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

Abstract:
no abstract found in this volume

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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)

	Sales 1926	Sales 1927	Sales 1928
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	10,028,000	10,807,000	11,888,000
Hogs	3,896,000	4,459,000	5,645,000
Poultry	4,221,000	4,188,000	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-

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(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					
	Calves - 196 days (a)		Yearlings - 175 days (b)		Calves - 194 days (c)		Calves - 208 days (d)		2-year-old steers - 140 days (e)	
	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	Ground barley lot	Ground corn lot
Initial weight - lbs.	494.30	487.60	692.7	681.3	349.5	351.0	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	1.89
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 "	3.34	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	24.3
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)

Year	For grain per cent	For silage per cent	For forage, cut for feeding, grazed or hogged off 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-

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(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 beeves 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 hundredweight than did similar steers fed hulled barley. In another trial hulless 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 (33) 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 43 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.

Age of the animals is an important factor in fattening on alfalfa. When roughage only is fed to young growing cattle they do not gain rapidly enough to fatten them. When the animals fed are very nearly mature they will make fair daily gains, and may finish out for market on good quality alfalfa hay.

Table V shows that alfalfa hay and red clover hay are very nearly equal in feeding value when fed either with or without silage for fattening steers. Both of these legumes are superior to timothy or wild hay.

Williams (39) of the Arizona Station found that the addition of alfalfa hay to a ration of silage, cottonseed meal, and ground milo maize slightly increased the rate of gain. The addition of 3.97 pounds of alfalfa hay per head daily decreased the amount of silage consumed by 4.23 pounds, and resulted in more uniform gains by the steers.

Clover Hay. The amount of clover hay produced in Montana is small. There is considerable mixed clover and timothy hay produced, it being the second most important hay crop in the state. In 1927 (21) the total estimated production of mixed clover and timothy hay in Montana was 292,000 tons.

Red clover hay equals alfalfa for fattening cattle. Mixed timothy and clover hay probably has a somewhat lowered feeding value in the fattening ration. Clover is mildly laxative, and there is usually less trouble from scouring and bloating with clover than with alfalfa hay. Red clover is very palatable to livestock.

Skinner and King (28) of the Indiana Station compared the value of alfalfa hay and clover hay when fed as the only roughage and also when fed with corn silage. When thus fed, clover hay was fully equal to alfalfa

Table V - A Comparison of Hays for Fattening Beef Cattle

Roughage	Iowa Experiment Station (a) Two-year-old steers - 150 days				Kansas Experiment Station (b) Calves - 108 days		Indiana Experiment Station (c) Two-year-old steers - 154 days	
	Alfalfa hay*	Red clover hay	Mixed hay**	Timothy hay and oat straw	Alfalfa hay***	Prairie hay	Alfalfa hay****	Red clover hay
Initial weight - lbs.	1126.5	1120.00	1117.00	1107.00	377.96	370.33	1016.2	1017.2
Daily gain "	2.38	2.47	2.28	1.99	2.46	2.15	2.27	2.38
Shelled corn "	20.3	20.3	21.0	20.0			15.83	16.15
Ground corn "					9.74	9.83	2.90	2.91
Cottonseed meal "					1.12	1.36		
Alfalfa "	9.6				6.03		12.66	
Clover "		8.7						12.12
Mixed hay "			8.5					
Timothy hay "				6.0				
Oat straw "				.3				
Prairie hay "						4.43		
Cost per cwt. gain	$12.13	$10.65	$12.47	$13.45	$9.31	$9.91	$15.28	$14.28
Selling value per cwt.	8.25	8.25	8.15	7.90	13.25	12.50	9.29	9.33

*Hay prices charged per ton: Alfalfa $20, clover $16, timothy $18, oat straw $10.
**Mixed hay one-half to two-thirds timothy, balance red clover.
***Hay prices charged per ton: Alfalfa $15, prairie hay $10.
****Hay prices charged per ton: Alfalfa $14.62, clover $13.52

(a) Evvard, J. M., Culbertson, C. C., Wallace, Q. W. and Hammond, W. E. "Roughages for Fattening Two-Year-Old Steers" Iowa Experiment Station Bulletin 253.
(b) Anderson, B. M., McCampbell, C. W. and Alexander, M. A. "Cattle Feeding Investigations 1927 - 1928." Kansas Experiment Station Circular 151.
(c) Skinner, J. H. and King, F. G. "Value of Alfalfa Hay for Fattening Cattle" Purdue University Agric. Exp. Sta. Bulletin 245.

hay ton for ton. Any differences in the feeding value of the two kinds of hay were due to variations in the quality of the hay rather than to difference in the variety. In these experiments enough cottonseed meal was supplied to balance the ration.

Table V shows that clover is superior to mixed clover and timothy hay for fattening beef cattle. The cattle receiving clover made more rapid gains and at less cost than the cattle fed mixed hay. The gains were not only made at less cost per hundred pounds gain, but the clover-fed steers sold at higher prices per hundredweight.

Sweet Clover and Other Legumes. What has been said of alfalfa and red clover applies in a general way to other legumes, such as sweet clover and soy beans. Considerable inconvenience may be encountered in curing and storing these forage crops. In many cases sweet clover is allowed to become woody before it is harvested. At this stage it is very unpalatable and difficult to handle. For these reasons care should be taken to cut sweet clover at an early stage.

Henry and Morrison (11) report a trial from the South Dakota Station, in which sweet clover hay proved practically equal to alfalfa hay. However, some difficulty was experienced in getting the steers to eat it until it had been run through a hay cutter.

Muir and Chagnon (20) of the Dominion Experimental Farms, Ontario, Canada, reports that sweet clover may take the place of red clover. However, sweet clover hay is not so palatable and the cattle have to be forced to eat it at first, but they eventually develop a taste for it. As it is usually coarser than alfalfa or good quality red clover, it is not as valuable for feeding young animals.

Trials conducted at the Dominion Experimental Farms, Scott, Saskatchewan, Canada, comparing sweet clover hay, western rye hay, sunflower silage, and straw as roughage for fattening steers when fed with barley chop, showed sweet clover hay to be an excellent roughage. The animals receiving sweet clover produced the greatest gains and returned the greatest profits, with sunflower silage ranking a close second.

In some of the arid sections of the Great Plains area of Montana, sweet clover gives promise of becoming an important forage for livestock. Being a biennial, sweet clover works in very nicely with a short rotation system of grain farming practiced in the arid wheat producing sections of this state. A stand of sweet clover can usually be secured under conditions of more severe drought where alfalfa and other legumes will not start.

Timothy Hay. Timothy hay is the fourth most important hay crop in the state with a total production of 159,000 tons in 1928. Timothy is not a legume and therefore comes under the class of carbonaceous roughages. In former years timothy was considered the standard roughage for fattening cattle and other classes of livestock. Timothy has no laxative effects, and for this reason it may be valuable when fed in combination with laxative feeds.

Cattle on full feed, if allowed free access to roughages will eat from 20 to 35 per cent (29) more legumes than timothy. In such cases cattle will likely consume more of the expensive concentrates, thereby making the cost of gains higher when timothy is fed. Snapp (29) reports the average of many trials with a corn-alfalfa ration and a corn-timothy ration. The average daily gains with two-year-old steers with timothy as

a roughage was 1.85 pounds daily as against 2.40 pounds when alfalfa supplied the roughage. In spite of the fact that the timothy-fed steers consumed over a third more corn than the alfalfa-fed steers they made smaller gains.

In table V the Iowa trials show that the timothy-fed steers made smaller daily gains and that the cost per hundred pounds gain was greater than when alfalfa, clover or mixed hays were fed. The timothy-fed steers sold for less per hundred pounds than did the steers fed clover or mixed hays.

In eastern Canada timothy is one of the standard hay crops. Here it is often used in beef cattle feeding with fair results. It is possible that when timothy is fed with such grains as barley or wheat, which are not so low in protein as corn, that the difference between the value of timothy and alfalfa may not be so great as reported in experiments where corn was fed.

Prairie or Wild Hay. Prairie or wild hay is similar to timothy hay in composition. Its value will vary with the different kinds of grasses as found in different localities. Table V shows that fair gains have been made on prairie hay at the Kansas Station. Though hay produced in Kansas will differ somewhat from that produced in Montana, it is very probable that the prairie hay produced in this state has an equal feeding value to that produced in other sections of the country. When prairie hay is produced on land that is low in calcium and phosphorus it may be advantageous to add bone meal or other mineral supplements to the ration. Anderson and associates (1) at the Kansas Station found that when bone meal was added to a ration of cane silage, prairie hay, shelled corn, and cottonseed meal

that it increased the gains and lowered the cost of gains.

Van Nice (32) at the Dominion Experimental Farms, Scott, Saskatchewan, Canada, compared prairie hay, western rye, oat sheaves and sunflower silage as roughage for fattening steers with a meal mixture of barley chop. The average figures for the three principal comparisons and with a check lot included which received no other roughage than oat straw, are given in table VI.

Table VI. Roughages for Fattening Steers - Average Two Years

Roughage	Prairie hay	Western rye	Oat sheaves	Sunflower silage	Oat straw only (check)
Average daily gain per head .....lbs.	1.81	1.66	1.53	1.70	1.32
Grain required per 100 pounds gain..lbs.	555.	611.	696.	687.	936.
Cost per 100 pounds gain.....	$9.81	$10.71	$12.23	$9.70	$13.50

Prairie hay ranks highest in two out of the three points of comparison, and is a close second in the third. This table indicates the relative values of these roughages to be in the following order, when used for fattening steers in conjunction with a liberal grain ration: 1. prairie hay 2. sunflower silage 3. western rye 4. oat sheaves and 5. oat straw.

Beet Pulp. Beet pulp is available for feeding in both the dried and the wet form as it comes from the factory. On account of the cost of the dried pulp it is seldom used for fattening cattle, but is used mainly by dairymen. Wet beet pulp may be stored in large tank-like silos, straw silos or well drained trench silos; the trench silos are practically as efficient and usually cheaper than the other methods.

Beet pulp is lacking in protein and lime, for this reason

alfalfa is especially valuable as a supplement. Cottonseed cake fed in limited quantities is a very valuable supplement for feeding with beet pulp. From one to three pounds of cottonseed cake are recommended according to the amount of alfalfa used and size of cattle fed.

Maynard and Osland (17) of the Colorado Station, report feeding siloed beet pulp with various combinations of feeds. Steer calves fed a ration of siloed beet pulp, barley, cottonseed cake and alfalfa hay made a daily gain of 1.89 pounds daily. The addition of corn silage to this ration decreased the gains to 1.80 pounds daily. Steers fed a ration without corn silage or beet pulp made daily gains equal to those receiving the corn silage addition. The cost of a hundred pounds gain was 50 cents less for the standard beet pulp ration, than where corn silage was added, and 75 cents less than where neither corn silage or beet pulp was fed.

Sugar Beet Tops. Sugar beet tops are a protein or growth producing feed. They are available in the fall as soon as the beets are harvested. During the fall and early winter beet tops are usually fed to cattle before they are put on a heavy finishing ration. In many instances no grain is fed during this preliminary feeding period, alfalfa being the only supplementary feed used. Either wet beet pulp or a light grain ration fed with tops and alfalfa tends to balance the ration and give more economical gains.

Miscellaneous Roughages. In some sections of the state, especially the northeastern part of Montana, cultivated varieties of grasses such as western rye, brome grass, and others are used for hay. Where cattle are fed on silage, hay from the grasses can be used to supply

the dry roughage, and very good results may be secured.

Straw is very bulky and low in nutrients, and for this reason usually should not be included in the fattening ration. However, when cattle are given a full feed of silage or beet pulp, good quality bright straw may be used to supply a part of the dry roughage.

Bean straw is a by-product from the bean crops grown for commercial use, and the amount available for feeding purposes is limited. Vinke (36) and (38) at the Montana Station fed bean straw in combination with sugar beet by-products during two trials. Very satisfactory results were secured the first year by substituting bean straw for half the alfalfa in a ration of beet pulp, alfalfa and molasses. The steers receiving bean straw returned $12.88 for each ton consumed, as compared to those fed pulp, alfalfa, and molasses. In the second trial bean straw was used to replace either half or all of the alfalfa in a ration of beet pulp, cottonseed cake, molasses, and barley. With this combination of feeds the use of bean straw in place of half or all of the alfalfa reduced the daily gains and lowered the selling price and the profits.

McKillican (18) at the Dominion Experimental Farms, Manitoba, Canada, conducted experiments during several different seasons with sheaf oats as the main fodder. Comparisons with native hay came out to the advantage of sheaf oats as to gains in weight. In 1916-17 an experiment was made to determine whether the labor of threshing and grinding oats was repaid by increased gains, or whether as good results could be obtained by feeding in the sheaf. The gains in weight were practically alike, but where the cost of putting on a pound of gain with the oat straw and chop was 10.2 cents, it was only 6.9 cents with the oat sheaves.

While these latter roughages are not recommended to form the bulk of forage in the fattening ration, it is possible that where legumes cannot be successfully grown, or in case of an unexpected shortage in the hay crop that they may be used with fair results as a part of the roughage in a fattening ration.

Silage. Silage is a succulent feed and very palatable to cattle. The amount of silage fed will vary with the kind of silage and length of feeding period. Silage has a high water content which varies widely with the stage of maturity of the crop at time of ensiling. Because of this great variation its dry roughage equivalent can only be approximated, but for practical feeding purposes it can be roughly estimated by dividing the weight of fresh silage by three. In other words, silage is equal to about one-third its weight in dry matter.

The cost of building a silo, and the outlay for equipment amounts to a considerable expense. The labor costs for harvesting and filling the silo are high. Because of these high costs silage may only prove an economical feed when used in large quantities and when other forms of roughage are relatively high priced.

Corn is by far the most important crop used for silage in this country. To a limited extent silage is also made from alfalfa, sunflowers, peas, oats and other forage crops. At the outset it may be said that silage does not form an important source of feed for livestock in Montana. There are, however, certain sections where its use has been found profitable, and it is possible that there is room for an expansion of its use in certain sections of the state.

Corn Silage. During the period of years from 1924 to 1927 in-

clusive, the percentage of the corn crop of the state used for silage varied from 2.9 to 4 per cent. Stanley and Scott (30) at the Arizona Station in a trial with fattening calves on a ration of alfalfa hay, barley, and cottonseed meal found that with the corn silage added, the calves made a hundred pounds gain on 35.16 pounds less dry matter, and at a saving of 69 cents per hundred pounds gain when compared with the no silage group. They figured that a ton of corn silage would be worth $7.82 for fattening calves.

In a trial by Maynard (16) at the Colorado Station with steers the addition of corn silage to a barley-alfalfa ration increased the daily gain from 1.78 pounds to 2.03 pounds daily per head. With the barley and alfalfa-fed steers there was a loss of $2.79 per head, while with the addition of corn silage there was a profit of $3.71 per head.

At the Washington Station, Hackedorn and associates (8) fed calves corn silage added to a ration of corn and alfalfa. The average daily gain produced over a period of 63 days was practically the same for both groups. Approximately 2.5 pounds of silage replaced 1 pound of alfalfa hay when fed in a mixture of 3 pounds silage to 1 pound of hay. It is also noted that the addition of silage to the ration stimulated the consumption of hay.

Sunflower Silage. Sunflower silage is probably better adapted to Montana conditions than is corn silage. Where the growing season is not long enough for the production of corn, sunflowers make a valuable silage crop. Sunflowers produce a larger tonage per acre than corn. Some difficulty is encountered with sunflowers in securing the desired uniformity of maturity.

Sunflower silage may have a somewhat lower feeding value than corn silage, and is less palatable to livestock. Hackedorn and associates (8) at the Washington Station compared corn silage and sunflower silage for fattening steers in a ration of cottonseed meal and alfalfa. Both groups made exactly the same gains. However, in the replacement of feeds required per hundred pounds gain, if corn silage is rated as 100 per cent then sunflower silage has a replacement value of 88 per cent.

In a trial at the Oklahoma Station, Blizzard (3) fed calves a ration of sunflower silage, cottonseed meal, shelled corn, and alfalfa hay. To a second group he fed a like ration except that corn silage was fed in place of sunflower silage. The calves fed the ration with sunflower silage made slightly more rapid gains than those fed the ration with corn silage. The selling price for each group was the same, but the cost per hundred pounds gain was 21 cents more for the calves receiving the corn silage.

Wilson and Kuhlman (41) at the South Dakota Station fed steers corn silage and sunflower silage as the sole feeds. One lot was fed corn silage only; a second lot 75 per cent corn silage and 25 per cent sunflower silage; a third lot half corn silage and half sunflower silage; and a fourth lot 25 per cent corn silage and 75 per cent sunflower silage. The gains made by the steers were in direct proportion to the amount of corn silage in the ration. Steers receiving all corn silage made the most rapid gains, and those receiving 25 per cent corn silage and 75 per cent sunflower silage made the least gains.

Several trials have been conducted by Maynard (14) at the Colorado Station comparing corn silage with sunflower silage in different

rations. Sunflower silage fed with barley and alfalfa reduced the cost of gains. In a ration of dried molasses beet pulp, (a) cottonseed cake and alfalfa, corn silage proved very efficient in putting on gains. When sunflower silage was used to replace the corn silage in this ration the feeds did not niche well and a lower value was shown for the sunflower silage than was justified. In another trial with dried molasses beet pulp, cottonseed cake, and alfalfa the corn silage produced gains on 11.5 per cent less silage, 11 per cent less dried molasses beet pulp, 11.3 per cent less cottonseed cake, and 37 per cent less alfalfa than did sunflower silage.

Alfalfa Silage. In some cases it may be desirable to ensilage a part of the alfalfa crop, especially may it be an advantage to do this in very wet seasons. It sometimes happens that the first cutting of alfalfa is badly mixed with weeds, so as to be of little value for hay. True and associates (31) at the California Station conducted trials with first cutting alfalfa silage for feeding three-year-old steers. The ration consisted of barley, alfalfa hay and alfalfa silage. The average daily gain was 1.53 pounds per head. The results indicated that silage may be made from weedy alfalfa which would make but inferior hay, and that such silage will be eaten without waste, and that it can be used as supplementary feed for fattening steers on barley and alfalfa hay.

Oat and Pea Silage. A mixture of oats and peas is often grown in the northern part of the United States and Canada. This makes a very palatable silage. Hays (10) at the Wyoming Station conducted trials in

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(a) Dried molasses beet pulp contains approximately 1600 pounds of dried beet pulp and 400 pounds of dried molasses.

wintering steers with alfalfa hay and sunflower silage or oat and pea silage. Steers receiving a full feed of sunflower silage made a daily gain of 1.54 pounds, while those fed oat and pea silage made a daily gain of 1.02 pounds.

Work done at the University of Alberta by Dowell and Bowstead (5) with silage for fattening steers indicates that oat and pea silage is equally as efficient as sunflower silage. Steers receiving a grain mixture, hay and linseed meal with oat and pea silage made a daily gain of 2.48 pounds per head, while those receiving sunflower silage in place of the oat and pea silage made a daily gain of 2.06 pounds.

Pea vine silage from the canning factory is probably of somewhat lower feeding value than regular pea silage. The exact value of such refuse from the canning factories has a wide variation. In stacks of this material there is considerable waste from the top and sides. Other green crops may be used for silage. However they do not pack into the silo so well as corn, sunflowers, or peas.

PREPARATION OF FEEDS

The preparation of feeds for fattening beef cattle is given serious consideration by feeders of cattle. Generally speaking feeding stuffs can most economically be fed in the form that requires the least labor. But under certain conditions processing of some feeding stuffs is justified.

Grinding of Grain. It is true that the grinding of most grains increases consumption, digestibility, and results in more rapid daily gains. Whether the increase in daily gains will be great enough to pay for the cost

of grinding will depend upon a number of factors. When cattle prices and grain prices are high the returns for grinding grain will be greater then when one or both of these are low.

The hulled varieties of barley have their kernels surrounded by a though, heavy hull which lessens the digestibility. Crushing or rolling is preferred to grinding. Peters and Denner (24) of the Minnesota Station conducted trials with whole barley versus ground barley in a ration of linseed meal, alfalfa hay, and corn silage for fattening yearling steers. The ground barley lot made an average daily gain of 2.25 pounds and the whole barley lot 2.12 pounds. The cost of gains for the ground barley lot was less than for the whole barley lot, and excluding hog gains the former made a profit of $6.79 per head and the whole barley group lost $4.33 per head. The price charged for grinding the barley in this trial was eight cents per hundredweight. These results are fairly representative of experience at other experiment stations with fattening cattle on ground and whole barley.

Oats have heavy hulls, which constitute about 30 per cent of their total weight. Whole oats are not well digested by cattle, but because of their lower feeding value than corn or barley, it appears that it does not pay to grind them. Peters and associates (23) of the Minnesota Station compared a ration of ground versus a ration of whole grain for fattening baby beeves. For the first 168 days the grain consisted of 60 per cent shelled corn, 30 per cent oats, and 10 per cent linseed meal. For the last 49 days the grain mixture was 75 per cent shelled corn, 15 per cent oats, and 10 per cent linseed meal. The whole grain group made slightly less rapid gains, but at lower cost than did the ground grain

group. Excluding gains made by hogs, the whole grain group returned a profit of $15.40 per head and the ground grain group only $12.73 per head. When the gains made by hogs is considered, the profits are even higher for the whole grain group. These results are in line with those from other stations on grinding shelled corn and oats.

When ear corn or shelled corn is fed to cattle a considerable amount of it passes through the entire digestive system without having the outer covering broken, and other kernels are but partially digested. Where hogs follow the cattle they will pick up a large percentage of this grain, while if the corn is ground a much smaller amount of it will be recovered. Unless the price of cattle is very high it is not advisable to grind corn where hogs are used to follow the cattle.

Wheat and rye usually give better returns when crushed before feeding to cattle. Best results are obtained when they are not too finely ground. Wheat very finely ground tends to form a pasty ball in the mouth, and the cattle do not eat it with so much relish.

Soaking and Cooking Grain. In the early years of beef production it was a rather common practice to soak the feed or cook it. These treatments were supposed to increase the digestibility and palatability of the grain. These practices are now obsolete with progressive cattle feeders, and are used only in fitting show cattle. The returns secured from preparing feeds in these ways do not justify the added labor and expense.

Chopping Roughage. Chopping of hay may be practiced where the hay used is rank and coarse and there is considerable waste if fed whole. Sometimes the hay is ground very fine and mixed with the grain. The evi-

dence from various experiments is somewhat confusing as to the practicability of grinding alfalfa hay for cattle. Fuller (6) of the Wisconsin Station reports trials with chopped versus whole alfalfa or soybean hay with dairy cows, beef cows, and beef calves. The results give no definite conclusions, for in some of the trials the gains were greatest on whole hay, and in others there was a marked advantage for the chopped hay. For a number of years experiments have been carried on at the Oregon Station by Potter and Withycombe (26) with feeding chopped and long alfalfa hay to beef cattle. They found when hay alone was fed that chopping made an improvement in the gains of about 18 per cent; when fed with small grains, chopping made an improvement of 14 per cent. These results compare closely with those secured at the Idaho Station with feeding chopped alfalfa hay.

It is quite safe to say that chopping will save waste, will make larger gains, and will require less feed per hundred pounds gain. The actual improvement will probably be between 10 and 20 per cent. The Oregon Station estimates the cost of chopping at $2.75 per ton. When this figure is taken into consideration it will be seen that it is only under rare conditions that chopping will pay for its cost in fattening cattle in Montana.

FULL FEEDING VERSUS LIMITED GRAIN FEEDING

During the early years in Montana when only small amounts of grain were produced in the state, the advisability of fattening cattle on full grain feeding was given little thought. Under these conditions most of the cattle were marketed as two and three-year-old grass steers. Since Montana has become an important grain producing state more attention has

been given to full feeding grain.

Snapp (29) compiled a table from a series of Indiana experiments from 1915 to 1922 on the use of limited corn rations in steer fattening. Four lots were used each year, fed as follows:

1. Full feed during entire period.
2. One-half feed, based on consumption of first group.
3. No corn during first part of feeding period, full feed during last half.
4. No corn at all.

The results for the entire period show that the full-fed group made the most rapid gain, and the no corn group the least gain. The steers receiving the full feed of corn the last half of the period made slightly better gains than those receiving one-half of the corn throughout the period. The cost of gains per hundred pounds were highest for the full-fed group, and lowest for the group receiving no corn. However, this fact did not make the profits from the no corn group the highest, rather they were the lowest and the full-fed corn group returned the most profit. This may be accounted for because of their higher degree of finish, which resulted in a higher price per hundredweight.

Anderson and associates (2) at the Kansas Station conducted trials with yearling steers on full corn feeding versus light corn feeding for a limited period of 90 days, following which all lots were full-fed. The steers were appraised at the end of 150 days and again at the end of 225 days. This furnishes information as to the advisability of medium feeding periods compared with prolonged feeding periods. The light grain group received only five pounds of corn daily per head for the first 90 days. At the end of 150 days the full-fed lots had made the largest gains, at less cost, and their selling price was 75 cents more per hundred-

weight, resulting in $8.23 greater profit per head for the cattle full fed from the beginning of the test. The gains of the full-fed group at the end of 225 days were slightly more expensive than those of the limited grain fed group. However, the full-fed group sold for 50 cents more per hundredweight, and returned $4.47 more margin per head than the limited fed group.

Vinke (34) at the Montana Station conducted trials to compare limited and full feeding of steers on a ration of barley and wheat equal parts by weight, and alfalfa hay. Steers were full-fed, two-thirds full fed, and one-half full fed for a period of 157 days. The full-fed steers made the greatest gains and returned the most profit, while the one-half full-fed group made the least gains and returned the least profits.

Vaughan and Harvey (33) at the Minnesota Station conducted experiments to determine the advisability of limited grain feeding for fattening baby beeves. In a ration of corn silage, alfalfa hay, linseed meal and shelled corn, the corn was limited to 78 per cent of a full feed for one lot, and another lot limited to 91 per cent. The 78 per cent allowance gave a larger profit than the 91 per cent allowance. Both the 78 and the 91 per cent allowance of shelled corn resulted in larger margins of profit than was obtained when a full feed of corn-and-cob meal was given. In two previous trials at this station a full feed of corn-and-cob meal surpassed a full feed of shelled corn in profit. These trials seem to justify the statement that where silage is fed it will ordinarily be most profitable to limit the allowance of shelled corn to about 78 per cent of a full feed. This allowance amounts to about 1.6 pounds of shelled corn daily per hundred pounds live weight.

The advisability of limiting the grain ration will depend to some degree on the relative cost of grain and hay, also the amount and kind of roughage to be consumed on the farm. Cattle on full grain rations eat less hay than limited grain-fed cattle; thus less hay can be marketed in the same time with full grain feeding. Fully matured steers, thin in flesh, with large frames and good deep middles are the ideal kind for limited grain rations. Young growing animals require a higher per cent of concentrated feeds to finish them out than do mature animals. Unless the feeder's problem is primarily one of selling roughage through cattle, it is generally agreed that in the case of cattle of good quality a full feed of grain is advisable, rather than limiting the amount of grain fed during the fattening period.

PART III

THE MONTANA EXPERIMENTS - THREE YEARS' RESULTS

Investigations have been carried on during four years by the Department of Animal Husbandry of the Montana Experiment Station in an attempt to determine the most profitable methods of fattening steers in Montana. The investigations have included a study of the value of various home-grown feeds for fattening cattle.

These experiments have been in charge of Louis Vinke at the Montana Experiment Station, Bozeman, Montana. The results of the first three years' experiments beginning in 1926, are presented herewith in brief form.

The fourth years' experiments, 1929-30, conducted jointly by Louis Vinke and the writer, are discussed in detail both as to methods of procedure and results in Part IV. Practically the same methods were used in conducting the experiments in each of the four years.

PROPORTIONS OF GRAIN AND ROUGHAGE FOR FATTENING YEARLING STEERS

In many sections of Montana hay usually has a rather low market value as compared to the small grains. The first problem that this series of experiments attempted to solve was the most profitable proportion of grain and hay to feed to fattening cattle.

First Trial 1926-27. Five lots of cattle were fed varying proportions of alfalfa hay and grain or alfalfa hay alone. High grade Hereford yearling steers were used. Fair quality first and second cutting alfalfa hay was fed. The steers were started on first cutting hay and

Table VII. Full Feeding Versus Limited Grain Feeding

November 16, 1926 to April 17, 1927 - 152 days

Lot number Ration	I Full fed grain full fed alfalfa	II ¾ full fed grain full fed alfalfa	III ½ full fed grain full fed alfalfa	IV Stepping up grain full fed alfalfa	V Alfalfa hay only
Number in lot	10	10	10	10	10
Average initial weight	743.8	746.1	748.4	746.5	744.3
Average final weight	1043.7	1024.7	1007.8	1000.3	919.7
Average daily gain	1.97	1.83	1.70	1.67	1.15
Average daily feed consumed:					
Barley lbs.	8.78	6.58	4.39	5.30	
Oats "	2.93	2.19	1.46	1.77	
Alfalfa "	15.93	19.83	22.74	20.78	23.48
Feed required per 100 lbs. gain:					
Barley	445.04	358.33	257.27	317.49	
Oats	148.34	119.44	85.75	105.82	
Alfalfa	807.20	1081.94	1352.81	1243.42	2034.78
Cost of feed per 100 lbs. gain*	$12.93	$12.58	$11.81	$12.57	$10.17
Initial cost per cwt. in feed lot	$ 7.06	$ 7.06	$ 7.06	$ 7.06	$ 7.06
Initial cost per head	52.57	52.67	52.84	52.69	52.54
Total cost of feed per head	38.79	35.04	30.64	31.92	17.85
Final cost per head	91.30	87.71	83.48	84.61	70.39
Selling price per cwt. (Chicago)	$10.50	$10.00	$ 9.25	$ 9.65	$ 9.00
Selling price per cwt. (Bozeman)**	8.75	8.25	7.50	7.90	7.25
Selling price per head (Bozeman)	91.32	84.54	75.58	79.02	66.68
Margin or loss per head over feed costs	$ .02	$-3.17	$-7.90	$-5.59	$-3.71

*Feed prices charged: grain $1.50 per cwt., hay $10.00 per ton.
**Chicago price less $1.75 per cwt.

finished on second cutting hay. The grain consisted of a mixture by weight of three parts barley and one part oats. The grain was rolled or ground in preparation for feeding.

The results given in table VII indicate that on the basis of the prices used the greatest returns per steer were obtained in the full-fed lot. The selling prices were directly proportional to the amounts of grain consumed.

If hay was worth $10 a ton in this trial, the grain fed the different lots was marketed at the following prices:

	Lot I Fullfed grain	Lot II ¾ fullfed grain	Lot III ½ fullfed grain	Lot IV Stepping up grain
Price received per cwt. grain	$1.50	$1.19	$0.61	$0.98

If on the other hand the grain is charged at $1.50 per hundredweight the returns per ton of hay in this trial would be as follows:

	Lot I Fullfed grain	Lot II ¾ fullfed grain	Lot III ½ fullfed grain	Lot IV Stepping up grain	Lot V Hay only
Price received per ton of hay	$10.01	$7.90	$5.42	$6.42	$7.92

Except for the hay lot, the prices returned by the steers for feed consumed were in direct proportion to the amount of grain consumed and favor fullfeeding grain.

Lot IV, fed no grain at the beginning of the trial, and a full feed during the latter part of the trial, gave slightly higher return per steer than where a half feed of grain was given throughout the period. Lot V, which received hay alone, made an average daily gain of 1.15 pounds, but the result was feeder cattle, as the Chicago Packers would not bid on

them. However, the demand for feeder cattle at this time of the year was above average, and they sold for enough so that their loss was less than that on Lots III and IV, which were fed a half feed of grain.

Second Trial 1927-28. During the winter of 1927-28 the trial of the previous year was repeated, except that different grains were used. The steers were high grade Shorthorns and were somewhat heavier at the beginning of the trial than the steers the year before.

The steers were started on fair quality first cutting alfalfa hay and finished on second cutting. The grain was coarsely rolled, and consisted of equal parts by weight of frosted wheat and hulled barley.

The results of this trial given in table VIII bear out the results of the previous year - namely, that on the basis of the feed prices used the greatest returns per steer were made on the fullfed lot. The selling price was directly proportional to the gains made and amount of grain consumed. The fact that more profits were made this year than the previous year is due to the following factors: First, to market conditions, second, to gains made, third, to a difference in the grains used, and fourth, increased grain consumption resulting in fatter steers than the previous year.

If alfalfa was worth $10 a ton in this trial, the grain fed the different lots was marketed at the following prices:

	Lot I.	Lot II.	Lot III.
Price received per cwt. for grain	$2.44	$2.59	$3.07

These results indicate that if a prospective feeder has a large supply of

Table VIII. Full Feeding Versus Limited Grain Feeding

November 11, 1927 to April 16, 1928 - 157 days

Lot number	I Full-fed grain full-fed alfalfa	II ¾ full-fed grain full-fed alfalfa	III ½ full-fed grain full-fed alfalfa
Number in lot	9*	10	10
Average initial weight lbs.	821.6	829.1	829.9
Average final weight "	1178.3	1139.2	1103.4
Average daily gain "	2.27	1.79	1.74
Average daily feed consumed:			
Barley lbs.	8.03	6.03	4.02
Frosted wheat "	8.03	6.03	4.02
Alfalfa "	9.95	13.13	16.83
Feed required per 100 lbs. gain:			
Barley lbs.	353.4	305.29	230.76
Frosted wheat "	353.4	305.29	230.76
Alfalfa "	437.9	664.97	966.10
Cost of feed per 100 lbs. gain**	$12.79	$12.48	$11.75
Initial cost per cwt. in feed lot	$8.50	$8.50	$8.50
Initial cost per head	69.84	70.47	70.54
Total cost of feed per head	45.63	38.70	32.14
Final cost per head	115.47	109.17	102.68
Selling price per cwt. (So. St. Paul)	$13.30	$12.90	$12.60
Selling price per cwt. (Bozeman)***	11.80	11.40	11.10
Selling price per head (Bozeman)	139.04	129.87	122.48
Margin per head over feed costs	$23.57	$20.70	$19.80

*One steer died, not due to ration fed.
** Feed prices charged: Grain $1.50 per cwt., hay $10.00 per ton.
***So. St. Paul price less $1.50 per cwt.

alfalfa hay and a limited supply of grain that he will ordinarily find it most profitable if he can purchase enough grain at a reasonable price to feed a full allowance of grain with the alfalfa. The price that he can afford to pay for grain will depend on the value of his hay, price of feeder cattle, and price of fat cattle. On the other hand if there is a market for hay, he may find it advantageous to sell a part of his hay and then full feed a smaller number of cattle with the grain that he has produced.

If the grain is worth $1.50 a ton in this trial, the hay fed the different lots was marketed at the following prices:

	Lot I	Lot II	Lot III
Price received per ton of hay	$40.16	$30.10	$24.98

These results favor full feeding of grain. Lot I full-fed grain consumed only three-fifths as much hay as Lot III, half-fed grain. This means that in full feeding there must be a large amount of grain available for feeding in proportion to the amount of hay fed.

Conclusions. 1. The gains, selling price, and profits are in direct proportion to the amount of grain consumed.

2. Full feeding of yearling steers with small grains and alfalfa hay results in larger gains, more finish, and a higher market price than limited grain feeding.

3. In years of narrow margins resulting in negligible profits or losses on the basis of the prices of feeds used in these trials, the greatest returns per hundredweight of grain are made with full grain feeding.

4. On the basis of feed prices used the greatest returns per ton of hay are made when the steers are full-fed grain. Since fullfed cattle eat less hay than limited grain-fed cattle, less hay can be marketed through a given number of steers.

5. When limited grain feeding is practiced the most profitable method will be to withhold the grain during the first part of the trial and full feed grain during the latter part of the trial.

6. Yearling steers fed on alfalfa hay only cannot be fattened for the central markets. This practice results in feeder steers.

COMPARISON OF GRAINS FOR FATTENING YEARLING STEERS

In many sections of Montana various kinds of grain and certain low priced by-products from crops are available for feeding to livestock. The second problem that this series of experiments attempted to solve was the relative value of these feeds when fed with alfalfa hay for fattening yearling steers.

First Trial 1927-28. Three lots of grade Shorthorn yearling steers were used in a test to determine the feeding value of frosted wheat as compared with hulled barley. The steers were started on first cutting alfalfa and finished on second cutting. The wheat was badly discolored and from 70 to 90 per cent of the kernels were frosted. The weight per bushel ranged from 56 to 59 pounds. The hulled barley was of good feeding quality but contained a little smut.

Each lot was fed 75 per cent of a full feed of grain. One lot received equal parts of barley and frosted wheat by weight, a second lot received an equal amount of frosted wheat, and a third lot received the

same amount of barley. All grains were coarsely rolled in preparation for feeding.

Table IX shows that each of the three lots consumed practically the same amounts of grain and hay per head. The gains made were directly proportional to the amount of frosted wheat in the ration. The lot fed frosted wheat only, made the most gains. Figuring the price of grain at $1.50 per hundredweight the cost of gains were lowest in the lot fed frosted wheat only, and highest in the lot fed barley only.

The frosted wheat lot had the highest market value at the close of the trial, while the barley fed lot had the lowest market value. The frosted wheat lot returned the most profit per head, the lot fed wheat and barley ranked second, and the barley-fed lot third.

If alfalfa hay is worth $10 per ton the return per hundredweight of grain fed for the different lots was as follows:

	Lot II Barley and frosted wheat	Lot IV Frosted wheat	Lot V Barley
Price received per cwt. of grain	$2.59	$2.87	$2.45

On the other hand if the grain is worth $1.50 per hundredweight the return per ton of hay for the different lots of hay was as follows:

	Lot II Barley and frosted wheat	Lot IV Frosted wheat	Lot V Barley
Price received per ton of alfalfa	$30.10	$35.58	$27.20

These results show that if frosted wheat and barley are both available, that frosted wheat fed as the only grain will yield more per

Table IX. Barley Vs. Frosted Wheat Vs. Mixture of Barley and Frosted Wheat

November 11, 1927 to April 16, 1928 - 157 days

Lot number Ration		II Barley, frosted wheat and alfalfa	IV Frosted wheat and alfalfa	V Barley and alfalfa
Number in lot		10	10	10
Average initial weight	lbs.	829.1	829.3	827.8
Average final weight	"	1139.2	1163.5	1124.4
Average daily gain	"	1.97	2.13	1.89
Average daily feed consumed:				
Barley	lbs.	6.03		12.05
Frosted wheat	"	6.03	12.05	
Alfalfa	"	13.13	12.92	12.99
Feed required per 100 lbs. gain:				
Barley	lbs.	305.29		637.84
Frosted wheat	"	305.29	566.08	
Alfalfa	"	664.97	606.95	687.60
Cost of feed per 100 lbs. gain*		$12.48	$11.52	$13.01
Initial cost per cwt. in feed lot		$8.50	$8.50	$8.50
Initial cost per head		70.47	70.49	70.36
Total cost of feed per head		38.70	38.53	38.59
Final cost per head		109.17	109.02	108.95
Selling price per cwt. (So. St. Paul)		$12.90	$13.10	$12.75
Selling price per cwt. (Bozeman)**		11.40	11.60	11.25
Selling price per head (Bozeman)		129.70	134.97	126.50
Margin per head over feed costs		$20.70	$25.95	$17.55

*Feed prices charged: Grain $1.50 per cwt., hay $10.00 per ton.
**St. Paul price less $1.50 per cwt.

hundredweight of grain than the barley and frosted wheat mixture and considerably more than the lot fed barley as the only grain. The frosted wheat also returned a larger profit per ton of hay than did the barley.

Second Trial 1928-29. In this trial five lots of high grade Hereford yearling steers were used. There were ten head in each lot. When all the cattle had learned to come up to the feed bunks and eat grain, the amounts fed were increased as rapidly as possible without the cattle scouring or going off feed. It required from 40 to 50 days to get the different lots to consume a full feed of grain.

The alfalfa used in this trial was of good quality first cutting. The hulless barley was good quality, mostly Faust's blue hulless variety. Except for a small amount of the previous year's crop containing some smut, the hull barley was very good quality Trebi. The wheat, of Marquis variety, was good quality, but low in protein content. Very good heavy feed oats, mostly of the Victory variety were used. The cull beans were culls and splits, mostly of the Great Northern variety. All grains were ground in preparation for feeding.

There is considerable trouble with bloat when barley and alfalfa are fed together. It was thought that by mixing the oats and barley in Lot IV that this trouble might be overcome. This combination of feeds however did not lessen the number of bloats occurring when barley alone made up the grain ration.

Table X shows that the steers fed hulless barley consumed less grain and more hay than the steers fed hull barley. They made somewhat more rapid gains at slightly less cost, sold at a little higher price when

finished, and returned a higher margin of profit over feed costs than any other lot.

The steers fed low protein wheat consumed less grain and more hay than the steers fed hull barley. The wheat lot made more rapid gains and at slightly less cost than those fed hull barley. For the wheat-fed steers the margin of profit over feed costs was $8.43 per head, whereas the margin on the hull barley-fed lot was only $4.65, or $3.78 less per head.

If alfalfa hay is charged at $10 per ton, the hull barley-fed steers paid $35.08 per ton for ground barley, the hulless barley group returned $44.28 per ton for the ground hulless barley, and the low protein wheat group returned $39.75 per ton for the ground wheat.

Substituting one-fourth oats for part of the barley in Lot IV increased the total grain consumption and at the same time lowered the rate of gain, increased the cost of gains, resulted in less finish, and reduced the profits as compared to Lot I. The oats fed in this trial would have to be reduced in cost from $30 per ton to $14.46 per ton in order to make the oats-fed steers as profitable as the hull barley-fed steers.

Substituting cull beans for part of the hull barley in Lot V reduced the rate of gain, increased the cost of gains, and produced less finish than in any of the other lots. The substitution of beans for slightly less than one-fourth of the barley changed the profit of $4.65 per head in the barley-fed group to a loss of $1.48 per head in the lot fed beans and barley. If the beans used in this trial had been available

Table X. Comparison of Grains for Full Feeding Yearling Steers

November 7, 1928 to April 14, 1929 - 158 days

Lot number Ration		I Hull barley alfalfa	II Hulless barley alfalfa	III Wheat alfalfa	IV Hull barlet, oats alfalfa	V Hull barley cull beans, alfalfa
Number in lot		10	9*	10	9*	9*
Average initial wt.	lbs.	765.4	756.0	765.7	760.7	762.1
Average final wt.	"	1085.5	1097.0	1092.5	1071.2	1038.8
Average daily gain	"	2.03	2.16	2.07	1.97	1.75
Average daily feed consumed:						
Hull barley	lbs.	11.58			8.81	8.06
Hulless barley	"		10.45			
Wheat	"			10.94		
Oats	"				3.13	
Cull beans	"					2.85
Alfalfa	"	9.05	10.71	9.97	8.68	10.02
Feed required per 100 lbs. gain:						
Hull barley	lbs.	571.58			448.0	460.23
Hulless barley	"		484.19			
Wheat	"			528.9		
Oats	"				159.0	
Cull beans	"					162.73
Alfalfa	"	446.7	496.24	482.0	441.6	572.15
Cost of feed per 100 lbs. gain**		$10.81	$10.47	$10.34	$11.32	$11.15
Initial cost per cwt. in feed lot		$11.82	$11.82	$11.82	$11.82	$11.82
Initial cost per head		90.47	89.36	90.51	89.91	90.09
Total cost of feed per head		34.60	35.71	33.80	35.15	30.85
Final cost per head		125.07	125.07	124.31	125.06	120.94
Selling price per cwt. (So. St. Paul)		$13.45	$13.75	$13.65	$13.25	$13.00
Selling price per cwt. (Bozeman)***		11.95	12.25	12.15	11.75	11.50
Selling price per head (Bozeman)		129.72	134.38	132.74	125.87	119.46
Margin per head over feed costs		$4.65	$9.31	$8.43	$.81	-$1.48

*Steer removed from lot.

**Feed prices charged: Hull barley $30 per ton, hulless barley $33 per ton, oats $30 per ton, wheat $30 per ton, cull beans $17 per ton, alfalfa $10 per ton.

*** St. Paul price less $1.50 per cwt.

for feeding at no cost whatever, the beans-fed steers would still have failed to equal the barley-fed steers in profit. When beans were fed in the amounts used in this trial they were too laxative and unpalatable to give satisfactory results.

Conclusions. 1. Frosted wheat weighing over 55 pounds per bushel and alfalfa proved superior to hulled barley and alfalfa in rate of gain, finish and profits in fattening yearling steers.

2. Hulled barley when used to replace half the frosted wheat gave poorer results than wheat, and better results than fullfed barley.

3. A ration of low protein wheat and alfalfa hay surpassed a ration of hull barley and alfalfa hay in rate of gain, finish, and profits in fattening yearling steers.

4. A ration of hulless barley and alfalfa hay proved only slightly superior to a ration of low protein wheat and alfalfa.

5. When a full allowance of grain was fed in combination with alfalfa hay, hulless barley gave better results than frosted wheat, hulled barley, or a mixture of hulled barley and oats.

6. Oats when used to replace one-fourth of the barley gave relatively poorer results than when barley alone was fed. The oat substitution resulted in slower gains, lower selling price per hundredweight, and a decreased margin per steer.

7. Cull beans when used to replace approximately one-fourth of the hulled barley proved to be unsatisfactory. The cull beans were very laxative and their substitution resulted in slower gains and a lower selling price of 45 cents per hundredweight.

PART IV

THE MONTANA EXPERIMENTS - FOURTH YEAR - 1929 - 1930

In a series of experiments in fattening steers carried on by the Montana Experiment Station, those of the fourth year, 1929-1930, were conducted jointly by Louis Vinke and the writer. These are reported herewith in detail.

A COMPARISON OF CONCENTRATES FOR FATTENING YEARLING STEERS

Considerable quantities of cheap and unmarketable concentrates are available in Montana for feeding purposes. Many ranchers produce a large amount of roughage which must be utilized as feed for livestock. Maximum returns for much of the concentrates and coarse feeding stuffs produced in Montana can be obtained by using these feeds in the fattening of beef steers.

Determination of the relative values of different concentrates when fed in combination with a full allowance of alfalfa hay in the winter fattening of yearling steers is the major object of this experiment. When barley and alfalfa hay are fed considerable trouble is experienced with bloat while getting the steers on full feed. The problem of getting steers on to a full feed of barley and alfalfa without bloat is one of the questions this research throws light upon.

OBJECTS OF THE EXPERIMENT

1. To determine the possibilities of fattening yearling steers on concentrates produced in Montana.

2. To determine the relative feeding values of wheat and barley when fed with alfalfa hay for fattening yearling steers.

3. To determine if it is advisable to add oats or cull peas to a ration of barley and alfalfa, when the oats or peas are fed in the proportion of 1 part oats or peas, to 3 parts barley.

4. To compare the feeding value of oats and cull peas when fed with barley and alfalfa hay in a fattening ration.

5. To determine if starting steers on oats and alfalfa hay and changing them to barley and alfalfa after they are on full feed will prevent "barley bloat" and to note if this method of feeding makes any difference in the gains and finish of the steers.

6. To determine the effects of the different rations upon the gains, finish, and market value of the steers.

METHODS OF EXPERIMENTATION

Duration of Experiment. The experiment started November 15, 1929, and continued until April 4, 1930, a period of 140 days.

Steers Used. Fifty head of good grade Shorthorn yearling steers were purchased near Manhattan, in the Gallatin Valley, having been selected from approximately 150 head of steers. Just previous to bringing the steers to Bozeman they had been running on bottom land pasture. During the summer they had run on native summer range.

The steers arrived in the feed lots at the Montana Experiment Station on November 7, 1929, after having been driven about 35 miles in two days. They were immediately given a good feed of bright alfalfa hay,

and in about two hours they were watered and weighed. They averaged 743 pounds per head. The purchase price in the feed lots was $9.50 per hundredweight. Prior to starting the experiment the steers were given two weeks to get accustomed to their quarters. During this period they were fed all the alfalfa hay they would eat with a small allowance of barley so as to get them accustomed to coming up to the feed bunks and eating grain before the experiment started.

Allotment Considerations. The fifty head of steers were divided as uniformly as possible into five lots of 10 head each. As the animals were weighed the first day, they were ear-tagged, and as they came off the scales they were scored individually on each of the following points: form, condition, quality, and head. They were then divided into lots as evenly as possible with respect to size, form, quality, condition, color and other points, so that each lot contained the same number of large and small steers, blocky and rangy steers, fleshy and thin steers, etc. They graded from good to choice dehorned feeding steers. (See Fig. 1). On the third consecutive day of weighing each steer was treated with blackleg vaccine. At the beginning of the experiment the average weight per steer for the various lots ranged from 747 to 759 pounds.

Housing and Yards. The animals were housed in a long experimental feeding shed which faced the south. The shed had a dirt floor. Solid wooden partitions divided the shed into five pens or sections, and each pen or lot of steers had an inside lying down floor space of approximately 18½ by 21½ feet. The floor of the shed was bedded with wheat straw as needed, and the sheds were cleaned at intervals of three or

four weeks. There was a 10-foot open doorway and two windows in the south wall of each of the five sections of the shed. Along both the east and west walls of each pen were mangers or bunks in which the grain and hay were fed. In each section of the shed on the north wall salt was kept in a box to which the steers had access at all times. Each of the five sections of the shed opened on the south into an unpaved yard approximately 25 by 106 feet. In the south end of the yard there was a galvanized iron water tank through which there was a continuous flow of clean fresh water available to the steers at all times.

Weights of Animals. Each steer was identified by a neck chain bearing an individual number. Each animal was weighed on three consecutive days at the beginning of the trial, and the average of the three weights was taken as his initial weight. During the trial lot weights were taken every 28 days. At the close of the trial lot weights were taken for three consecutive days, and the second day of these individual weights were taken. The average of the three weights were taken as the final average weight of each lot.

Rations Fed and Methods of Feeding. Following are the rations fed to the various lots:

Lot I - Wheat and alfalfa.

Lot II - Started on oats and alfalfa and changed to barley and alfalfa when on a full feed of grain. For the first 56 days oats were fed, during the third 28-day period the steers were gradually changed from oats to barley, and thereafter barley was the sole grain fed until the end of the trial.

Lot III - Barley and alfalfa.

Lot IV - Barley, oats and alfalfa. The grain was made up of three-fourths barley and one-fourth oats.

Lot V - Barley, peas and alfalfa. The grain ration was made up of three-fourths barley and one-fourth cull peas.

The steers in all lots were fed twice daily, about seven a. m. and four-thirty p. m. The alfalfa was fed first in the east bunk, and the grain shortly after in the west bunk. All grains were coarsely ground in preparation for feeding. Each lot was given all the alfalfa hay it would clean up. Each lot was started on grain at the rate of 2 pounds per head daily and increased as rapidly as possible without the steers going off feed or scouring until they were on full feed. It required from 40 to 50 days to get the various lots on full feed.

Feeds Used. A description of the various feeds follows:

Hull barley - Trebi barley of very good quality, fairly free from weeds and foreign material.

Oats - Good heavy feed oats of the Victory variety were fed.

Wheat - Marquis wheat, very hard and dry, low moisture content. Some of it two years old. Good soft wheat (Federation) was fed the last three weeks.

Peas - Cull peas were obtained from three different seed companies in Bozeman.

Alfalfa - Good quality first cutting irrigated alfalfa hay was fed. It was produced on the College farm, or on farms near the College.

Salt - Granulated stock salt manufactured by the Morton Salt Company was available to all lots of steers.

The grains were all produced in the Gallatin Valley, but were secured from several different growers. Table XI shows the actual analysis of the feeds as reported by Jesse Green, of the Chemistry Department of the Montana Agricultural Experiment Station.

Table XI. Analyses of Feeds Used

Feed	Moisture	Moisture-free basis				
		Ash	Crude protein	Fiber	N-free extract	Fat
	per cent	per cent	per cent	per cent	per cent	per cent
Hard wheat	8.36	2.20	13.00	5.03	78.77	1.00
Soft wheat	8.57	2.13	10.77	4.23	81.52	1.35
Barley	8.00	2.70	12.13	5.72	78.25	1.20
Oats	7.69	4.09	11.44	12.43	68.04	4.00
Cull peas	6.74	3.98	30.62	7.50	56.50	.95
Alfalfa	6.56	7.09	10.53	47.10	33.75	1.52

RESULTS OF THE EXPERIMENT

A careful study of the data given will be instructive in determining the relative values of some Montana grown concentrates when fed with alfalfa hay for fattening yearling steers. Hulled barley and wheat are compared, as well as the advisability of adding oats or cull peas to a barley-alfalfa ration.

Average Daily Feed Per Period. Table XII gives the average daily feed consumption per steer by periods. This table is useful in that it shows how the feeds were distributed throughout the trial. There is a direct relation in each lot between the amount of concentrates consumed and the amount of alfalfa consumed. From the beginning of the trial there was a gradual increase in the amount of concentrates consumed and a corresponding decrease in the roughage consumed. Lot II,

receiving oats required the least time to get them on a full allowance of grain. Lot V, receiving barley and cull peas required the most time to get them on a full allowance of grain. The latter may be accounted for in part by the trouble experienced during the first part of the trial with indigestion.

The average daily grain consumption in Lot I, 10.11 pounds was lower than for any of the other lots, while the average daily consumption of alfalfa, 12.10 pounds, was greater than for any of the other lots. On the other hand Lot V consumed the most concentrates, 13.11 pounds and had a higher total daily feed consumption of concentrates and alfalfa combined than any other lot. It is probable that the low consumption of wheat in Lot I may be due in part to the wheat being hard and unpalatable. That the cull peas fed in Lot V added to the palatability of the ration and increased the grain consumption is shown by a comparison with Lots III and IV.

Comparisons by Lots. Figures are given in table XIII summarizing the weights, gains, feeding and financial data of the experiment by lots.

Lots I and III. Lot I was fullfed wheat and alfalfa, while Lot III was fullfed barley and alfalfa. Contrary to the results of the previous trials of this series of experiments, the barley-fed lot made more rapid gains, carried more finish, was valued $.40 higher per hundredweight and made a greater margin of profit over feed costs than Lot I fed wheat. (See Figs. 2 and 4). This can probably be explained by the wheat being hard and unpalatable, which resulted in the steers not eating

Table XII. Average Amount of Feed Consumed Daily By Periods Per Head

November 15, 1929 to April 4, 1930 - 140 days

Lot number Ration		I Wheat Alfalfa	II Oats (start to full feed) Barley (from full feed to finish) Alfalfa	III Barley Alfalfa	IV Barley (3 parts) Oats (1 part) Alfalfa	V Barley (3 parts) Cull peas (1 part) Alfalfa
First 28-day period:						
Wheat	(lbs.)	4.88				
Barley	"			4.99	3.72	3.74
Oats	"		6.77		1.24	
Peas	"					1.25
Alfalfa	"	16.06	15.85	16.26	16.24	16.24
Second 28-day period:						
Wheat	(lbs.)	8.80				
Barley	"			10.63	8.00	7.55
Oats	"		12.69		2.67	
Peas	"					2.51
Alfalfa	"	11.23	10.05	13.06	13.21	13.07
Third 28-day period:						
Wheat	(lbs.)	11.02				
Barley	"		8.98	14.08	10.96	10.33
Oats	"		6.62		3.65	
Peas	"					3.44
Alfalfa	"	11.71	11.00	10.61	10.86	11.28
Fourth 28-day period:						
Wheat	(lbs.)	12.27				
Barley	"		16.32	16.05	11.84	12.46
Oats	"				3.95	
Peas	"					4.15
Alfalfa	"	11.11	9.64	9.25	9.50	9.71
Fifth 28-day period:						
Wheat	(lbs.)	13.57				
Barley	"		17.19	17.49	12.75	15.08
Oats	"				4.25	
Peas	"					5.03
Alfalfa	"	10.71	8.75	8.68	8.61	7.04
Average daily feed for entire period:						
Wheat	(lbs.)	10.11				
Barley	"		8.49	12.65	9.46	9.83
Oats	"		5.22		3.15	
Peas	"					3.28
Alfalfa	"	12.10	11.06	11.57	11.68	11.47

sufficient quantities to make rapid gains. The wheat-fed steers made more economical gains than the barley-fed steers, but not enough more to offset the greater gains, finish and higher selling price of the barley lot.

Lots III and IV. Lot IV was fed a grain ration of 3 parts barley and 1 part oats by weight, and alfalfa. In comparison with Lot III, which was fed barley and alfalfa, Lot IV made a slightly lower rate of gain, at a higher cost per hundredweight of gain, carried a little less finish and consequently had a slightly lower selling price, and changed a margin of profit over cattle and feed cost in Lot III to a loss (See Fig. 5). The results of this trial are similar to previous trials and show that it does not pay to include oats with barley in a fattening ration for steers unless oats are considerably cheaper than barley. The oats fed in Lot IV would have to be reduced in price from $30 to $21.80 per ton in order to make the feeding of Lot IV as profitable as the feeding of Lot III.

Lots II, III and IV. Lot II was started on oats and after the steers were on full feed the grain was gradually changed to barley. This lot made slightly greater gains, but at a higher cost per hundredweight gain, had less finish, a lower selling price and made less profit than Lot III, fed barley and alfalfa, or Lot IV fed barley and oats (3 to 1) and alfalfa.

The feed record for Lot II shows that the steers in this lot received more oats and less barley than Lot IV, indicating that the more oats are used with barley the less finish one can expect. (See Fig. 3). The fact that Lot II made larger gains than Lots III or IV may be due to

Table XIII. Fattening Yearling Steers

November 15, 1929 to April 4, 1930 - 140 days

Lot number Ration	I Wheat Alfalfa	II Oats (start to full feed) Barley (from full feed to finish) Alfalfa	III Barley Alfalfa	IV Barley (3 parts) Oats (1 part) Alfalfa	V Barley (3 parts) Cull peas (1 part) Alfalfa
Number in lot	9*	10	10	10	10
Average initial wt.(lbs.)	746.9	757.3	753.5	759.5	755.6
Average final wt. "	1049.4	1077.2	1068.8	1067.0	1093.5
Average daily gain "	2.16	2.28	2.25	2.20	2.41
Average daily feed consumed: (lbs.)					
Wheat "	10.11				
Barley "		8.49	12.65	9.46	9.83
Oats "		3.22		3.15	
Peas "					3.28
Alfalfa "	12.10	11.06	11.57	11.68	11.47
Feed required per 100 lbs. gain: (lbs.)					
Wheat "	467.9				
Barley "		371.9	561.6	430.5	407.3
Oats "		228.3		143.5	
Peas "					135.8
Alfalfa "	560.0	484.0	513.4	532.0	475.2
Cost of feed per 100 lbs. gain**	$ 9.82	$11.43	$10.99	$11.27	$10.52
Initial cost per cwt. in feed lot	$ 9.50	$ 9.50	$ 9.50	$ 9.50	$ 9.50
Initial cost per head	70.96	71.94	71.58	72.15	71.78
Total cost of feed per head	29.70	36.54	34.66	34.65	35.55
Final cost per head	100.66	108.48	106.24	106.80	107.33
Selling price per cwt. (So. St. Paul)	$11.20	$11.40	$11.60	$11.50	$12.00
Selling price per cwt. (Bozeman)***	9.70	9.90	10.10	10.00	10.50
Selling price per head (Bozeman)	101.79	106.64	107.95	106.70	114.82
Margin per head over feed costs	$1.13	-$1.84	$1.71	-$0.10	$7.49

*One steer died from unknown cause.

**Feed prices charged: Grain $30 per ton, cull peas $30 per ton, alfalfa $10 per ton.

***South St. Paul price less $1.50 per cwt.

the fact that there were no cases of bloat in Lot II. The oats fed in Lot II would have to be reduced in price from $30 to $20.28 per ton in order to make the feeding of Lot II as profitable as Lot III. It is probable that had the trial continued 40 days longer, Lot II would have made more profit than Lot IV. Over a longer period the total oats received by Lot II would have been less than the total amount of oats received by Lot IV.

Lots III and V. Lot V was fed a ration of three parts barley to one part cull peas by weight and alfalfa. Compared with Lot III which received barley and alfalfa, Lot V required less grain and less hay per hundred pounds gain, made more rapid gains at less cost per hundredweight, and carried considerably more finish than Lot III. (See Fig. 6). The margin of profit over cattle and feed costs returned by Lot V was $5.79 per head greater than was returned by Lot III. If this difference in profits is credited to the cull peas, the cull peas were worth $55.18 per ton. The indigestion experienced with the cull peas during the early part of the trial could probably be avoided by feeding a smaller allowance of peas at the start and increasing the proportion during the latter part of the trial.

Lots IV and V. Lot IV was fed a ration of barley and oats (3 to 1). Compared with Lot V they consumed more grain and more hay per hundred pounds gain, but made less rapid gains at a higher cost per hundredweight, carried less finish, which resulted in a lower selling price per hundredweight than was received for Lot V. The steers in Lot V returned a profit of $7.39 per head more than the steers in Lot IV,

Fig. 1. A representative lot of yearling steers at beginning of trial. Average weight 753.5 pounds. Fig. 4 shows this lot at end of feeding period.

Fig. 2. Lot I, yearling steers at close of trial after 140 days on wheat and alfalfa. Average weight 1049.4 pounds.

Fig. 3. Lot II, yearling steers at close of trial after 140 days. Started on oats and alfalfa and changed to barley and alfalfa when on a full feed of grain. Average weight 1077.2 pounds.

Fig. 4. Lot III, yearling steers at close of trial after 140 days on barley and alfalfa. Average weight 1068.8 pounds.

Fig. 5. Lot IV, yearling steers at close of trial after 140 days on three parts barley, one part oats, and alfalfa. Average weight 1067.0 pounds.

Fig. 6. Lot V, yearling steers at close of trial after 140 days on three parts barley, one part cull peas, and alfalfa. Average weight 1093.5 pounds.

thus showing that cull peas had a much higher feeding value when substituted for one-fourth of the barley in a barley and alfalfa ration, than did oats when sibstituted for one-fourth of the barley in a barley and alfalfa ration.

Bloat. Cattle feeders and experiment stations report that serious difficulties have been encountered with so called "barley bloat." When steers are started on a ration of barley and alfalfa and are brought up to a feed of approximately seven pounds barley per head daily they often start to bloat and continue to do so until they are on a full feed of grain when the trouble practically stops. When wheat is fed with alfalfa much less trouble is experienced from bloat. Mixing the barley with oats (3 to 1) or cull peas (3 to 1) did not reduce the number of bloat cases in this experiment. As there is very little trouble with steers bloating on oats and alfalfa, Lot II was started on such a ration and brought up to a full feed of oats before barley was fed. When the change from oats to barley was begun, the steers were eating an average of 15 pounds of oats per head daily. The change from oats to barley was made by replacing approximately 2 pounds of oats per head every three days during a period of 24 days. No indications of bloat were observed in this lot at any time during the course of the experiment. During the same time there were 16 bloat cases in Lot IV, fed barley and oats (3 to 1) and alfalfa, 14 cases in Lot III, fed barley and alfalfa, 11 cases in Lot V, fed barley and cull peas (3 to 1) and alfalfa, and one case in Lot I, fed wheat and alfalfa.

Conclusions. 1. On the basis of this trial the results indi-

cate that the farmer who produces alfalfa and barley or wheat can market the grain by feeding to steers at approximately $30 per ton and the alfalfa at approximately $10 per ton. This conclusion disregards labor cost, risk, and incidental expenses. However, the value of the manure will very nearly balance these expenses.

2. Old dry hard wheat was not as good as Trebi barley when fed with alfalfa for fattening yearling steers. The steers fed wheat made more economical gains than the steers fed barley, but the latter made more rapid gains, and returned a higher margin of profit.

3. The addition of oats to a barley and alfalfa ration lowered the rate of gain, increased the cost of gains, and reduced the finish, selling price and profit.

4. The addition of cull peas to a barley and alfalfa ration increased the rate of gain, decreased the cost of gains, raised the selling price, and increased the margin of profit from $1.71 per head to $7.49 per head.

5. Cull peas had a much higher feeding value than oats when substituted for one-fourth of the barley in a barley and alfalfa ration for fattening yearling steers. The cull peas had a value of $55.18 per ton and the oats a value of $21.80 per ton when added to a ration of barley and alfalfa.

6. Starting steers on oats and alfalfa and changing to barley and alfalfa when on a full feed of oats seemed to eliminate all trouble with bloat. But the feeding of oats increased the cost of gains, and reduced the margin over cost of cattle and feed as compared to the feeding of barley as the sole grain throughout the experiment.

SUMMARY

1. Livestock represents approximately 52 per cent of the total agricultural income of Montana.

2. Beef cattle represents approximately 20 per cent of the total agricultural income and about 40 per cent of the total livestock income of Montana.

3. Cattle from Montana grade a little higher and sell better at the central markets than do cattle from other western states.

4. Some Montana ranchers have neglected their breeding operations, and have failed to realize the importance of getting the proper type of sires.

5. From 50 to 80 per cent of the Montana cattle arriving at the Chicago and South St. Paul markets are sold as feeders and stockers.

6. Fattening yearling steers in Montana with small grains and alfalfa hay can be done most successfully and profitably by full feeding grain.

7. Yearling steers fed alfalfa hay only, do not make rapid enough gains to finish them for sale as killers at the central markets.

8. Good weight frosted wheat is superior to hulled barley, or barley and oats, when fed with alfalfa for fattening yearling steers. Hard dry wheat is unpalatable and steers do not eat enough to make as rapid gains as they do when fed soft wheat or barley with alfalfa.

9. When oats make up a part of the grain ration for fattening yearling steers, the gains, finish, and selling price decline as the proportion of oats increases.

10. Cull beans are unpalatable and too laxative to be a satisfactory feed for fattening cattle.

11. Cull peas when fed in the proportion of one-fourth cull peas to three-fourths barley in a barley, peas and alfalfa ration have a very high feeding value for fattening yearling steers.

12. Bloat may be prevented by starting steers on oats and alfalfa and changing to barley and alfalfa when on a full feed of oats.

ACKNOWLEDGMENTS

Acknowledgments are made to Professor H. W. Vaughan, head of the Department of Animal Husbandry, Montana State College, for his valuable assistance in the preparation of this manuscript; also to Professor Louis Vinke, animal husbandman, Montana Experiment Station, for his aid in the experimental work.

To Senator Thomas J. Walsh, the author wishes to express his appreciation of the Walsh Research Fellowship in Agriculture, which made possible this work at Montana State College.

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