



Fattening beef cattle in Montana
by Paul B Pearson

A Thesis Submitted to the Graduate Committee in Partial Fulfillment of the Requirements For the
Degree of MASTER OF SCIENCE in AGRICULTURE
Montana State University
© Copyright by Paul B Pearson (1930)

Abstract:
no abstract found in this volume

FATTENING BEEF CATTLE IN MONTANA

BY

PAUL B. PEARSON

A Thesis Submitted to the Graduate Committee
in Partial Fulfillment of the Requirements
For the Degree of

MASTER OF SCIENCE
IN
AGRICULTURE

APPROVED:

H.W. Vaughan
In charge of Major Work

H.W. Vaughan
Chairman Examining Committee

R.E. Turk
Chairman Graduate Committee

N378
P31f
cop. 2

CONTENTS

	Page
Introduction	v
Part I - Present Status of Beef Cattle Production and	
Fattening in Montana	1 - 9
Sources of Farm Income	1
Rank of Montana in Number of Beef Cattle	2
Quality of Montana Cattle at Central Markets	3
Growth of Cattle Fattening in Montana	5
Outlook for Development of Fattening Cattle	5
Montana Cattle Sold for Slaughter and for	
Feeders	6
Importance of Quality in Montana Cattle	8
Conclusions	8
Part II - Feeds Available for Fattening Cattle in	
Montana - Preparation of Feeds - Full Versus	
Limited Grain Feeding	10 - 45
Concentrates	10
Barley	10
Corn	12
Wheat	15
Oats	16
Beans	18
Rye	18
Beet Molasses	19
Nitrogenous Concentrates	20
Linseed Meal Versus Cottonseed Meal	22
Roughages	23
Alfalfa Hay	24
Clover Hay	25
Sweet Clover and Other Legumes	27
Timothy	28
Prairie or Wild Hay	29
Beet Pulp	30
Miscellaneous Roughages	31
Silage	33
Corn Silage	33
Sunflower Silage	34
Alfalfa Silage	36
Oat and Pea Silage	36
Preparation of Feeds	37
Full Feeding Versus Limited Grain Feeding	40

F 8 - 41 of Eppes. Station to College Library. Added cop.

	Page
Part III - The Montana Experiments - Three Years'	
Results	44 - 56
Proportion of Grain and Roughage for Fatten- ing Yearling Steers	44
Conclusions	49
Comparison of Grains for Fattening Yearling Steers	50
Conclusions	56
Part IV - The Montana Experiments - Fourth Year	
1929 - 1930	57 - 72
A Comparison of Concentrates for Fattening Yearling Steers	57
Objects of the Experiment	57
Methods of Experimentation	58
Average Daily Feed per Period	62
Comparisons by Lots	63
Bloat	71
Conclusions	71
Summary	73 - 74
Acknowledgments	75
Bibliography	76 - 79

INTRODUCTION

The importance of the beef cattle industry in Montana and the many economic changes which the industry has been undergoing during the last fifteen years have created a new interest in the business of fattening cattle in this state before sending them to market. The author hopes, therefore, that this work may be of practical value in solving some of the many problems arising under these changing conditions.

This thesis is not intended as an exhaustive treatise on all the factors which influence the production of beef cattle in this state, but rather as a summary of present available information which may apply to the fattening of beef cattle in Montana. It is hoped that this, together with the discussion of the experiments conducted by the author under the direction of the staff of the Animal Husbandry Department of the Montana Experiment Station, will give the reader a comprehensive knowledge of this phase of the beef cattle industry in this state.

For the convenience of the reader this thesis is divided into four parts:

Part I briefly presents the status of beef cattle production and fattening in Montana.

Part II gives in a condensed form important findings of experiment stations regarding properties and feeding values of practically all the feeding stuffs that may be used for fattening beef cattle in Montana.

Part III briefly presents the results of the first three years of a series of experiments with fattening beef cattle at the Montana Ex-

periment Station.

Part IV presents in detail the methods of procedure and the results of the fourth year of this series of experiments, which the author assisted in conducting.

The author has endeavored to present the material in a manner sufficiently elementary to be within the grasp of livestock producers, yet at the same time technical enough to be of scientific value, and to add to our present knowledge of livestock feeding and nutrition.

In gathering material the author has had access to all the published work of the experiment stations and the standard books on the subject. The information selected has been limited to that which is practicable and useful under conditions within the state.

It is hoped that this work may lead to a better utilization of our present knowledge; that it may further the scientific study of the factors which may influence the fattening of beef cattle; and that it may aid in establishing the beef cattle industry of Montana on a more sound economic basis.

FATTENING BEEF CATTLE IN MONTANA

PART I

PRESENT STATUS OF BEEF CATTLE PRODUCTION

AND FATTENING IN MONTANA

Since the early settling of Montana the raising of cattle has been one of the leading industries of the state. While within the last two decades some other industries have grown in importance much more rapidly than the cattle industry, cattle have maintained their important position in the agriculture of the state. Because of certain natural advantages for beef production in Montana, it is probable that the raising of beef cattle will continue to be an important source of income in the state.

The six most important sources of income from livestock are shown in table I.

Table I. Annual Income From Livestock and Livestock Products
in Montana (a)

	<u>Sales</u> <u>1926</u>	<u>Sales</u> <u>1927</u>	<u>Sales</u> <u>1928</u>
Cattle.....	\$31,185,000	\$23,293,000	\$32,207,000
Sheep and lambs.....	14,590,000	12,333,000	13,944,000
Wool.....	8,855,000	7,974,000	10,118,000
Milk and dairy products..	10,023,000	10,807,000	11,888,000
Hogs.....	3,896,000	4,459,000	5,645,000
Poultry.....	4,221,000	4,183,000	4,314,000

Sources of Farm Income. Sales of crops constituted 48.8 per

(a) Olsen, N. A. and Diamond, J. G. Montana Farm Review Vol. IV: No. 1, June 1929 State Division of Publicity, Helena, Montana.

cent of the total farm income in 1928, compared with 58.2 per cent in 1927 and 43.6 per cent in 1926. Only twice during the six-year period from 1923 to 1928 has the proportion derived from crop sales exceeded that from livestock sources. These two years were 1924 and 1927.

Among the sources of income from crops and livestock, wheat and cattle held first place in 1928. Wheat income in 1928 represented about 38 per cent of the total farm income and 77.7 per cent of the total crop income. Beef cattle income in 1928 represented approximately 21 per cent of the total farm income and 40.9 per cent of the total livestock income. Since 1923 cattle have held this relative position of importance in the livestock income of the state. However, the income from wheat has gradually increased since 1923.

Rank of Montana in Number of Beef Cattle. The following table gives the leading states in numbers of beef cattle January 1, 1929:

Table II. Leading States in Beef Cattle

1. Texas	4,652,000
2. Iowa	2,531,000
3. Nebraska	2,153,000
4. Kansas	2,130,000
5. California	1,329,000
6. Missouri	1,299,000
7. Minnesota	1,254,000
8. Oklahoma	1,113,000
9. Colorado	1,073,000
10. South Dakota	1,047,000
11. Illinois	1,018,000
12. New Mexico	952,000
13. Wisconsin	927,000
14. Montana	926,000

Table II shows that Montana ranks fourteenth in total number of beef cattle per state. According to number of cattle per square mile, Montana ranks lower than in state totals. In other words, the beef cattle popu-

lation in Montana is not very dense.

Quality of Montana Cattle at Central Markets. No definite records are available to show how cattle from the various states are classed and graded at the central markets. It would be very desirable to know just how cattle from Montana are classed and graded at the central markets, as compared with cattle from other western states. In an effort to secure this information the writer made a survey of the Chicago and South St. Paul markets. These are the two markets receiving the bulk of Montana cattle. Approximately forty letters of inquiry were sent out to secure this information from livestock commission companies, stockyard companies, packing houses, and the United States Bureau of Agricultural Economics. Some of the replies received and presented herewith in full are thought to be fairly representative of the entire group.

Edward N. Wentworth, Director of Armour's Livestock Bureau, makes the following statement:

"In my opinion in grass range cattle I would prefer Montana cattle to Texas, Oklahoma, or Colorado cattle. Montana cattle probably fatten with a little harder finish than the other western states, with the exception of the Flint Hills cattle from Kansas."

James Casgrove, head cattle salesman for the Farmer's Union Livestock Commission Company, at South St. Paul, has the following to say:

"The bulk of the Montana cattle are of better quality than the cattle coming from other western states and therefore are graded a little better and packer buyers are always glad to buy Montana cattle at better prices than they would give for the same quality of cattle from other states. I believe that the grass in Montana is a little better and the beef dresses better than cattle from the Dakotas."

Not all the buyers and commission firms favor Montana cattle over cattle from other western states. Two reports, one each from South St. Paul and Chicago express the opinion that in some respects cattle

from Montana are inferior to those from other western states.

The report by J. S. Montgomery, Manager of the Central Co-operative Association at South St. Paul, is of special interest:

"There is no question but what some of the best feeder cattle which are produced anywhere in the country come from Montana. However, there are a great many cattle coming from Montana which do not show the type and breeding that we get in the range cattle from the western part of South Dakota and western Nebraska. Apparently many of the Montana ranchers have neglected their breeding operations to some extent, and have not realized the importance of getting sires which would produce a thick set, early maturing type of feeding cattle which the market now demands. I think this is due to the fact that lots of Montana growers still are following the practice of trying to produce grass beef in the form of three and four-year-old steers instead of catering to the demand for choice quality yearling feeders. The fact remains that Montana is capable of producing the best feeder cattle which can be produced anywhere in the United States because of the hardiness which develops with the northern climate and the fact that they have grass which will produce size and ruggedness."

Gene McAdams, cattle salesman for John Clay Commission Company, Chicago Stock Yards, sends the following reply:

"While there are in Montana a considerable number of herds of high quality cattle, the majority of the cattle from that state reaching Chicago are considerably inferior to those from Wyoming and compare rather closely with the North Dakotas. As you know, there has been a world of little ranchers go into the business in Montana and in a very large number of cases their cattle are of quite indifferent quality, show poor breeding and rather poor condition. This a condition that has become intensified as the years have passed."

The conclusions which may be drawn from the foregoing comments are the following:

1. That Montana is capable of producing as good grade of beef cattle as any other state.
2. Feeder cattle from Montana of equal type and quality may sell at a premium over those from other states, because of their vigor, thrift, and firmness of flesh.
3. Some of the Montana ranchers should give more attention to

type and to improvement of herds with better sires.

Growth of Cattle Fattening in Montana. For a number of years there have been limited sections in Montana where cattle have been fed and fattened during the winter and spring months. This has been especially true of the Big Hole district. In sections where sugar beet by-products are available the fattening of beef cattle has grown to be a profitable business of considerable importance.

There is each year, in this state, a large amount of unmarketable grain, especially frosted wheat. So long as Montana continues to be an important wheat producing state there will always be more or less of this unmarketable grain. The only profitable way to market this grain is by feeding it to livestock.

That there is a growing interest in this phase of the beef cattle industry is evidenced by the increasing number of letters of inquiry regarding the fattening of beef cattle, that are received each year by the Montana Experiment Station.

Outlook For Development of Fattening Cattle. With the increase in farm population and more intensive types of farming, conditions will become more favorable for fattening cattle in this state. More cultivated crops will be grown and provisions made for winter feeding of stock. There is, on the majority of farms, considerable rough land which can only be used for pasture and production of roughage. This surplus roughage in large quantities can be most efficiently utilized by cattle. Some ranchers who raise their own feeders are so situated that they can produce their own roughage and concentrates necessary for fattening some cattle. In such cases there is considerable room for expansion.

It is true that the bulk of the heavy weight steers and heifers off the range are graded as beef and sold to the packers for slaughter, but the light weight yearlings are mostly sold to go back to the country as stockers and feeders. There is a growing tendency among Montana ranchers to market their cattle as yearlings, or even calves. There are a number of factors that are bringing this change about, such as the increased demand for baby beeves, higher land values and less available grazing land. To produce a fat three or four-year-old steer on grass requires that he be kept growing all the time, and the winter before he is to go to market he must be fed hay and turned out in the spring carrying considerable flesh. Too many stockmen just get their cattle through the winter, and it then takes them all summer to get back what they lost the previous winter. Under these conditions a number of ranchers are now turning to the winter fattening of steers at home.

Montana Cattle Sold For Slaughter and For Feeders. In connection with the study of how Montana cattle are graded at the central markets an effort was also made to secure figures to show the per cent that are sold for slaughter and the per cent sold for feeders at the two central markets, Chicago and South St. Paul. The number of cattle sold for either purpose has a wide variation from year to year, because there are so many factors that may determine whether cattle sell as killers or feeders. Following a winter of plentiful feed and a summer of good grass, Montana cattle come to market in the fall in good shape, and there are a great many two-year-old steers and also some yearling steers fat enough to sell as killers. Another year range conditions may be reversed and the cattle may be thinner; the fall of 1929 was one of these years.

Practically all the yearlings were feeders and only a very few of the two-year-olds were fat enough for beef. In some years the demand for feeders is very limited so that it is necessary to sell a lot of the plainer quality steers with only feeder flesh as killers. There are no statistics available to show what proportions of Montana cattle are sold for slaughter or feeders. The following are estimates by livestock commission firms located at large market centers.

George Conover, of Alexander, Conover & Company, Chicago, Illinois, makes the following estimate:

"From our observation would judge that 20 per cent of the Montana cattle shipped to this market are sold for slaughter, and about 50 per cent of the Kansas cattle sold for slaughter."

Gene McAdams, of John Clay & Company, Chicago, makes the following report:

"We figure that 50 per cent of the Wyoming, North Dakota and Montana cattle received on this market go back to the country for feeders. We think that the last few years there are more of them going back to the country for feeders than ten years ago, for ten years ago we were receiving more range beef cattle from that country, which run largely to the butcher stock and aged steers. The last five years ranchers have been handling younger and lighter cattle which naturally are more desirable for stocker and feeder purchases and the per cent of cattle that we are selling for stockers and feeders would be greater at this time than it would have been ten years ago."

M. A. Harrins, of John Clay & Company, South St. Paul, Minn., makes the following statement:

"It is our opinion that about 75 per cent of the Montana and North Dakota cattle go out from here for stocker and feeder purposes, the remaining 25 per cent going for immediate slaughter."

J. S. Campbell of the United States Bureau of Agricultural Economics, estimates that from 80 to 90 per cent of the cattle received at the St. Paul market are sold as feeders.

Importance of Quality in Montana Cattle. According to the Bureau of Railway Economics, 15.9 per cent of the Chicago sale price for Montana cattle goes for freight and marketing costs; the corresponding figure for South Dakota is 6.8 per cent of the total sale price. Per unit of weight it costs as much to market a poor quality unfinished animal as it does one of high quality and well finished. With such a large percentage of the total value of the animal going for market costs, the Montana producer should raise and offer for sale only such animals as are of the highest quality and type if he is to overcome the handicap of distance from market centers and successfully compete with the producer nearer the markets.

Conclusions. The following conclusions are the main points that may be drawn from the discussion of fattening and production of beef cattle in Montana.

1. Among the sources of farm income in Montana, livestock represents about 52 per cent of the total.
2. Cattle represent about 20 per cent of the total agricultural income and approximately 40 per cent of the total livestock income.
3. Montana ranks fourteenth in number of beef cattle per state.
4. Cattle from Montana grade a little higher and sell slightly better than cattle from other western states.
5. Montana is capable of producing the best feeder cattle that can be produced anywhere in the United States.
6. Some Montana ranchers have neglected their breeding operations, and have failed to realize the importance of getting the proper type of sires.

7. Where sugar beet by-products are available the fattening of cattle has grown to be a profitable business.

8. There is a large amount of unmarketable grain produced in this state which can be profitably marketed through livestock.

9. Some ranchers now produce the necessary concentrates and roughages for fattening cattle.

10. There is a growing tendency on the part of some ranchers to market their cattle as yearlings or calves rather than to grow them out as mature grass-fat cattle.

11. From 50 to 80 per cent of Montana cattle reaching the Chicago and South St. Paul markets go back to the farms for fattening.

12. The cost of marketing cattle is much higher for Montana than it is for many other beef producing states.

FEEDS AVAILABLE FOR FATTENING CATTLE IN MONTANA - PREPARATION
OF FEEDS - FULL VERSUS LIMITED GRAIN FEEDING
CONCENTRATES

Concentrates are the feeds which contain a large amount of nutriment in relatively small bulk and weight, with high digestibility. The group of feeds known as roughages are much lower in feeding value, and contain a large amount of woody fiber and other undigestible matter. In the discussion of fattening feeds we will be concerned in the main with the concentrates.

The important concentrates used for fattening cattle in Montana are barley, wheat, oats and corn. Others of less importance and limited to certain sections are rye, beans and beet molasses. Purchased feeds are used to some extent, especially cottonseed meal and linseed meal. A brief discussion of the value of various feeds follows:

Barley. While barley ranks only third in the total production of Montana grain crops, it is one of the most important feeds used for fattening livestock. The major portion of the crop is utilized on the farms as feed. The increasing importance of barley in Montana as compared with oats is shown by the fact that in 1920 (21) (a) the barley acreage was only 12 per cent of the oats acreage, whereas in 1928 the barley acreage had increased to 37 per cent of the oats acreage.

Throughout the entire continent where corn cannot be grown success-

(a) Reference is made by number (*italic*) to bibliography, page 76.

fully, large amounts of barley are produced to take its place as feed for livestock. In the hulled varieties the kernel is surrounded with a tough outer covering. For this reason it is always advantageous to grind or crush barley for feeding. Though corn is considered the supreme feed for fattening purposes, barley may equal it in some respects. In composition barley is between corn and oats, being higher in protein and ash than corn and lower in carbohydrates and fat. For this reason it is a better balanced feed than corn.

Gains made by cattle full fed on barley may be as rapid as when fed corn, but slightly more feed per hundred pounds gain may be required when barley is fed.

Wilson (40) at the South Dakota Station, and Haney (9) at the Hays Branch Station, Kansas, found that steers fed ground barley made slightly less rapid gains than others fed corn, but required no more feed per hundred pounds gain.

Steers fed barley and alfalfa hay at the Colorado Station by Martin and Leiper (13) made nearly as rapid gains as others fed corn and alfalfa. In this trial barley proved to be worth only five per cent less than corn.

Results of work at the Minnesota Station have been decidedly in favor of corn where hogs followed the steers. In this work by Peters and Carnes (22), ground barley proved equal pound for pound to shelled corn in producing gains in weight on the cattle. Hogs following the steers receiving corn made an average saving of \$2.57 worth of feed per steer, while those following the barley group made practically no saving of feed.

Work conducted at the Montana Experiment Station indicates that

barley ranks high as a fattening feed for cattle. Experiments conducted by Linfield (12) from 1902 to 1905 show that barley ranks slightly below wheat, but above oats in the rate and economy of gains produced. In a recent trial by Vinke (37) hulless barley proved slightly superior to wheat, while hulled barley was lower than wheat, but considerably better than oats or a combination of oats and barley for fattening steers.

From the experimental data available it appears that for fattening purposes hulled barley ranks high. Among the farm grains it is excelled by corn and wheat. Where hogs are used to follow the steers and their gains are credited to feed costs, corn will return the larger profits.

Table III gives a summary of recent work at the Minnesota and Colorado Stations comparing barley with corn in various rations for fattening calves, yearlings and two-year-olds. In only two of the ten lots did the barley-fed steers excel in rate of gain and in amount of feed required per hundred pounds gain. That the price per hundred pounds was higher for the corn-fed steers in all except two lots would indicate that corn is superior to barley as a feed for finishing cattle.

Corn. Though Montana is not an important corn producing state, there is in the southeastern part of the state a considerable acreage of corn produced for home feed. Both the total acreage and farm value of corn is greater than that for barley. As shown in table IV, the bulk of the corn crop in Montana is cut for forage, grazed or hogged off.

Table III - A Comparison of Corn and Barley Rations in Fattening Calves, Yearlings and Two-Year-Olds

Ration	Minnesota Experiment Station				Colorado Experiment Station				2-year-old steers - 140 days (e)	
	Calves - 196 days (a)		Yearlings - 175 days (b)		Calves - 194 days (c)		Calves - 208 days (d)		Ground barley	Ground corn
	Ground barley and ground oats lot	Shelled corn and ground oats lot	Whole barley lot	Shelled corn lot	Ground barley lot	Ground corn lot	Ground barley lot	Ground corn lot	lot	lot
Initial weight - lbs.	494.50	487.60	692.7	681.3	549.5	551.0	347.8	348.5	1051.7	1054.5
Daily gain "	2.11	2.22	2.12	2.49	1.99	1.95	1.99	1.93	1.54	1.69
Daily feed:										
Barley "	8.40		14.84		3.8		6.9		10.4	
Corn "		8.46		14.34		3.8		6.8		10.3
Oats "	3.54	3.34								
Linseed oil cake "					1.1	1.1	1.0	1.0		
Linseed meal "	1.30	1.31	1.97	1.97						
C. S. cake "									2.4	2.3
Dried beet pulp "					3.5	3.5				
Corn silage "			14.76	12.71	9.0	9.0	9.2	9.2	24.5	24.5
Sunflower silage "									24.5	24.5
Alfalfa "	5.82	5.33	4.30	4.30	4.1	4.4	4.9	5.7	9.8	12.1
Cost of feed per cwt. gain	\$8.13	\$7.06	\$16.37	\$12.54	\$8.87	\$9.45	\$11.38	\$12.19	\$13.63	\$12.43
Selling price per cwt.	8.70	9.00	12.45	13.00	10.65	10.65	10.81	10.64	7.95	7.75

- (a) Peters, W. H. and Carnes, N. K. "Cattle Feeding Investigations" University of Minnesota, Agric. Exp. Sta. Bul. 200
 (b) Peters, W. H. and Denner, S. G. "Fattening Yearling Steers For Market" University of Minnesota, Agric. Sta. Mimeographed Report B-18, 1929.
 (c) Maynard, E. J. "Calf Feeding Experiments" Colorado Agric. Exp. Sta. Mimeographed Report (6044) 1928.
 (d) Maynard, E. J. "Calf Feeding Experiments" Colorado Agric. Exp. Sta. Mimeographed Report (7072) 1927.
 (e) Maynard, E. J. "Steer Feeding" Colorado Agric. Exp. Sta. Mimeographed Report 1922.

Table IV. Use of Corn Crop in Montana (a)

<u>Year</u>	<u>For grain</u> per cent	<u>For silage</u> per cent	<u>For forage, cut for feed- ing, grazed or hogged off</u> per cent
1924.....	35	4	61
1925.....	30.1	2.9	67
1926.....	23	3	74
1927.....	34	4	62

It is oftentimes said that the great development of the beef cattle industry in the United States is largely due to the large quantities of corn available for that purpose. As a farm grown feed for fattening beef cattle corn has no superior. It is greatly relished by all classes of livestock. Its value as a forage or silage crop will be taken up later. Shelled corn and corn meal are lacking in protein, and for this reason should be fed in combination with feeds high in protein, such as linseed meal, cottonseed meal or legumes.

In three of the five trials reported in table III, the lots fed corn made a higher rate of gain than the lots fed barley. It is also noted that in three of the five trials the cost per hundred pounds gain was less for the corn-fed lots than it was for the barley-fed lots.

Peters and Winters (25) of the Minnesota Station fed one lot of yearling steers a ration of ground barley, linseed meal, molasses and alfalfa hay; a second lot was fed shelled corn, linseed meal, molasses and alfalfa hay, and a third group received the corn ration without the mo-

(a) Olsen, N. A. and Diamond, J. G., Montana Farm Review Vol. IV No. 1, June 1929, State Division of Publicity, Helena, Montana.

lasses. The corn-fed groups made more rapid gains, finished out better, and sold for more per hundredweight than did the ground barley group.

It seems difficult to fix an exact value for corn as compared with barley for fattening cattle. In the hulled varieties of barley there is probably a wide variation in hardness of hulls from year to year depending upon the season and locality. It is probable that corn is worth between 5 per cent and 15 per cent more than barley for fattening cattle.

Wheat. This grain is not very widely fed to cattle except when it is damaged for market or unusually low in price. Because of the fact that Montana is located so far from the central wheat markets there will be a large per cent of the low grade wheat that cannot be profitably marketed. Where livestock will make good gains on rejected wheat, the feeding of wheat affords a means of securing a fair return for poor quality wheat.

The amount of experimental work that has been done to determine the value of full feeding wheat to cattle is rather limited. In 1904 Sheppard and Richards (27) at the North Dakota Station conducted a trial to compare rejected wheat and bran with corn meal and bran when fed with various kinds of poor quality hay. The grain mixture was made up of three-fourths wheat or corn meal and one-fourth bran. The corn-fed steers made 52.3 per cent greater gain than was made by the steers receiving the wheat. The average amount of grain consumed daily per steer was between 12 and 12.5 pounds for each group. The cost per hundred pounds gain was \$12.90 for the wheat lot and only \$8.50 for the corn lot.

More recent experiments at the Montana Station with full feeding wheat to fattening calves and steers indicate that its feeding value

is comparable or superior to barley. Vinke (35) compared full feeding ground frosted wheat and alfalfa hay with ground barley and alfalfa hay for fattening baby heaves over a period of 146 days. The wheat-fed calves made more rapid gains, more economical gains, carried more finish, had a higher market value, and made more money than the calves fed barley. In two trials (34) and (37) with yearling steers full-fed, the wheat group made more rapid gains, at less cost, and sold at a higher price per hundred-weight than did similar steers fed hulled barley. In another trial hullless barley proved to be slightly superior to wheat or hulled barley for fattening yearling steers.

Rejected and damaged wheat will vary widely in composition and feeding value according to the cause and degree of damage. Very hard wheat is less palatable and probably less digestible than soft wheat. It is however safe to say that low quality wheat that cannot be profitably marketed will usually return a fair price if fed to cattle and other kinds of livestock.

Oats. Of the grain crops produced in Montana, oats rank second, both in total production and value. In 1928 (21) the total production for the state was 20,221,000 bushels. In recent years there has been a downward trend of oat acreage. This may be accounted for in part by the decreasing number of horses and the growing popularity of barley as a feed.

Oats are very bulky, higher in fiber and protein than barley, corn, or wheat and contain relatively less carbohydrates. For these reasons they are not as efficient for fattening purposes as other kinds of grain. When mixed with other concentrates they may give good results during the first part of the fattening period. Even when fed alone the gains

made on the oats during the first part of the feeding period may compare favorably with gains made on barley, corn or wheat. As the fattening period advances the ration must be made less bulky and more concentrated feeds should be substituted for the oats.

Best results are secured with heavy plump oats. Wilson (40) of the South Dakota Station fed ground oats with corn silage and linseed meal in comparison with corn. The oats-fed steers required 862 pounds of concentrates and 746 pounds of silage per hundredweight gain. The corn-fed group required only 856 pounds of concentrates and 648 pounds of silage for the same amount of gain.

In Montana Linfield (12) reported in 1905 that considering the amount of grain required per pound of gain that oats were inferior to wheat or barley, and in rate of gain oats ranked last. These tests were conducted with clover hay. Vinke (37) in 1929 found that when oats made up a part of the barley ration that the gains were less rapid and less economical than where the grain ration was hull barley or wheat.

Trials in fattening baby beeves at the Minnesota Station by Vaughan and Harvey (35) compared a ration of shelled corn, linseed meal, corn silage and alfalfa hay with a ration otherwise equal except that one part oats by weight was fed with every four parts of shelled corn. The no oats lot made a daily gain of 2.32 pounds per head, while the oats lot gained only 2.19 pounds daily per head. The cost of a hundred pounds gain on the baby beeves in the no oats lot was \$9.61 as compared with \$10.01 for the corn-oat lot. The addition of oats gave less finish, and resulted in a lower selling price per hundredweight.

Clark and Tinney (4) at the Prince Edward Island Experimental

Farm, carried on experiments demonstrating the relative value of oats and barley for fattening steers with and without the addition of other concentrates, with the following results:

Lot I, fed ground oats, other concentrates and blood meal, the average profit per animal was.....	\$51.40
Lot II, fed similarly to Lot I, but without blood meal, average profit per animal.....	\$54.83
Lot III, fed ground barley, other concentrates, and blood meal, average profit per animal.....	\$56.83
Lot IV, fed similarly to lot III, but without blood meal, average profit per animal.....	\$59.46

They report that the feeding value of oats for fattening purposes is fully 10 per cent lower than that of barley.

Beans. Commercial production of beans in Montana is chiefly centered in Yellowstone and adjoining counties. Beans are produced for human consumption. In 1928 over 75 per cent of the crop in Montana was marketed. Beans used for livestock feed are the culls and splits not suitable for sale on the markets. Vinke (36) and (37) at the Montana Station has conducted trials to determine the feeding value of cull beans. In a ration of beet pulp, alfalfa, molasses, cottonseed cake and three pounds of beans the gains made were unsatisfactory. The beans were not very palatable and tended to produce scours. Their addition to the ration reduced the gains and increased the costs, resulting in reduced profits. On a ration of hull barley, alfalfa, and 2.85 pounds of cull beans daily, yearling steers gained 1.75 pounds daily, while similar steers receiving the same ration without the beans gained 2.03 pounds daily. The beans were too laxative and were decidedly unprofitable.

Rye. Rye thrives well on poor soils that will not give profitable returns with other cereals. A considerable amount of rye is

produced in the northern and eastern part of Montana. As a feed for cattle it does not rank high. It is unpalatable, livestock do not eat it with relish, and seem to tire of it in a short time. Best results are secured when it is mixed with other feeds. When fed alone in large amounts there is some danger of it causing digestive disturbances.

Beet Molasses. Beet molasses is a by-product from the manufacture of beet sugar. It is practically devoid of fiber, has a moisture content of 20 to 25 per cent, is very palatable and greatly relished by all classes of livestock. Beet molasses is a highly concentrated and digestible feeding material, being high in sugar and low in protein for best results it should be supplemented with a protein feed. Molasses is often fed in combination with beet pulp. It is wise to start feeding a small amount of molasses, about one-half pound per day, and then increase the amount gradually. It is customary to feed only four to six pounds daily, although aged steers will consume more without apparent injury.

The feeding of molasses in proper combination with other feeds will increase the rate of gain and cheapen the cost. Vinke (36) and (38) of the Montana Station has conducted four tests in two years, and concludes that there are right and wrong ways to feed molasses with a pulp and hay ration. In two trials, one with the addition of three pounds molasses, and a second trial with the addition of five pounds molasses, to a ration of wet pulp and alfalfa, both resulted in slower gains, higher costs, less finish, and a lower selling price. When 1.4 pounds of cottonseed cake was added to this ration of molasses, pulp, and alfalfa very good gains were made. In the first trial the addition of cottonseed cake increased the daily gain from 1.12 to 2.16 pounds. The second year's trial the addition of the cottonseed cake increased

the daily gain from 1.97 to 3.59 pounds. The addition of 3.8 pounds of molasses to a ration of alfalfa, pulp, cottonseed cake and barley increased the rate of gain from 2.62 to 2.72 pounds daily, resulted in a higher finish and increased the profits. These tests show that when molasses is fed with pulp, alfalfa hay and cottonseed cake good results are secured, and that feeding the molasses in combination with pulp and alfalfa hay without the cottonseed cake, is unsatisfactory.

Maynard (15) at the Colorado Station found that the addition of 3.7 pounds of molasses to a ration of barley, sunflower silage and alfalfa resulted in increased gains, and lowered the cost of gains.

Experiments indicate that when molasses is fed in a no grain ration with beet pulp it will not be profitable unless a protein supplement such as cottonseed cake is added. When fed in combination with barley and alfalfa it may not be necessary to add cottonseed cake.

Nitrogenous Concentrates. While protein is used in the main for growth, a certain amount of protein is also necessary for mature animals. Without an adequate supply of this constituent satisfactory results will not be secured in the feed lot. All ordinary feeding stuffs contain some protein, but the amount present in the cereal grains is relatively small. Since the feeding values of the protein supplements are stated in this thesis in discussions of the various farm grown feeds, only a brief consideration of their relative values will be given here. So far as possible protein used for beef cattle feeding should be furnished in the form of legume hay. The two most important purchased protein supplements used in Montana are cottonseed meal and linseed meal. Wheat bran contains less protein and is very bulky, and for these reasons is seldom used in fatten-

ing beef cattle. Wheat bran has approximately the same composition as alfalfa hay, but its cost is usually more than double that of alfalfa hay.

When a legume supplies a part of the roughage the amount of concentrated protein feeds needed to balance the ration will increase as the amount of legume hay fed is decreased. Where a legume hay supplies the entire amount of roughage it is not generally considered that a protein supplement is needed. When silage or beet pulp are fed in large quantities best results will be obtained if a small amount of protein supplement is added to the ration.

Cottonseed Meal. Cottonseed cake and meal are manufactured from cottonseeds. The three most common forms of cottonseed feeds are, meal, cake, and cold pressed cottonseed cake. The cold pressed cottonseed cake does not have the hulls removed. The best grades of cottonseed meal contain 40 to 45 per cent crude protein and cold pressed cottonseed cake about 21 per cent, while linseed meal contains only about 32 to 34 per cent crude protein. Cottonseed meal is somewhat costive in effect and for this reason is valuable when fed in combination with laxative feeds such as alfalfa hay, silage, and beet pulp.

Linseed Meal. Linseed cake and meal are flaxseed by-products resulting from the manufacture of linseed oil. Linseed cake is available in various degrees of fineness, from the very fine ground meal to the large slabs. The pea size is very popular with cattle feeders. Because of the lower protein content of linseed meal than cottonseed meal, it would appear that the feeding value of the former would be less. However, most feeders prefer linseed meal for fattening cattle. It produces a thrifty appearance with sleek glossy coats, and this results in higher prices for the cattle

finished with linseed meal. Linseed meal is rather laxative in effect and for this reason it is not advisable to include it in a ration with other feeds of the same nature.

Linseed Meal Versus Cottonseed Meal. Although both of these supplements give good results, trials carried on by various experiment stations have shown that linseed meal is worth much more than cottonseed meal for fattening cattle. In a study of the comparative values of these feeds for fattening cattle, Morrison and Roche (19) of the Wisconsin Station compiled the results of 21 experiments at six different stations in which linseed meal was directly compared with cottonseed meal for fattening cattle. In these trials the steers fed linseed meal as the only supplement gained 2.34 pounds a head daily on the average, while those fed cottonseed meal gained 2.21 pounds. The cost of feed for 100 pounds gain was less for the linseed meal-fed steers, and due to the superior finish, the steers fed linseed meal sold for 18 cents more per hundredweight.

In these trials the actual average cost of linseed meal was \$49.30 per ton and of the cottonseed meal \$49.28. However, on account of the more expensive gains and the lower selling price of the steers fed cottonseed meal, this feed was actually worth only \$23.71 per ton compared with linseed meal at \$49.30. In other words, with linseed and cottonseed meal available at these latter prices, the returns from fattening the cattle would have been equal.

Since the price of linseed meal is high and the supply limited, it was thought desirable to find some combination of protein-rich feeds which would produce as efficient results as linseed meal. With this object in view Fuller, Morrison and Roche (7) of the Wisconsin Station conducted an

experiment with calves fed for baby beef. One lot was fed 2.0 pounds linseed meal a head daily as a supplement to corn, clover hay, and corn silage, while the other lot was fed 1.76 pounds of a mixture of half cottonseed meal and half linseed meal. Less of this mixture was needed to balance the ration than of linseed meal alone, due to the higher protein content of the cottonseed meal. The two lots made practically identical gains and the calves fed the combination of cottonseed and linseed meal sold at a trifle higher price at the close of the trial. In this experiment the combination of linseed meal and cottonseed meal was actually worth more instead of less than the linseed meal used as the only supplement.

ROUGHAGES

Roughages differ from concentrates in being high in fiber material, which to a large extent is undigestible and passes off as waste. The fiber content of the plant increases as the plant approaches or reaches maturity.

Roughages like concentrates may be divided into two classes depending upon the amount of protein they contain. Nitrogenous roughages are high in protein, and include hay and forage from the legumes. The carbonaceous roughages are low in protein and include the non-legumes, pasture from grasses, and straws from cereal grains. Roughages may be further divided into dry roughages and green roughages. Silage is included in the latter class.

Function of Roughage in the Fattening Ration. Most of the gains made by fattening cattle come from the concentrate part of the ration. However the profitable utilization of farm-produced roughage is often the factor that determines the success of cattle feeding. Roughages may make up the

larger portion of the ration during the early part of the fattening period and become less important as the period of feeding advances. Because of the capacity and nature of their digestive system, cattle thrive much better when some roughage is supplied, though it has been shown that cattle will live for some time on a grain diet, alone.

Amount of Roughage to Feed. The amount of roughage to feed cattle will vary with individual conditions. Where there is an abundant supply produced on the farm it is usually well to feed the maximum amount that can be used efficiently. If most of the roughage must be purchased at relatively high prices it will be desirable to limit the roughage in the ration and feed a maximum of concentrates. When both roughages and concentrates are produced at home it is usually a satisfactory practice to give a full feed of grain and then allow all the roughage the animals will clean up.

Alfalfa Hay. Alfalfa is by far the most important hay crop produced in Montana. Of the total hay crop produced in 1928 (21) over 63 per cent was alfalfa. For a number of years alfalfa has formed over half of the hay crop produced in the state.

Alfalfa is a standard roughage for fattening and maintaining livestock in the west. It holds the same important position in the west that clover does in the east. Most of the experimental work on roughages for fattening cattle has been carried on in the states where corn is the principal concentrate.

Henry and Morrison (11) report that steers fed alfalfa hay alone made an average gain of 1.23 pounds daily for 100 days, and that on the average each pound of concentrate saved three pounds of alfalfa when a limited grain ration was fed.

