question that such an observation would hold true in Montana.

(2) They reported that the larger feed manufacturing plants were able to produce a ton of finished feed with 25 percent less labor than the smaller feed manufacturing plants.

(3) It was also reported that wage rates were significantly

---

*Ibid., p. 7.

**Ibid., p. 3.
lower, i.e., approximately 20 per cent, for the smaller mills. This may afford a competitive advantage for the smaller mills, which is not determined by production efficiency. Obviously, the degree of unionization is the determining factor.

(4) Generally speaking, the smaller mills enjoy lower tax charges than do the larger mills, especially those located in metropolitan areas.

Some significant differences were apparent to the authors pertaining to the relative size of mills.

(1) It was found that the smaller mills were more occupied with custom manufacturing than were the larger mills. Fourteen mills were observed in the smaller category and only three of these did not custom manufacture. Of the remaining eleven that did perform custom manufacturing, 28 per cent of their volume was represented by this endeavor. Whereas, of fourteen larger mills, only three performed custom manufacturing and in these cases, the volume of custom production amounted to only 15 per cent of the total production.*

This same general pattern holds true in Montana, where three of the larger producers actively seek to eliminate or reduce custom manufacturing. This resistance takes the

*Ibid., p. 2.
form of higher prices and delay in the execution of orders. In spite of the higher prices charged for custom work by some of the larger mills, custom manufacturing still seems to gain in popularity. Delay in execution of custom orders seems to have proven more effective in reducing custom manufacturing than has the price increase. This is not to say that if price increases were pressed to a point that custom orders could be reduced or eliminated.

On the other hand, one large chain operating in Montana welcomes custom manufacturing and seeks to encourage the manufacture of a completely balanced ration. The larger mills tend to produce a more standardized product, selling under the company's brand name, and therefore do not wish their production pattern disturbed by the entrance of the relatively small custom order. Breaking the production pattern to fill a custom order necessitates mechanical adjustments as well as cleaning where highly medicated rations are produced. The smaller mills encourage custom manufacturing in several areas in Montana. Where custom manufacturing is performed, the basic grain utilized is generally furnished by the customer, thereby making it unnecessary for the feed manufacturer to hold large inventories in the form of barley - the feed grain upon which the Montana feed manufacturing industry is
based, and upon which the industry seeks to grow.

(2) The second point observed was that the smaller mills, using their own equipment, transport more of the ingredients they utilize in feed manufacturing than do the larger mills. Again, this is a general rule with application to the Montana industry, however, several smaller mills in Montana do not transport any ingredients in their own equipment. In fact, some small mills in Montana report no transportation equipment whatsoever. With the present pattern of truck transportation, more ingredients are delivered to the warehouses. In most cases the truck operator physically participates in the unloading of the truck.

(3) Smaller units tend to handle more sacked ingredients than do the larger mills. Again, this appears to be an accurate observation. However, it is doubtful that this is a significant difference between small and large mills in Montana.

(4) The authors report that the smaller mills do not pellet as much of their total feed production as do the larger mills. They report that approximately 50 per cent of the smaller mills do not have pelleting machines, and of those that do, pelleting accounts for only 17 per cent of their total feed production volume. In the larger mill category, only one mill did not have pelleting equipment. In the
case of the larger mills, pelleting accounted for 30 per cent of the total feed production. It must be remembered that these percentages are reported for the year 1953, and that significant increases in pelleting have occurred since that time. If those mills utilizing only grinding, mixing and steam rolling operations are excluded, nearly all of the remaining smaller feed manufacturing plants in Montana have pelleting equipment; in a significant number of cases, pelleting accounts for their total production. Notwithstanding, all of the larger mills in Montana have pelleting equipment. This is true because of the nature of the feed manufacturing industry in Montana as opposed to the industry of the Pacific Coast area as observed by Troute and Wood. In the latter case, chicken, turkey and general poultry feeds were significantly more important than in Montana where the large range cube is the more dominant production item.

(5) It was further observed that smaller mills are less specialized than the larger mills. They report that none of the smaller mills mix over 80 per cent of their volume in one type of feed.

(6) The smaller mills are basically retail mixers in that they sell nearly their entire output directly to the consumer, whereas the larger mills sell approximately 68 per cent
directly to the consumer.

(7) The larger mills are more mechanized than are the small mills.*

Without more information than was reported, it is impossible to make comparisons on this point with the Montana industry.

A report entitled, "Empirical Estimates of Cost Functions for Mixed Feed Mills in the Midwest", appeared in 1956 in the Agricultural Economics Research Bulletin. The author, Mr. Richard Phillips, states that the project was directed toward the operation of feed mixing plants and that it was not concerned with the size of the organization, or the functions of the several types and varying sizes of feed firms. It was designed to establish the relationship between total mixing volume and cost efficiency in feed mixing, taking into account the degree of capacity utilized. Because of the restricted area of investigation, only the summary points have application in this review. Mr. Phillips states:

Data for the feed-mixing plants reported here, together with the models and analysis used, illustrate some possibilities as well as some problems, in fitting empirical cost functions for firms in agricultural marketing industries. A simple regression of cost on output does not provide an appropriate estimate of the long-run total and average cost functions when the plants studied operate at various points on their short-run average cost functions. When actual plant capacity can be measured realistically, the introduction of capacity variable into the model provides one means of adjusting for variations in short-run output.

The nature of the relationship between cost and the capacity variable specifies the characteristics of the family of short-run average total-cost functions for the plants studied. As each plant is observed at only one point on its short-run curve, selection of the model is somewhat arbitrary in this respect. When monthly outputs and major variable costs can be observed for the plants studied, regression analysis can be applied to these data as a check on the model used for the long-run analysis.*

The author observes, from studying his data, that mixing costs per ton appear to decrease at a diminishing rate as output increases. Studies of this nature have more application in areas where the feed manufacturing industries are concerned with mixing extremely large volumes of feed and where this mixing constitutes the primary manufacturing step.

The Department of Agriculture is generally interested in supplying information directed toward the improvement of efficiency in custom mill operations with the hope that the increased efficiencies will result in cost reductions with the benefits from such reductions accruing to the farmer. Further, the farmer, as prime supplier of the principle raw ingredients, is closely associated with the feed manufacturing industry. With this in mind, the Department of Agriculture, by contract arrangement with the Midwest Research Institute of Kansas City, Missouri, sought to establish a model stationary

custom feed mill, and with this model ascertain cost standards for the industry.*

The methodology used was to initiate a mill survey in the Midwest, in which survey 104 custom milling firms cooperated. This work was undertaken by Agricultural Economist, Frank M. Ross. Of the 104 surveys received, the analysis was drawn from 36 contributors. Mr. Ross conducted a personal interview with the managers of the selected firms, and at that time collected such additional cost and production data as was available. He also made observations concerning the methods of production. Further, he conducted time studies to be used in his cost standard preparation. The basic operating data was supplied by those firms engaged in the manufacture of feed mill equipment. Mr. Ross was also able to draw upon previous experience gained from analyzing mills ranging in size up to 50,000 tons of finished feed per year. From this array of general information he sought to establish a model mill, as nearly representative as possible of those operating in the Midwest. The model mill developed was not intended to serve as a blueprint for the construction of manufacturing facilities, but was rather intended to serve as a framework from which labor standards could be determined. In addition, it was hoped that the plant managers would be better able to analyze their own operations.

as a result of the study. It was observed that the majority of plant managers did not possess sufficient and accurate information necessary to obtain the proper operational efficiency. Cost standards will enable the smaller custom mill to better appraise its operation.

In discussing the characteristics of custom milling, some rather unusual observations were revealed. One was that many mill managers did not expect to return a reasonable profit on investment in their custom milling operations, since approximately 33 per cent did not cite the profit motive as their reason for being in business. Approximately half of the managers interviewed cited service to customers and the creation of good will as their prime motive for operation.* It became obvious then that other divisions of their business were expected to return a profit and to pay for "the service rendered". Many of the mills were integrated with grain elevators, and dealers in fertilizer and farm machinery, etc. The necessary equipment for the operation of custom feed manufacturing was set forth and some general observations as to the characteristics of such equipment were noted. Data concerning the hammer mill and the vertical and horizontal mixers were collected, as the prime emphasis was centered on grinding and mixing operations. Capital requirements for hammer mills, mixing equipment, crimpers and crackers, sewing machines, scales and other necessary equipment were reported, and the

figures are generally representative of 1960 price levels.*

The study area was composed of two cost centers. Cost center number one included the truck hoist, truck scale, the grain feeder, the hammer mills, the blower spout and the dust collector. The second cost center included the spout, the mixer, the load-out conveyor, and hand trucks. The capacities for key units of equipment were: the hammer mill, four to eight tons per hour, with a horsepower rating of fifty to seventy-five. Depending upon the equipment selected, the capital investment would range from $14,000 to $20,000.** It was with this equipment arrangement in mind that the labor cost standards were determined.

The time and motion approach was used to determine the standards for the multiple activities necessary to the operation of such a model unit.

Another report using time and motion studies to establish standards was published in 1956.*** It dealt with labor efficiencies in Indiana grain elevators which provided grinding and mixing services. The most significant contribution of this report lies in its recommendations concerning grinding and mixing. It was stated:

---


***Charles E. French, Labor Efficiency in Grinding and Mixing Feeds in Indiana Grain Elevators, Agricultural Experiment Station, Purdue University, Station Bulletin 639 (Lafayette, Indiana, 1956).
Grinding

1. Coordinate grinding and shelling capacities. Grinding usually took longer than shelling.

2. Change screens from grinding floor where possible. A well-located stairway was quicker than a manlift or ladder in getting to the basement.

3. Reduce the number of screen changes. One elevator used seven screen sizes; however, four of these screens accounted for 92 per cent of the orders.

4. Keep grinding area switches and bin levers close together.

5. Add flexibility in grinding by using two grinding bins.

6. Discourage unusually fine grinding.

Mixing

1. Store supplement near mixer. Getting supplement required much of the mixing time.

2. Move a full hand cart of supplement each trip, especially if supplement is stored some distance away.

3. Slide or carry supplement, rather than using a hand cart, if it is stored close to the mixing area.

4. Avoid upstairs storage of supplement. It required as much as one-third more handling time than storage on the mixing floor.

5. Store most commonly used supplements nearest the mixer.

6. Prepackage minor ingredients such as antibiotics.

7. Preposition knife or other equipment for opening bags. Opening bags took nearly one-sixth of the mixing time.

8. Eliminate needless sweeping around the mixer. Sweeping took more than one-sixth of the mixing time.

9. Avoid overmixing. Recognize characteristic colors of thoroughly
mixed orders.*

Point number 9 under "Mixing" is a recommendation that most Montana operators would do well to heed, it being a common fault.

A pressing problem in the Montana feed manufacturing industry is the inefficiencies that exist in most warehousing functions. Therefore, an industry-wide publication dealing with labor cost and efficiencies was very important. The study was conducted by Richard Muther and Associates, consultants in industrial management, Kansas City, Missouri, under a contract arrangement with the United States Department of Agriculture.**

The principle objective of the study was to analyze the relative efficiencies of warehouse labor between firms in the feed manufacturing industry, and to obtain information on how the efficiencies of different systems varied among mills. From their study of six manufacturing concerns, the authors concluded that: (1) Idle or delay time amounts to 29 per cent of the worker's time, and that 75 per cent of this idle or delay time resulted from circumstances beyond the control of the worker, and (2) that the fork-lift method of handling bagged ingredients appeared in most cases to result in higher efficiencies, and that


generally, the use of hand trucks represented the least efficient utilization of warehouse labor. The authors hastened to qualify that each mill is a case study in itself, and that general rules are dangerous. The belt conveyor warehouses loaded over 50 per cent of their output directly into waiting rail cars or trucks. Some warehouses in Montana, whether forklift or hand truck operations, utilized a belt conveyor, of one variety or another, when the opportunity existed to load directly.

Cost data and comparisons for the warehousing stage of production as found in the Montana industry will be presented in chapter five.

The Feed Production School, Inc., of Kansas City, Missouri, contracted through its research division with the Wolf Management Engineering Company, of Chicago, Illinois, to conduct a study of pelleting cost in mills located in the Midwest.*

The pelleting cost analysis dealt with mills of three sizes: i.e., 50 tons, 100 tons, and 200 tons. Pelleting costs were determined for poultry pellets, ranging in size from 10/64ths to 12/64ths inch; for hogs, ranging from 10/64ths to 12/64ths inch; and for dairy, 10/64ths inch. Steer cubes were also analyzed and ranged in size from 9/16th to 3/4ths inch, however, the analysis for steer range

---

cubes was restricted to the 50 ton mill class. The individual items included in the pelleting costs were: (1) power cost, including steam and electricity, (2) die and roller cost; (3) maintenance cost, (4) supervision cost, and (5) direct labor cost. These costs were reduced into per ton increments. The labor, supervision and maintenance costs were reported in hours per ton.

The author also set forth the capital investment required to establish mills of 50 ton, 100 ton and 200 ton capacity. The 50 ton mill was reported to require $21,000 to $24,000 in capital. The 100 ton mill had a price range from $42,000 to $48,000; the 200 ton mill required from $84,000 to $96,000 in capital investment.* Of course, these figures include only the pellet mill, the coolers and crumblers; however, these items are complete with motors, starters and controls. A 40 per cent increment has been added to cover freight and millright charges.

The author reaches the conclusion that the average manager can not answer the all-important question, "What does it cost?" He reports that the costs are hidden in the multitude of steps and operations, raw materials, and equipment, and the many formula variations necessary to the production of manufactured feed. The inability to answer the question, "What does it cost?" leads to incorrect selling prices, reduced profit margins, and even operational losses. Mr. Bohl points out that the best profit insurance a feed manufacturing executive can

*Ibid., p. 66.
have is the knowledge of a break-even point at the various levels of plant capacity.* Although this study did not prepare break-even points, it recommended that this should be the next logical step in a feed manufacturing research program.

An article entitled, "Economic-Engineering Methods in Marketing Research", appeared in the Journal of Farm Economics in 1953, in which it was pointed out that the key element in studies of plant efficiency is the development of cost functions for the separate plant stages.** Although this type of economic-engineering approach was applied to another industry, it is the basic approach to be taken in the present study. The technique of analysis, explained in a subsequent chapter, was determined independently of the recommendations made by Sammet and French.

A survey of the Montana feed manufacturing industry would not be complete without some observations on mobile feed milling. There are several such operations in existence in the State of Montana, varying from rather primitive grinding operations to highly complex formula pelleting. One of the better mobile feed milling surveys was conducted through the Farmer Cooperative Research Service.***

---

*Ibid., p. 67.


***Arno J. Hangas, Mobile Feed Milling by Cooperatives in Michigan
The area of study was in Michigan and Wisconsin and the data was supplied by 11 cooperatives operating 15 separate mobile units. The principle objective of the study was to determine the policies and practices used by the cooperatives and to ascertain the general nature of the problems that were involved in the mobile operations. Further, it was important to present general expense data, income figures, and as much other operating information as might be beneficial to all concerned. The mills were analyzed on a straight profit and loss basis. It was generally observed that the revenue from grinding and mixing was not sufficient to cover the operating expenses in most of the operations studied. Even under conditions of superior management it was necessary to derive income from the sale of molasses and other ingredients to meet the general expenses of operation. Without these revenues the mills studied would have operated at a loss.* Using the accounting data supplied by the eleven cooperatives, break-even points were established. It was reported that the average operation must grind and mix a yearly volume of 3,190 tons to break even.**

Some of the reasons for the adverse financial report were due to: (1) time lost because of inclement weather, (2) seasonal variations


**Ibid.*, p. 27.
in volume, (3) breakdowns during the business season, and (4) managerial inability.*

It must be remembered that these were cooperative associations and that service to patrons occupied high priority in their pattern of operation.

In contrast to the Farmer Cooperative Service report, a report by R. J. Cellar to the Feed Production School, Inc., in Kansas City, Missouri,** points out that the revenue from grinding and mixing exceeds cost of operation, which includes labor, depreciation, insurance, gas, oil, allowance for repairs, and interest on investment. All revenues from concentrates and molasses are classified as profit, over and above operating cost. In the "typical" examples reported to the Feed Production School, the net profit from the mobile feed operations ranged from $6,798 per year to $14,172 per year, all figures before federal income tax.*** The average capital investment in both the cooperative cases and in the examples reported by Mr. Cellar amounted to approximately $20,000 per operating unit.

---


**R. J. Cellar, Feed Production School, Inc., Kansas City, Mo.

CHAPTER III

STEAM ROLLING, GRINDING AND MIXING

Steam rolling, grinding and mixing, are inherent parts of the feed manufacturing industry of Montana. These two operations, more principally steam rolling, have become an essential characteristic of the Montana feed industry. Evidence to support this contention is found in the following four areas: (1) The amount of new investment which is planned for the future and has taken place to expand steam rolling capacities; (2) The high degree of complexity in the feed formulation, i.e., as many as sixteen different elements are added, and in substantially all of steam rolled production at least three different elements are added; (3) The significant percentage of total Montana barley production that is utilized by steam rolling. Industry expectation is for even greater increases in this direction as evidenced by plans for further plant expansion.

This chapter will explore the three areas and also develop with the aid of additional information the industry framework within which these functions operate. Attention will also be directed toward the degree and type of integration which has evolved. The firms studied and the production relationships reported in this chapter include only those mills that either steam roll, grind and mix, or both, but does not include those plants which furnish a complete feed processing service, i.e., pelleting, both custom and formula, steam
rolling, grinding and mixing.

Considering both industrial and geographical characteristics, Montana has been divided into three areas: the first, or Eastern, area extends from the Montana-North and South Dakota line to a point just east of Billings, Roundup and Hardin. The second, or Central, area extends from this horizontal line to the Continental Divide; and the third division, or Western, area extends westward from the Continental Divide to the Idaho line. This follows generally the continental classification where three locational regions are distinguished. Loosely the Western Area corresponds with a montane area, i.e., mountains and valleys, the Central Area with the piedmont, i.e., along the foot of the mountains, and the Eastern Area, which is related to the midland, i.e., the relatively flat lands of this interior of the continent. (See Map No. 4)

Table Number I shows the total volume of steam rolled, ground and mixed feeds for the year 1960 as 144,863 tons, of which 87 per cent was steam rolled. This figure is for all three Montana areas but does not include those feeds that were processed either on the farm or by the larger strictly private feed lot operations, which produce no feed for commercial sale. The total steam rolled commercial production was 126,001 tons.

The Western area accounted for 5 per cent of the total Montana commercial production, whereas the Central area provided 69 per cent of total steam rolled production. The remaining 26 per cent was
Table I. Total Production Volumes for Ground, Mixed and Steam Rolled Feed - 1960

<table>
<thead>
<tr>
<th>Area</th>
<th>Ground and Mixed (tons)</th>
<th>Steam Rolled (tons)</th>
<th>Total (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western</td>
<td>8,102</td>
<td>5,948</td>
<td>14,050</td>
</tr>
<tr>
<td>Central</td>
<td>5,840</td>
<td>87,651</td>
<td>93,491</td>
</tr>
<tr>
<td>Eastern</td>
<td>4,920</td>
<td>32,402</td>
<td>37,322</td>
</tr>
<tr>
<td>Total</td>
<td>18,862</td>
<td>126,001</td>
<td>144,863</td>
</tr>
</tbody>
</table>
concentrated in the Eastern area. The ground and mixed feeds accounted for 13 per cent of total production. By contrast, the Western area produced 43 per cent of this total; the Central area produced 31 per cent; the Eastern area produced only 26 per cent of the total Montana ground and mixed feed production. This variation may be somewhat accounted for by the small farm unit size and the general nature of the Western area's agricultural pattern.

The Central and Eastern areas are characterized by a different type of agricultural program, i.e., larger farm units and more commercial feeding.

The 144,863 tons of steam rolled, ground and mixed feed represents approximately 6,260,577 bushels, or approximately 12 per cent of the total 1960 production in Montana. This conversion is based on an average of 45 pounds of barley per bushel.

The principal use for steam rolled barley,* as reported by feed manufacturing firms, is shown in Table II.

The significant observation of the firms studied is that 69 per cent report that the principal use for their steam rolled production is for cattle fattening. The major part of this effort is located in the Central and Eastern areas. Other uses so far as firms involved are concerned do not appear too important except that

*This includes dry rolled barley, however, most firms do not keep separate records for steam and dry rolled barley.
Table II. Principal Use for Steam Rolled Barley

<table>
<thead>
<tr>
<th>Number of Firms Reporting*</th>
<th>Combination Cattle Fattening</th>
<th>Cattle Fattening &amp; Dairy</th>
<th>Eastern</th>
<th>Central</th>
<th>Western</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>13</td>
<td>18</td>
<td>3</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

*12 firms did not report this information
selected firms produce relatively large amounts for dairy use. Two firms report a specialty in steam rolling for bull feeding. In this production, a wide variety of supplements are utilized, with each feeder espousing his own particular custom formula.

In summary, cattle fattening is the principal use for Montana's steam rolled barley. Table III shows that 57 per cent of steam rolled barley went into fattening, 17 per cent was used as range feed, and only 4 per cent was used in swine production. Dairy accounted for 12 per cent of the total, with the balance made up of poultry and other production.

Table III further shows that of the 71,435 tons of steam rolled cattle feed, the Central and Eastern areas produced 98 per cent of the total. In the case of dairy feed, the Central area alone produced 83 per cent of the 15,551 tons of steam rolled used in that endeavor. The Western area accounted for 17 per cent of that total, with the Eastern area producing the balance. In poultry, with reference to steam rolling total production, the Western and Central area produced 46 and 52 per cent, respectively. The Central area produced 79 per cent and the Western area produced 21 per cent of the swine feed. Again, the Eastern area accounted for only a negligible volume.

The production picture changes somewhat with reference to grinding and mixing. The Central area produced 85 per cent of the total for cattle feeding. The balance was almost evenly divided between the Eastern and Western areas. However, for dairy use, of the
Table III. Distribution of Ground and Mixed and Steam Rolled Feeds

<table>
<thead>
<tr>
<th>Classification of Use</th>
<th>Total Production in Tons</th>
<th>Western</th>
<th>Central</th>
<th>Eastern</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>G.M.*</td>
<td>S.R.</td>
<td>G.M.*</td>
<td>S.R.</td>
</tr>
<tr>
<td>Range:</td>
<td></td>
<td>61</td>
<td>1,000</td>
<td>613</td>
<td>18,817</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50</td>
<td>1,498</td>
<td>21,980</td>
<td>21,315</td>
</tr>
<tr>
<td>Fattening:</td>
<td></td>
<td>272</td>
<td>1,288</td>
<td>2,043</td>
<td>1,999</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4,260</td>
<td>71,435</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy:</td>
<td></td>
<td>3,141</td>
<td>2,714</td>
<td>722</td>
<td>132</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3,994</td>
<td></td>
<td>15,551</td>
<td></td>
</tr>
<tr>
<td>Poultry:</td>
<td></td>
<td>2,867</td>
<td>1,020</td>
<td>1,575</td>
<td>1,164</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6,042</td>
<td></td>
<td>2,238</td>
<td></td>
</tr>
<tr>
<td>Swine:</td>
<td></td>
<td>1,656</td>
<td>1,076</td>
<td>1,602</td>
<td>4,106</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3,937</td>
<td></td>
<td>5,207</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td>95</td>
<td>0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>225</td>
<td></td>
<td>2,915</td>
<td></td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td>8,102</td>
<td>5,948</td>
<td>5,840</td>
<td>87,651</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4,920</td>
<td></td>
<td>32,402</td>
<td>126,001</td>
</tr>
</tbody>
</table>

*G.M. - Ground and Mixed
S.R. - Steam Rolled
3,995 tons of ground and mixed feed produced, the Western area produced 79 per cent while the Central Area accounted for only 18 per cent of the total.

Some balance among the areas takes place in the production of poultry feed. With 6,042 tons produced, the Western area accounted for 47 per cent, the Central area 26 per cent, and the Eastern area 26 per cent.

Swine feed production in the form of ground and mixed rations reached 3,937 tons in 1960 and the Western area again led slightly with 42 per cent, compared with 41 per cent for the Central area. The Eastern area produced 17 per cent.*

Source of Barley Supply

The firms engaged in steam rolling grinding and mixing obtain their barley supplies from a variety of areas. In the aggregate 71 per cent of the firms report that they obtain from 76 to 100 per cent of their total barley supplies from local sources, i.e., from within a radius of 30 miles of the plants locations. The significant variation among the areas is shown by the fact that in the Western area acquire 75 per cent or less of their total supply from other sources as obtain from 76 to 100 per cent of their supplies locally. This

*These figures do not include ground and mixed feed manufactured by mobile feed units.
relationship does not hold true in the Eastern and Central areas. This is evidenced by the fact that 14 per cent of the firms in the Eastern area obtain 75 per cent or less of their supplies from local origins. In the Central area, 19 per cent of the firms acquire 75 per cent or less of their supplies from outside areas. The Triangle area exports into the western region significant percentages of those firms requirements. Notwithstanding one firm operating in the Eastern area receives 100 per cent of its barley supply from the Triangle area. With reference to the production maps showing cattle, barley and alfalfa production, it can be clearly seen why this relationship exists.

By and large, Montana's barley production is concentrated in the two general areas known as the Triangle and Hi-Line area, and are so referred to in the trade. In the Eastern area which encompasses the Hi-Line production, 83 per cent of those mills report that their barley supply is obtained locally. Information obtained from personal interviews from firms operating in the industry shows that feed manufacturers prefer to purchase their barley locally, as a matter of accommodation. However, during times of shortages these same firms will purchase their barley supplies from distant areas such as the Judith Basin, Triangle and Hi-Line areas. (See Maps 5, 6 and 7)

Barley Delivery

Table IV shows the importance of truckers in the delivery of these supplies. This is particularly true in the Western area. The
Table IV. From Whom Barley Supply is Obtained

<table>
<thead>
<tr>
<th>Percentage of Supply Obtained</th>
<th>From Local Farmers</th>
<th>From Truckers</th>
<th>From Dealers and Others</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eastern</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 25</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26 - 50</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>51 - 75</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>76 - 100</td>
<td>12</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Central</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 25</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>26 - 50</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>51 - 75</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>76 - 100</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Western</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 25</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>26 - 50</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>51 - 75</td>
<td>3</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>76 - 100</td>
<td>8</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

*4 firms not reporting
truckers do, as a matter of general policy, purchase the barley for their own account and thereafter sell the barley to the mills. They are in effect operating in a dual capacity and much of their buying is on a speculative basis as they hope to gain the price differential that exists among the several areas. These truckers supply an inherently useful function to the feed manufacturing industry. Although it is more evident that speculative buying and the resulting transportation takes place for the Western area this is not to say that this function is any less important in the other areas. The so-called "back-haul" accounts for enormous movements of barley supplies even though we have no quantitative measure of this.

The over-all importance of the use of trucks as a prime mover of barley supplies is completely overwhelming as compared with delivery by rail. In the Eastern area all reporting firms receive their barley via trucks and rarely by way of railroad. In the central area only two firms of the thirty-two reporting utilize rail facilities, and then the two firms obtain less than 10 per cent of their supply by this method of delivery. The Western area reports receiving barley via railroad transportation and again this firm receives less than 10 per cent of its total supply by this means.

Therefore, the use of railroads in the movement of barley supplies to the feed manufacturing plants is nil for the entire state. Notwithstanding, in all three areas approximately 90 per cent of the feed manufacturing firms have rail facilities available.
It will be shown later that certain other ingredients used in feed processing do utilize rail transportation.

Expansion Plans

The expansion plans of the firms in this area of feed manufacturing indicate the dynamic conditions of all but the Western area. As can be seen in Table V, four new plants in the Eastern area alone were completed and readied for production during the period of the study.

This investigation revealed that in the period from September 1958 to September 1961, slightly over $1,000,000 was invested to expand steam rolling capacities alone. This expansion has continued since the last mentioned date and should easily account for several hundred thousand dollars. Whereas a complete steam-rolling facility requires an investment in the fifty to seventy-five thousand dollar range at least two firms have invested in excess of one hundred thousand dollars for steam rolling facilities. In the Central area, four firms report plans to add additional steam rolling units with the new additions to have a production capacity in excess of the older units. Five firms report a general equipment remodeling program with larger boilers and molasses equipment.

Price Structure

The economic importance of steam-rolling as a source of
### Table V. Expansion Plans (if any)

<table>
<thead>
<tr>
<th>Expansion Plans</th>
<th>Number of Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eastern</td>
</tr>
<tr>
<td>No plans</td>
<td>4</td>
</tr>
<tr>
<td>New plants</td>
<td>4</td>
</tr>
<tr>
<td>Plants with new equipment, re-modeling</td>
<td>2</td>
</tr>
<tr>
<td>Plans for new rebuilt pellet machinery</td>
<td>1</td>
</tr>
<tr>
<td>Plans for new mixer</td>
<td>1</td>
</tr>
<tr>
<td>Plans for additional steam roller</td>
<td>1</td>
</tr>
<tr>
<td>Plans for molasses equipment</td>
<td>1</td>
</tr>
<tr>
<td>Hopes</td>
<td>1</td>
</tr>
<tr>
<td>Depending on financing</td>
<td>0</td>
</tr>
<tr>
<td>General expansion</td>
<td>0</td>
</tr>
<tr>
<td>Plans for larger boiler</td>
<td>0</td>
</tr>
<tr>
<td>Plans to add de-stoner</td>
<td>0</td>
</tr>
</tbody>
</table>

In Central area several mills have been installed since field work was completed. (Total investment in all new plant capacity between 1958 and 1961, $2,500,000.)
revenue is highly significant and many firms report that steam rolling is their "bread and butter" line. Several plants that were observed in this study would not have survived without the revenue supplied by their steam rolling operations. Though there are obviously several firms in all areas that operate their steam rolling per se on a marginal basis they do so because of other motivations, i.e., attempting to close entry to new firms and/or attract business for their other integrated services. Table VI shows a complete break-down for all charges by firms operating in the several areas. However, account must be taken of the prices charged for the various elements that are added as extras, i.e., molasses, Vitamin A, special pelleted concentrates, trace-minerals, etc. There are any number of pricing policies in effect. It is not the purpose of this report to reveal the percentage mark-ups. Notwithstanding, it may be generally said that in most cases this mark-up is substantial and delivers to the firms a comfortable total operating margin again notwithstanding the prices charged for the various services themselves.

Integrated Operations

These firms engaged in grinding and mixing in substantially all cases reported highly integrated operations, which accounts in part for the wide variations in pricing policies as seen in Table VII. Table VII shows that the overall development of integration has reached a very close balance in the Eastern and Central area, while
Table VI. Prices Charged for Custom Services per c.w.t. (Number of Firms*)

<table>
<thead>
<tr>
<th></th>
<th>Ground &amp; Mixed</th>
<th>Steam Rolled</th>
<th>Dry Roller</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sack</td>
<td>Bulk</td>
<td>Sack</td>
</tr>
<tr>
<td>Eastern</td>
<td>.05 - .10</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>.11 - .15</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>.16 - .20</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>.21 - .25</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>.26 - .30</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Central</td>
<td>.05 - .10</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>.11 - .15</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>.16 - .20</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>.21 - .25</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>.26 - .30</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Western</td>
<td>.05 - .10</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>.11 - .15</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>.16 - .20</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>.21 - .25</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>.26 - .30</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>State</td>
<td>.05 - .10</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>.11 - .15</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>.16 - .20</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>.21 - .25</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>.26 - .30</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

*These reporting firms do not offer any additional feed manufacturing service. Those firms offering pelleting service as well as steam rolling and grinding and/or mixing are not reported in this table.
Table VII. Integrated Services Furnished by Plants Grinding-Mixing and Steam Rolling

<table>
<thead>
<tr>
<th>Service</th>
<th>Eastern*</th>
<th>Central</th>
<th>Western</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line Elevator</td>
<td>14</td>
<td>22</td>
<td>4</td>
<td>40</td>
</tr>
<tr>
<td>Seed and Salt</td>
<td>12</td>
<td>27</td>
<td>4</td>
<td>43</td>
</tr>
<tr>
<td>Fertilizer and Chemicals</td>
<td>9</td>
<td>26</td>
<td>5</td>
<td>40</td>
</tr>
<tr>
<td>Complete Farm Store</td>
<td>11</td>
<td>17</td>
<td>5</td>
<td>33</td>
</tr>
<tr>
<td>Retailing Full Feed Line</td>
<td>16</td>
<td>26</td>
<td>6</td>
<td>48</td>
</tr>
<tr>
<td>Farm Machinery and Equipment</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Retailing Limited Feed Line Steam Rolling</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

*1 firm—grain and bean cleaning main revenue producing effort
falling behind in the Western area. In the Eastern area, 56 per cent of the firms operate line elevators whereas only 25 per cent of the Central firms do so, however, with reference to fertilizer and chemicals the latter area reports 84 per cent of the firms operating in this area with 56 per cent furnishing this service in the Eastern area. It is apparent in all areas that the retailing of a full line of manufactured feeds is the leading service provided.

In the aggregate 80 per cent of all the firms considered provide this service. Next in importance as an integrated service is the merchandising of seed and salt. A total of 72 per cent of the firms reported this line of service. Retailing of fertilizers and chemicals follows in a very close third position. Two-thirds of the total firms studied offer this complimentary line. Other important services which are offered by these plants may be observed by referring to Table VII. Records of the firms involved are generally kept in such a manner that it would be nearly impossible to establish clearly the relative dollar importance of these various lines. An additional step on the integration scale has been taken by some firms and is planned by others, and this involves feed-lots operated on a variety of basis. One of the leading established line organizations operates with a flexible policy concerning both entering and leaving feeding ventures. Most of their past operations have been on a terminal basis. Responsibility for the initiation of such feeding programs depends upon the local plant managers with the subsequent approval of
higher authorities. It has been the plant managers duty to appraise the supply and demand conditions in Montana concerning all involved elements and then reach a tentative decision. The future may well see more feeding operations added by feed manufacturing firms.

The Accounts Receivable Problem

The direction that these firms as well as firms offering a complete feed processing service may take in the future may well be determined by the availability of capital and general credit conditions. Personal interviews with many of the leaders in the industry reveal a serious concern for credit problems. Delinquent accounts receivable became so aggravated for all classes and types of feed manufacturing firms that during the period of this study two of the three largest organizations in the state were obliged to adopt a new general credit policy and many other firms were forced to apply a strict credit policy which had inadvertently become lax. At least 60 per cent of these accounts were over ninety days delinquent and the probability of collection declining with each additional month. A few firms have been forced to strictly C.O.D. terms. Table VIII gives a general picture of credit conditions as they exist for Montana firms engaged in steam rolling, grinding and mixing. In spite of the fact that a few firms demand C.O.D. terms 93 per cent of the firms consider thirty days as tantamount to cash. Considering all firms, 55 per cent report what may be classified as a moderate problem in
Table VIII. Credit Conditions in Feed Manufacturing Firms

<table>
<thead>
<tr>
<th></th>
<th>Eastern</th>
<th>Central</th>
<th>Western</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowing no credit, i.e., cash</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Considering 30 days as cash</td>
<td>15</td>
<td>30</td>
<td>11</td>
<td>56</td>
</tr>
<tr>
<td>Reporting no credit problems</td>
<td>0</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Reporting moderate credit problems</td>
<td>8</td>
<td>17</td>
<td>8</td>
<td>33</td>
</tr>
<tr>
<td>Reporting serious credit problems</td>
<td>3</td>
<td>10</td>
<td>3</td>
<td>16</td>
</tr>
</tbody>
</table>
their delinquent accounts receivable. More importantly, over one-fourth of all firms report a serious credit problem. There must be some inherent characteristic involved in the collection of accounts receivable growing out of the sale of feeds. Poor collection of accounts receivable was reported by one banker interviewed as the prime reason that one firm was forced into insolvency. Notwithstanding, only one firm in the entire Montana feed manufacturing industry went into insolvency during the period of time that this study was conducted, i.e., September, 1958 to September, 1961.

Distribution of Production

Other important characteristics of this segment of the Montana feed industry are shown by Tables IX and X. A significant number of firms in the Western area distribute their production within a radius of fifteen miles of the plant, or more precisely 54 per cent. Conversely, in the Eastern area only 7 per cent and in the Central area 23 per cent distribute their product within this same radius. When the radius is expanded to 31 to 45 miles, 25 per cent of the firms in the Eastern area fall into this classification whereas the Western area has a negative report. The Central area reports 16 per cent of its firms distribute within this radius of 31-45 miles. Generally speaking the Eastern and Central areas distribute their product over a wider radius than do firms in the Western area as can be seen in Table IX.
Table IX. Radius Output as Distributed by Firm Grinding-Mixing and Steam Rolling

<table>
<thead>
<tr>
<th>Region</th>
<th>0 - 15 miles</th>
<th>16 - 30 miles</th>
<th>31 - 45 miles</th>
<th>46 - 60 miles</th>
<th>61 - over miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern</td>
<td>1</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Central</td>
<td>7</td>
<td>7</td>
<td>5</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Western</td>
<td>7</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>17</td>
<td>9</td>
<td>11</td>
<td>5</td>
</tr>
</tbody>
</table>
Table X. Percentage of Total Production Sold in Less Than Ton Lots

<table>
<thead>
<tr>
<th>Percentage</th>
<th>0 - 20</th>
<th>21 - 40</th>
<th>41 - 60</th>
<th>61 - 80</th>
<th>81 - 90</th>
<th>91 - 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Central</td>
<td>10</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Western</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
<td>9</td>
<td>7</td>
<td>11</td>
<td>7</td>
<td>3</td>
</tr>
</tbody>
</table>

*7 firms not reporting
With reference to Table X which shows the percentage of total production sold in less than one ton lots, the Western area firms sell a significantly larger proportion of their production in one ton lots than do the firms of the Eastern and Central areas.

In the Western area 38 per cent of the firms report that they sell 41 to 60 per cent of their total production in less than one ton lots, while another 31 per cent report that they sell from 61 to 80 per cent of their total production in less than one ton lots. However, only three firms which are located exclusively in the Central area report a 91 to 100 per cent distribution in less than one ton lots. Again as a general rule, the firms of the Eastern and Central areas sell their production in significantly larger volumes than do the firms of the Western area. This may be accounted for by observing the structure of the farming industry in their respective areas.

Seasonality in Grinding and Mixing and Steam Rolling

Seasonality for grinding, mixing and steam-rolling is another important factor of this segment of the industry, and plays a part in explaining integration developments and revenue patterns for the firms involved. Table XI shows in three classifications the seasonality breakdown.

Certain types of farming enterprises contribute to a more constant pattern of production than do others. Financial stability
Table XI. Seasonality for Grinding-Mixing and Steam Rolling Firms

<table>
<thead>
<tr>
<th></th>
<th>Number of Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Constant  Seasonal  Uncertain or Not Reporting</td>
</tr>
<tr>
<td>Eastern</td>
<td>8            3          5</td>
</tr>
<tr>
<td>Central</td>
<td>20           4          7</td>
</tr>
<tr>
<td>Western</td>
<td>11           1          1</td>
</tr>
<tr>
<td>Total</td>
<td>39           8          7</td>
</tr>
</tbody>
</table>

Note: Volume of production varies because of demand for specialty feed such as bull feeds. The demand for dairy feeds tends to act as a stabilizing factor.
of the farming units involved also reflects an important impact upon seasonality. A constant seasonal pattern is desired from the point of view of the firms interviewed. In the Western area 84 per cent of the firms report a constant annual production pattern. Sixty-four per cent of the firms in the Central area report a constant demand for steam rolled and ground and mixed feeds. In the Eastern area 50 per cent of the firms report a constant pattern of demand. Of the firms reporting this information concerning seasonality, 72 per cent report a constant demand pattern for both steam rolled and ground and mixed feeds.

Trends in Feed Characteristics

As noted earlier in the chapter the degree of complexity that has developed in grinding and mixing and steam rolling demands elaboration. The present frame of reference is narrowed to steam rolling, because the first element, i.e., molasses is used primarily in connection with that product. This is a general rule and exceptions can be found. By referring to Table XII it may be preclusively observed that 75 per cent of the firms in the Eastern area and 65 per cent of the firms in the Central area add molasses in either the dry or liquid form. Again a difference is apparent in the Western area where 38 per cent of the firms add molasses in one form or another. The addition of molasses in the liquid form necessitates an additional investment that can run into several thousand dollars.
Table XII: The Use of Molasses by Firms Grinding-Mixing and Steam Rolling

<table>
<thead>
<tr>
<th></th>
<th>Number of Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eastern</td>
</tr>
<tr>
<td>Adding no molasses to feeds</td>
<td>4</td>
</tr>
<tr>
<td>Adding molasses to feeds</td>
<td>12</td>
</tr>
<tr>
<td>Adding molasses in dry form</td>
<td>3</td>
</tr>
<tr>
<td>Adding molasses in liquid form</td>
<td>.9</td>
</tr>
<tr>
<td>Using molasses extracted from cane</td>
<td>1</td>
</tr>
<tr>
<td>Using molasses extracted from beet</td>
<td>11</td>
</tr>
</tbody>
</table>

* & **Some firms adding molasses in both forms

***Several firms report blending cane and beet molasses
depending upon the type of equipment installed. Notwithstanding the additional requisite investment the current trend is toward the use of molassitizing equipment. As seen in Table XII, 56 per cent of the firms in the Eastern area and at least 50 per cent of the firms in the Central area and 16 per cent of the firms in the Western area add molasses in liquid form. In all plants with steam rolling facilities that were built in Montana during the period of this study, 100 per cent of these installed liquid molassitizing facilities.

There exists in the industry some controversy as to the advisability of the use of beet molasses in feed preparation. In spite of this, 91 per cent of the firms in the Eastern area use molasses extracted from beet pulp. In the Central area, 35 per cent of the firms report the utilization of beet molasses. One large chain feed manufacturing firm blends cane and beet molasses on a 50-50 basis. Because of the price differential and the close proximity to the source of supply, beet molasses predominates in use over cane in the Eastern and Central areas. This is true despite the fact that many firms in the Central area strongly support the use of cane molasses. It was not the purpose of this study to determine the relative merits of the two competitive products, but rather to point out the extensive use of molasses in its role as a complementary element with barley. As will be enumerated in another section of this report, even mobile grinding and mixing units provide liquid
molasses on a custom basis and further the addition of liquid molasses is an important revenue device for the mobile operators.

In addition to the universal use and acceptance of molasses as a supplement in feeding barley in Montana both Vitamin A and Vitamin D are equally as widely utilized. The method of adding these vitamins varies from rather crude hand feeding operations to the use of modern mechanical feeders with precise measurements and uniform distribution control. There are several mechanical feeders manufactured by various firms each possessing certain engineering advantages and characteristics.

The complexity increases with the use of the following ingredients. Depending on the type of feeding: Soybean Oil Meal, Linseed Oil Meal, Wheat Middlings, Dehydrated or Suncured Alfalfa Meal, Urea, Salt, Di-Calcium Phosphate, Calcium Carbonate, i.e., ground limestone, Manganous Oxide, Iron Carbonate, Calcium Iodate, Magnesium Oxide, and Iron Sulphate. Supplements of this nature may be added to the ground mixed or steam rolled barley either in the form of meal or pellets. The mixing is done both by hand or with mechanical mixers depending on the availability of the latter. The newer installations are all equipped to do this mixing of ingredients with a high degree of efficiency. These ingredients are generally provided as a manufactured unit and a wide variety of formula variations are available. The preponderance of the evidence obtained in this study points to the increasing use of these supplements in the future.
KEY

Present Interstate Routing
U.S. Numbered Highways
Montana Numbered Highways

SOURCE
Map of the Montana State Highway System, 1960,
Montana State Highway Comm., Helena, Mont.
ALL CATTLE SHOWING PELLET MILLS

Key:
0 - FEED PLANT - PELLETING, STEAM ROLLING AND GRINDING AND MIXING

Used by permission from: MONTANA IN MAP, BY N. HELBURN, M. EDIE AND G. LIGHTFOOT.

SOURCE
U.S.D.C., Census of Agriculture—Preliminary, 1959
HAY HARVESTED SHOWING PELLET MILLS

Key:
0 - FEED PLANT - PELLETING, STEAM ROLLING AND GRINDING AND MIXING

Used by permission from: MONTANA IN MAP. BY N. HELBURN, M. EDIE AND G. LIGHTFOOT.

SOURCE
U.S.D.C., Census of Agriculture—Preliminary, 1959
BARLEY HARVESTED SHOWING PELLET MILLS

Key:
0 - FEED PLANT - PELLETING, STEAM ROLLING AND GRINDING AND MIXING

Used by permission from: MONTANA IN MAP, BY N. HELBURN, M. EDIE AND G. LIGHTFOOT.

SOURCE
U.S.D.C., Census of Agriculture—Preliminary, 1959
CHAPTER IV

PELLETING FEED PLANTS

Production Considerations

Introduction

The physical characteristics of the feed manufacturing plants of Montana are noted more for their differences than for their similarities. The plants analyzed in this chapter stress the pelleting function while the previously discussed plants do not have pelleting facilities. While practically 100 per cent of all feed manufacturing plants within the state are of the vertical design, nevertheless, the plant layouts inside and the structures are many and varied. One of the principal reasons for the two above statements is found in the fact that many of the older flour mills and elevators were converted into feed manufacturing plants. One third of the feed manufacturing plants were converted from other uses to that of feed manufacturing. The Eastern area leads the state in the percentage of feed mills converted from flour mills and elevators, etc. In the Eastern area 44 per cent of the feed manufacturing plants operating in 1960 were originally built for other uses. This figure is lowest in the Central area of the state where only 27 per cent of all feed manufacturing firms were converted. The significance of this converted factor and other similarly related problems will be dealt with later in this chapter.

The entire feed manufacturing industry in Montana remained
dormant through the 1930's and 1940's from a growth point of view. It is possible to account for this rather long period of inactivity by considering the great depression followed by World War II. The awakening of the industry was brought about by the technical improvements that nutritional research brought into the area of formula feeds. Another development paralleling the improvement in formula feed technology was the creation of a large supply of barley in Montana which became widely accepted as a feed grain. The barley supply continued to grow as acreage was diverted from the production of wheat. This awakening and the subsequent development of the Montana feed manufacturing industry can be benchmarked at 1951. While any exact date is difficult to establish, approximately 68 per cent of the feed manufacturing plants in Montana became operational in the past decade.

Another significant fact concerning the evolution of the feed manufacturing industry in Montana is the length of time that firms presently engaged in formula feed manufacturing have operated as business entities. These firms were previously engaged in buying and selling grain, operating elevators, supplying seed, chemicals, and milling flour. Approximately 50 per cent of these business firms came into existence in the period from 1955 to 1960.

Many of the older firms entered the feed business by degrees as it offered a complementary element to their general business operations. Those firms engaged in buying and selling grain quite
often carried various seed lines as well as chemicals and commercial fertilizers, therefore, the next step into the feed business was a natural and logical development. Today a substantial degree of integrated services and lines are found among the feed manufacturing firms. Table XIII shows the various services offered by feed manufacturing firms. Subsequently all of the feed manufacturing firms merchandise chemicals and commercial fertilizers at retail and 68 percent of the feed manufacturing firms buy and sell grain. Many of these firms consider the added services as "bread and butter functions". One rather new innovation in the service line is the operation of a grain bank. Several firms have initiated operations within the past three years. While various motives are expounded for the justification of this service all of the interviewed firms admit that certain economic advantages are gained. This is true in spite of the fact that several firms offer the grain bank service on a gratis basis or charge only a nominal fee. Some of the areas of indicated advantage include tax, inventory, and perhaps more significantly, the creation of a vested relationship that will ultimately climax in the sale of a tag-line feed or in rendering a custom manufacturing service thereby tending to maximize profits in the long run.

Present trends and indications lead to the expectation that the future will see an increasing volume of grain bank activity and with this it is reasonable to expect that the service idea will
<table>
<thead>
<tr>
<th>Number of Services Available</th>
<th>Number of Firms</th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operate Grain Bank</td>
<td>4</td>
<td>6</td>
<td>1</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>Chemicals and fertilizer</td>
<td>12</td>
<td>8</td>
<td>4</td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>General farm store</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Seed</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Feed lot</td>
<td>*</td>
<td>3</td>
<td>1</td>
<td></td>
<td>4*</td>
</tr>
<tr>
<td>General farm equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>including storage equipment</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Buy and sell grain</td>
<td>9</td>
<td>6</td>
<td>2</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td></td>
<td>9</td>
</tr>
</tbody>
</table>

*Flexible, i.e., periodically engage in this activity
gradually be replaced by a more direct profit motive. Notwithstanding
the fact that only 16 per cent of the firms reported engage in feed
lot activities, nevertheless this line of activity appears destined
for a dynamic future. At present there is no established pattern
inherent in these feedlot operations. Several different types of
both formal and informal equities arrangements exist, with reference
to title, etc. It is therefore impossible to stereotype this function
at this early date. One firm interviewed reported a flexible policy
concerning feedlot operations among its several branches, and
indicated that when "conditions were right" they would move into and
out of feedlot operations. This much is certain the future in this
direction will be both interesting and dynamic and will lead log­
ically to integrated production steps beyond the feed lot, its
packing plants, etc.

Seasonality in Montana's Pellet Production

The existence of integrated services in Montana's feed manu­
facturing industry and the expected growth in this direction is not
only economically healthy but is financially necessary. In the
pelleting of range cubes 18.5 per cent of the total pelleted volume
occurs in January, 15 per cent in February, 10.5 per cent in March,
4 per cent in April, 1 per cent in both May and June, nil in July
and August, 4 per cent in September, 8.5 per cent in October, 16.5
per cent in November and 21 per cent in December. In short, the
six month period extending from November through March accounts for approximately 82 per cent of the total range cubes produced in Montana.

By narrowing our frame of reference to the production of range cubes which alone accounts for 55 per cent of the total pelleted production in the state of Montana the highly seasonal pattern of production presents a formidable problem. Essentially this is a six month business and this is further complicated by the uncontrollable variable weather. The importance of this variable and its impact on the feed manufacturing industry was clearly illustrated during the relatively mild mid-winter of 1960-61 when the volume of pelleted range cubes declined by a minimum of 10 per cent. The burden of financial success must be carried to a substantial degree by the several integrated functions. Four firms report that they have entered into swine and sheep feeding to utilize plant capacity which otherwise would have remained idle during the slack period of the production cycle. The problem of seasonality is more significant in Montana than reports indicate in the Midwest. Firms that report on the production of dairy cubes and poultry pellets and crumbles have a relatively constant production pattern. However, the production of these two general categories is rather localized in nature and many firms produce only minimal volumes of these feeds.

**Expected Future Trends in Feed Manufacturing**
Recognizing the dynamic nature of the feed manufacturing industry in Montana and the inter-relationships involved it is apropos to survey the expectations of the feed manufacturing industry concerning future trends. Although a substantial majority of the firms in the entire state expect general increases in all lines of feed endeavors four firms throughout the state anticipate a decrease in demand for pelleted range cubes. It may be further reported that a consensus of the interviewed firms believe that while the demand for range cubes will increase, a point may soon be reached when one firm may increase its volume only at the expense of a competitor. On the other hand the feed manufacturing industry in Montana expects significant increases in the demand for steam rolled barley.

These optimistic expectations are responsible for the level of investment activity that has taken place within the Montana feed manufacturing industry in the past few years in the area of both new plant capacity and in the modernization and expansion of existing plant facilities.

Future Expansion Plans

It is significant that the Montana feed industry has additional plans for expansion and the dynamic tide of investment growth has not yet receded. Table XIV reveals the various individual areas in which future expansion is planned. Table XIV also gives recognition to the Central area which evidently has not yet reached a mature level.
Table XIV. Plans For Expansions

<table>
<thead>
<tr>
<th>Type of Expansion</th>
<th>Eastern</th>
<th>Central</th>
<th>Western</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>New pelleting equipment including cooling system</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Additional storage capacity and warehousing</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Steam rolling equipment</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Boiler</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>General remodeling and miscellaneous equipment</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td><strong>18</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No plans</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Additions or new plants just completed</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>Sub-Total</strong></td>
<td><strong>10</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>28</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
of the economic development. Of the total of nineteen firms in the combined Eastern and Central areas only five of the firms report that they have no plans whatsoever for expansion or modernization of existing facilities. However, of these five firms three report that extensive investment in additional capacity or new plants has been recently completed.

The general philosophy of the Montana feed manufacturing industry is definitely optimistic, nevertheless, top management is well aware that certain problem areas exist and therefore must be enumerated in this account. Candid interviews with top management in the feed manufacturing industry indicate problem areas in credit, financing, competition, government policy, education, cattle prices, and low operating margins. An additional area of uncertainty is the impact of integration on the industry, yet several interviewees were cognizant of the need for further development of integrated feed operations and ultimately the need for meat packing plants within the state to complete the complementary production functions.

Firms in this classification also have the same immediate short-run concern in the realm of credit as do the firms in the grinding and mixing and steam-rolling category. With one exception the firms interviewed consider thirty days on open account as tantamount to cash. Numerous firms in all areas report that accounts often run sixty to ninety days before collection. With the terms of trade set at thirty days a sixty day condition indicates that one-
half of the accounts receivable are in arrears and since many feeders will pay much sooner than thirty days this delinquency becomes more obvious. Three firms interviewed report that they attempt to secure post-dated checks whenever possible. One firm has initiated the use of trading stamps to induce the prompt payment of accounts and thus far reports a favorable reaction. This firm considers the cost of the trading stamps inconsequential if accounts can be kept current. A few firms extend ninety day credit terms to select customers, however, these are exceptions.

It is standard policy throughout the industry to levy an interest charge against delinquent accounts. Generally, these rates vary from six to seven per cent to one per cent per month on delinquent balances. However, this policy is more difficult to enforce and the exception becomes the general rule. There are a multitude of extenuating circumstances which inject flexibility into the individual case involved. A common complaint heard by this interviewer was that "too many of the customers are operating on our money". The credit problem became aggravated to such an extent that during the course of this study two large chain producers accounting for nine plants within this pelleting classification and a much larger number within the steam rolling and grinding and mixing classification adopted a new credit policy with an avowed determination to strictly apply this policy. This was imperative for their economic survival.
A real contribution to the Montana feed manufacturing industry could be made if formal financing programs could be developed. At the present time there is only one formally organized feed financing program in existence in Montana and this is sponsored by a nationally established corporation. Four of the larger Montana feed manufacturing organizations are actively studying this problem, and as solutions are found it is reasonable to expect that financing programs will become available in the near future. On an informal basis several of the feed manufacturing firms will "carry" the customer through the entire feeding cycle and other firms report that as a matter of policy they will aid an established customer in securing short-term bank financing. The many advantages to both the feed-producer and the "feeder" that would be brought about by a well functioning financing program are obvious and need not be enumerated here. Again it is necessary to point out that this financing service if provided by the feed manufacturer will represent another step on the ladder of integration.

Barley Supply

Another unique characteristic of the Montana feed manufacturing industry is found in the barley supply patterns. By referring to Table XV it may be quickly observed that the local farmers in the Eastern area supply the overwhelming majority of the barley used by the feed manufacturing plants. Only two mills in the Eastern area
Table XV. Source of Barley Supply

<table>
<thead>
<tr>
<th>Area</th>
<th>Local Farmers</th>
<th>County Elevators</th>
<th>Dealers</th>
<th>Truckers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern</td>
<td>78%</td>
<td>8%</td>
<td>2%</td>
<td>12%</td>
</tr>
<tr>
<td>Central</td>
<td>91%</td>
<td>2%</td>
<td>2%</td>
<td>5%</td>
</tr>
<tr>
<td>Western</td>
<td>45%</td>
<td>4%</td>
<td>6%</td>
<td>45%</td>
</tr>
</tbody>
</table>
obtain a significant proportion of their supply from truckers and only two mills utilize the country elevator as a barley supply source.

It is customary practice in the trade for the independent truckers to purchase barley directly from the farmer for their own account thereby assuming full risk of ownership with the intention of subsequently negotiating a sale with the feed manufacturing plant. These truckers engage in what might be termed informal arbitrage, i.e., buying barley in one market and within a brief period of time reselling in another market area taking advantage of any price differentials that may have been previously observed. A supporting factor for this type of operation is the empty cargo space which might otherwise not have been utilized "on the back-haul". Two factors then are basically responsible and account for these types of operations, i.e., knowledge and the transportation facility. In many cases the choice of alternatives for "back-haul" items is very limited. It is impossible to report quantitatively the volume of barley that moves out of Montana on the "back-haul", however, based on the best evidence available unquestionably a large part of Montana's barley production does leave the state by this method.

Again observing Table XV it is apparent that generally the same type of local-farmer supply prevails in the Central region. The exception to the pattern is seen in the Western area where the trucker becomes the predominant prime mover of the barley supply.
Interviews reveal that as truckers who have purchased barley in the Triangle area move southward through the Western area and fail to negotiate sales for their barley they continue to move down through interstate routing 15 and U. S. Hiway 91 and therefore in effect export Montana barley (see Map No. 8). Their subsequent points of sale and often their planned destinations are points as far away as Arizona and California. By observing Map No. 4 it becomes evident why these relationships exist. Further the location and the classification of various types of feed plants the feed mills may be seen in relationship to the barley harvest as a per cent of total crop land harvested.

Further information concerning the distance that barley moves into the feed manufacturing plants is shown in Table XVI, on an individual mill basis. The individual reporting is necessary because of the wide variations which occur among the several mills. Each mill seems to have its own unique supply area, and it is difficult to establish a pattern involving a supply radius. Additional revealing information concerning the Montana barley supply and two of its principally related elements, i.e., alfalfa and cattle, may be observed by referring to Map Nos. 4, 5 & 6.

The next important aspects to consider are the changes that are occurring in the barley supply patterns. Both interviews and records indicate that in all three areas the local supply is increasing. In two areas, the Western and Central, where reclamation projects
Table XVI. Distance the Barley Supply Moves to Manufacturing Point

<table>
<thead>
<tr>
<th></th>
<th>Percentage of Total Consumption Within Various Mileages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>less than 10 miles</td>
</tr>
<tr>
<td><strong>Eastern</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5%</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td><strong>Central</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>8</td>
<td>40</td>
</tr>
<tr>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td><strong>Western</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>60-70</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>
are anticipated, feed manufacturers expect rather sharp increases to the point of surplus. In all three areas a preponderance of the interviewees reports that as their demand increases they are forced to obtain their supplies from more distant points.

When discussing expected future changes in Montana's barley supply one of the first considerations advanced is the development of irrigation projects as mentioned above. The second area of future concern is that of the changes brought about by the various government programs and particularly governmental policy which deals with feed grains. The third area is the concern for weather and the impact that it has on the volume of barley available for feed processing. Several manufacturers report that if barley falls into short supply the possibility of importing corn from the mid-west at least on the short-run basis presents a very attractive alternative. Most feed manufacturers interviewed hold the view that in the future more barley will be produced in reasonably close proximity to their plants and that if any supply adjustments are necessary it will be possible to cope with these situations by moving barley within the limits of the state boundaries. The prevailing view is that as demand for barley increases the individual mill facing a shortage will always have a ready supply from either the Triangle, Judith Basin or Hi-line areas. By popular consensus the Triangle area with its prolific barley production is the "cup of perpetual supply".
Geographic Considerations

Reference to Map No. 9 showing the railroad system in Montana and the location of all types and classifications of feed manufacturing plants will reveal that 95 per cent of the feed manufacturing firms have physical access to railroad facilities and that the majority are located on either the Great Northern or the Northern Pacific. Rail transportation plays a rather insignificant role in the distribution of the finished feed products. This is not to say, however, that rail transportation is not important with reference to obtaining the supporting ingredients that Montana feed manufacturing firms utilize. Such ingredients as cane molasses, cottonseed meal, soybean meal, fish and bone meal, minerals, etc., are imported via rail transportation. An issue of prime importance in determining the form of transportation is the point of origin and the classification that applies to the particular commodity with reference to rates.

Additional location characteristics of Montana's feed manufacturing plants are shown in Table XVII and further substantiates the declarations previously made. Obviously the firms are located within the incorporated boundaries of their respective cities and there is a wide disparity with reference to the total area occupied. The physical area occupied varies without regard to regional classification. Approximately 50 per cent of the firms operate on less than 43,000 square feet and this includes area that must serve as the truck terminal. The largest area reported was 10 acres and this firm
Table XVII. Location Characteristics of Montana's Feed Manufacturing Plants

<table>
<thead>
<tr>
<th>Area</th>
<th>Within City Limits</th>
<th>On Railroad</th>
<th>On Hi-Way</th>
<th>Truck Terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern</td>
<td>9</td>
<td>9</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Central</td>
<td>10</td>
<td>9</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Western</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>
was located in the Western area. The general rule that may be drawn is that the majority of firms operate with less than adequate land area. A major problem faced by many of these firms is the lack of adequate truck terminal facilities. Under the present scheme of things the solution of this problem is rather difficult.

Production Volumes

Considerable interest within the feed manufacturing industry has been indicated concerning the volumes of the various types of feed that are manufactured in Montana. As expected there are variations in Montana just as there are variations in the Mid-West and in areas adjoining Montana. For example, in the Mid-West the swine pellet is the leading production item except in the more specialized areas where such items as dairy cubes become the production leaders. The production of turkey mash and turkey pellets is the principle production line in Utah. Table XVIII reports the total volumes of the many various manufactured feeds that are produced in the three geographical areas of Montana. Considering Montana as one large production unit approximately 55 per cent of all pelleted feed production is in the form of range cubes. This range cube falls within the 20 per cent protein classification and is made up of from 65 to 85 per cent barley as a general rule. The two principle exceptions to this are custom pelleted range cubes which often run as high as 95 per cent barley and those range cubes which utilize wheat mixed
### Table XVIII. Total Production Volumes for Areas in Montana 1960
(Total Volume Reported in Tons)

<table>
<thead>
<tr>
<th>Produce</th>
<th>Eastern</th>
<th>Central</th>
<th>Western</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam Rolled</td>
<td>25,167</td>
<td>57,700</td>
<td>14,330</td>
<td>47,197</td>
</tr>
<tr>
<td>Ground and Mixed</td>
<td>5,389</td>
<td>8,750</td>
<td>15,500</td>
<td>29,639</td>
</tr>
<tr>
<td>Range Cubes</td>
<td>25,030</td>
<td>49,470</td>
<td>10,725</td>
<td>85,225</td>
</tr>
<tr>
<td>Sheep Cubes</td>
<td>1,105</td>
<td>3,860</td>
<td>1,192</td>
<td>6,217</td>
</tr>
<tr>
<td>Dairy Cubes</td>
<td>490</td>
<td>13,161</td>
<td>2,839</td>
<td>16,490</td>
</tr>
<tr>
<td>Swine Cubes</td>
<td>700</td>
<td>13,107</td>
<td>5,002</td>
<td>18,811</td>
</tr>
<tr>
<td>Poultry Cubes and Crumbles</td>
<td>875</td>
<td>7,512</td>
<td>6,316</td>
<td>14,703</td>
</tr>
<tr>
<td>Other Pelleted Feeds</td>
<td>2,772</td>
<td>7,755</td>
<td>2,968</td>
<td>13,495</td>
</tr>
<tr>
<td>Total Pelleted Production</td>
<td>31,032</td>
<td>94,867</td>
<td>29,042</td>
<td>154,941</td>
</tr>
<tr>
<td>Total Combined Production</td>
<td>61,588</td>
<td>161,317</td>
<td>58,872</td>
<td>281,777</td>
</tr>
</tbody>
</table>
feed or a similar by-product generally obtained from another division of their respective operations. When wheat mixed feeds are used the barley content of the pellets will range from 30 to 50 per cent with a similar range for wheat mixed (millfeeds) feeds. While a wide range of ingredients is possible a typical range cube might include the following ingredients:

1. Barley
2. Wheat mixed feed
3. Dehydrated alfalfa and/or sun-cured alfalfa
4. Cottonseed meal
5. Soybean meal
6. Linseed meal
7. Urea
8. Salt
9. Molasses (either beet and/or cane)*
10. Calcium carbonate (perhaps in the form of ground limestone)
11. Di-calcium phosphate
12. Tallow
13. Vitamins A and D
14. Maganous oxide

*Several firms blend beet and cane molasses in a 50-50 per cent basis while others use one or the other in an unmixed form. One firm successfully produces pellets by using dry molasses in the form of partially processed beet pulp.
15. Iron carbonate
16. Iron sulphate
17. Zinc Oxide
18. Copper Oxide
19. Cobalt Carbonate
20. Calcium Iodate
21. Magnesium Oxide

These various ingredients may be grouped into units of the various trace minerals, or they may be added to the raw ingredients in the form of various pre-mixes. These pre-mixes vary substantially in the number and type of ingredients depending upon the type of feeding result that is desired. The Central area produces 58 per cent of the range cube production while the Eastern and Western areas produce 29 and 12 per cent respectively. When a high protein content is desired, with the resulting substantial increase in price, this objective is gained by adding principally soybean meal. Table XVIII further shows a complete breakdown by area of production volumes for sheep cubes, dairy cubes, swine cubes, poultry cubes and crumbles.

*Poultry crumbles are produced to gain certain nutritional advantages and the operation consists of first pelleting the mash, and second, cooling and drying and finally passing the finished pellet between large steel rollers thereby crushing and crumbling the pellet. For a detailed explanation of the reason for crumbling see "More Efficient Crumblizing" by Robert G. Bartikoski, Assistant Director of Manufacturing, Nutrons Mills, Inc., Minneapolis, Minnesota. Proceedings of the 1959 Feed Production School, Published by Feed Production School Incorporated, Kansas City, Missouri, 1959.
and other pelleted feeds. In addition Ground and Mixed and Steam Rolled volumes are reported. The typical ingredients utilized in the production of these several feeds are enumerated in the appendix.

With reference to the remaining general feed lines Table XVIII also shows the production figures in tons and Table XIX reports the percentage break-down by major items produced and for each of the principal classifications reports in detail the percentage produced by each area.

To briefly recapitulate, sheep cubes comprise only 9 per cent of the total pelleted feed production. Poultry feeds including both cubes and crumbles constitute 9 per cent of total pelleted production. Dairy cubes account for 10 per cent of total pelleted production thereby placing swine cubes as a second most important production line with a 2 per cent lead over dairy cubes. However, the future should see a widening of this differential in favor of swine pellets. Other pelleted feeds including such specialty items as rabbit, fish, horse, dog pellets, etc., account for approximately 9 per cent of total pelleted production. Several firms interviewed report a strong desire to develop this market area. It is their opinion that this specialized market area is still virtually unexploited. In all feed lines the Central area holds a production lead ranging from approximately 50 to 80 per cent of all lines reported.

In addition Table XIX also reports the percentage of steam rolled production of total manufactured feed production by areas for this
<table>
<thead>
<tr>
<th>Table XIX. A Breakdown of the Various Production Lines Shown With Reference to the Area of Production (Reported by Percentages)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Of Total Production:</strong></td>
</tr>
<tr>
<td>(a) The Eastern Area Produced</td>
</tr>
<tr>
<td>(b) The Central Area Produced</td>
</tr>
<tr>
<td>(c) The Western Area Produced</td>
</tr>
<tr>
<td><strong>II. Of Total Pelleted Production:</strong></td>
</tr>
<tr>
<td>(a) The Eastern Area Produced</td>
</tr>
<tr>
<td>(b) The Central Area Produced</td>
</tr>
<tr>
<td>(c) The Western Area Produced</td>
</tr>
<tr>
<td><strong>A. Of Range Pellets:</strong></td>
</tr>
<tr>
<td>(a) The Eastern Area Produced</td>
</tr>
<tr>
<td>(b) The Central Area Produced</td>
</tr>
<tr>
<td>(c) The Western Area Produced</td>
</tr>
<tr>
<td>1. Range Cubes of Total Pelleted Production</td>
</tr>
<tr>
<td><strong>B. Of Sheep Cubes:</strong></td>
</tr>
<tr>
<td>(a) The Eastern Area Produced</td>
</tr>
<tr>
<td>(b) The Central Area Produced</td>
</tr>
<tr>
<td>(c) The Western Area Produced</td>
</tr>
<tr>
<td>1. Sheep Cubes of Total Pelleted Production</td>
</tr>
<tr>
<td><strong>C. Of Dairy Cubes:</strong></td>
</tr>
<tr>
<td>(a) The Eastern Area Produced</td>
</tr>
<tr>
<td>(b) The Central Area Produced</td>
</tr>
<tr>
<td>(c) The Western Area Produced</td>
</tr>
<tr>
<td>1. Dairy Cubes of Total Pelleted Production</td>
</tr>
</tbody>
</table>
Table XIX. (Continued)

D. Of Swine Pellets:

(a) The Eastern Area Produced 4%
(b) The Central Area Produced 70%
(c) The Western Area Produced 26%

1. Swine Pellets of Total Pelleted Production 12%

E. Of Poultry Cubes and Crumbles:

(a) The Eastern Area Produced 6%
(b) The Central Area Produced 51%
(c) The Western Area Produced 43%

1. Poultry Cubes and Crumbles of Total Pelleted Production 9%

F. Other Pelleted Feeds:

(a) The Eastern Area Produced 20%
(b) The Central Area Produced 58%
(c) The Western Area Produced 22%

1. Other Pelleted Feed of Total Pelleted Production 9%

III. Percentages of Total Combined:

Production that is steam rolled: 34%

A. Percentage of Steam Rolled:

(a) In Eastern Area 26%
(b) In Central Area 59%
(c) In Western Area 15%

100%
Table XIX. (Continued)

IV. Percentage of Total Combined

Production that is Ground and Mixed: 11%

A. Percentage of Ground and Mixed:

(a) In Eastern Area 18%
(b) In Central Area 30
(c) In Western Area 52

100%

V. Percentage Steam Rolled of Combined Steam
Rolled and Ground and Mixed Feed:

(a) In Eastern Area 82%
(b) In Central Area 87
(c) In Western Area 48

Steam Rolled of Combined
Steam Rolled and Ground and
Mixed for entire state 77%

VI. Percentage Ground and Mixed of Combined
Steam Rolled and Ground and Mixed Feed:

(a) In Eastern Area 18%
(b) In Central Area 13
(c) In Western Area 52

Ground and Mixed of Combined
Steam Rolled and Ground and
Mixed for entire state 23%

VII. Percentage of Combined Steam Rolled and
Ground and Mixed of Total Combined
Production:

(a) In Eastern Area 50%
(b) In Central Area 41
(c) In Western Area 51

Combined Steam Rolled and Ground
and Mixed of Total Combined Pro-
duction for the entire state 45%
Table XIX. (Continued)

VIII. Percentage of Pelleted Feed of Total Combined Production:

(a) Eastern Area 50%
(b) Central Area 59
(c) Western Area 49

1. Total Pelleted Feeds of Total Combined Production for entire state 55%
feed plant classification. Again the Central area accounts for over one-half of this type of production. The same percentage of production break down is shown for ground and mixed feeds, and only here does the Western area excel reporting 52 per cent of all ground and mixed production in the state. A further relationship is shown in section V, VI and VII of Table XIX, where production volumes in percentages are compared as between steam rolled and ground and mixed feeds. With reference to steam rolled production the Eastern and Central areas account for 82 and 86 per cent respectively while the Western area reported at 48 per cent. Section VI therefore obviously shows the proportion of ground and mixed feeds as percentage of combined steam rolled and ground and mixed feeds. This relationship shows the Western area leading in ground and mixed feed production. Section VII shows that when total combined production is considered steam rolled and ground and mixed feeds constitutes 45 per cent of all combined production for the entire state and therefore Section VIII shows that 55 per cent of all combined production for the state of Montana is in the form of pelleted feeds. It must be recalled that these relationships exist only for mills within this classification reported in this chapter, and the impact of the figures in Chapter III will be analyzed in the summary and conclusion. Summary Tables XX and XXI show by area the total production volumes in tons of the following six classifications:
Table XX:
1. Combined Steam Rolled and Ground Mixed
2. Total Pelleted Feed
3. Total Combined Production with Summary Totals

Table XXI:
1. Steam Rolled
2. Ground and Mixed
3. Total and Summary Totals

MARKETING

Changing Patterns of Demand

There are several changes in the demand pattern for manufactured formula feeds, which of course, utilize barley as the principle ingredient. Over 40 per cent of the firms reporting indicate a general increase in the demand for all their formulated feeds and only two firms of the twenty-four firms within this classification report a decrease in the demand for pelleted feeds generally. Approximately 75 per cent of the firms in the Eastern and Central area indicate an increasing demand for steam rolled barley. While only three firms in the Eastern and Central areas indicated an increased demand for custom pelleting the preponderance of the opinion was that there would be an increased demand for this type of service in spite of the fact that several of the leading manufacturers showed a feeling against such a trend. In addition to the above information,
Table XX. Totals for Steam Rolled and Ground and Mixed, Pelleted, Combined Total Production Volumes in Tons

<table>
<thead>
<tr>
<th>Area</th>
<th>Combined Steam Rolled and Ground and Mixed</th>
<th>Total Pelleted Feed</th>
<th>Total Combined Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern</td>
<td>30,556</td>
<td>31,032</td>
<td>61,588</td>
</tr>
<tr>
<td>Central</td>
<td>66,450</td>
<td>94,867</td>
<td>161,317</td>
</tr>
<tr>
<td>Western</td>
<td>29,830</td>
<td>29,042</td>
<td>58,872</td>
</tr>
<tr>
<td>Total</td>
<td>126,836</td>
<td>154,941</td>
<td>281,777</td>
</tr>
</tbody>
</table>
Table XXI. Combined Steam Rolled and Ground and Mixed Production in Montana

<table>
<thead>
<tr>
<th>Area</th>
<th>Steam Rolled</th>
<th>Ground and Mixed</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern</td>
<td>25,167</td>
<td>5,389</td>
<td>30,556</td>
</tr>
<tr>
<td>Central</td>
<td>57,700</td>
<td>8,750</td>
<td>66,450</td>
</tr>
<tr>
<td>Western</td>
<td>14,330</td>
<td>15,500</td>
<td>29,830</td>
</tr>
<tr>
<td>Totals</td>
<td>97,197</td>
<td>29,639</td>
<td>126,836</td>
</tr>
</tbody>
</table>
Table XXII also shows that in answer to a direct question concerning increases in competition one firm in the Eastern area was fearful of competition from another source. The manager of this mill felt that the use of Safflower meal as a substitute for barley in formula feed manufacturing might prove increasingly competitive in the future. This issue will be dealt with fully in another section of this paper.

Observation of Competitive Structures

Considering the subjective nature of the interviews dealing with the degree of competition in the Montana feed manufacturing industry some clearly evident patterns can be reported. In the Western area there was a noticeable lack of concern about competition. However, interviews in the Central area reflect an increasing concern for "too much competition" and as the interviewer moved into the Eastern area of Montana most of the top management officials interviewed were deeply and gravely concerned by what they considered sharp and even "unfair" competition. It is possible to account at least in part for this deeper concern on the subject of competition in the Eastern area by an economic chain between a large private chain organization and an equally large and well organized cooperative effort. The Eastern area of Montana is characterized by a duopoly industry in spite of this feeling of intensive competition on the part of the participants. Our frame of reference may be narrowed to a key area and one which involves more emotion than some of the other
Table XXII. Changes That Have Occurred in the Demand for Manufactured Formula Feeds

<table>
<thead>
<tr>
<th>Various Changes Indicated</th>
<th>Eastern</th>
<th>Central</th>
<th>Western</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased competition</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Increased demand for steam rolled barley</td>
<td>5</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Increased demand for custom pelleting*</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Increased demand for pelleted rations</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Decreased demand for pelleted rations</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>General increase in all feed lines</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Increased demand for bulk</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>None</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

*Most manufacturers expect a trend in this direction
competitive points. This is the aspect of capital accumulation when the private segment feels the cooperative element holds an unfair advantage that results from alleged tax shelters.

There is a general absence of both price and quality competition. Efforts as are made toward creating demand, i.e., advertising and promotional schemes. Table XXIII shows the price structure for 20 per cent protein range cubes and there is little variation in posted prices. Appeal is often made to customers on the philosophical basis with reference to cooperative versus the private corporation. Obviously this is a very subjective area but nevertheless there is a terrific impact involved and the ultimate decision; from whom to purchase depends on the individual customer's point of view.

**Concern for Government Policy**

There is no apparent division of concern about Government farm policy among the several areas. Every three or four interviewees voice varying degrees of concern about existing and future government policy changes. This concern includes opinions that government policy will force an end to all private enterprise within ten to fifteen years to the more mild point of view that constant change will be necessary to "live with" government policy. The feed grain program of the present administration is of immediate concern to most of these interviewees. It is difficult to appraise accurately the sincerity of some of the more extreme convictions if in fact they are
Table XXIII. Price Structure for Tagged Range Cubes in the 20 Per Cent Protein Classification

<table>
<thead>
<tr>
<th>Area</th>
<th>Firm</th>
<th>Individual Firm Prices by Bulk &amp; Bag*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Bulk</td>
</tr>
<tr>
<td>Eastern</td>
<td>1</td>
<td>62.20</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>66.66</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>70.00</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>60-75.00</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>67.001</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>72.00</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>72.00</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>69.50</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>69.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Average cost</strong> 68.48</td>
</tr>
<tr>
<td>Central</td>
<td>1</td>
<td>58.00</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>66.66</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>66.00</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>64.00</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>72.00</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>70.00</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>69.50</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>70.00</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>68.00</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>68.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Average cost</strong> 67.16</td>
</tr>
<tr>
<td>Western</td>
<td>1</td>
<td>72.00</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>72.00</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>70.00</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>71.00</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>68.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Average cost</strong> 70.60</td>
</tr>
</tbody>
</table>

*Price variation and flexibility are present in some degree in all the reporting firms. Various types of purchasing arrangements are available including the trading in of barley on the finished product.

1 depends on ingredients

2 53.00 for dairy

3 less when grain traded

4 discount when cash
convictions. It is quite possible that these extremists are using the interview as an opportunity to display their personal feelings toward government policy.

This much can be said, however, that the uncertainties of the future will be deeply involved and closely related with not only government policy but with all of the other dynamic forces that are at work within our economic system. A case in point is the displacement of wheat acreage into barley production and the subsequent and allied growth of the Montana feed manufacturing industry which is utilizing barley as its prime feed ingredient.

On the subject of education, most top management felt a need to inaugurate an extensive educational program in the field of animal nutrition. The goal of such a program would be to enlighten Montana's "feeders" on the necessity to keep abreast of the latest scientific nutritional research developments, and to make information available at the grass root level concerning the application of the advanced feed practices. In this area it was generally believed that the agricultural experiment stations and the leading feed manufacturers should participate on a complementary basis.

Fluctuating cattle prices are of concern to many operators in the feed manufacturing industry. They feel that any period of prolonged price depressions will lead them to the "brink of insolvency", and ironically some have indicated the need for government participation in this area. It is not the purpose of this present discussion to
pursue this further.

Another problem area, that of low operating margins, will be examined in great detail in Chapter V. Financial ratios will be presented comparing many of the elements involved in the cost price area.

**Marketing of Manufactured Feed**

Another revealing characteristic of the feed manufacturing plants of Montana is the fact their products are sold by and large directly to the "feeder". Although this is the general rule, Table XXIV shows that some exceptions are present in all three areas. Interviews with several leading feed manufacturers support the point of view that profit margins in feed manufacturing are not sufficiently broad enough to carry the additional function of a middle man. While this may be the prevailing philosophy at least one notable exception can be found in each of the three areas. In each case the production volume of the plant is directly dependent upon the successful operation of its retail system. This much can be said based on empirical evidence. Those mills that do successfully utilize the retail outlets are meeting a demand which is characterized by short run buying in small lots. The principle exception to this point is the manufactured formula feeds produced and sold through the cooperative chain organizations.

Table XXV shows a very slight differential in marketing radii
Table XXIV. Distribution of Manufactured Feed

<table>
<thead>
<tr>
<th></th>
<th>Direct to Feeder</th>
<th>Through Agents</th>
<th>Through Retail Outlets</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern</td>
<td>74%</td>
<td>0%</td>
<td>23%</td>
<td>2%</td>
</tr>
<tr>
<td>Central</td>
<td>75%</td>
<td>1%</td>
<td>23%</td>
<td>2%</td>
</tr>
<tr>
<td>Western</td>
<td>82%</td>
<td>.5%</td>
<td>17%</td>
<td>0%</td>
</tr>
</tbody>
</table>
between the Eastern and Central areas. The feed manufacturing plants in the Western area obviously distribute their products over a smaller marketing area. While the marketing radii of the firms operating in the Eastern and Central areas seem generally uniform within each of the areas an individual firm or so will extend its marketing radius well beyond the limits of the general pattern. These individual firms all operate their own bulk delivery equipment and/or utilize large heavy duty trucks, but practically never employ rail transportation. Their financial records show many of these deliveries to be questionable operations. They are engaged in holding production volumes that the plant managers surmise to be advantageous. Many of these decisions are based on imperfect knowledge and additional research in this area employing transportation models, etc., would be highly beneficial to these firms. One step forward for these firms would be to establish sunk depreciation accounts for the equipment involved.

Table XXVI shows that whereas the finished product moves almost exclusively by truck there is a separation as to the ownership of these vehicles. A strong general rule is that when custom processing is involved the buyer or feeder invariably furnishes the transportation. By referring to Map No. 4 a simplified commercial traffic flow map of Montana may be observed in relationship to the manufacturing plants.

In marketing this pelleted production perhaps one of the most important issues may be condensed into three words, i.e., bag versus
Table XXV. Marketing Radius for Manufactured Feed Products

<table>
<thead>
<tr>
<th>Distance Ranges</th>
<th>Eastern</th>
<th>Central</th>
<th>Western</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 10 miles</td>
<td>6%</td>
<td>15%</td>
<td>12%</td>
</tr>
<tr>
<td>10-24 miles</td>
<td>27%</td>
<td>22%</td>
<td>53%</td>
</tr>
<tr>
<td>25-49 miles</td>
<td>30%</td>
<td>28%</td>
<td>6%</td>
</tr>
<tr>
<td>50-99 miles</td>
<td>21%</td>
<td>19%</td>
<td>6%</td>
</tr>
<tr>
<td>100-200 miles</td>
<td>12%</td>
<td>9%</td>
<td>9%</td>
</tr>
<tr>
<td>Over 200 miles</td>
<td>4%</td>
<td>6%</td>
<td>4%</td>
</tr>
</tbody>
</table>
Table XXVI. Method of Transportation Utilized in the Marketing of Manufactured Feeds

<table>
<thead>
<tr>
<th></th>
<th>Own Trucks</th>
<th>Railroad</th>
<th>Hired Trucks</th>
<th>Buyers Trucks</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern</td>
<td>54%</td>
<td>0%</td>
<td>3%</td>
<td>33%</td>
<td>10%</td>
</tr>
<tr>
<td>Central</td>
<td>29%</td>
<td>1%</td>
<td>12%</td>
<td>57%</td>
<td>2%</td>
</tr>
<tr>
<td>Western</td>
<td>43%</td>
<td>.5%</td>
<td>1%</td>
<td>52%</td>
<td>5%</td>
</tr>
</tbody>
</table>
bulk. The feed producers all ask the same question. Where do the economies lie? The answer to this question with reference to the unique conditions in Montana could only be obtained by research inquiry into the many aspects that are involved, and consideration must also be given to consumer preference. Table XXVII relates by area the percentage of tag-line pelleted production that is marketed by bag and bulk. The Eastern area has developed into largely a bulk delivery system. This may be accounted for in part by the somewhat greater transportation distances involved. The Central and Western areas remain primarily bag distributors. The future may well see in all areas an increasing amount of bulk delivery where the finished feed is discharged from bins located at the feed mill directly into feed bunkers at the point of consumption. In all three areas when custom pelleting is performed the substantial part is delivered by bulk in the buyer's own truck.

EQUIPMENT AND PLANT LAYOUT

It is absolutely imperative to explore the types of equipment involved and the various physical arrangements that are possible in order to appreciate fully the impact of these features on the internal economies that are to be found within the six production stages as they have previously been defined and subsequently will be analyzed from a cost point of view.

The equipment arrangements that are employed by the individual
Table XXVII. Percentage of Total Pelleted Production Marketed by Bag and Bulk

<table>
<thead>
<tr>
<th>Area</th>
<th>Percentage Distribution by Individual Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bulk</td>
</tr>
<tr>
<td>Eastern</td>
<td>65%</td>
</tr>
<tr>
<td>Central</td>
<td>30%</td>
</tr>
<tr>
<td>Western</td>
<td>30%</td>
</tr>
</tbody>
</table>
firms within the Montana feed manufacturing industry range from well balanced firms employing the latest available technology to those that are characterized by imbalance in equipment and integrated work assignments. Many of the plants have sound lay-out arrangements with each individual stage in the production process being well supported with efficient equipment, while on the other hand there are plants that operate substantially below capacity because of a particular bottleneck. In some of these latter examples the lack of balance between the various stages of production and the equipment involved therein is so severe that any number of bottlenecks occur and diseconomies result. In some of the more severe examples efficient plant arrangements could only be obtained by complete rebuilding processes. In the case of some of the less severe bottlenecks improvement is prevented by capital shortages. Some particular bottleneck areas have been observed as follows:

1. In the conveying systems
2. In the cooling systems
3. In the boiler capacity
4. At the bagging stage
5. In some cases in the pelleting machines

Close observation of the Montana industry indicates that perhaps the cooling equipment represents the greatest bottleneck.
Cooling Equipment

It is impossible to correlate or to associate difficulties at this stage in the production cycle with the basic type of cooling equipment employed. Approximately one firm out of every five employs a horizontal type of cooling system. The firms that manufacture horizontal cooling equipment also manufacture the vertical types. However, there are firms that specialize exclusively in the manufacture of one type or the other. The remaining 80 per cent of the Montana feed manufacturing plants employ a vertical type cooling mechanism. It is not the purpose of this study to engage in a discussion of the relative merits of the two basic designs. The problem area in Montana is characterized by breakdowns, cloggings, functional failures and the failure to do an adequate cooling and drying job. Many of the firms encounter difficulty in this area because the pellet mill and the cooling system were not properly mated at the time of design or installation. In a few cases operators have hoped to gain additional pelleting capacity by increasing horsepower of the coolers without properly analyzing the ability of the cooling system to compensate for the increased rate of production. This results in a misdirected investment and an economic waste.

Conveying Systems

Perhaps the second area for concern in terms of problems to be solved, is that of the conveying systems. Many of the conveying
systems now utilized in the handling of pellets were designed to handle grain. Some of the problems are small buckets, poor pick-up conditions at the boot point, and improper speed in the overall movement. Pellet breakage and the creation of fines results from improper conveying. The buckets are often steel and this together with the rapid movement contributes to the volume of fines. Some mills have installed open belts and have thus improved this function. While some authorities still advocate screw conveyors they are to be viewed for use in Montana's industry with scepticism. This is true because of the volume of range cubes of a larger size which are often managled in the conveying process. In addition there is the problem of contamination within the screw conveyor system.

There are several areas of economic loss involved when fines occur in excessive volume. The Montana feed manufacturing plant that does not have a fines problem is the exception rather than the rule. First, there is the resulting loss in production capacity and in some cases analysis has shown this to reach a figure equal to 16 per cent of actual machine output. These fines must be separated and returned for re-pelleting. Obviously this is an extreme economic waste. Secondly, when fines are returned directly to Stage #4 power requirements increase as the rollers force the heavier particles through the dies. Of course, there is an increase in the "wear and tear" on the pellet machine as it was not designed as a grinder. Some mills chose to return the fines to Stage #1 for regrinding.
This of course necessitates an additional use of the hammer mill, however, this may be desirable in the two alternatives. The problem of consumer satisfaction is a third consideration. When excessive fines are sold to the consumer and this discovery is made the consumer becomes rather irate and chooses to meet his future demand from a competitive source.

**Boiler**

The boiler problem in Montana has two basic problem areas. The first is inadequate capacity and the second is lack of efficiency. The importance of proper steam requirements cannot be over emphasized. Without properly heated steam with appropriate pressures it is impossible to operate the pellet mills at optimum output. With reference to inadequate capacity several mills expanded other capacities without increasing boiler capacity, which had the effect of nullifying their other capital expenditures. In the case of new mills that have been installed inadequate boiler capacity was the result of improper planning. There are several reasons for this. First was the necessity to depend upon boiler capacity to heat the entire plant facility under Montana's rather frigid weather conditions. The capacity of the plants are most heavily taxed during the winter months. Second and of equal importance is the necessity to provide a steam capacity that would support a steam rolling operation. There are examples where boiler capacity is sufficient to support either the pelleting
or steam rolling but not both.

Packing Equipment

Again Montana's industry is characterized by a feast or famine situation with regard to bagging and weighing equipment. Approximately 75 per cent of Montana's firms operate this production step with antique equipment. In many cases the only equipment utilized is a sewing machine suspended from the ceiling on a flexible cord or attached to a stationary platform, supported by a hand weighing mechanism of one type or another. In the weighing area there is a wide variety of devices used. In spite of the fact that 75 per cent of mills are within this classification, the remaining 25 per cent have availed themselves of the latest technology and operate automatic or semi-automatic weighing and sewing devices.

Pelleting Equipment

Although the pelleting machines employed in Montana's feed manufacturing industry range in age from ultra-modern to "voting" age or more and employ two basic designs the efficiency variations are not as great as might be supposed with the exception of those machines that are in a state of disrepair. Several firms employ pelleting machines over fifteen years of age that still rival in many ways their more modern counterparts. This is not to say that dynamic improvements have not come forth as a result of modern technology and some new models can produce barley cubes at rates as high as ten
to twelve tons per hour.

Another innovation that has been of substantial benefit to feed producers is the time saving that can be had in die change-overs. Both basic designs, i.e., the horizontal and the vertical, have made substantial improvement in die changing procedures.

Because of Montana's interest in alfalfa the industry is interested in the newer models which are designed to handle high roughage pellets. Approximately 75 per cent of the plants in Montana operate pellet mills of the vertical design. Yet of the total number of pellet mills that are in existence in Montana approximately 50 per cent of these are of the horizontal design. The horizontal mills as a group are five to ten years earlier in design than those of the vertical design. Several of the leading manufacturers produce both types and a mild controversy exists as to which type of design offers the most economic advantages and the fewer disadvantages.

Some general characteristics concerning the pelleting equipment in the Montana feed industry whether it be horizontal or vertical in design can be made. The capacities of these mills will vary from 3 to 5 tons per production hour depending on the size of die and conditions employed. The nature of the ingredients, the temperature of the steam, the horsepower used, the temperature of the molasses and the presence or absence of fat all effect the output. In spite of all of these conditions the average capacity of a typical pellet mill in Montana producing a barley based range cube would be very
close to a constant 4 tons per production hour with a driving force of 50 horse power. Extreme exceptions are found, however, with some pellet machines employing as little as 30 horsepower and producing approximately 2 tons per hour of what might be called a typical Montana range cube. At the other extreme there are several pellet machines in use in Montana that utilize 100 horsepower and under ideal operating conditions may reach production volumes as high as 12 tons per hour. In any case the important objective is to maintain an operating balance between all equipment employed in all stages of production so as to give the optimum efficiency from all resource inputs including labor.

Seventy per cent of all feed plants employ only one pelleting machine. With the exceptions of material cloggs and machine break-downs the average pellet machine is not a "bottleneck". Nevertheless in some plants, down-time due to die change-overs does constitute a real problem and a real economic loss.

Mixers

Approximately 53 per cent of the mixers in the Montana industry are of the horizontal design and are generally found in the mills with the larger capacities. Generally speaking the mills that use the vertical mixers have lower capacities. There is one example in the Montana industry where the continuous line mixer is employed. In this case the mill in question is one of the larger mills in the
state.

Although the mixing equipment utilized in most Montana mills does not constitute a bottleneck per se nevertheless any number of observations may be found where excessive labor and power are expended in the mixing operation. Narrowing our frame of reference to specific examples we find vertical single screw mixers which generally require twenty to twenty-five minutes per batch to operate at maximum efficiency being allowed to mix as much as a hundred per cent past their peak efficiency. By and large the newer model horizontal ribbon type mixers can mix a batch, i.e., 1 to 2 tons of a barley based ration with 3 to 7 1/2 minutes. Maximum mixing efficiency is generally reached in approximately 5 minutes. The peak efficiency depends upon the ingredients involved and such items as uniform particle size. The barley based rations are generally regarded as possessing this latter characteristic.\(^1\)

To determine if overmixing is present it is necessary to analyze each individual formula with reference to the relative weights of the various ingredients as well as the particle characteristics.\(^2\)

---

\(^1\)For a more complete discussion concerning "Causes of Particle segregation" and "Experiments in Particle Distribution", see "Distribution of Feed Particles During Mixing", by Dr. W. H. Hastings. Proceedings of the 1959 Feed Production School, Published by the Feed Production School, Inc., Kansas, Mo., 1959.

\(^2\)Concerning tests for mixing efficiencies for both the horizontal
amount of overmixing that takes place in some Montana mills. Examples can be cited where 500 to 600 per cent too much time is allowed to pass while ingredients are mixing. Obviously this represents several economic wastes. This over-mixing in many mills can be accounted for by the fact that many millers carry out various other functions while the mixing operation is in process and assume the attitude that no harm is being done and that a good mix is thus being obtained. Enlightenment on this subject has corrected this condition in several cases. In most mills the mixing operation has no difficulty in processing a sufficient volume of raw ingredients to fully utilize the capacity of the pellet mill or mills. As previously pointed out, however, this is not the point.

Table XXVIII shows the power requirements for mixers of various capacities ranging from 1 to 5 tons. The horse power employed on both general types of mixers in Montana falls fairly well in line with the horsepower requirements that were set out in Table XXVIII and 99 per cent of the mills in Montana fall within the 1 or 2 ton capacity classification. There are several old home-made mixers in use and generally speaking they are inefficient and inadequate and it is

and vertical mixer, see the following two authorities.

1"The Vertical Batch Mixer", Henry Schipke.

Table XXVIII. Power Requirements for Mixers of Various Capacities Ranging From 1 to 5 Tons

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Vertical</th>
<th>Horizontal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Ton</td>
<td>5 H. P.</td>
<td>7 1/2 H. P.</td>
</tr>
<tr>
<td>2 Tons</td>
<td>10 H. P.</td>
<td>15 H. P.</td>
</tr>
<tr>
<td>3 Tons</td>
<td>15 H. P.</td>
<td>25 H. P.</td>
</tr>
<tr>
<td>5 Tons</td>
<td>20 H. P.</td>
<td>40 H. P.</td>
</tr>
</tbody>
</table>
impossible to rate the capacity of these machines.

In those cases where molasses is added at this production point additional horsepower is required to complete the mixing function and periodic clean outs are necessary to eliminate molasses accumulation. This is the exception in Montana because molasses is seldom injected at this point.

**Pre-Mixing**

The equipment used in pre-mixing the micro-ingredients is characterized in Montana by the lack of uniformity. Even in plants that are owned by the same parent organization a great deal of variation is present. In some plants standard or established pre-mixed formulas are simply added to the central mixing facility. In other plants an additional mixer of smaller capacity is used in formulating the pre-mixes. While some plants do not have pre-mixing equipment per se there are examples where the entire pre-mix operation is completed by the use of hand labor. Other mills will employ as many as two separate mixers in performing this function. Those mills that have no pre-mixing equipment generally purchase a completed pre-mixed package from one of several national firms that supply this service. During the period of this survey only one firm was found that utilized liquid micro-ingredients in feed formulation and this plant cannot be properly classified as a feed manufacturing plant within the scope of this report.
Grinding Equipment

In the area of grinding equipment the hammer mill is used almost exclusively for grinding in Montana. There are at least twelve different makes of machines in use but in general it can be said that the average hammer mill will grind a minimum of 5 tons per hour and employs from 50 to 75 horsepower and are of a fairly recent vintage. Most operators feel there is no problem encountered at this point in the production process. In spite of the dominance of the hammer mill there are in operation three double runner attrition mills. Again in this area there is some controversy as to the best and most economical way to obtain reduction as between the hammer mill and attrition mill. The attrition mills in Montana are generally very old but remain in excellent working order.

With reference to age the rollers used in Montana fall into two clearly distinguishable categories; either very old, 15 years or more, or very recent. As a general rule subject to few exceptions, the rollers use steam in the feed processing system. The average steam roller in Montana will average approximately 3 1/2 to 4 tons of production per hour. This depends on the weight of the barley as well as the contamination factor. Most of the later systems have installed cleaning and/or screening devices to eliminate foreign objects. Some of the new 42 inch rollers are capable of producing in excess of 7 tons of rolled barley per hour. The prime mover for the roller is the electric motor and generally ranges from 40 to 50 horsepower.
Because of the rather minor roll of poultry feeds in the Montana Feed Manufacturing Industry only five firms utilize crumbilizing equipment and generally the crumbilizers are in excess of 20 years of age.

**Warehouse System**

It is reasonable to expect that in the future more firms will add the fork lift to their operations. Four firms in Montana now employ the fork lift and all report an economic advantage in its use. The majority of feed manufacturing firms in Montana move the finished product within the plant with a series of gravity chutes, portable conveyors and hand trucks. In all cases these devices require a substantial amount of hand labor. It is predicted that the necessity to reduce cost will lead to improved conveying systems all designed in support of a fork lift operation. This will be especially true in those operations that distribute a large proportion of their product in bags. Based on information gained in personal interviews, it appears evident that as the future brings improved technological advances in equipment the individual firms within the Montana industry will take advantage of these advances as their capital permits and, of course, within the limitations set by their existing plant lay-outs.
RAILROADS

RAILROADS SHOWING ALL FEED PROCESSING PLANTS

Key:
O - FEED PLANT - PELLETING, STEAM ROLLING AND GRINDING AND MIXING
O - FEED PLANT - STEAM ROLLING AND GRINDING AND MIXING
O - FEED PLANT - GRINDING AND MIXING
A - ALFALFA PELLET MILL
P - PORTABLE UNIT
+ - FEED PLANT - PELLETING ONLY

Used by permission from: MONTANA IN MAP, BY N. HELBURN, M. EDIE AND G. LIGHTFOOT

SOURCE
Board of Railroad Commissioners, Helena, Montana
KEY

Present Interstate Routing
U.S. Numbered Highways
Montana Numbered Highways

SOURCE

Map of the Montana State Highway System, 1960,
Montana State Highway Comm., Helena, Mont.

HIGHWAYS SHOWING ALL FEED PROCESSING PLANTS

Keys:
0 = FEED PLANT - PELLETING, STEAM ROLLING AND GRINDING AND MIXING
0 = FEED PLANT - STEAM ROLLING AND GRINDING AND MIXING
0 = FEED PLANT - GRINDING AND MIXING
A = ALFALFA PELLET MILL
P = PORTABLE UNIT
+ = FEED PLANT - PELLETING ONLY

Used by permission from MONTANA IN MAP, BY N. HELBURN, M. EDIE AND G. LIGHTFOOT.
CHAPTER V

A COST ANALYSIS OF SELECTED FIRMS IN THE
FEED MANUFACTURING INDUSTRY OF MONTANA

Introduction

Chapter V will present an inquiry into three major areas. First, a cost analysis based upon six production stages including a micro analysis of Stage #4 of the central production area will be discussed and analyzed. The second area to be dealt with will include a ratio analysis of firms operating in Montana and Utah with some specific ratio observations drawn from the national feed manufacturing industry. Corollaries will be drawn where possible as between Montana's and Utah's industry and that of the national industry. The third and final area in Chapter V will present model mills together with break-even calculations and graphs. The impact of depreciation as a cost factor will be illustrated in terms of break-even points. The following six points will briefly reiterate the production stages.

(1) Stage Number One includes the unloading, grinding, and elevating of all the raw ingredients that will comprise the finished product. This stage ends when the several ingredients have been processed through Stage One and have come to rest either in their respective holding bins, or at some other position from which they will move into the next stage of production.
(2) Stage Number Two of operations is an integral part of pelleting and is concerned with the pre-mixing of the micro ingredients that are included in nearly all pelleted range feed in Montana.

(3) Stage Three of operations is referred to as the milling and percentage allocation stage. This stage starts as the raw ingredients are withdrawn from their respective holding bins and delivered into the mixer, i.e., horizontal, vertical, or continuous line. This stage ends when the raw ingredients have been properly mixed and conveyed to the hopper above the pelleting machine, or where special molassesizing equipment or mixers are used, into the surge bins above the pelleting machine.

(4) Stage Number Four is the pelleting and cooling operation. This phase of the study begins when the mixed feed elements enter into the surge bin above the pelleting machine, or in the case of other mixing equipment preceding the pelleting process, when the raw ingredients enter that mixer-blender. This stage of operation ends after the raw ingredients have been compressed into pellets and have been cooled, dried and discharged into the holding bins above the packaging equipment.

(5) Stage Number Five of operations is packaging. This stage begins when the cooled and dried pellets have been dis-
charged into the holding bins above the weighing apparatus, and ends when the packaged pellets are discharged into a delivery chute leading to a warehouse, or when the packaged pellets are moved away by either conveyor belt, hand truck, or forklift.

(6) Stage Number Six is the warehousing operation. It begins when the packaged pellets begin their movement to warehousing from the packaging stage, i.e., Stage Number Five, and includes all movements within the warehouse, and ends when the product is placed on the vehicle that offers the final transportation step.

A. Cost Break-Down by Production Stages

In attempting to ascertain the existence of economies of size within the existing structure of the Montana feed manufacturing industry three size classifications were established. Mills producing 11,000 tons and over per year were designated as Class "A" mills; mills producing 5,000 to 10,000 tons per year were Class "B"; and those producing 5,000 tons and under per year were Class "C". Three mills were chosen for each of the three classifications. The choice was dependent largely upon willingness to participate in this study. All six stages of production have been subjected to economic analysis and the totals are reported for all mills within the three classifications. Further a detailed seven point cost classification is presented for production.
Stage #4. This was necessary as Stage #4 represents the heart of the feed manufacturing process as it exists in Montana. This stage involves the actual blending, pelleting and cooling of the manufactured feed. The variations in the several cost items that comprise Stage #4 will be dealt with as one unit thus reflecting the cost patterns for the nine mills that constitute this area of the study.

Class A Mills

The three selected mills within this, the largest of the classifications, rank fourth, sixth and ninth on the total per ton cost schedule. Reference to Table XXIX shows that within this classification the total cost per ton of pelleted feed considering all six of the production stages ranges from $6.15 for Mill IA to $10.47 for Mill 3A. The simple average total cost is therefore $8.47 per ton for all three mills within the A classification. This average cost per ton figure compares quite favorably with what may be reported as "typical" cost figures for selected feed mills in the Mid-West. To explain the over-all cost variation of $4.57 as between Mill 1A and 3A, it will be necessary to analyze each stage in the production cycle to ascertain where the economies or dis-economies lie. After this area has been designated it will be apropos to analyze them from both an economic and engineering point of view. Table XXIX shows a very close cost correlation between Mill IA and Mill 2A, however, Mill 3A shows a cost increment of approximately $1.00 per ton over the
Table XXIX. Mills Producing 10,000 Tons and Over Per Year

<table>
<thead>
<tr>
<th>Costs for the Six Stages of Production</th>
<th>Mill Number 1A</th>
<th>Mill Number 2A</th>
<th>Mill Number 3A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage #1</td>
<td>1.24</td>
<td>1.52</td>
<td>2.37</td>
</tr>
<tr>
<td>Stage #2</td>
<td>0.54</td>
<td>*</td>
<td>0.37</td>
</tr>
<tr>
<td>Stage #3</td>
<td>0.28</td>
<td>1.34</td>
<td>2.05</td>
</tr>
<tr>
<td>Stage #4</td>
<td>1.85</td>
<td>3.96</td>
<td>3.25</td>
</tr>
<tr>
<td>Stage #5</td>
<td>0.66</td>
<td>**</td>
<td>0.73</td>
</tr>
<tr>
<td>Stage #6</td>
<td>1.59</td>
<td>2.08</td>
<td>1.97</td>
</tr>
<tr>
<td>Total</td>
<td>6.15</td>
<td>8.53</td>
<td>10.74</td>
</tr>
</tbody>
</table>

*Included in Stage #3

**Included in Stage #6
average per ton cost for Mills IA and 2A. It is possible to clearly account for the variance even though the wage rates of Mill IA and 3A are quite similar. The point is that in Stage I of Mill 3A there are simply more labor inputs designed to this particular production stage than are necessary to fully carry out this production function. Reference to the cost figures for Stage 1 for Mills IA and 2A shows a close correlation with a slightly higher cost incurred by Mill 2A. This is true in spite of the fact that Mill 2A operates on a somewhat lower wage scale, whereas Mill IA is highly unionized with the resulting higher wage rates. It is possible therefore to account for the 28 cents per ton variation in this stage by the fact that Mill IA employs certain mechanical unloading devices that Mill 2A has not yet adopted.

In Mills IA and 3A Stage #2 which covers all pre-mixing activities may be clearly separated from Stage #3, which is the mixing or milling function, however, in 2A these two functions are so interwoven as to defy practical separation. The 17 cent cost per ton differential in Stage #2 favoring Mill 3A may be explained by the fact that Mill IA uses hand operated scales for each of the many trace minerals, etc., that compose their various pre-mix lines. This is not necessary in Mill 3A as the pre-mix elements are shipped into the plant in packaged units. These packaged pre-mixed units are produced by a central mill located in another state but nevertheless a part of the same organizational system.
The extreme contrast in the cost pattern at Stage 3 is quickly accounted for when the nature of the three systems employed at Stage #3 are subjected to analysis. First, in Mill IA a continuous line mixer has been installed. This continuous line mixer is capable of feeding completely mixed ingredients into three large pelleting machines therefore maximizing completely the labor input assigned at this stage and also gaining maximum benefit from the capital outlay involved. Though not as significant from a direct economic point of view this system does not "over-mix" the raw ingredients and thereby incur needless power expenditures nor subject the raw ingredients to particle separation. The latter is a significant consideration from the standpoint of quality control. In extreme contrast Mill 3A assigns labor inputs far beyond that necessary for maximum efficiency, and at the same time continues to pay at the top of the wage scale. Mill 2A again pays a somewhat lower wage rate than either Mill IA or 3A but all considerations weighed they fully utilize their labor input at this stage of the production cycle. However, this mill overmixes from a time point of view by 200 or 300 per cent. This increases an obvious waste of power, etc., as well as resulting in overmixing with the consequence of danger in quality of the finished pelleted ration. From an economic point of view the most serious misappropriation of resources to this point is found in the labor problem in Mill 3A and equally important is the lack of flexibility for production runs as between Stages 1, 2, and 3. An example of
the latter situation is found in the fact that when barley enters the hammer mill there is no alternative except to proceed with the operation until that barley has become the finished pelleted product.

In Stage 4 the three mills rank as follows, Mill IA third, Mill 3A seventh, and Mill 2A ninth or last in the nine selected mills analyzed. Again the cost advantage rests with Mill IA. It is difficult to compare cost figures for this stage with average costs for mills in the Midwest. What figures are available have not considered such items as machine or water costs in their calculations. Notwithstanding, the above mentioned omissions reports seem to indicate a cost figure of approximately $1.00 per ton. The average cost for Stage 4 in the "A" classification is $2.98. A complete six item cost analysis of Stage 4 will be reported and analyzed following the presentation of all three classifications as outlined.

In Stage 5 there is a relatively uniform cost pattern principally because all three mills have adopted the same basic type of operation with the slight exception that Mill IA has taken advantage of very recent technology and has installed an automatic bagging and weighing machine. Mill 2A has gained an advantage over Mills 1A and 3A when Stage 5 and Stage 6 are considered together. This advantage develops when one labor input assigned to Stage 5 actually delivers the finished product to the warehouse while the second assigned labor unit continues to operate the bagging and weighing equipment. Mill IA is presently remodelling and streamlining their
operation at Stage 6 and the $1.59 figures should be reduced substantially, thus improving their competitive position. When these cost calculations were made none of these mills utilized a forklift at Stage 6. All three mills used extensive hand labor in their warehouse operations. Reiterating Mill 3A continues to employ excessive labor in Stage 6.

Class B Mills

Mills in the "B" classification have an annual production range of from 5,000 to 10,000 tons, however, the three mills selected for this category all tend to produce at the upper limit of this classification. Classification "B" possesses some rather unique mill characteristics as one mill has a capital investment of less than $10,000 per ton of pelleting capacity while another Mill has a capital investment of more than $22,500 per ton of pelleting capacity. Further, one mill has been constructed largely from fully depreciated equipment and thought by some to be obsolete while another mill employs some of the latest and most efficient pelleting and cooling equipment in the market. The economic impact of these contrasts will predilect some of the cost variances that are present within this classification.

Narrowing the frame of reference to specific total cost figures, it is seen that Mill 1B occupies the first place with the lowest total cost per ton while 3B ranks fifth and Mill 2B ranks seventh
among the nine mills analyzed. The average total cost for mills within this classification was $6.63 or $1.89 less per ton than the average total cost for mills within the "A" classification, however, the total costs for Mill 1A, the largest within its classification, is approximately 50 cents per ton more economical than the average mill cost per ton of Class "B" mills. The startling observation is the 100 per cent cost differential between Mill 1B and 2B. Therefore, to reconcile these extreme conditions attention should be directed to Table XXX to fully appreciate the economic impact of the conditions stated at the beginning of this chapter.

In Stage 1 within this "B" classification Mill 2B and 3B are relatively close from a cost point of view and the slight additional cost incurred by 2B results from the fact that Mill 3B operates with the lowest wage rates in the Montana feed manufacturing industry. The wage rates paid by Mill 3B are below the wage rates paid by many other mills by as much as $1.00 per hour. However, Mill 1B avails itself of a labor supply drawn from essentially the same market and also pays a relatively low wage rate. The principal explanation of the cost variation in Stage 1 is that Mill 1B was built by and large from fully depreciated assets, therefore, a lower machine cost per ton explains the Stage 1 difference.

In Stage 2, Mill 1B and 3B have combined Stage 2 with Stage 3 with one labor unit input utilized on a full-time basis. The quality aspect leaves something to be desired at Stage 2 for Mill 2B, however
Table XXX. Mills Producing 5,000 to 10,000 Tons Per Year

<table>
<thead>
<tr>
<th>Stage</th>
<th>Mill Number 1B</th>
<th>Mill Number 2B</th>
<th>Mill Number 3B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage #1</td>
<td>.82</td>
<td>1.30</td>
<td>1.14</td>
</tr>
<tr>
<td>Stage #2</td>
<td>***</td>
<td>.60</td>
<td>***</td>
</tr>
<tr>
<td>Stage #3</td>
<td>.61</td>
<td>1.19</td>
<td>1.25</td>
</tr>
<tr>
<td>Stage #4</td>
<td>1.34</td>
<td>2.86</td>
<td>2.63</td>
</tr>
<tr>
<td>Stage #5</td>
<td>.50</td>
<td>.59</td>
<td>.31*</td>
</tr>
<tr>
<td>Stage #6</td>
<td>1.36</td>
<td>2.70</td>
<td>.96**</td>
</tr>
<tr>
<td>Total</td>
<td>4.36</td>
<td>9.24</td>
<td>6.29</td>
</tr>
</tbody>
</table>

*Labor assignment is fluctuating

**Utilizes a forklift

***This is a single combined operation of 1 labor unit
this situation is to be corrected when Mill 2B adopts the same type of Stage 2 procedure as is presently being used by Mill 3A. The cost advantage that is apparent in Mill 1B at Stage 3 is the direct result of the complete labor utilization resulting from the combining of Stage 2 and Stage 3 along with a very low wage rate and secondly but not less importantly is the fact that all machinery employed at this stage was completely depreciated before it was installed in the present mill. Mill 3B combines the same labor efficiency as Mill 1B and employs a beautiful automatic mixing system, however, the capacity of Stage 4 substantially reduces the degree to which the capacity of Stage 3 can be utilized. The system at Stage 3 in Mill 3B has the capacity to produce 300 or 400 per cent more output than the present balance of the system allows. Of course, this large and otherwise efficient system requires a substantial capital investment and the unused capacity represents a gross misuse of resources. As noted earlier, the cost variations for all mills at Stage 4 will be dealt with in detail at the conclusion of the analysis dealing with the mills of the "C" classification. It is difficult in this study to introduce any general rules without citing a catalog of exceptions, however, it does seem appropriate to state that most mills may be highly efficient in one or several stages and grossly inefficient in some other stage, therefore negating and/or mitigating any efficiencies realized at any given time in Stage 4, the production cycle.
At Stage 5, Mill IB and 2B have very similar cost patterns and throughout the industry Stage 5 is a relatively inexpensive stage from a capital investment point of view. The slight cost advantage gained by Mill IB over Mill 2B doubtlessly results from the type of labor utilization employed in Mill IB. At this stage one of the labor units assigned has the added responsibility of supervising and operating the pellet machine. This is physically possible because of the pre-planned location of the pellet mill relative to the packing and weighing station. Mill 3B has a completely flexible labor assignment at Stage 5 and when their services are not required they are immediately transferred to other duties either in the feed mill or in another related business area of the firm's activities. In addition no labor is necessary in moving the bagged product into the warehouse as the bags are automatically discharged down a chute directly to a loading platform where they are picked up by a forklift.

Reference to Table XXX shows a variation of $1.75 per ton between Mill 3B and 2B. This extreme variation is the result of two factors. First, Mill 3B has a well designed warehouse and utilizes a forklift operation for all materials handling involved at Stage 6, and secondly, Stage 6 in Mill 2B is a complete hand-truck operation with an excessive number of units of labor assigned with a top wage rate in effect. The $1.34 variation between Mill IB and 2B results again from the excessive labor assignments and the rather substantial wage differential that exists among the several mills. This $1.34 variation is the
result of the above mentioned conditions in spite of the fact that the
two methods of physical operations are quite similar, i.e., the use of
hand trucks and physical labor.

Class "C" Mills

The mills that fall within the Class "C" classification also
represent a contrast in cost variation. The total production cost
ranges from a high of $9.84 to a low of $5.74 with an average total
cost per ton of finished pelleted feed of $7.13. This average com­
pares with an average cost per ton in "B" class mills of $6.63 and
further contrasts with the average cost per ton in Class "A" mills
of $8.47, an overall nine mill average cost per ton of $7.41.

Mills in the "C" classification produce under 5,000 tons per
year and under their present operating conditions it is doubtful if
any of the three can expand above this 5,000 ton production limita­
tion. Narrowing the frame of reference to Stage 1 in the "C"
classification (see Table XXXI) the cost ranges from $1.09 in Mill 3C
to a high of $2.31 for Mill 1C. Mill 3C is the most unique perhaps of
all mills within the nine mill classification. This mill is a one man
operation in which one labor unit is responsible for carrying out the
functions involved in all six production stages. In addition to
this the mill has been "home made" including design and millwright.
Therefore, the $1.09 cost at this stage is the consequence of lower
per ton machine cost and labor input. On the other hand, Mill 1C has
Table XXXI. Mills Producing 5,000 Tons and Under Per Year

<table>
<thead>
<tr>
<th>Stage</th>
<th>Mill Number 1C</th>
<th>Mill Number 2C</th>
<th>Mill Number 3C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage #1</td>
<td>2.31</td>
<td>1.39</td>
<td>1.09</td>
</tr>
<tr>
<td>Stage #2</td>
<td>*</td>
<td>*</td>
<td>.02*</td>
</tr>
<tr>
<td>Stage #3</td>
<td>1.88</td>
<td>1.55</td>
<td>1.11</td>
</tr>
<tr>
<td>Stage #4</td>
<td>3.50</td>
<td>2.00</td>
<td>1.37</td>
</tr>
<tr>
<td>Stage #5</td>
<td>.94</td>
<td>.00</td>
<td>.82</td>
</tr>
<tr>
<td>Stage #6</td>
<td>1.21</td>
<td>.87</td>
<td>1.33</td>
</tr>
<tr>
<td>Total</td>
<td>9.84</td>
<td>5.81</td>
<td>5.74</td>
</tr>
</tbody>
</table>

*Labor cost is included in Stage #3 as this is a one man operation
an investment to output ratio of approximately $27,500 per ton of production capacity. In the case of Mill 2C the $1.39 figure represents the cost of carrying out the functions of Stage 1 after the portable unit has been delivered to the production site. The reported cost for Stage 1 for Mill 2C does not include the cost necessary to transport the portable pelleting unit from location to location. Under certain circumstances this transportation cost even when calculated on a per ton basis can become quite significant. In Mills 1C and 2C Stage 2 of operations has been completely absorbed into Stage 3.

This amalgamation is more readily possible in mills with lower production volumes. In the case of Mill 3C a cost allocation of 2 cents per ton was assessed because Stage 2 is still maintained in a separate location and is considered a distinct function separate and apart from Stage 1. In Stage 3 of Mill 1C as in the other stages of Mill 1C the somewhat higher cost of $1.88 per ton is the result of the previously mentioned factor and in addition and perhaps even more significant importance is the limited market area in which Mill 1C must operate. Were it not for the restrictions imposed upon this mill by the limited market area and the unfavorable investment capacity ratio this mill would have an entirely different cost picture. In short, this mill represents too large an investment in a limited market area. Further the nature of the demand is such that only small production runs are possible thereby adding to the cost problem.
The cost reported, for Mill 2C at this stage does not include transportation costs necessary to relocate from the previous production site, nor does this cost include the cost of owning and maintaining the necessary supporting equipment, i.e., a minimum of a 2 1/2 ton truck and some authorities maintain a 30 foot flota is essential to transport the necessary supporting ingredients on an economical basis. The same type of situation exists at Stage 3 for Mill 3C that was discussed earlier in this section. This influence will continue to be reflected in almost all of the various production stages for Mill 3C. The variations in Stage 4 within this classification as in the two preceding classifications will be fully analyzed at the close of this section.

Continuing to Stage 5 of the production cycle Mill 1C although it has the highest cost within this classification could become competitive with any of the other mills within the three classifications if production volumes could be increased, however, as previously stated market expansion would be extremely difficult and hazardous under existing economic conditions. Mill 2C does not generally perform this Stage 5 function, however, it would be possible to discharge the production directly from the pellet mill into waiting bags or sacks and subsequently remove the bagged production into a warehouse.

At this stage technological development in sophisticated bagging and weighing equipment is available for portable mills. Risking reiteration Mill 3C, the entire operation of the mill is the respon-
sibility of one man and at this stage this same labor unit must weigh, bag and sew each unit of packaged production and then "runs" with the loaded handtruck into the warehouse. It is safe to say, therefore, that with the present state of the acts this mill has worked its full capacity. All movements of the finished product as well as incoming raw ingredients are handled in Stage 6 by this single individual. The higher cost in Stage 6 reflects the labor that must be expended to meet the functional requirements involved in Stage 6. It was originally conceived that with development and use of portable pelleting units that Stage 6 as it is defined in this study could be eliminated from the production cycle. Although some economies may be possible it is nevertheless impossible to eliminate operational procedures which are tantamount to those found in Stage 6 in the stationary facilities.

To properly conduct the function involved in Stage 6 it is necessary to have, as a general rule, one labor unit available to spread and distribute the pellets as they are discharged from the pellet machine into storage bins. Admittedly there is some flexibility here and with practice will vary from operation to operation. The 87 cents per ton figure reported at Stage 6 for Mill 2C will vary but nevertheless some cost allocation must be made to account for the labor expended in performing this function. It is irrelevant who furnishes the labor. Stage 6 is an excellent example of the propositions previously stated concerning the lack of production
volume for Mill 1C. Doubtlessly the $1.21 per ton cost would compare favorably with the cost at Stage 6 of Mill 3B if production increases were feasible. Stage 6 in this mill is a streamlined well planned forklift operation similar in many respects to the facilities found in 3B, however, Mill 3B produces several thousands tons of pelleted production per year than does Mill 1B.

**A Cost Break-Down of Stage 4 for All Three Classifications**

Stage 4 begins when the raw ingredients are discharged from Stage 3 into the hoppers or holding bins of Stage 4 and ends when the finished pellet has been discharged from the cooling and drying mechanisms. This stage is set apart and analyzed separately considering all nine units because it represents the heart of the feed manufacturing operation as it is found in Montana. The production costs at Stage 4 have been divided into seven distinct areas (see Table XXXII). With the exception of one cost area in Stage 4, the wide variation in cost among the mills is reminiscent of the previous discussion concerning the costs at the other five stages; however, before a micro analysis of Stage 4 is undertaken, the general cost pattern will be explored. The total cost range of Stage 4 extends from $1.34 per ton for Mill 1B to a high of $3.59 per ton for Mill 2A with an average cost per ton for all nine mills of $2.48. The average cost for mills within the "A" classification was $2.89 per ton or 41 cents per ton in excess of the overall average cost at Stage 4. This excess can be
Table XXXII. Production Cost at Stage #4 for All Mills

<table>
<thead>
<tr>
<th>Item A: Power</th>
<th>Item B: W/G Steam</th>
<th>Item C: Direct Labor</th>
<th>Item D: Machine Cost</th>
<th>Item E: Supplies &amp; Maintenance</th>
<th>Item F: Die &amp; Roller</th>
<th>Item G: Supervision</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>.31</td>
<td>.09</td>
<td>.21</td>
<td>.97</td>
<td>.02</td>
<td>.21</td>
<td>.04</td>
<td>1.85</td>
</tr>
<tr>
<td>.71</td>
<td>.30</td>
<td>.71</td>
<td>1.50</td>
<td>.07</td>
<td>.26</td>
<td>.35</td>
<td>3.58</td>
</tr>
<tr>
<td>.41</td>
<td>1.07</td>
<td>.58</td>
<td>.79</td>
<td>.05</td>
<td>.23</td>
<td>.12</td>
<td>3.25</td>
</tr>
<tr>
<td>.27</td>
<td>.43</td>
<td>.22</td>
<td>.12</td>
<td>.11</td>
<td>.08</td>
<td>.11</td>
<td>1.34</td>
</tr>
<tr>
<td>.37</td>
<td>.34</td>
<td>.67</td>
<td>.88</td>
<td>.05</td>
<td>.20</td>
<td>.10</td>
<td>2.86</td>
</tr>
<tr>
<td>.42</td>
<td>.13</td>
<td>.48</td>
<td>1.34</td>
<td>.61</td>
<td>.45</td>
<td>.02</td>
<td>2.63</td>
</tr>
<tr>
<td>.43</td>
<td>.00</td>
<td>.48</td>
<td>.27</td>
<td>.25</td>
<td>.26</td>
<td>.05</td>
<td>3.50</td>
</tr>
<tr>
<td>.52</td>
<td>.19</td>
<td>.48</td>
<td>.47</td>
<td>*</td>
<td>.48</td>
<td>.01</td>
<td>2.00</td>
</tr>
<tr>
<td>.31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.37</td>
</tr>
</tbody>
</table>

*Included in Item C
largely attributed to Mill 2A with its rather extreme power cost and to Mill 3A with its wasteful steam cost. Mills within the "B" classification had an average cost of $2.41 per ton which is tantamount to 7 cents below the overall average for Stage 4. In the case of the "C" classification the three mills averaged 6 cents per ton below the overall average. Specifically this figure was $2.42 per ton at Stage 4. At this writing no satisfactory standard costs have been developed for the feed manufacturing industry therefore it is impossible to compare the costs that have been reported to date in the other five stages with mills in other regions of the United States. Nevertheless, one highly respected cost study has been undertaken for Stage 4, therefore some comparison can be made with what is referred to as a "typical" mill in the Midwest.

**Power Cost**

Power cost represents the most uniform of the seven cost patterns. Considering all mills within the three classifications the average cost for this item is 41 cents per ton with a cost range from 27 cents to a high of 71 cents per ton. With the extremely high mill removed from the average cost the average power cost is reduced to 38 cents per ton. The "typical" mill referred to above operates at a cost of 40 cents per ton for this item of Stage 4. The extreme cost figure is found in Mill 2A where the pellet machines are in excess of twenty years of age and employ a considerably higher horsepower in
relation to output than do some of the more modern mills. In addition and equally significant is the fact that fines exceed 10 per cent of production and are continually fed back into the production system thereby consuming additional power. The power cost reported for Mill 2C is diesel and is approximately 10 cents per ton higher than the average.

Steam Cost

Steam cost per ton reflects wide variations and Mill 2C does not incur a steam cost therefore the average cost per ton for the eight mills is 36 cents. Mill 3A reports a figure approximately 2 1/2 times as large as the average cost per ton. This is because the boiler that is in present use is in a pathetic state of repair. It is possible to view the open fire from numerous vantage points and it, in fact, constitutes something of a fire hazard. The gas loss of course is tremendous. It is not possible to compare this cost item in Montana's industry with its counterpart in the Midwest because of wide variations in gas rates and also because water costs are not included in the Midwest figures. One of the low cost mills within this item classification employs a steam "Jenny" and thereby has been able to reduce cost in this area. However, it is important to observe that this is a low volume mill and increases in production volume could only be achieved if additional capacity were added. One very large mill with the lowest per ton cost has a very large efficient
boiler which it utilizes completely. The boilers employed in the Montana industry include such extremes as steam "Jennys", converted railroad steam engine boilers, boilers taken from long-outdated farm machinery to the ultimate in recent boiler technology. The severe weather conditions of Montana together with the steam demands resulting from large steam rolling operations necessitate steam capacity in excess of that generally employed in the Midwest. Engineering specifications that were acceptable in the Midwest with reference to steam requirements, have proven grossly inadequate in mills recently established in Montana.

**Direct Labor Cost**

The direct labor cost ranges from 12 cents to 71 cents per ton in Montana and both extremes are represented by extremely unique firms, i.e., firm IC and 2A, respectively. The characteristics of these two mills have been sufficiently discussed in each cost segment. The reported average cost per ton for direct labor for Item C in the Midwest is 19 cents per ton while in Montana the average charge per ton, all mills considered, is 46 cents.

In considering the significance of this variation it must be remembered that the "typical" mill in the Midwest will probably employ a battery of three pellet machines whereas this condition is an exception in Montana. Wage rates are basically the same with the exception of the "union shops" and some of the co-operatives. Of
course, these latter mentioned operations incur higher wage costs.

Machine Cost

Within this cost area there is no opportunity for comparison with other regions of the United States and within the Montana industry the general rule of extreme variation in cost patterns still prevails. The average machine cost per ton in Montana is 82 cents with a variation from 12 cents for Mill 1B to $1.50 per ton for Mill 2A. It will be recalled that Mill 1B is an extremely high volume operation within its classification and that the machinery employed was completely depreciated before it was installed in its present location, yet it continues to function adequately. Mill 2A along with Mill 2C both representing extremes on the high side of the cost pattern, are mills with high investment to capacity relationships and neither are producing toward the top of their respective classification. Mill 2C has no cooling equipment and therefore the investment at this point is substantially reduced.

Maintenance and Supply Cost

In this area the "typical" mill in the Midwest incurs a cost of approximately 3 cents per ton to cover the maintenance and supply cost in Stage 4. The Montana industry conforms quite well in this respect with the exception that three mills raise the average cost per ton to 13 cents in Montana. The 11 cents per ton figure reported by Mill 1B is expected in view of the nature of the equipment that
composes this mill. Mill IC over the years has experienced rather excessive break-downs which cannot be explained. Perhaps it is not proper to include 2C in this classification because of its mobile nature as it is normal to expect a significantly higher rate of repair for this type of operation.

**Die and Roller Cost**

The average die and roller cost for the typical mill in the Midwest is 24 cents per ton, while the average cost per ton in Montana is 27 cents. In spite of this 3 cents differential several mills in Montana incur die and roller costs of slightly below the Midwest figure. In this area it often becomes a matter of policy as to when a given die will be withdrawn from production. Another variation is found in the individual die itself. Some dies seem capable of producing fantastically larger volumes as compared with the same type of die manufactured by the same company, bearing the same specifications, with serial numbers in sequence. Mill 1B is again in focus with an unusually low cost figure, nevertheless, their records reveal an actual cost of only 8 cents per ton. It may be possible that this mill continues the use of a die long past its optimum capabilities. However, there may be some other factors that result in the reported economies. The mill uses considerably "hotter" steam than is generally used and the pellet produced by this mill does not contain any mill feeds. Further no sun-cured alfalfa is used. Therefore, the basic
ingredient is barley, and with its natural oils to serve as a protective coating, die life is greatly extended. One mill has invoked a policy that requires that the die be taken out of production after a given number of tons of pelleted feed has been produced. This is a rather conservative figure and accounts for a die cost per ton substantially above the average of 27 cents.

Mill 2C reports the highest die cost per ton and, of course, this is expected as the alfalfa that is added into the pelleted feed formula is extremely abrasive and contains significant amounts of foreign material thereby reducing the die life. Further the raw ingredients must be forced through the die without the benefit of the heat that is imparted into the raw ingredients in the stationary mills. This, of course, leads to greater die wear. This may in part be offset by the fact that there is no steam or boiler cost incurred for this portable operation.

Supervision Cost

In the last analysis supervision cost is largely a matter of individual mill policy. Some mills follow a policy of minimum supervision while one mill employs a labor unit in the supervisory capacity on a continuing basis. The average cost per ton for the "typical" mill in the Midwest is 3 cents contrasted with 8 cents per ton in the Montana industry. The amount of supervision that is necessary is a direct function of the pellet mill operator, and many such
operators have been observed to have skills and capacities in excess of their supervisors thereby casting some doubt as to the necessity of this cost.

**Total Cost for Stage 4.**

Table XXXIII shows in increasing order the total cost per ton for Stage 4 and identifies each cost with the mills that comprise the three size classifications. It is obvious that within the size classifications established that no clear cut pattern of economies are reached by size alone.

Reference to Table XXXIV shows the same identifying factors related to the total cost for all stages of production. The average cost per ton of pelleted feed is $7.41 and with the extremely high and low figure removed the average cost per ton is only altered 4 cents per ton as the average cost is then $7.37 per ton. It is interesting to observe in Table XXXIII and XXXIV that the mills closely maintain their relative positions as the cost pattern develops. This is not to say however, that mills which report favorable cost figures for certain stages are not grossly inefficient in other stages. Nevertheless, it is gratifying that corrections are being taken in several mills to correct these economic wastes.

The Economic Significance of Ratio Analysis as Applied to Feed Manufacturing Plants

The economic impact of the analysis that was presented in the
Table XXXIII. Total Cost at Stage 4

<table>
<thead>
<tr>
<th>Mill Identification</th>
<th>Rank</th>
<th>Total Cost Per Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>1B</td>
<td>1</td>
<td>$1.34</td>
</tr>
<tr>
<td>3C</td>
<td>2</td>
<td>1.37</td>
</tr>
<tr>
<td>1A</td>
<td>3</td>
<td>1.85</td>
</tr>
<tr>
<td>2C</td>
<td>4</td>
<td>2.00</td>
</tr>
<tr>
<td>3B</td>
<td>5</td>
<td>2.63</td>
</tr>
<tr>
<td>2B</td>
<td>6</td>
<td>2.86</td>
</tr>
<tr>
<td>3A</td>
<td>7</td>
<td>3.25</td>
</tr>
<tr>
<td>1C</td>
<td>8</td>
<td>3.50</td>
</tr>
<tr>
<td>2A</td>
<td>9</td>
<td>3.59</td>
</tr>
</tbody>
</table>
Table XXXIV. Total Cost for All Production Stages

<table>
<thead>
<tr>
<th>Mill Identification</th>
<th>Rank</th>
<th>Total Cost per Ton of Pelleted Feed</th>
</tr>
</thead>
<tbody>
<tr>
<td>IB</td>
<td>1</td>
<td>$4.36</td>
</tr>
<tr>
<td>3C</td>
<td>2</td>
<td>5.74</td>
</tr>
<tr>
<td>2C</td>
<td>3</td>
<td>5.81</td>
</tr>
<tr>
<td>1A</td>
<td>4</td>
<td>6.15</td>
</tr>
<tr>
<td>3B</td>
<td>5</td>
<td>6.29</td>
</tr>
<tr>
<td>2A</td>
<td>6</td>
<td>8.53</td>
</tr>
<tr>
<td>2B</td>
<td>7</td>
<td>9.24</td>
</tr>
<tr>
<td>1C</td>
<td>8</td>
<td>9.84</td>
</tr>
<tr>
<td>3A</td>
<td>9</td>
<td>10.74</td>
</tr>
</tbody>
</table>
preceding chapter, must in various ways, show impacts upon the financial relationships that are reported in the feed manufacturing firm's balance sheet and their profit and loss statement. The relationships that will be presented have been taken from actual current financial reports and are not based on hypothetical models. There are any number of areas of economic concern, however, the problems of the most pressing nature in the Montana industry include excessive accounts receivable, insufficient sales volume or extensions into submarginal market areas and the lack of working capital. The seriousness of the problem in the first area has already been indicated, and will subsequently be explored further. The second area is interwoven with the unique marketing structure in Montana which includes the seasonality of demand, among other things. The lack or insufficiency of working capital can often be traced or in some way associated with an excessive investment in plant capacity or fixed assets. The high ratio of invested capital to capacity has already been established and is reflected in the machine cost element that was discussed in Section I of this chapter.

The importance of ratio analysis cannot be over emphasized as a tool in analyzing economic and financial conditions. It is further recommended that feed manufacturing firms apply this type of analysis as a continuing function over time. If this is done economic trends can be discovered shortly after their inception and the necessary economic-engineering decisions made to correct any adverse trends.
(If this is an overstatement then it may be pointed out that perhaps the leading manufacturing firm in the United States utilizes this type of analysis on a quarterly basis as its financial statements become available.)

Reference to Table XXXV will show eleven basic ratios calculated and chosen to facilitate the economic analysis of the feed manufacturing industry in Montana and Utah. For clarity of association, Mills "U" and "V" represent the firms selected in Utah, and Mills W, X, Y and Z are all presently operating firms in Montana. The data is based on 1959-1960 financial statements.

**Current Ratio**

The first and most popular ratio to be analyzed is the current ratio and it is calculated by dividing total current assets by total current liabilities. This ratio then serves to measure the ability of the firm to meet its current debt and creditors may expect prompt payment of claims. Of course, this implies that the higher the ratio the more financial stability is indicated. Ceteris paribus, the higher the ratio the greater the financial stability and from a capital investment point of view, a very high ratio with a significant percentage of cash indicates that when expansion is possible or necessary the firm can meet the challenge. Changing technology can also play a role in this respect. The ceteris paribus reference was included to cover such items as accounts receivable and inventory.
Table XXXV. Eleven Financial Ratios Applied to Feed Manufacturing Firms in Montana and Utah

<table>
<thead>
<tr>
<th>Ratios</th>
<th>1960 Industry Standards</th>
<th>Six Selected Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(250 m to m)</td>
<td>U</td>
</tr>
<tr>
<td>1. Current</td>
<td>2.19</td>
<td>8.92</td>
</tr>
<tr>
<td>2. Net Worth/Fixed</td>
<td>1.82</td>
<td>2.23</td>
</tr>
<tr>
<td>3. Net Worth/Debt</td>
<td>1.38</td>
<td>3.00</td>
</tr>
<tr>
<td>5. Cost Sales/Inventory</td>
<td>16.30</td>
<td>9.43</td>
</tr>
<tr>
<td>7. Sales/Fixed</td>
<td>10.52</td>
<td>5.49</td>
</tr>
<tr>
<td>8. Sales/Net Worth</td>
<td>5.78</td>
<td>2.47</td>
</tr>
<tr>
<td>9. % Profit/Net Worth</td>
<td>5.86</td>
<td>25.19</td>
</tr>
<tr>
<td>10. Sales/Total Assets</td>
<td>3.35</td>
<td>2.39</td>
</tr>
<tr>
<td>11. Profit/Total Assets</td>
<td>3.39</td>
<td>2.44</td>
</tr>
<tr>
<td>Working Capital</td>
<td>$ *</td>
<td>335,467</td>
</tr>
</tbody>
</table>

*Not reported
The point being that a high ratio may be explainable in terms of delinquent accounts receivable and/or obsolete or improperly valued inventory. In short, a high current ratio raises the presumption of financial stability but the presumption is a rebuttable one.

The national feed manufacturing industry's standard for 1960 was 2.19. The two Utah mills represent the ultimate in financial stability and the basic presumption holds hard and fast. Their average ratio is 9.3. The only criticism that can be leveled is that if this high ratio is maintained over time it represents a waste of economic resources. The Montana industry ranges from .65 to 3.12 with an average current ratio for the state of 2.01. However, by analyzing the individual businesses it is found that Mill V, when doubtful receivables are withdrawn, has a ratio of approximately 1:1.

**Worth/Fixed**

This ratio is computed by dividing net fixed assets into tangible net worth. This net fixed asset figures requires that all plant and equipment facilities be valued after accumulated depreciation, and the "tangible" indicates that such items as good will, trade marks, copyrights and patents, etc. be removed, thereby establishing the "tangible" net worth of the proprietorship as the case may be. This financial relationship expresses the proportion between the owner's capital and the long term investment in plant
High ratios indicate that the net worth is liquid and therefore the more effective for the protection of creditors, the proprietor's capital will be in the event of insolvency. When this ratio is found to be in excess of 1.00 the excess indicates the amount of the contribution of the proprietor to the working capital. The national industry's standard is 1.82. Again the Utah firms are in a favored position with an average ratio of 3.66 and by referring to Table XXXV the rather substantial volumes of working capital may be observed. By contrast Mill Y in Montana with a ratio of .22 shows a dangerous condition and working capital is nil. The Montana average of 1.11 is somewhat below the national standard but nevertheless Montana proprietorship is making some contribution, even though slight, to working capital. A dynamic industry should show an increasing relationship with the passing of each fiscal period and if the increase is not forthcoming, analysis should be immediately undertaken. From a business cycle point of view an unfavorable relationship here creates a serious problem. This is true because of the economic loss that results when a substantial portion of fixed assets lie idle for a given length of time. Of course, there are considerations in the form of maintenance cost.

Worth/Debt
In computing this financial relationship total debt is divided into tangible net worth and therefore relates the proportion of equity capital to the capital supplied from outside sources. Obviously, therefore, the higher the ratio the more substantial is the position of the financial institutions granting credit to the feed manufacturing firms. Of course, the total economic resources are composed of the total capital which is at the disposal of a firm and this has two segments - the proprietorship or net, or the owner's equity capital, which is of a permanent nature and the capital that is provided by creditors. This latter factor is a temporary condition and a reckoning must eventually culminate. The national industry's standard in 1960 was 1.38 and Montana compared reasonably with an average of 1.29, but again Mill Y was in serious trouble. The economic significance of this ratio may be related to sudden adversities in sales, rapid demand changes, quick business cost increases, strikes, and any number of other factors that radically disturb the normal business operation. When one or any of these events occur the very survival of the business is at issue if this ratio is in a precarious condition. The higher this financial relationship the easier the debt pressure and the greater the protection for both the business and the creditors.

Sales/Receivables

The net annual sales are divided by the total dollar volume of
the trade accounts and bills receivable in computing this ratio. This extremely important ratio relates the volume of business or sales to the outstanding receivables. A higher ratio indicates a swift collection of sales during a given fiscal period and a more liquid receivables condition. The national industry standard is 10.23 and Montana's average is helped rather substantially by Mill U and Z and can therefore report an average of 10.7. However, the two ratios reported by Mills W and Y are more representative of what would be found if all the firms revealed their financial statements. The economic impact of this relationship is commented on in Chapter VI.

Cost of Sales/Inventory

The method of computation for this ratio involves dividing the cost of sales by the total of inventory. Therefore this financial relationship expresses the proportion between the cost of sales and the inventory at the end of a fiscal period. The principle involved is that the physical turnover measures the marketing capacity or ability of a firm. This is the main economic concept involved here. The higher this ratio the greater is this marketing ability or capacity and the more likely that the manufactured feed possesses freshness and salability. The national standard for the feed manufacturing industry is 16.3 while the Montana industry falls to 13.03. In this relationship the Utah mills fall below the Montana mills with
a ratio of 10.69. Again in the Montana industry, Mills Y and Z need to take immediate action to correct their situation.

Sales/Inventory

This ratio is included principally for empirical comparative purposes and is computed by dividing the total of merchandise and work-in-process inventory into the net annual sales. The economic significance of this ratio is that it can measure, within reasonable limits the merchandising and/or marketing capacity of the firm in terms of sales per unit of inventory. However, this is difficult to accomplish. In short, this ratio expresses the proportion between sales volume and merchandise and can add a warning signal when the physical inventory turnover becomes too low. In the feed manufacturing industry, because of the deterioration of quality in the finished feed that occurs with the passage of time inventories are purposely held to a minimum level by the more informed and quality conscious feed mills. The national standard is 19.57 as compared to 15.68 for the four co-operating Montana mills. The Utah mills again in this particular respect follow the four Montana mills with a 12.62 ratio. Montana's position would improve significantly were it not for Mills Y and Z, which again show very unfavorable positions.

Sales/Fixed Assets

To calculate this ratio divide total net fixed assets into net
annual sales. The economic significance of this relationship is that the ratio helps measure the productivity of the fixed assets in terms of sales. When capital investment is made in plant capacity or in other capital assets it is for the purpose of facilitating the production function. Therefore as the relationship of sales to fixed assets increases there is a strong presumption that the capital investment in the plant is being used efficiently. Sometimes an extremely high ratio, where relatively small capital outlays are invested in fixed assets, indicates that the firm is leasing its productive equipment and leasing or renting its real estate. One firm, i.e., Mill Z indicates this probability with a ratio of 50.7 whereas the national industry standard is 10.52, and the remaining Montana mills combined with the two Utah mills reflect a 7.69 average ratio. This generally substantiates the relationships indicated in Section I of this chapter, i.e., that many firms are not properly utilizing their resources.

Sales/Net Worth

Tangible net worth is divided into net annual sales in arriving at this ratio. This ratio reflects the activity or the run-over of the proprietor’s capital during a fiscal period. Capital investment in economic enterprise is only made in hope of gaining a reasonable return. The probability of a reasonable return is to a large extent dependent upon the activity of the capital investment and this
ratio helps to measure this investment activity. The national standard for this ratio is 5.78 and Table XXXV shows two extreme departures from the norm. It is therefore necessary to account for this; when invested capital is turned over too rapidly the probability is that liabilities will build up excessively, as the capital owed to creditors becomes a substitute for permanent capital that should have been invested in the business. Mill Y with a sales/worth ratio of 79.00 has a current ratio of .65.

**Percentage Profits/Worth**

The method of computation for this ratio involves dividing net profit after taxes, i.e., federal income taxes primarily, by tangible net worth. Of course, the ratio expressed the relationship between the proprietor's share of operations for the fiscal year and the capital previously invested by the proprietor.

**Sales/Total Assets**

The Sales/Total Assets ratio is computed by dividing total assets into net annual sales. The economic significance of this ratio is that the higher the ratio becomes, the more effectively the total assets of the business enterprise are being utilized. This ratio also expresses the sales activity of the total resources of the business and also the total activity of both the permanent and temporary assets. The national industry standard is 3.35 as compared to combined averages of Montana's and Utah's mills of 2.63,
which indicates that something is left to be desired in the efficiency of total resource use.

**Profits/Total Assets**

Computation is made by dividing total assets into the net profit after taxes. Briefly and finally this relationship indicates the net profit ability of the utilization of all economic resources employed by the business enterprise. The national industry standard in 1960 was 3.39 and all contributing mills in Montana and Utah average a disappointing 2.44.

In concluding this section it is recommended that all feed mills compute these financial relationships on a dynamic basis so as to ascertain the efficiency to which they are employing their economic resources.

**Model Mills**

**Introduction**

Two model mills will be recommended for use in Montana and the cost figures and specifications reported are based on the latest and most accurate data possible. The first model mill is essentially a completely balanced plant built around a 75 horsepower pellet mill. The second model mill recommended for use in Montana is built around a battery of two, 100 horsepower pellet mills. The second mill would have a capacity of 128 tons of pelleted feed per eight hour
day. The rated capacity of the machines recommended for the second model mill would be slightly higher, however, "rated" capacity is seldom obtained on a continuing basis. For Model Mill I a capacity of 40 tons per eight hour day is expected. In planning a feed manufacturing plant the volume, quality and type of finished feeds that will be produced in the feed plant must be set forth in terms of detailed formulas and the raw ingredients that are involved in each formula must be established. This covers all classes of feeds and in turn will help to set the capacity of the feed manufacturing plant in terms of tons per hour of finished feeds. It may be that the mill will wish to produce "X" amount of bulk or bagged and the finished feed may be in a mash form or in a pelleted form. The latter is the case in Montana where the pelleted range cube accounts for 55 per cent of the total pelleted rations.

Information on the raw materials received at the feed plant must be analyzed. In Montana a large number of mills utilize wheat-mixed feeds in their production and therefore, must plan their mills so as to facilitate the intake of this raw material. The per cent of all feed grains and other items such as wheat mixed feeds received by rail and the per cent to be received by truck is also necessary information. It is imperative to estimate the amount of grain storage that will be necessary to support the feed manufacturing plant. Buying and inventory policies should receive advanced consideration so as to gain the maximum economic benefit from inventory control.
and when feed grains are readily obtainable in close proximity to the feed plant less capital investment will be required for storage facilities.

In planning a feed mill the thirty-six considerations in Appendix B represent a start in obtaining the necessary detailed information upon which to base adequate planning.

Facilities for steam rolling have not been included in either Model I or Model 2S, however, the present nature as well as the expected future demand for manufactured feeds in Montana makes the inclusion of such facilities imperative. From a revenue point of view steam rolling has many attractive features and will add financial stability to any feed manufacturing plant. Steam rolling facilities are complementary rather than competitive with pelleting operations. The focal point of this study is pelleting, however, the growing importance of steam rolling demands that mills plan for this additional operation. Estimates for steam rolling operations run from ten to thirty thousand dollars depending upon present equipment arrangements and capacities.

Model Mill 1

The following is the equipment schedule for Model 1. The equipment manufacturer names are represented by an "X" indication. It is further recommended that horizontal drop-bottom mixers be utilized in all mills built in the future. This is because the
future will doubtlessly see the Food and Drug Administration apply increasingly strict controls.

Basic Equipment

1. X No. 6 Truck hoist
   3 HP 1750 RPM open motor
   3 HP starter
   Pushbutton
   $ 915.50
   133.00
   31.59
   15.39
   1095.48

2. Pipe grill for dump pit
   260.00

3. Steel hopper in pit
   208.00

4. X 20" wide double chain drag feeder, 21'
   overall length, flights every 4th pitch,
   3 HP vari-drive open motor R660 roller
   chain drive, starter, pushbutton, trip
   relay and built-up sides
   1920.00

5. X F-99 mill fan on separate base = 100 HP
   on mill 50 HP on fan = stub hopper, long
   sweep elbow, three screens, magnet and
   ammeter
   7275.94

6. Mill pipe 56"
   182.00

7. Long sweep elbow = included in Item #5

8. X 60" long cone collector
   500.00

9. X Swing flow distributor 4-12" dià outlets
   flanges and indicator cable
   369.00

10. 12" dia spouts = 4 spouts 4" long flanged
    one end
    49.20

11. 9000# hopper scale complete with hopper
    1357.00

12. Horizontal mixers with drop bottom doors,
    size #248, style "9", Stainless steel
    construction
    4000.00
13. 9" dip auger 12' over all complete with drive 1 1/2 HP Motor, starter and push-button $466.00
14. X Model 8524 Elev. leg = 72' discharge height
   3 HP motor TEFC drive 1722.30
   3 HP starter 392.00
   Pushbutton 31.59
   Service platform 15.39
   Extra boot pocket 100.00
   Steel ladder 16.50
   Weather cover 42.00
   Vented cups 35.00
   Total 2378.43
15. Distributor adapter 50.00
16. X distributor 8' 8" outlets
   Indicator cable 365.00
   Total 28.00
   Total 433.00
17. 8" dia spouts from item #16 to bins 190' reqd. 484.50
18. X Z high stand roller mill (dry only) Model 1036 W-2
   25 HP 3/60/220/440 electric motor TEFC 3400.00
   Starter 665.00
   Push button 68.04
   Total 4148.43
19. 4' sq. surge bin = 45° bottom side draw off 400.00
20. Spout from 19 to 14 35.00
21. X 12" double chain drag feeder 23' 6" overall length, starter, pushbutton, flights every 4th pitch, RC 50, drive, 2 HP gear head, 150 RPM motor, motor base and built up sides 1267.23
22. Grill for car unloading pit 375.10
23. Steel hopper in pit 208.00
24. X 12" double chain drag feeder 29' overall, starter, pushbutton, flights every 4th pitch, RC-60 drive, 3 HP gear head motor, motor base and built up sides 1444.46
25. Drag head hopper $ 175.00
26. X Model 8524 elevator leg 72° discharge height, price same as Item #14 2378.43
27. Distributor adapter 50.00
28. X distributor 10-8" dia outlets Indicator cable 440.00  28.00 468.00
29. 8" dia spouts from 28 to bins 285° reqd. 740.00
30. X 9" screw feeder with inlet and discharge outlet, motor mount, including one 1 1/2 HP G.H. motor, 155 RPM, one 1 1/2 HP 3/60/440 and starter, one 9 pushbutton starter, 20 tooth RC-60 sprocket, one 30 tooth RC 60 sprocket, 10" RC 60 chain 616.15
31. X 9" screw feeder with inlet and discharge outlet motor mount, including one 1 HP GH motor, 155 RPM, one 1 HP 3/60/440 starter, one pushbutton, 20 tooth RC 60 sprocket, 30 tooth RC 60 sprocket, 10" RC 60 chain 496.53
32. Same as item 30 616.15
33. 5° sq. mash bin 588.00
34. 75 HP Pellet mill 10000.00
35. X 2B-2 Pellet cooler 10 HP on fan 4000.00
36. Hopper under cooler 65.00
37. Spout from 36 to 38 35.00
38. 6 x 4 Cool pellet leg = 66° discharge height elev. leg 1322.50 3 HP motor TEFC and drive 392.00 3 HP starter 31.59 Pushbutton 15.39 Service platform 100.00 Steel ladder 35.00 Weather cover 35.00 Vented cups 19.42 1950.90
39. Spout from 38-40 $25.50
40. X Pellet crumbling mill 15 HP motor $0.00
41. X 36 x 60 double deck shaker $0.00
42. 8" 2-way flop gate $39.50
43. Spout from item 41 to 33 $37.00
44. Spout from item 42 to bagging 8" dia x 6' $15.30
45. 14" dia pipe from 35 to 46 - 30° reqd. $82.50
46. Pellet cooler cyclone No. 656 inlet adapter No. 46A, included in item #35
47. X model 120 belt feeder 12" wide 28' overall, complete with 2 HP motor, starter, pushbutton and weather cover 859.96
48. Included in item #47
49. Belt feeder end hopper $45.00
50. X distributor 4° 8" dia outlets $275.00
   Indicator cable $15.00
   $290.00
51. 4-8" dia spouts 5° long $51.00
52. 6° sq. bagging bin cap. 350 bu. $536.55
53. Adapter $15.00
54. 9" dia screw conveyor 4° overall same as Item #31 $496.53
55. 9" dia screw conveyor 4° overall same as Item #31 $496.53
56. Manlift and machinery tower $340.00
57. Pipe grill $260.00
58. Steel hopper in pit $208.00
59. Spout from bin 10-11-12 to floor drop $ 192.00
60. 45° elbows - reqd. 20 320.00
61. Floor drop to mill 260.00
62. 8" K Valve offset on 45° 39.50
63. 8" Spout 15' long 38.25
64. 8" Spout 22' 36.10
65. thru 67. Chain operated rock and pinion 166.50
68. Hopper over roller mill 5.00
69. thru 73. Chain operated rack and pinion 277.50
74. thru 79. Chain operated rack and pinion 333.00
80. Canvas shocks 25.00
81. Spout from bin 2-3-4 to hopper scale 40.50
82. Spout from bin 1 to hopper scale 3.00
83. Chain operated rack and pinion 55.50
84. thru 89. Chain operated rack and pinion 333.00
90. 8 Load out bins over drive way 5785.20

Total $61,924.75

Plant Structure.

There are several basic alternatives available. These include such choices as concrete, steel, and wood or some combination of these materials. The cost of any one of the above mentioned alternatives will vary from locality to locality depending on land costs, prevailing wage scale and other factors. Steel, of course, is somewhat
more expensive than either concrete or wood and for obvious reasons, wood is not a satisfactory material. In Model Mill 1, a bolted tank feed mill can be obtained for $42,421.79, whereas a concrete mill with reinforcing is quoted at $30,000. In any event, a mill planned in Montana must consider the necessity for proper insulation. The following is a schedule of cost for a concrete mill together with the auxiliary items.

Excavating and backfill .......... $ 3,000
Concrete and reinforcing. .......... 30,000
Bins and hoppers (extra). .......... 10,000
Electrical. ....................... 1,500
Plumbing. .........................  750
Millwright. .......................  7,000
Miscellaneous (including sewing machine, and bagging scale) .............. 2,500

Land. ............................  7,500

Total $62,250

When an expansion program is planned the steel mill offers more flexibility and may well merit the additional expenditure of $12,421.79.

Special Auxiliary Supplies and Inventory.

Steel warehouse 50' x 14' x 100' erected on a concrete slab complete .......... $12,095

Forklift truck. .....................  4,000
Pellets and Miscellaneous ........... $  750

Total ................ $16,845

Therefore, the total cost for Model Mill 1 including a budgeted land cost of $7,500 is $141,019.75 or this may be expressed as an investment of $28,203.93 per ton of expected hourly capacity. This represents a somewhat higher figure than seems desirable and perhaps with hard bargaining it could be reduced, however, it is seriously doubted if anything above 10 per cent discount could be obtained.

One mill recently built in Montana invested $55,000 per ton of expected capacity. Conditions such as these make some operations marginal. Diagram 2 shows a typical cross-section of the mill that has just been presented and Diagram 3 shows a cross-section in the opposite direction of the same mill. Special attention is called to the equipment layouts. Stage 4 and Stage 5 are located on the same floor level and in close proximity to each other with the hope of gaining higher utilization of labor inputs. Diagram 2 shows the stairway leading from Stage 4 and 5 directly to Stage 1. The same objective is intended for this arrangement.

**Break Even Analysis**

In the calculation of the following break-even points the latest available data were used. Three basic values were determined, i.e., sales or revenue, fixed costs and variable costs. Much of this information was taken from the financial reports of feed manufacturing
DIAGRAM - 2
SIDE VIEW MODEL NO. 1
firms operating in the state of Montana. It is necessary to classify the various cost items into either the fixed or variable category. Of course, there are many authorities espousing the various methods that may be used to accomplish this end. Our budget arrangement will classify such items as rent, interest, depreciation and general and administrative expenses as fixed costs. These items are readily obtainable from any income statement. The major elements in the variable cost classification for feed manufacturing concerns raw ingredients, direct labor, sales costs, etc. One authority suggests that all fixed costs be established and this amount subtracted from total cost thereby placing the balance in the variable cost classification. The formula used to arrive at the break-even point which is expressed in dollars or in terms of capacity is as follows:

\[ X = \frac{\text{Fixed costs}}{1 - \frac{\text{Variable costs}}{\text{Sales}}} \]

The mathematical basis for this formula is given in Appendix A.

**Fixed Costs**

- Equipment for Model Mill 1 $62,924
- Ten year straight line depreciation* $6,192

*It has been assumed that all equipment is contained in one general depreciation schedule. Advanced information concerning the new Bulletin "F" indicates that this assumption here may become tax law.
Plant Structure  $ 54,750
   Twenty year straight line depreciation  $ 2,737
Steel Warehouse  12,095
   Twenty-five year straight line depreciation  483
Forklift Truck and Pallets  4,750
   Five year straight line depreciation  950
Total depreciation for Year One  $ 10,362
Insurance  7,500
Interest and Banking  1,000
General and Administrative (including
   basic accounting and owner's wages)  21,000
Office Labor  4,800
Taxes, Ad Valorem, Pay Roll and
   Unemployment Compensation  6,300
Water - Commercial base  720
Total Fixed Costs  $ 51,682

Variable Costs

Raw Ingredients

   This cost is based on an annual production
   of 14,600 tons which is equal to 100% of capacity
   based on an eight hour day. An ingredient cost
   of $51.80 per ton has been established for a stand-
   ard 20% protein Montana range cube. These prices
   were in effect generally in 1959-1960.  $756,280

Direct Labor

   3 men at $6,500 per year =  $19,500
   1 man at $8,400 per year  =    8,400  27,900
Advertising (50 cents per ton, Montana average)  
(Variable unless fixed by policy) $ 7,300

Power Costs (.41 + .10 = .51 per ton) 7,446

Natural Gas 4,500

Bad Debt (1/2 of .1 per cent of sales) 5,205

Supplies (expense includes bags, tags, etc.) 9,000

Commissions and Sales Cost  
(average 3.00 per ton) 43,000

Miscellaneous Variable Costs  
(rate of 1.00 per ton) 14,600

Total Variable Costs $875,231

The total fixed costs is $51,632 and the total variable cost at 100 per cent of capacity is equal to $875,231. With an average selling price of $68.50 per ton and a total projected volume of 14,600 tons representing 100 per cent of capacity, total revenue is equal to $1,000,100. By applying the formula previously indicated the following break-even point is determined:

\[
X = \frac{51,682}{875,231} \left( \frac{1}{1,000,100} \right)
\]

Therefore the break even point in terms of dollars of sales volume is $413,456. This is equal to the total revenue from the sale of 6,035 tons of what may be called a "standard" 20 per cent protein Montana range cube. This relationship may also be expressed as 41.34 per cent of plant capacity. This calculation is established
by dividing the total revenue at 100 per cent of capacity which is $1,000,100 into $413,456 which represents the total sales volume in dollars necessary to break even. This relationship is shown graphically in Diagram 4.

Ostensibly this break even point is a reasonably favorable relationship, however, as was pointed out in Chapter IV, the problem of seasonality must be considered. At best this break even point must be reached in a production season that has a maximum length of six months. This is tantamount to saying that the effective break even point for this mill is in reality approximately 82.6 per cent of capacity. One of the most significant contributions made by Model Mill 1 is the planned equipment arrangement which provides the opportunity for a more complete utilization of labor than is normally found in the Montana industry. Mills of this size presently in operation employ approximately four additional labor units which would raise the break-even point by approximately 21 per cent if the labor expenditure were incurred by Model Mill 1.

Reference to Diagram 3 indicates that automatic weighing and packing equipment has not been installed, therefore, the economic considerations involved in this installation may be explored. Assuming an additional investment of $18,000 to cover the purchase and millwright expenditure necessary to install the equipment, it is reasonable to expect a marginal increment in fixed costs of approximately $2,000. If it is not possible to reduce variable cost, i.e., direct labor,
Diagram 4
Break Even Chart, Showing Profit & Cost Relationship for Model Mill No. 1

\[ x = \frac{51,682}{875,231} = \$413,456 \text{ OR } 41.34\% \text{ OF CAPACITY} \]

- **Profit Area**
- **Loss Area**
- **Break Even or Profitless Point**
- **Fixed Cost**
- **Percentage of Capacity**
- **Revenue**
- **Variable Cost**
then the break-even point will be increased by $16,000 or an equivalent of the revenue derived from the sale of 233 tons of range cubes. This relationship is illustrated in Diagram 5. It will be noted that the fixed cost line has moved vertically by an amount equal to $2000 while the variable cost line maintains a constant slope as indicated in Diagram 5.

If by the installation of a completely automated device for the handling of packing and weighing it is possible to reduce the variable cost then an improvement in the break-even point can be expected. The reduction in variable cost is related to the displacement of one labor unit which reduces direct labor cost by $6,500. Therefore, assuming a $2,000 increase in fixed costs and a reduction of $6,500 in variable costs a new break even point is reached. The new break even point is $406,681 in sales volume which represents the total revenue received from 99 tons of production.

Another consideration that exerts dynamic influence is the element of depreciation. Many Montana mill operators are not cognizant of the impact of depreciation on their cost structure and several operators do not consider depreciation when special sales situations are negotiated. To illustrate the impact of depreciation on the break even point for Model Mill 1 a second calculation may be made as follows:
DIAGRAM—5
ADJUSTED BREAK EVEN POINT, SHOWING INCREASE
IN FIXED COST

NOW $x = \frac{53,682}{.125} = 429,456$ OR 42.94% OF CAPACITY

REVENUE
VARIABLE COSTS

BREAK EVEN OR PROFITLESS POINT
PLUS INCREASE IN FIXED COST

LOSS AREA

30.05% 41.34% 42.94%

FIXED COST

PERCENTAGE OF CAPACITY
$51,682 - Total Fixed Cost

10,362 - less depreciation

$41,320 - Fixed Cost without considering depreciation

therefore, $41,320 \div 0.125 = $330,560

or X = $330,560 in terms of dollars of sales volume

This relationship is presented graphically in Diagram 6. The
failure to calculate depreciation in the preceding example has the
effect of reducing the break-even point by $82,896 or perhaps more
vividly the revenue from 1210 tons of pelleted production. It should
be recognized in all feed manufacturing plants that depreciation is
one of the more significant costs of doing business. The profit
structure for feed manufacturing firms operating within the feed manu-
facturing industry could be substantially improved by solving the
seasonality problem. The six months of idle capacity represents a
tremendous waste of resources. The solution to this problem, by and
large, may be found through various types of integration. Montana's
need to integrate is one of its most paramount problems.

Model Mill 2

Model Mill 2 represents a somewhat different approach than its
basic counterpart that is presently operating in Montana. Model Mill
2 is designed to produce sixteen tons of finished pelleted feeds per
hour utilizing two 100 horsepower pellet mills. Mills of comparable
BREAK EVEN CHART, SHOWING THE RESULTS OF REMOVING DEPRECIATION AS A FIXED COST ITEM

\[ x = \frac{41,320}{.125} = 330,560 \text{ OR } 33.05\% \text{ OF CAPACITY} \]

BREAK EVEN OR PROFITLESS POINT LESS DEPRECIATION

30.05% 41.34%

PRECENTAGE OF CAPACITY
size within the Montana industry generally employ a battery of three pellet machines to gain approximately the same production.

Basic Equipment.

In Model Mill 1 the pellet mill designed was an optional condition, however, it is felt that the vertical mill should be the mill installed for Model Mill 2, this is because the preponderance of the evidence seems to favor the vertical mill when the higher production volumes are demanded. As in Model Mill 1 the drop bottom mixer is strongly recommended.

Plant Structure.

The same applications as were recommended in Model Mill 1 also extend to Model Mill 2. The $30,312 investment per ton of capacity is projected into Model Mill 2, therefore, Model Mill 2 requires a minimum total capital investment of $485,000.* Cost variations in the projected figure would more likely be caused by special equipment demands and by variations in the quality of the equipment than in any other factors. The requirements for auxiliary supplies and inventory are considered in the same manner as they were for Model Mill 1. In short, Model Mill 2 has replaced with its twin 100 horsepower vertical mill arrangement its three battery

*Based on information supplied by a leading feed plant engineering and manufacturing company, July, 1962.
counterpart which is presently operating in the Montana industry.

Break-Even Analysis.

Again the three basic factors must be established, i.e., sales or revenue, fixed costs, and variable costs. When the break-even points have been calculated it will become evident that a rather substantial marketing area will be necessary to support a mill the size of Model Mill 2. Whereas Model Mill 1 could quite likely operate with a marketing area having a radius of fifty to seventy-five miles, Mill 2 must cover one or more of the geographical areas of the state. Further, in all probability Model Mill 2 will engage in inter-state marketing depending on several factors, including geographical location.

Fixed Cost.

Empirical evidence seems to indicate, however, that mills operating in this size range seem to experience higher administrative costs than do the smaller units. Adequate planning and management should be able at least to hold this cost to a proportionate economic point with reference to mills in the 5 ton classification. Because of the slightly higher capital investment required for Model Mill 2 the depreciation charge will exceed that for Model Mill 1.

Variable Costs.

Inasmuch as raw ingredients constitutes the largest single
variable cost item it offers one of the most attractive areas in which to gain economies. Because of the necessity to purchase the multiple ingredients in substantially larger quantities than were obtained for Model Mill 1, an enhanced bargaining position is realized. It is necessary to point out, however, that economies to be gained from this enhanced bargaining position will not accrue automatically but will be a direct function of the individual management skill involved. A second area of prime concern is sales cost and this will be largely determined by the type of policy employed by the mill concerned. It is generally recommended that mills follow a straight commission rate applied to the tonnage sold. A third area that demands comment is direct labor. It is felt that direct labor will be fully utilized in both Model Mills so that the question of unionization becomes the paramount issue. There seems to be a marked tendency for mills within the larger classification to be subjected to more intensive unionization. Of course, the result will be higher wages and therefore, higher direct labor costs and a resulting higher variable cost. The smaller mills appear less attractive to unionization and thereby largely go unorganized. Both models were assumed to pay a wage rate equal to the going union standard.

Revenue.

Total revenue at 100 per cent of capacity is calculated by
multiplying total tonnage by the average revenue per ton. This amounts to $3,200,320, therefore, applying the formula previously stated the following relationships evolve.*

\[
X = \frac{183,878}{1 - \frac{2,806,599}{3,200,320}}
\]

thus, \(X = 1,482,887\)

This represents a break-even point in terms of dollars of sales volume. The percentage of plant capacity necessary to break-even is 46.33, however, the significant point is that a much larger market area is required to support this higher volume of operations. Whereas, Model Mill 1 could break even by selling in its respective market area, approximately 6,000 tons of pelleted feed, Model Mill 2 must sell 21,647 tons of pelleted feed. The significant relationships to be drawn from these two models will be enumerated in the conclusion.

*The fixed and variable cost figures were established from data obtained from an existing feed plant operating in the Northwestern area. The plant possesses most of the characteristics of Model Mill 2.
CHAPTER VI

SUMMARY

Steam Rolling, Grinding and Mixing and Pelleting

With reference to grinding and mixing and steam rolling, steam rolling with its increasing complexity is the overwhelming type of feed processing in the state of Montana. The only exception is found in the Western area where grinding and mixing exceeds steam rolling. During the period of this study substantial capital investment took place to expand the steam rolling capacity of the Montana industry. Where grinding and steam rolling are the predominant endeavors the problem of seasonality is not so great as where pelleting operations are employed. The predominant use for steam rolled barley is for fattening cattle with lesser amounts being used in other operations. The major concentration of this effort is in the Central and Eastern areas of the State.

Several firms in Montana have integrated swine feeding operations into their feed manufacturing program. This facilitates increases in production volumes and also helps to solve the problem of seasonality. Where this integration has taken place the firms report a substantial degree of success.

The supply of barley has been sufficient to support this phase of the feed manufacturing industry, as well as pelleting, and it is expected that supplies will increase perhaps at an even greater rate.
then increases in this type of feed processing. Feed manufacturing plants in all areas of Montana report a preference to obtain barley supplies locally to as great an extent as possible. However, when local shortages materialize or when price differentials are present the firms obtain their supplies from any source at hand. The Judith Basin, the Triangle area and the Hi-line are the most important areas of supply. The Western area relies particularly heavily on the Triangle area.

The trucking industry plays an extremely important role in the distribution of barley supplies to the many users. There is no established "formal" movement or pattern of supply. The transportation of these supplies is the result of many small trucking entrepreneurs seeking to maximize revenue by any opportunity that presents itself. The railroads play a very minimal role in the movement of barley and hay supplies.

Steam rolling, grinding and mixing facilities have as a general rule been integrated into businesses that serve agriculture. Particularly in the case of steam rolling many of the firms report that the revenue gained from this activity contributes substantially to the economic welfare of the firm. Probably this source of revenue would be even more significant if more accurate and detailed financial records were maintained by the firms engaged in this type of feed manufacturing.
What of the Future for Steam Rolling, Grinding and Mixing?

There will definitely be an increase in investment in steam rolling capacity. This capital investment will come from new firms entering the field and from firms that are adding steam rolling as an integrated function in an already existing business. The relatively low capital investment, i.e., $50,000 to $75,000 will facilitate the entry of firms into the field. This is in reference to the Central and Eastern areas and the Western area is generally excepted. It is expected that the status quo will be substantially maintained in the Western area. The only exceptions will be the result of the efforts of isolated entrepreneurship.

The general consensus is that swine feeding will increase generally and will serve as an additional step on the ladder of integration. In short integration is the by-word for nearly all phases of this industry.

With reference to the transportation of supplies, i.e., barley and hay, the trucking industry will continue to overwhelmingly dominate in the future. The railroads will doubtlessly continue in a passive capacity. The very nature of the transportation problem supports this concept.

Pelleting

One of the most striking observations is the wide difference that exists in the Montana feed manufacturing industry with reference
to the type, age and arrangement of equipment employed. However, the feed manufacturing plants of the Eastern area are relatively more similar in terms of plant arrangement and capacity. It is possible to account for this by the fact that the majority of these mills are the property of the same parent organization. This wide variation continues into the area of basic construction. This construction varies from new all steel mills to old wooden plants that have been converted from elevators.

The pelleting of range cubes is the most important single line of endeavor. This is particularly true in the Central and Eastern areas of Montana. It is felt that with the few isolated locations the Montana industry presently has sufficient capacity to meet both present and future demands. Investment in feed manufacturing plants with pelleting facilities has reached a figure of approximately $2,500,000 in the past four years. As in the case of firms with steam rolling and grinding and mixing facilities, firms with pelleting operations are also integrating into whatever areas seem attractive. The barley supply conclusions previously expressed also apply to the feed manufacturing firms that offer the pelleting service and market a tagged line of pelleted formula feeds. Delinquency in accounts receivable is a very real problem which also applies to all segments of the feed manufacturing industry.

Another very significant conclusion to be drawn from the data presented is that there are no apparent economies of size within the
present structure of the Montana industry. Notwithstanding, one mill in the "A" classification, in fact the largest mill, may possess the necessary requisites to achieve economies through size. This mill had an excellent cost pattern through all stages of production save one, and steps are presently being taken to correct this condition. In addition to this consideration, had this mill been constructed with a more economical relationship between total investment and capacity, it is realistic to expect that this mill would in fact have been the lowest cost per unit of output in the Montana feed manufacturing industry.

Mill 1B which has the lowest reported cost per unit in the Montana industry in all likelihood is facing a short run condition and it is only reasonable to expect that when the short-run period expires not only will the equipment which has been previously depreciated require expensive repairs but it will become increasingly obsolete. In the long run, then it is logical to expect that the cost curve for Firm 1B will shift abruptly upward and that as a consequence it will lose its favored competitive position. As discussed in the ratio section of Chapter V, Mill 1B may be in a dangerous position in terms of delinquent accounts receivable. One of the dangers of pushing into marginal market areas is that the accounts that are incurred leave a great deal to be desired and constitute an extremely high cost to pay for giving increased production volumes. At best it is a short run situation and financial danger is the
strongest inherent characteristic. If firms within the Montana industry choose to follow operational patterns such as the one just described they should do so with the realization of all the possible dangers.

Regardless of the size of the firm in the Montana industry the economies that will most enhance the profit structure of the firm are all internal economies. These economies can best be obtained by employing the latest technology available and constructing the physical plant lay-out in such a way as to maximize the return gained from the equipment employed in each of the six basic production stages. In short, the mill should possess as a requisite to economic success, a "line balance". Further this study has pointed out on numerous occasions that equipment can be so arranged, from an engineering point of view, as to fully utilize each labor unit that is employed in the various feed manufacturing stages. An example of this is the mills where the equipment is so arranged that the pellet machine operator can also function in Stage 5 or in other stages that can be arranged to allow for this flexibility.

It is feared that mills of larger size such as represented by Model Mill 2 will be more subject to what might be called excessive "industrial bureaucracy". This, of course, will lead to increased fixed costs at least in the short run. There is empirical evidence to support the reality of this idea. The larger mills are also quite likely to appear as more lucrative fields for unionization.
Generally speaking, there is a one dollar wage differential between union shops and mills without union representation.

The opportunity exists in almost all mills to gain internal economies from one or more of the production stages. These economies are possible without disturbing the line balance. Further in some cases additional capital inputs could facilitate line balance where it had not been established. However, when line balance has been achieved a marginal input at any one of the production stages quite likely will lead to a break-down in plant equilibrium with a resulting complexity of problems. This is with specific reference to capital outlay in the form of equipment.

Further, it is necessary to reiterate the proposition that a substantially larger marketing area is necessary to support a Model Mill in the size range of Model Mill 2. This market expansion leads to a complexity of problems. An inquiry into this area would serve well as a basis for future research.

The present price structure in the Montana industry is such that marginal producers will not be forced out. The availability of substitutes for pelleted feeds will operate in a significant degree to keep prices within reasonable limits, ceteris paribus. This offers another area for future research.

The ratio analysis presented in Chapter V points out the need for a higher degree of resource utilization and the accompanying idea that more efficient managerial application is needed. Further,
firms within the Montana feed manufacturing industry should be encouraged to keep more detailed financial records as well as recording production data. Only with such detailed information can profits be maximized.

Finally, the geographical distribution of the feed manufacturing plants in Montana may be likened to a giant ellipse superimposed upon the map of Montana. The reasons for this are evident by observing the several maps that have been included within this report.

**What of the Future for Pelleting?**

It is expected that a few mills may find suitable locations and enter the field. However, these opportunities are rather limited and location choices should only be made after considerable research in the areas of marketing and supply. As technology continues to develop the more enlightened existing plants will add these special features. One future development is very evident, i.e., the existing plants that have not installed steam rolling facilities will do so. The complexity in feed formulation will show substantial progress. One thing is certain, both federal and state regulation will grow. To prepare for this the Model Mills developed in Chapter V both provided for stainless steel drop bottom mixers. This will facilitate cleaning and substantially reduce the chance of contamination from the medicated feeds that are processed. The
future mill doubtlessly will see a slight trend toward bulk delivery as the cost price squeeze tightens. It is predicted that this trend will indeed be slight because the economies of bag versus bulk have not been clearly and fully established when account is taken of the capital investment necessary to support bulk delivery. Liquid feeds are playing an increasing role in Montana but this participation is largely limited to the role of a protein supplement.

The dynamic nature of the industry raises the presumption that integration will continue at a substantial rate and in whatever directions offer the most attractive results. Because of the unique characteristics of the Montana industry it is felt that the "pushbutton" mill is on the very distant horizon.

A future danger might occur if as the industry over-expands capacity. However, the leaders in the feed manufacturing industry are well aware of this and therefore the "new start" firm must be alert also.

Recommended Future Research

The first recommendation for future research is in the area of on the farm feed manufacturing. One of the purposes of the research would be to fully apprise the farmer of the alternatives that were open to him in the field of feed processing. A study of this nature could explore the advantages and disadvantages involved thereby allowing the farmer a more enlightened choice. There would be quality
consideration that would demand careful analysis.

Another interesting area for future research, and one that the industry is experimenting with, is integrating feeding operations into the firm's current operations. Not only are stationary mills starting operations in this direction but also mobile mills. It is felt a substantial contribution to the industry could be made from a practical research effort in this direction. The industry is seeking the answer to many problems and a high degree of co-operation could be expected. Progress toward a solution for the seasonality problem may well be in this direction.

A complete demand analysis for pelleted feeds generally could be undertaken. What might be called a "price substitute line" might be drawn under various situations. The farmer-feeder is well aware of the fact that after a certain price point the various substitutes and procedures come under close scrutiny. Information of this nature would be valuable to both sides of the market.

The use of safflower meal as the basic ingredient for pelleted rations has several distinct advantages as well as some marked disadvantages. Safflower pellets are produced in Montana as a by-product of a local industry. There are several areas of research possible, some of which are not within the realm of agricultural economics. Nevertheless, the possible expansion of safflower pellet production as well as the quality aspects could be explored. Considerable controversy rages with reference to the nutritional value
of safflower pellets. Both extremes of the controversy are strongly opinionated. The consumer aspect of beef fattened on safflower is worth more extensive exploration.

Natura non facit saltum
Looking at the graph from a mathematical viewpoint shows it to be simply a graph of two straight lines (sales and total cost) which intersect at some point. Each of these lines has an equation. On rectangular graph paper, the sales income is represented by the equation $y = x$, where $y$ equals sales and $x$ denotes the plant capacity. The variable expense line can be expressed as $y = mx$, where $m$ is the slope of the line or the percentage of variable expenses to sales. The fixed expense is a straight line parallel to the $X$ axis cutting the $Y$ axis at $b$; i.e., $y = b$; in other words, when $x$ equals 0 or sales are at 0 capacity, the value of the $Y$ ordinate is $b$. The equation for total costs is therefore: $y' = mx + b$. Solution of the sales and total cost equations then produces a formula for the profitless point or break-even point as follows:

Sales equation: $y = x$

Total cost equation: $y' = mx + b$

The business breaks even when $y'$ equals $y$. But $y$ equals $x$. Therefore:

$x = mx + b$

$x - mx = b$
\[ x (1-m) = b \]
\[ x = \frac{b}{1-m} \]

or

\[ x = \frac{\text{Fixed Costs}}{1 - \frac{\text{Variable Costs}}{\text{Sales}}} \]
Considerations for Planning a Feed Mill

1. Is rail receiving dump pit required?
2. Is truck receiving dump pit required?
3. Is material handling equipment from pits to elevator required?
4. Is high speed receiving elevator bushel per hour capacity desired?
5. Type receiving scales, etc.
6. Number of grain storage bins desired.
7. Name basic grains received for processing.
8. What cleaning facilities for incoming grain are desired?
9. What grains will be ground through a hammer mill?
10. What hammer mill capacity is desired?
11. Will a roller mill be required? If so, what capacity is desired for rolling and crimping of grains? Will steam rolling be desired?
12. All ground and crimped materials will be in ___ bins discharging into batching scale.
13. Receiving ground ingredients to complete the feed formula will be in bulk or bagged.
14. Receiving ingredients by rail in bulk in hopper cars or box cars.
15. Receiving ingredients by truck in bulk, truck flat bottom.
16. Is soft feed receiving elevator leg for bulk ingredients required?
17. What type of scale and capacity is required?
18. Give number of bulk ingredients bins discharging into batching scales.
19. What is the capacity of bulk bins for incoming ingredients?
20. What is the tonnage of bagged ingredients received?

21. What is the batching scale capacity desired - 1 ton or 2 tons?

22. Which is the desired type of control center for batching of formula feeds?
   a. Panel board
   b. Screw feeder - from bins to scale
   c. Air cylinder controlled slide gates and valves
   d. Hydraulic controlled slide gates and valves
   e. Manual operation of slide gate and valves
   f. Bag dump to mixer of small items of ingredients

23. What type mixer? 1 ton or 2 ton capacity? Can fats and molasses be added at mixer?

24. Check surge bin under mixer capacity: 1 ton or 2 ton?

25. Belt feeder from surge bin to soft elevator leg - capacity rated on ton per hour of plant.

26. Is soft elevator leg to turn head for distribution to finished feed bins or to the pellet operation required?
   a. Will there be bulk feed bins for truck loading?
   b. Will there be bagging line for finished feed?
   c. Will there be bagging line for pellets?
   d. Will there be bins for bulk pellets for truck loading?

27. Pelleting.
   a. Type of pellets to be produced
   b. Capacity of pellets desired per hour (Cooler capacity will be determined by capacity of pellet mill and must be adequate)
   c. Are pellet and crumbles desired?
d. Number of bins required for pellets

e. Estimated capacity required

28. Should all bulk bins for finished feeds and pellets be over a truck scale? (Molasses feeds will not be binned - only applied to feeds per order unless bagged off molasses feed line.)

29. What type building is desired to house the feed plant?

30. Molasses storage capacity desired.

31. Flat storage capacity desired.

32. Is fat conditioning tank required?

33. Boiler capacity other than pelleting operation.

34. Is car shovel required for unloading railroad car?

35. Is truck hoist or lift for dump trucks required?

36. What arrangement can you make for financing?
LITERATURE CONSULTED


Bakken, Henry H., Cyril Bright, and M. A. Khalil. Retail Feed Distribution in Wisconsin. Milwaukee: Central Retail Feed Association in cooperation with the University of Wisconsin, 1958.


Dahl, Reynold P. *Credit Problems and What to Do About Them*. Reprint of talk presented to the GTA Managers' Institute, March 8, 1960, St. Paul, Minnesota.


Ellis, Theo. H. *Linear Programming and Optimum Combination of Enterprises*. Reprint of a paper first presented to Agricultural Production Economics Seminar at North Dakota Agricultural College, Fargo, North Dakota, Fall, 1956, Alabama Agricultural Experiment Station, 1959.


Feeding Molasses to Livestock. Sugar Branch FMA Leaflet No. 352, USDA, October, 1953.


Fletcher, Charles W. *Selling Feeds and Farm Supplies*. Feedstuffs, September 14, 1957.

French, Charles E. *Labor Efficiency in Grinding and Mixing Feeds in Indiana Grain Elevators*. Agricultural Experiment Station, Purdue University, Station Bulletin 639, Lafayette, Indiana, 1956.


Seares, Al. N. *Marketing Intelligence.* Text of a lecture sponsored by the Department of Ind., Ad. of Yale University and National Association of Manufacturers.


Sherwood, Ross M. *Feed Mixers' Handbook.*


Eubanks, K. W
An economic-engineering study of the feed manufacturing industry of Montana.