THE RELATIVE VALUE OF BARLEY AND CORN AS FATTENING FEEDS FOR CATTLE

by

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INTRODUCTION

In any particular region economy in the production of beef is largely dependent upon the feeding of feeds that can be grown most successfully in that region.

In several regions of the United States barley can be raised more successfully than corn or other grains, consequently, barley as a feed for fattening cattle is worthy of much consideration by investigators in the field of beef production. Experiments to determine its feeding value have been conducted at several stations, and there is considerable published data of feeding trials in which this grain has been compared with other grains for fattening cattle.

In order to provide Kansas cattle feeders with first-hand information as to the relative feeding value of barley and corn; of the advantages, if any, of mixing barley and corn in equal parts; and of the advisability of feeding barley with silage as the sole roughage, an experiment was conducted at the Kansas Agricultural Experiment Station during the winter of 1935-'36, in which experiment ground barley, ground shelled corn, and a mixture of equal parts of each were compared, first, when silage was the sole

roughage, and second, when alfalfa was the sole roughage.

This thesis includes a detailed discussion of this feeding experiment, and in addition an analysis and review of the work of previous investigators.

REVIEW OF LITERATURE

Owing to the fact that barley can be produced more successfully than corn in some regions of the country, many feeding trials have been conducted for the purpose of comparing its value for fattening cattle with that of corn, which latter grain is generally regarded as the standard grain for fattening cattle in the United States.

Preparation of Barley for Beef Cattle

Because of the hardness and small size of the common barley grain, it is generally believed that this grain should be ground, crushed, or rolled before being fed to fattening cattle. Investigations reported by Peters (22), in which whole barley was compared with ground barley, bear out this contention by the somewhat more favourable gains made by each lot of steers fed ground barley in the two trials conducted, although these steers ate considerably less grain per 100 pounds of gain. The steers

fed ground barley were fatter at the close of each trial, and sold at a slightly higher price than those in each lot fed whole barley.

In discussing these trials Peters said, "One unexpected result was that cattle fed whole barley ate much more barley per day. One would expect that barley, being a hard grain, small in size, and covered with a fibrous hull would not be palatable. However, in both trials, the cattle eating whole barley ate their grain quickly and greedily, always seeming to be more hungry at feeding time than those receiving ground barley. These steers eating whole barley remained healthy throughout the trials and were not troubled with digestive disorders of any kind. They apparently swallowed a large part of the barley whole, and it passed through the digestive tract without being digested."

In both these trials hogs following the steers fed whole barley did a better job of salvaging feed, but not good enough to make up for the higher feed consumption of these steers. "These trials (the results of which are summarized in Table 1) show that grinding barley will increase its value 20 to 40 per cent for fattening cattle," writes Morrison (20).

Table 1 - Results obtained where ground barley and whole barley were compared as fattening feeds for cattle.

Station	Ref. no.	Initial wt. of steers	Length of feeding period	Average daily gain: Ground barley	Average daily gain: Whole barley	Average daily ration: Ground barley	Average daily ration: Whole barley
		Pounds	Days	Pounds	Pounds	Pounds	Pounds
Minnesota	22	690	175	2.25	2.12	12.48	14.84
Minnesota	22	1115	112	3.08	2.13	15.05	17.45

Preparation of Shelled Corn for Fattening Cattle

After reviewing reports of a few experiments that have been conducted to determine whether shelled corn should be fed whole or ground to fattening cattle, one is inclined to feel that either manner of feeding is as satisfactory as the other. Among investigators of this question Allison (1), Call (11), and Peters (21) found that cattle fed ground corn made slightly larger daily gains, but more expensive gains. Call and Allison also report greater profits from cattle fed ground shelled corn. Peters found whole corn slightly more profitable. Gerlaugh (15) reports that calves fed shelled corn gained more rapidly and grinding did not pay with the light calves in his experiment. According to Morrison (20) it does not pay to grind shelled

corn for cattle when pigs are following them, but it pays to grind when pigs are not following, in which case he advocates coarse or medium-fine grinding for best results.

Ground Barley versus Corn

That ground barley, as a fattening feed for cattle, is practically equal to corn has been ascertained through feeding experiments in which these two feeds have been compared directly as the chief grains.

In Table 2 are summarized the results of 23 trials in which these two feeds were compared for fattening beef cattle of various ages. On the assumption that ground shelled corn and whole shelled corn are about equal in feeding value, experiments in which shelled corn was fed either ground or whole are included in this table.

In twelve of these experiments ground barley produced slightly larger average daily gains, and in the other eleven corn was slightly superior in this respect.

In two instances equal amounts of ground barley and shelled corn were required to produce a pound of gain; in thirteen instances more corn than ground barley was required, and in seven instances more ground barley than corn was required per pound of gain.

Table 2 - Results obtained where ground barley and shelled corn were compared as fattening feeds for cattle.

Agricultural experiment station	Reference number	Initial weight of steers	Length of feeding period	Average daily gain		Average daily ration	
				Shelled corn	Ground barley	Shelled corn	Ground barley
		Pounds	Days	Pounds	Pounds	Pounds	Pounds
Oklahoma	3	302	188	2.02	1.94	10.5	11.1
Michigan	6	364	205	1.93	1.97	6.3	6.3
Michigan	4	370	196	2.17	2.25	7.6	7.4
Minnesota	18	374	217	2.34	2.21	10.5	11.2
Michigan (b)	9	380	190	2.08	2.20	7.3	7.3
Michigan	7	380	203	1.89	1.90	8.0	7.8
Michigan	10	384	210	1.90	1.88	7.3	7.1
Michigan	8	395	195	1.83	1.84	7.0	6.7
Kansas (a)	16	400	182	1.85	1.62	10.1	8.4
Michigan (b)	5	406	196	2.03	2.16	8.4	8.2
Wyoming	13	446	77	1.73	1.79	6.7	6.7
Minnesota	22	450	189	2.50	2.37	12.8	12.7
Minnesota	22	452	189	2.30	2.38	10.9	12.2
Oregon	24	486	101	1.95	1.90	5.0	5.0
Minnesota	23	491	196	2.22	2.11	8.5	8.4
New Mexico	14	597	91	2.11	2.04	7.8	7.8
Minnesota	21	684	175	2.49	2.25	14.3	12.5
Minnesota	22	720	161	2.40	2.46	13.9	14.2
S. Dakota	26	738	115	2.13	1.90	18.0	13.0
Idaho	17	958	125	1.76	1.75	7.9	7.8
S. Dakota	26	994	101	2.26	2.28	15.7	16.7
Minnesota	23	1011	112	2.08	2.09	18.2	19.5
Minnesota	23	1013	112	2.33	2.56	14.6	14.9
Average of 23 trials				2.10	2.08	10.36	10.13

(a) Corn-and-cob meal.
(b) Five steers and five heifers in each lot.

In twelve of the feeding trials the corn-fed cattle showed a higher degree of finish; in six trials there was no difference in degree of finish between the barley-fed and the corn-fed lots; and in three trials those fed ground barley were better finished than those fed corn. Degree of finish was not reported for the other two trials.

The mean average of the "average daily gains" and of the "average daily rations" of the cattle fed in the twenty-three experiments included in Table 2, show insignificant differences in both the average daily gains and the average daily rations for the two feeds compared.

In all the above experiments in which hogs followed the cattle on ground barley or corn rations, much more pork was produced by those hogs following the corn-fed cattle. Commenting upon the results of the same experiments in which hogs followed the cattle, Morrison (20) remarks that "...ground barley was actually worth only 88 per cent as much as shelled corn in these trials."

However, these two feeds, when considered for their cattle-fattening qualities, are clearly shown to be equal on a unit weight basis by the results of the trials summarized in Table 2.

Crampton (12), after reviewing and analyzing published data comparing ground barley and shelled corn, reached about the same conclusion. He said, "Ground barley is equal to, if indeed not slightly more valuable than shelled corn in rations for this class of stock as measured by gains per 100 pounds feed eaten," and, "There is little if any difference to be expected between these two feeds in daily gains or in daily feed consumption."

Whole Barley versus Corn

Feeding trials in which whole barley and shelled corn were compared for fattening cattle have been conducted at a few stations. The results of six such trials are summarized in Table 3.

In four of these trials corn produced larger gains than whole barley; in one the gains were even; and in the sixth whole barley produced larger gains. However, in every instance it required more whole barley than corn to produce a pound of gain. In the first five experiments set down in the table, 15 to 24½ per cent more whole barley was required, and in the sixth trial, that in which whole barley made larger average daily gains, 4½ per cent more whole barley than corn was consumed for each pound of gain.

Table 3 - Results obtained where whole barley and shelled corn were compared as fattening rations for cattle.

Agricultural experiment station	Reference number	Initial weight of steers	Length of feeding period	Average daily gain		Average daily ration	
				Shelled corn	Whole barley	Shelled corn	Whole barley
		Pounds	Days	Pounds	Pounds	Pounds	Pounds
S. Dakota	27	368	91	2.05	1.69	4.3	7.3
S. Dakota	27	448	210	2.39	2.18	11.6	12.7
S. Dakota	27	538	133	2.06	1.77	14.8	13.8
Minnesota	21	687	175	2.49	2.12	14.3	14.8
S. Dakota	27	806	90	2.95	2.95	17.6	20.4
S. Dakota	27	1071	57	1.83	2.35	17.6	23.2

At the conclusion of the Minnesota trial those fed whole barley showed a poorer finish and sold for less per pound than those fed corn. In this experiment, pigs following the whole barley-fed steers did not do as well as those following the corn-fed steers as they seemed unable to recover the undigested barley very efficiently. Peters (21) attributes this "to the small size of the barley grains and their dark colour."

In the South Dakota trials finish is reported in only two instances. In one of these the corn-fed steers were better, and in the other those fed whole barley were fatter.

The results of these trials in which whole barley and corn were compared show that whole barley is inferior to corn, and accordingly support the contention that barley should be ground when fed to fattening cattle.

Feed-lot Ills Attributed to Barley

In spite of the fact that ground barley is about equal pound for pound to corn in producing gains in weight, it is a feed that needs more care in feeding because of certain shortcomings that may give rise to ill effects in cattle being fed barley. These shortcomings do not always manifest themselves but they are of sufficient importance

to warrant the consideration of those interested in this feed for fattening cattle.

Bloat. A problem in barley feeding that not infrequently confronts the cattle feeder is that of bloat.

Foster and Simpson (14) had considerable trouble from bloating in their feeding trial after the steers had been on feed for about seven weeks. Bloating usually occurred in the morning, just after watering, when the steers began to eat their grain feed. A few minutes of vigorous exercise was sufficient to relieve all those steers affected.

Vinke and Pearson (25) found that bloat trouble usually occurred with steers fed on a ration of ground barley and alfalfa hay from about the time the barley and alfalfa hay were increased up to seven pounds per head daily until they were on full feed, when the trouble usually stopped except among a few chronic bloaters.

Morrison (20) writes that mixing corn or ground oats with barley is helpful, but he does not recommend this practice when steers are on full feed unless such trouble is prevalent, or unless oats are considerably cheaper than barley.

Hickman[1] says, "Our experience has been that any feed such as silage or a protein supplement such as linseed meal, cottonseed meal, or wheat bran or even oats have all tended to reduce the possibility of bloat on a ration of barley and alfalfa."

Christensen[2] is also in favour of the practice of mixing other feeds with barley until the steers are on full feed. He recommends about 25 per cent of oats or emmer with the barley.

However, Vinke and Pearson (25) found that mixing oats or other feeds with barley did not eliminate or even reduce the number of cases of bloat, but that starting steers on oats and bringing them up to full feed on this grain before any barley was fed, and then gradually substituting barley for oats, gave no signs of bloat.

Dickson[3] on the other hand, found that starting on oats did not solve the problem, for in a summary of the

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[1]C. W. Hickman. Idaho Agr. Exp. Sta. Information to the author.

[2]F. W. Christensen. North Dakota Agr. Exp. Sta. Information to the author.

[3]W. F. Dickson. Montana Agr. Exp. Sta. Information to the author.

results of three calf feeding trials in which 167 calves were fed and 155 of these started on oats, he observed that 16 calves bloated 24 times, and 14 of these cases occurred while they were on oats and alfalfa. He remarks, "...that in some years bloat seldom occurs, while it breaks out violently in other years."

So it seems that bloat in barley feeding is a strange thing occurring intermittently, and usually when alfalfa is fed in conjunction with the barley. The direct cause seems to be undetermined, and the remedy or prevention seems to lie somewhere in the suggestions of Morrison, Hickman, and Christensen, although the results are not 100 per cent certain.

Unpalatability of Barley. Wilson (26) experienced some difficulty at first in getting steers to eat ground barley. Furthermore, there is sometimes a tendency for cattle, fed barley as the only grain in the fattening ration, to tire of it during a long fattening period (20), thereby reducing the rate of gain during the earlier part of the period.

Where these conditions prevail Morrison (20) suggests mixing corn or ground oats with the barley. Peters (21), in an endeavor to find a means for meeting the contingent

tiring of feed where ground barley is used for fattening cattle, fed one lot of steers ground barley during the first half of the feeding period, and then changed to corn which he fed the rest of the period. The results in Table 4 show that this lot did somewhat better than the lot fed ground barley throughout the period, but not as well as the lot fed shelled corn throughout the period. He, however, concluded that "There are no apparent advantages of feeding barley during the first part of the feeding period and corn during the latter part, unless a farmer has a partial supply of each grain on hand, in which case he had best feed the barley first and the corn toward the finish."

Why barley should cause bloat or be unpalatable in some cases and not in others is not known. Methods of feeding and management cannot always be held responsible, for under identical methods bloat and tiring of feed may occur with some animals but not with others. Nevertheless, it would be wise to assume that methods of feeding are responsible, and subsequently exercise the greatest care possible when feeding barley.

Table 4 - Results obtained where ground barley was fed the first half, and corn the second half of the feeding period, in comparison with each grain fed separately throughout the period.

Agricultural experiment station	Reference number	Initial weight of steers	Length of feeding period	Average daily gains			Average daily ration		
				Shelled corn	Ground barley 84 da. Shelled corn 91 da.	Ground barley	Shelled corn	Ground barley 84 da. Shelled corn 91 da.	Ground barley
		Pounds	Days	Pounds	Pounds	Pounds	Pounds	Pounds B-11.3 C-16.0	Pounds
Minnesota	21	681	175	2.49	2.39	2.25	14.34		12.48

THE EXPERIMENT

A cattle feeding experiment in which barley and corn played the major, but opposite, roles was conducted at the Kansas Agricultural Experiment Station during the winter of 1935-'36.

The objects of the experiment, the methods of procedure followed, and the results are here reported in detail.

Objects

(1) To obtain supplementary information regarding the relative feeding value of ground barley and corn for fattening cattle.

(2) To determine the advantages, if any, of mixing equal parts by weight of ground barley and ground shelled corn.

(3) To determine the advisability of feeding ground barley with silage as the sole roughage.

Methods of Procedure

Plan of the Experiment. On November 18, 1935, sixty steer calves, averaging 530 pounds, were divided into six lots of ten calves each. They were divided as evenly as

possible in respect to size, quality, weight, and general appearance. The steers were fed in two series of three lots each. In Series I, ground barley, ground shelled corn, and a mixture of equal parts of each by weight were compared when fed in conjunction with atlas sorgo silage, cottonseed meal, and ground limestone. In Series II, the grain portions of the rations were the same, but alfalfa hay was fed in place of the silage and ground limestone, and the amount of cottonseed meal was half that supplementing in the lots of Series I.

Steers Used. The steer calves used in this experiment were range-bred Herefords grading good to choice as feeders. They were delivered direct from the range one week after weaning, and arrived in Manhattan on October 16 and were fed in a large open lot on silage and one pound of cottonseed meal per day until November 18, when they were assigned to groups and put into the feed lots.

Weights. The initial and final weights used in this experiment were respectively the averages of three consecutive days' weights of each steer at the beginning and end of the feeding trial. Furthermore, each steer was weighed every twenty-eight days during the trial. Weights were taken starting at approximately 9 a.m. on each day

of weighing, without change in feed and water.

Feeds Used. No. 2 barley was used for this experiment. In view of the findings at other stations the barley was fed ground for maximum efficiency. No. 2 yellow corn, kiln dried, was used until March 20, and thereafter No. 2 mixed corn was fed. The shelled corn was also ground, not because experimental data indicate that it should be ground for young fattening cattle, but to eliminate the possible effect of the preparation of the grains on the results of the experiment, and to obtain a uniform mixture where the two grains were fed together. The alfalfa hay was bright, leafy, second-cutting hay, and the silage was made of atlas sorgo slightly mixed with other varieties of cane from plants that had suffered adverse weather conditions during the growing season and had failed to produce grain although mature when cut. The cottonseed meal fed had a guaranteed protein content of not less than 43 per cent. Both the barley and shelled corn were ground to a medium degree of fineness in a burr-type mill.

Length of Feeding Trial. The steers were fed from November 19, 1935 to May 27, 1936 inclusive, a period of 190 days.

Series I - Barley versus Corn for Fattening Steers, Fed With Silage, Cottonseed Meal, and Ground Limestone

The three groups of steers in this series were fed the following rations:

Lot 1 - Ground shelled corn, cottonseed meal, silage, and ground limestone.

Lot 2 - Ground barley, cottonseed meal, silage, and ground limestone.

Lot 3 - Ground shelled corn one-half, ground barley one-half, cottonseed meal, silage, and ground limestone.

Method of Feeding. The method of feeding was about the same in each of these three lots. The steers were started on one pound of grain, two pounds of cottonseed meal, and one-tenth pound of ground limestone per head per day. The ground limestone was supplemented to supply the calcium that has been proved needed, but lacking in silage, in experiments by Anderson (2), and McCampbell and Connell (19). These feeds were mixed and spread over as much silage as the steers would clean up. Concentrates and

silage were hand-fed twice daily - at approximately 7 a.m. and 4 p.m.

The grain portion of the rations was increased gradually, about one pound per head daily, at intervals of from four to eight days. On the 64th day lots 1 and 2, then receiving 12 pounds of grain per head per day, began leaving a little grain so it was deemed safe to allow them free access to grain in self-feeders. The steers in lot 3, apparently finding their grain more palatable, were not placed on self-feeders until the 65th day, after the grain had been increased to 13 pounds per head per day.

In order to avoid "sticking" when changing from hand-feeding to self-feeding the silage was increased materially in each lot about two days before the change was to be made.

Salt and fresh water were at the disposal of the steers at all times.

Observations

No difficulty was experienced in getting any of the steers on feed, and throughout the entire feeding trial there were no indications of any of the steers tiring of their feed, nor was there a single case of bloat or other digestive disturbances.

The detailed results secured in Series I of this experiment are presented in Tables 5 and 6.

Average Daily Gains. The average daily gains of each lot of steers as shown in Table 5 are:

Lot 1 - Fed ground corn - 2.10 pounds.

Lot 2 - Fed ground barley - 2.14 pounds.

Lot 3 - Fed ground corn one-half, ground barley one-half - 2.19 pounds.

The gains made by these three lots of steers were not significantly different, and the variations were no greater than may be found in three lots of steers fed on identical rations.

Average Daily Rations. The rate of gain is by no means the only criterion of the relative efficiency of feeds. A second factor to be considered is palatability of the feeds being tested. This is determined by the amount of feed consumed.

The average daily consumption of cottonseed meal was two pounds, of silage approximately 12 pounds, and of ground limestone 1/10 pound per steer in each of these three lots.

In view of the fact that the steers in these three lots consumed daily almost the same amounts of these three

Table 5 - Experimental Data - Series I.

November 19, 1935 to May 27, 1936 - 190 days

Lot number	1	2	3
Rations fed	Ground shelled corn, Cottonseed meal, Silage, Ground limestone	Ground barley, Cottonseed meal, Silage, Ground limestone	Ground shelled corn 1/2, Ground barley 1/2, Cottonseed meal, Silage, Ground limestone
Number of steers per lot	10	10	10
Initial weight per steer	Pounds 531.67	Pounds 531.83	Pounds 531.00
Final weight per steer	930.66	939.17	946.83
Total gain per steer	398.99	407.34	415.83
Average daily gain per steer	2.10	2.14	2.19
Daily feed consumption per steer:			
Ground shelled corn	11.68	....	6.16
Ground barley	....	11.54	6.16
Cottonseed meal	2.00	2.00	2.00
Silage	12.01	11.95	12.09
Ground limestone	.10	.10	.10
Feed consumption per 100 pounds gain:			
Ground shelled corn	556.26	....	281.57
Ground barley	....	538.08	281.57
Cottonseed meal	95.24	93.29	91.38
Silage	571.95	557.28	552.39
Ground limestone	4.81	4.71	4.62

Table 6 - Average daily rations by 28-day periods - Series I.

Lot number	1	2	3
First 28-day period:	Pounds	Pounds	Pounds
Ground shelled corn	4.29	....	2.14
Ground barley	....	4.29	2.14
Cottonseed meal	2.00	2.00	2.00
Silage	26.32	26.64	26.64
Ground limestone	.11	.11	.11
Second 28-day period:			
Ground shelled corn	10.18	....	5.09
Ground barley	....	10.18	5.09
Cottonseed meal	2.00	2.00	2.00
Silage	16.11	14.96	15.82
Ground limestone	.10	.10	.10
Third 28-day period:			
Ground shelled corn	11.89	....	6.08
Ground barley	....	9.72	6.08
Cottonseed meal	2.00	2.00	2.00
Silage	11.07	11.47	11.57
Ground limestone	.10	.10	.10
Fourth 28-day period:			
Ground shelled corn	13.76	....	7.15
Ground barley	....	12.63	7.15
Cottonseed meal	2.00	2.00	2.00
Silage	8.57	8.57	8.57
Ground limestone	.10	.10	.10
Fifth 28-day period:			
Ground shelled corn	13.77	....	7.36
Ground barley	....	14.11	7.36
Cottonseed meal	2.00	2.00	2.00
Silage	8.00	8.00	8.00
Ground limestone			
Sixth 28-day period:			
Ground shelled corn	14.10	....	7.92
Ground barley	....	15.51	7.92
Cottonseed meal	2.00	2.00	2.00
Silage	8.00	8.00	8.00
Ground limestone	.10	.10	.10
Last 22 days:			
Ground shelled corn	14.37	....	7.74
Ground barley	....	15.09	7.74
Cottonseed meal	2.00	2.00	2.00
Silage	4.36	4.36	4.36
Ground limestone	.10	.10	.10
Average for all periods:			
Ground shelled corn	11.68	....	6.16
Ground barley	....	11.54	6.16
Cottonseed meal	2.00	2.00	2.00
Silage	12.01	11.95	12.09
Ground limestone	.10	.10	.10

feeds, and that as much grain as the steers desired was fed, it follows that the average daily consumption of ground corn, ground barley, and the mixture of equal parts of each is the measure of palatability of the three grain rations.

The average daily grain ration of each lot of steers as shown in Table 5 is:

Lot 1 - Fed ground corn - 11.68 pounds.

Lot 2 - Fed ground barley - 11.54 pounds.

Lot 3 - Fed ground corn one-half, ground barley one-half - 12.33 pounds.

These figures and those in Table 6, in which the average daily rations are given by 28-day periods, indicate that the ground corn and ground barley were of equal palatability, and that the mixture of equal parts of each of these two grains was slightly more palatable than either grain fed separately.

Feed Consumption per 100 Pounds Gain. A third criterion of the relative efficiency of feeds is the amount of feed required to produce 100 pounds of gain in weight. Next to price of a feed it is this factor that determines the economic importance of that feed.

Referring again to Table 5, we see that in lot 1, 556.26 pounds of corn were required to produce 100 pounds of gain; in lot 2, 538.08 pounds of ground barley were required per 100 pounds of gain; and in lot 3, 563.14 pounds of grain mixture were required to produce 100 pounds of gain.

Using this criterion as a measure of efficiency we find that ground corn was worth 97 per cent as much as ground barley, and that the mixture was worth 96 per cent as much as ground barley and 99 per cent as much as ground corn.

Series II - Barley versus Corn for Fattening Steers, Fed With Alfalfa Hay and Cottonseed Meal

The three groups of steers in this series were fed the following rations:

Lot 4 - Ground shelled corn, cottonseed meal, and alfalfa hay.

Lot 5 - Ground barley, cottonseed meal, and alfalfa hay.

Lot 6 - Ground shelled corn one-half, ground barley one-half, cottonseed meal, and alfalfa hay.

Method of Feeding. In Series II the steers were also started on one pound per head per day of grain, but only one pound of cottonseed meal per head per day was supplemented as alfalfa hay, a protein-rich roughage, was fed in place of the silage of Series I. No ground limestone was added as alfalfa hay is also rich in calcium. The grain was increased gradually, at about the same rate as in Series I, until the steers were on full feed. The concentrate portion of these rations was fed separately from the alfalfa hay, of which as much as the steers would clean up was fed in racks. Both the concentrates and the hay were fed at 7 a.m. and 4 p.m.

On the 59th day after the experiment started, when these lots were receiving 12 pounds of grain per head per day, the steers in lots 4 and 5 were placed on self-feeders, and those in lot 6 were placed on self-feeders on the 65th day, after the grain had been increased to 13 pounds.

In this series the same precautions were taken to avoid "sticking" as in Series I, namely, the roughage was materially increased about two days before placing on self-feeders.

These steers also had free access to fresh water and salt at all times.

Observations

The steers in this series, as in Series I, consumed their feed from start to finish of the trial with no cases of tiring of it. Bloat and other digestive troubles sometimes experienced when feeding barley to cattle, were never apparent.

The results secured in Series II are given in Tables 7 and 8.

Average Daily Gains. The average daily gains of each lot of steers in Series II as shown in Table 7 are:

Lot 4 - Fed ground corn - 2.11 pounds.

Lot 5 - Fed ground barley - 1.96 pounds.

Lot 6 - Fed ground corn one-half, ground barley one-half - 2.12 pounds.

There is a larger spread in the daily gains made in this series than in Series I; however, they are not significantly different, thus we note that a mixture of equal parts of each grain gave no larger gains than each of the grains fed separately.

Table 7 - Experimental Data - Series II.

November 19, 1935 to May 27, 1936 - 190 days			
Lot number	4	5	6
Rations fed	Ground shelled corn :Cottonseed meal :Alfalfa hay	Ground barley :Cottonseed meal :Alfalfa Hay	Ground shelled corn 1/2 :Ground barley 1/2 :Cottonseed meal :Alfalfa hay
Number of steers per lot	10	10	10
Initial weight per steer	Pounds 530.67	Pounds 530.00	Pounds 530.83
Final weight per steer	931.83	902.00	934.50
Total gain per steer	401.16	372.00	403.67
Average daily gain per steer	2.11	1.96	2.12
Daily feed consumption per steer:			
Ground shelled corn	12.04	....	6.19
Ground barley	....	12.00	6.19
Cottonseed meal	1.00	1.00	1.00
Alfalfa hay	3.72	3.91	4.03
Feed consumption per 100 pounds gain:			
Ground shelled corn	570.15	....	291.60
Ground barley	....	612.66	291.60
Cottonseed meal	47.36	51.05	47.07
Alfalfa hay	176.11	199.46	189.76

Table 8 - Average daily rations by 28-day periods - Series II.

Lot number	4	5	6
First 28-day period:	Pounds	Pounds	Pounds
Ground shelled corn	4.29	....	2.14
Ground barley	....	4.29	2.14
Cottonseed meal	1.00	1.00	1.00
Alfalfa hay	6.86	7.71	7.89
Second 28-day period:			
Ground shelled corn	10.18	....	5.09
Ground barley	....	10.18	5.09
Cottonseed meal	1.00	1.00	1.00
Alfalfa hay	5.39	5.38	5.38
Third 28-day period:			
Ground shelled corn	12.40	....	5.99
Ground barley	....	11.52	5.99
Cottonseed meal	1.00	1.00	1.00
Alfalfa hay	2.86	3.32	3.93
Fourth 28-day period:			
Ground shelled corn	13.18	....	6.91
Ground barley	....	13.12	6.91
Cottonseed meal	1.00	1.00	1.00
Alfalfa hay	3.20	3.16	3.20
Fifth 28-day period:			
Ground shelled corn	14.05	....	7.39
Ground barley	....	13.89	7.39
Cottonseed meal	1.00	1.00	1.00
Alfalfa hay	2.46	2.46	2.46
Sixth 28-day period:			
Ground shelled corn	15.25	....	8.02
Ground barley	....	15.65	8.02
Cottonseed meal	1.00	1.00	1.00
Alfalfa hay	2.50	2.50	2.50
Last 22 days:			
Ground shelled corn	15.72	....	8.38
Ground barley	....	16.25	8.38
Cottonseed meal	1.00	1.00	1.00
Alfalfa hay	2.50	2.50	2.50
Average for all periods:			
Ground shelled corn	12.04	....	6.19
Ground barley	....	12.00	6.19
Cottonseed meal	1.00	1.00	1.00
Alfalfa hay	3.72	3.91	4.03

Average Daily Rations. The steers in each of these three lots consumed equal amounts of cottonseed meal, namely, one pound per head per day. Each one consumed nearly four pounds of alfalfa hay per day on the average, and the grain consumed, as recorded in Table 7 was:

Lot 4 - Fed ground corn - 12.04 pounds.

Lot 5 - Fed ground barley - 12.00 pounds.

Lot 6 - Fed ground corn one-half, ground barley one-half - 12.39 pounds.

These figures and those in Table 8, where the average daily rations by 28-day periods are given, indicate that the barley and corn were equally palatable, and that the mixture was slightly more palatable than either grain fed separately, for the steers in lot 6 consistently ate slightly more grain throughout the feeding period.

Feed Consumption per 100 Pounds Gain. If we refer to Table 7 we see that the grain consumption per 100 pounds of gain for the lots in Series II was:

Lot 4 - Ground corn - 570.15 pounds.

Lot 5 - Ground barley - 612.66 pounds.

Lot 6 - Ground corn one-half, ground barley one-half - 583.20 pounds.

In this series it required 42.51 pounds of ground barley more than ground corn to produce 100 pounds of gain, that is to say, on a percentage basis ground barley was worth 93 per cent as much as corn, and 95 per cent as much as the mixture. The mixture was worth 98 per cent as much as the ground corn.

Results of Feeding Barley with Silage as the Sole Roughage

A further analysis of the results obtained in this experiment reveals that the lot fed ground barley, cottonseed meal, silage, and ground limestone compared favourably with the lot fed ground barley, cottonseed meal, and alfalfa hay.

Studying the results of lots 2 and 5, placed together for convenience of comparison in Table 9, we see that the steers in lot 2, fed silage as the sole roughage with barley, made somewhat larger average daily gains, consumed about one-half pound less grain per day, and required considerably less ground barley to produce 100 pounds of gain than those steers in lot 5, fed ground barley with alfalfa hay as the sole roughage.

Table 9 - Experimental data, lots 2 and 5. Ground barley with silage as the sole roughage versus ground barley with alfalfa hay.

Lot number	2	5
Rations fed	Ground barley Cottonseed Silage Ground limestone	Ground barley Cottonseed meal Alfalfa hay
Number of steers per lot	10	10
	Pounds	Pounds
Initial weight per steer	531.67	530.00
Final weight per steer	939.17	902.00
Total gain per steer	407.34	372.00
Average daily gain per steer	2.14	1.96
Daily feed consumption per steer:		
Ground barley	11.54	12.00
Cottonseed meal	2.00	1.00
Alfalfa hay	....	3.91
Silage	11.95	....
Ground limestone	.10	....
Feed consumption per 100 pounds gain:		
Ground barley	538.08	612.66
Cottonseed meal	93.29	51.05
Alfalfa hay	....	199.46
Silage	557.28	....
Ground limestone	4.71	....

It is true that the steers in lot 2 received one pound more of cottonseed meal per head per day than those in lot 5, as well as one-tenth of a pound of ground limestone which was absent in the rations of the steers fed alfalfa, but, in view of the known lack of protein and calcium in silage, it was deemed necessary to add these substances in some form in order to determine whether barley may be fed satisfactorily with silage as the sole roughage, for this was one of the objects of the feeding trial, and there was no thought of comparing directly silage and alfalfa hay as roughages.

Marketing Data

In order to delve still deeper into the question of the relative efficiency and effects of the feeds compared, it was considered advisable to make an analysis of the marketing data recorded in Tables 10 and 11.

Appraisal of the Steers. At the conclusion of the feeding trial lots 1 and 4, fed ground shelled corn, and lots 3 and 6, fed the mixture of the grains, were slightly fatter than lots 2 and 5, fed ground barley. The steers were appraised in their respective lots at the Experiment Station by a representative of John Clay & Company. Lots 1,

Table 10 - Dressing yields.

Lot number	Grain ration	Marketing weight: Kansas City	Dressing percentage	Internal fat
		Pounds	Per Cent	Per Cent
1 (a)	Ground corn	909	61.6	6.6
2	Ground barley	910	60.1	6.5
3	Ground corn 1/2) Ground barley 1/2)	928	60.3	6.5
4	Ground corn	926	60.6	6.5
5	Ground barley	886	60.9	6.0
6	Ground corn 1/2) Ground barley 1/2)	917	60.4	6.5

(a) Average of only 9 carcasses in lot 1.

Table 11 - Carcass grades

Lot number	Grain ration	Grades	
		Prime	Choice
		Number	Number
1 (b)	Ground corn	8	1
2	Ground barley	7	2
3	Ground corn 1/2) Ground barley 1/2)	9	1
4	Ground corn	8	2
5	Ground barley	8	2
6	Ground corn 1/2) Ground barley 1/2)	8	2

(b) One of the steers in lot 1 was injured, apparently in shipping, and arrived at the market with a swelling in the region of the right flank. It was sold "subject" and its identify was lost at the packing plant, consequently, grades for only nine carcasses are available in lot 1.

3 and 4 were appraised at 10 cents above lot 6, which in turn was 5 cents above lots 2 and 5. The appraised values reflect the slight variation in degree of finish in favour of the corn-fed and mixture-fed steers over those fed barley.

Shipping Information. All lots were continued on the experimental rations until a few days prior to shipping. In preparation for shipment prairie hay was substituted for alfalfa hay and silage on the afternoon of June 6, and thereafter no other roughage was fed. Grain feeding was discontinued on the afternoon of June 7, leaving the steers on a ration of prairie hay ad. libitum, with free access to water and salt.

On the afternoon of June 8 the steers were trucked to the railroad livestock yards in Manhattan and were loaded into three cars that evening for the Kansas City stock yards, where they arrived in excellent condition the following morning.

Sales Information. Upon their arrival at the Kansas City stock yards the steers were divided into two groups according to size. By this undertaking they were exhibited to the best advantage, displaying unusual uniformity of quality and finish.

The steers were bought by Armour & Company in one group at a single price, the price paid almost topping the day's market, being exceeded only by that paid for six purebred native steers raised at the Kansas Station. The steers were slaughtered that afternoon.

Observations. Data supplied through the courtesy of Armour & Company pertaining to the dressing yields and carcass grades, are presented in Tables 10 and 11.

Both these tables clearly depict the uniformity of quality and finish of all lots of steers, and almost conceal the slight superiority of finish obtaining in those steers fed corn and those fed the mixture over the barley-fed steers.

The high grading of this group of carcasses was also due to a clear white thick covering of fat evenly distributed over each carcass. It might be worth mentioning that there was but little variation in the percentage of internal fat between lots.

SUMMARY AND CONCLUSIONS

(1) The results of previous investigations of the relative value of barley and corn, fed in direct comparison, are summarized in this thesis.

(2) This review of literature is followed by a treatment in detail of the results of an experiment conducted at the Kansas Agricultural Experiment Station during the winter of 1935-'36. In order to obtain supplementary information regarding the relative value of ground barley and shelled corn for fattening cattle, to determine the advantages, if any, of mixing ground barley and shelled corn in equal parts, and to determine the advisability of feeding ground barley with silage as the sole roughage, 60 head of steer calves were fed 190 days. There were two series of three lots each. In Series I, ground barley, ground shelled corn, and a mixture of equal parts of ground barley and ground shelled corn were fed in conjunction with atlas sorgo silage, cottonseed meal, and ground limestone. In Series II, the grain portions of the rations were respectively the same as in Series I, but alfalfa hay was fed in place of silage and ground limestone, and the amount of cottonseed meal supplemented was half that fed to the lots in Series I.

(3) Ground barley is equal to shelled corn as measured by gains per 100 pounds of feed eaten, and there is very little difference between these two feeds in daily gains and daily feed consumption.

(4) There is no necessity of mixing ground shelled corn with ground barley to get maximum returns from the ground barley, although the mixture was more palatable than either of the ground grains fed separately.

(5) Barley may be fed satisfactorily with silage as the sole roughage.

(6) Contrary to the findings of some investigators, in this experiment ground barley was just as palatable as ground shelled corn, and caused no digestive troubles whatever.

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