UNIVERSITY OF IDAHO
College of Agriculture

STEER FEEDING

BARLEY
in
Non-Roughage Rations

By

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Conclusions

A non-roughage ration of steam-rolled barley gave more rapid and economical gains than corn-cob meal for steers with initial weights ranging between 700 and 800 pounds.

A non-roughage ration of steam-rolled barley with 15, 30 or 43 percent dried molasses beet pulp produced more economical gains than steam-rolled barley without the dried molasses beet pulp.

The non-roughage ration composed of steam-rolled barley with 15 percent dried molasses beet pulp was the most profitable mixture as measured by the cost of 100 pounds gain.

Steers fed the non-roughage ration of steam-rolled barley without dried molasses beet pulp suffered more from excessively high environmental temperatures than steers fed the roughage-concentrate ration, corn-cob meal with dried molasses beet pulp and steam-rolled barley with dried molasses beet pulp.

Feeding small quantities of roughage with all the concentrate they would consume produced slower gains than the non-roughage rations.

Feeding a small quantity of straw with the concentrate mixture (less than 2 pounds) reduced the efficiency of gains.

Steer calves with initial weights between 450 and 600 lbs. were not adapted to the non-roughage rations for periods of over 140 days. There was a reduction in rate of gains and feed efficiency.

The most economical returns were made by steer calves fed a high roughage mixture during the first 84 days followed by a non-roughage ration during the last 84 days.

The quantity of roughage to feed steer calves before feeding the non-roughage ration will depend upon the price relationships of roughage to concentrates.

Steers weighing between 700 and 800 pounds may be finished on a non-roughage ration.

Steer Feeding—
Barley in Non-Roughage Rations

T. B. Keith, J. J. Dahmen, Leon E. Orme and T. Donald Bell[1]

Recent experimental work with finishing steers has emphasized the possibility of feeding barley without a roughage. However, the feeding of ruminants a non-roughage ration is not a new concept. Davenport (1897) was unsuccessful in attempts to rear calves on rations devoid of roughage. On various occasions economic conditions have induced steer feeders to feed shelled corn without roughage in the corn belt area and whole wheat without roughage in the soft white wheat area in the United States. The results of feeding these concentrate mixtures without roughage were considered satisfactory.

Several experimental studies on feeding corn meal to cattle have been reported. The digestibility of corn meal was determined by Beach (1906). He fed two dry-farrow cows exclusively on corn meal for a period of 130 days and determined the digestibility of the meal from the feces collected during the last week of the feeding. He concluded that the exclusive feeding of corn meal had no deleterious effects. Forbes and co-workers (1931) conducted an experiment to determine whether the energy value of a feeding stuff is affected by the combination in which it is fed with other feeding stuffs. The metabolizable energy, heat increment, and net energy values of corn meal and alfalfa hay were determined separately and in combination. The metabolizable energy value of corn meal was found to be practically the same whether fed to steers in combination with alfalfa hay or as the only feedstuff. The heat increment value of corn fed by itself was greater than in the mixed ration.

Wise **et al.** (1961) studied the length of the time a non-roughage ration could be fed to calves between liveweights of 410 to 741 pounds. These workers reported no improvement in gains or feed efficiency of steers fed sodium and potassium salts of bicarbonates and acetates with a ground shelled corn non-roughage ration. Hironaka and Slen (1961) fed steers an all-barley ration calculated to meet the maintenance requirements and to obtain a gain of 1.0 1.5, 2.0 and 2.5 pounds per day. The steers showed an abnormal appetite, consuming excess mineral-vitamin mixture. There was no noticeable kertinization of the rumen papillea or ulceration in the abomasum.

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Objectives of Studies

The objectives of the work conducted in the three series of studies were to evaluate: (1) a non-roughage ration containing only steam-rolled barley supplemented with adequate quantities of vitamin A, calcium, phosphorus, and sodium chloride; (2) a corn-cob-meal with 30 percent dried molasses beet pulp as a non-roughage ration; (3) levels of dried molasses beet pulp to mix with barley in a non-roughage ration; (4) the initial age and weight of the steer that could be fed a non-roughage ration composed of barley; (5) the length of time steer calves could be fed a non-roughage ration composed of barley; (6) the kind of roughage that could be fed in small quantities to steer calves fed a concentrate mixture composed of barley; (7) the length of time to feed a ration containing roughage previous to feeding a non-roughage ration; (8) the age and weight interval of steers that will give most efficient returns on the non-roughage ration; (9) the contributions of feeding limited quantities of roughage with the concentrate mixture.

The objectives were studied during three series of feeding tests. The first test was conducted during the summer months from June 21 to November 8, 1960. The steers weighed an average of approximately 760 pounds and were fed in six groups of 10 steers each for a period of 140 days.

The second series was conducted between the dates of December 6, 1960, and July 11, 1961, a period of 217 days. These steers weighed an average of approximately 532 pounds at the beginning of the test.

The third series was conducted between the dates of November 21, 1961, and May 7, 1962, a period of 167 days. These steers weighed an average of 680 pounds at the beginning of the test.

All three series of the feeding studies were made at the University of Idaho Caldwell Branch Experiment Station, Caldwell, Idaho.

Outline of the Studies (Series I)

The concentrate mixtures used in this study are presented in table 1. Outline of the experimental feeding is shown in table 2. Ration 1 contained rolled barley, ground oats, dried molasses beet pulp and a roughage composed of 3 parts corn silage and 1 part baled alfalfa hay. This ration had given the most efficient gains in previous work conducted at the station. A ration containing corn-cob-meal was fed to compare its value in a non-roughage ration with that of barley. Dried molasses beet pulp was fed at levels of 15, 30 and 43 percent to study its contribution to a non-roughage ration. Each concentrate had enough preformed vitamin A added to give approximately 15000 International Units per steer per day. This is approximately twice the quantity recommended

by the National Research Council (1958). The protein content averaged between 12 and 13 percent.

The steers in lot 1 were fed all the roughage they would consume and were allowed 2 pounds of the concentrate mixture per 100 pounds of live weight. The roughage was composed of 3 parts of corn silage and 2 parts of baled alfalfa hay by weight. This ration was used as a reference because it had been one of the better fattening rations in a previous test.

The steers in lots 2, 3, 4, 5 and 6 were fed the roughage mixture during the first two weeks of feeding. The concentrate mixture allowances for lots 2, 3, 4, 5 and 6 were increased each day until at the end of a two weeks period, steers in these lots were receiving their assigned rations.

Table 1. Rations and feedstuffs used in the study of the value of a non-roughage ration using steam-rolled barley. (parts per 100)

Feedstuffs	Rations (lots)					
	1	2	3	4	5	6
	lb.	lb.	lb.	lb.	lb.	lb.
Barley, steam-rolled	46.5		96.0	80.0	65.0	50.0
Corn-cob-meal, ground		54.0				
Dried Molasses beet pulp	23.0	30.0		15.0	30.0	43.0
Oats, ground	23.0					
Cottonseed oil meal	5.0	13.5	1.5	2.5	2.5	4.5
Sodium chloride	1.0	1.0	1.0	1.0	1.0	1.0
Dicalcium phosphate	1.5	1.5	1.5	1.5	1.5	1.5
Vitamin A concentrate[1]	+	+	+	+	+	+
Diethylstilbestrol[2]	+	+	+	+	+	+
Protein, percent	12.3	12.6	12.6	12.9	12.4	12.6
Fiber, percent	9.2	10.1	5.2	6.7	8.2	9.7

[1]Vitamin A was fed at the rate of approximately 15000 IU per day.
[2]Fed at the rate of 10 milligrams per day.

Table 2. Outline of the experimental feeding for series I.

Lot No.	No. Steers	Ration
1	10	Concentrate and roughage
2	10	Corn-on-cob-meal, 30 percent DMBP*
3	10	Steam-rolled barley
4	10	Steam-rolled barley, 15 percent DMBP*
5	10	Steam-rolled barley, 30 percent DMBP*
6	10	Steam-rolled barley, 43 percent DMBP*

*Dried molasses beet pulp.

Results (Series I)

The average daily feed consumption, feed required per 100 pounds gain, the average initial weights, and the average final weights of the 6 groups of steers in series 1 are presented in table 3. The average daily feed consumption was approximately the same for all non-roughage rations containing steam-rolled barley.

Those steers fed the corn-and-cob meal with 30 percent dried molasses beet pulp (lot 2) consumed 15 to 20 percent more than the steers fed steam-rolled barley or steam-rolled barley plus dried molasses beet pulp (lots 3, 4, 5 and 6). The steers fed the roughage-concentrate ration (lot 1) consumed the greatest quantity of feed and required the most feed per 100 pounds gain.

Conversely, the steers in lot 3 that were fed the steam-rolled barley ration without dried molasses beet pulp had the lowest average daily intake. The steers in lot 4 (barley with 15 percent DMBP) required the least total feed per 100 pounds of gain.

The average daily fiber intakes of the steers fed these rations were not in the same relationship as the average daily gains. The daily fiber intakes for lots 1 and 2 (concentrate and roughage; and corn-and-cob-meal, respectively) were higher than the daily intakes of the steers fed the non-roughage rations of barley and DMBP (lots 4, 5 and 6) (table 3).

Table 3. Average initial weights, final weights, daily rations, fiber percent of each ration, and feed per 100 pounds gain of the 6 different groups of steers.

Lot No.	Ration	Average weight initial	Average weight final	Average daily ration	Fiber	Feed per 100 lb. gain	Daily fiber intake
		lb.	lb.	lb.	percent	lb.	lb.
1	Concentrate and roughage	760	1075	27.0	13.1	1200	2.89
2	Corn-and-cob-meal, 30 percent DMBP*	744	1026	25.0	10.8	996	2.58
3	Barley	768	1124	20.3	6.2	798	1.20
4	Barley, 15 percent DMPB*	748	1134	21.0	7.6	760	1.52
5	Barley, 30 percent DMBP*	756	1133	21.7	9.0	806	1.86
6	Barley, 43 percent DMBP*	750	1138	21.7	10.4	816	2.24

*Dried molasses beet pulp.

Table 4. Accumulative average daily gain of the steers fed each ration for each weight period (June 21 to November 8, 1960)

Lot No.	Ration	Average daily gain to date on feed, days				
		28	56	84	112	140
		lb.	lb.	lb.	lb.	lb.
1	Concentrate roughage	2.79	2.58	2.54	2.54	2.25
2	Corn-and-cob-meal 30 percent DMBP*	3.04	3.10	3.00	2.78	2.51
3	Barley	2.23	2.55	2.73	2.68	2.55
4	Barley, 15 percent DMBP*	2.30	2.52	2.72	2.79	2.76
5	Barley, 30 percent DMBP*	3.18	2.66	2.67	2.66	2.69
6	Barley, 43 percent DMBP*	3.27	3.01	3.04	2.88	2.78

*Dried molasses beet pulp

The average daily gains for each lot of steers to the date of each weight period are shown in table 4. The average daily gains tended to decrease as time advanced with the exception of the steers of lots 3 and 4 (rations of steam-rolled barley and steam-rolled barley with 15 percent dried molasses beet pulp). The steers of these lots had a gradual increase in rates of gain as time progressed. The final rates of gain of the steers in lots 4, 5 and 6 (15, 30 and 43 percent dried molasses beet pulp respectively) were not significantly different ($P>0.05$). The rates of gain of the steers of lots 4, 5 and 6 were significantly greater than the steers of lots 1, 2 and 3 ($P<0.05$). The steers of lots 2 and 3 had significantly greater gains than the steers of lot 1 ($P<0.01$).

Observations (Series I)

The mid-day temperatures ranged from 85° to 115° F. The steers fed the non-roughage ration composed of steam-rolled barley, cottonseed oil meal, vitamin A concentrate, and dicalcium phosphate (ration 3, table 1) appeared to be uncomfortable throughout the entire feeding period. The steers of this group seldom ate during the period from 7:00 a.m. to 8:00 p.m. These steers spent most of the daylight hours panting. The respiration rate ranged from 50 to 90 counts per minute, whereas the respiration rate of the steers fed the concentrate-roughage ration of lot 1 and the corn-and-cob-meal of lot 2 averaged about 25 to 35 counts per minute. Also, the respiration rates of steers fed 15, 30 and 43 percent dried molasses beet pulp were less than the steers fed the steam-rolled barley alone. The steers of lots 1, 2, 4, 5 and 6 ate during the mid-day hours.

The steers fed the corn-and-cob-meal mixture appeared comfortable at all times and ate continuously. Their feed consumption averaged 15 to 20 percent more than that for steers receiving the steam-rolled barley and steam-rolled barley plus dried molasses beet pulp rations. Steers fed the steam-rolled barley ration had a higher incidence of stiffness, indicating signs of slight founder. Bloat was not observed among the steers fed any of the rations of this series.

Financial Consideration

A nomograph was constructed to compare the monetary returns of the three groups of steers fed the steam-rolled barley with dried molasses beet pulp (lot 4, 15 percent; lot 5, 30 percent; and lot 6, 43 percent). The financial results of a feeding trial are of value to the feeder only when interpreted in the light of the conditions existing at the time the data are to be used. Financial results based on prices prevailing at the time the experiment was conducted may be of little or no value to the average steer feeder since feed values vary from year to year and area to area.

Figure 1 presents a nomograph for the calculation of the feed cost per 100 pounds gain. The values presented in this nomograph

LOTS	BARLEY	DMBP
4	80.0%	15.0%
5	65.0%	30.0%
6	50.0%	43.0%

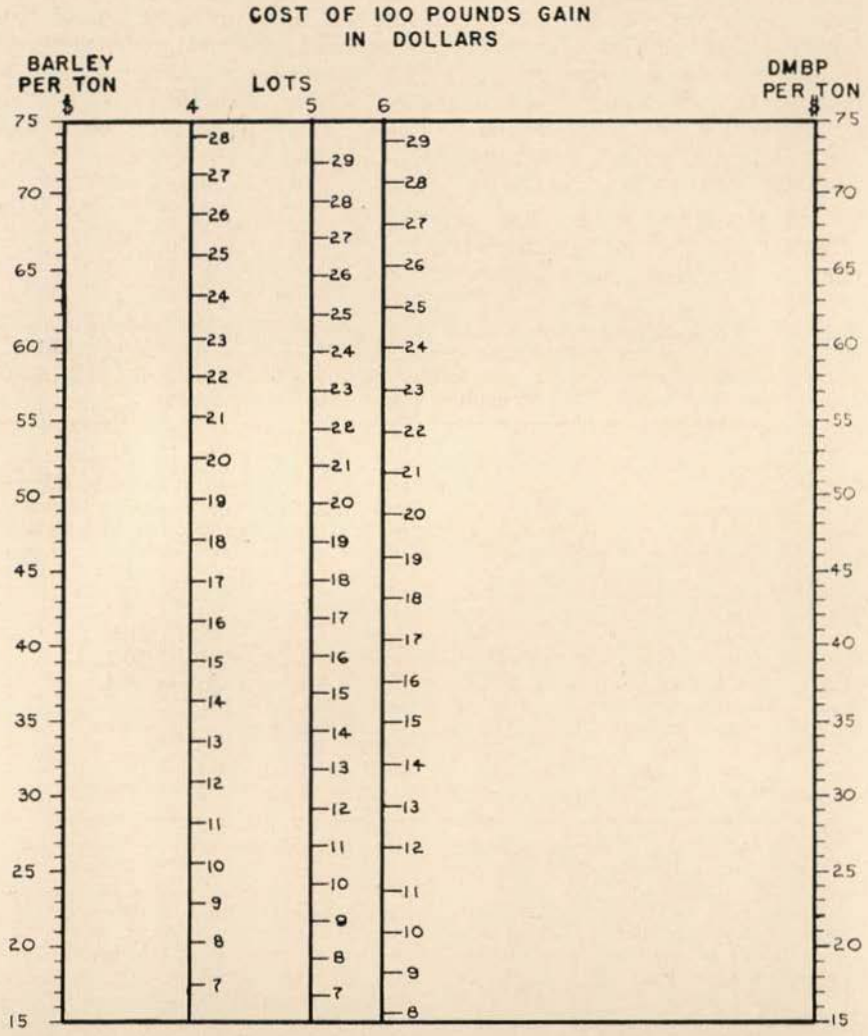

FIGURE 1. Nomograph for the calculation of feed cost of each 100 pounds gain on the steers of lots 4, 5 and 6 (15, 30 and 43 percent dried molasses beet pulp, respectively).

are based on the results of the feeding test presented in table 3. The left scale presents the cost of a ton of barley ranging from $15 to $75. The right scale gives the cost per ton of dried molasses beet pulp. This chart can be used to determine what percentage of dried molasses beet pulp would be most economical, depending upon known prices of steam-rolled barley and DMBP. To feed for the greatest monetary returns, place a straight edge at the known price of barley and the known price of dried molasses beet pulp. For example, if barley is $50 per ton and dried molasses beet pulp $40 per ton, place the straight edge at $50 on the left scale and $40 on the right scale. The points of intersection give a cost of $18.44 per 100 pounds gain for the steers fed barley with 15 percent dried molasses beet pulp; $18.94 per 100 pounds gain for steers fed barley with 30 percent dried molasses beet pulp; and $18.90 per 100 pounds gain for steers fed barley with 43 percent dried molasses beet pulp.

A summary of the data relating to the carcass values of the steers receiving each ration treatment is shown in table 5. The carcass data are presented as numerical values.

Table 5. Summary of average numerical scores[1] of slaughter and carcass grades, degree of marbling, conformation scores, fat thicknesses, loin-eye areas, dressing percentages, and cooler shrinkage percents of the steers fed each of the rations.

Lot No.	1	2	3	4	5	6
	Roughage	Corn-and-cob 30 % DMBP[2]	Barley	Barley, 15 % DMBP[2]	Barley, 20 % DMBP[2]	Barley 43 % DMBP[2]
Feeder grade	9.4	9.3	9.3	9.5	9.8	9.0
Slaughter grade:						
112 days	8.6	9.4	8.5	9.4	8.9	8.9
140 days	9.8	10.5	9.7	9.8	10.4	10.2
Carcass grade	10.0	9.9	9.8	9.8	10.7	10.4
Degree of marbling	5.9	5.6	5.7	5.7	6.4	6.0
Conformation score	11.4	11.3	11.4	12.0	11.7	11.8
Loin-eye area sq. in.	12.49	12.25	11.66	12.21	12.31	12.46
Fat thickness mm.	23.63	26.57	20.28	19.37	21.60	21.02
Dressing percentage	61.4	62.0	60.1	59.2	59.7	60.4
Cooler shrinkage, percent	1.41	1.34	1.44	1.54	1.47	1.44

[1]The feeder grade, slaughter grades, USDA carcass grades and conformation scores are coded as follows: 15=high prime, 12=high choice, 9=high good, 6=high standard, and 3=high utility. The degree of marbling is coded as follows: 11=extremely abundant, 10=abundant, 9=moderately abundant, 8=slightly abundant, 7=moderate amount, 6=modest amount, 5=small amount, 4=slight amount, 3=traces, 2=practically devoid, and 1=devoid.
[2]Dried molasses beet pulp.

The barley-fed steers (lot 3) had significantly lower ($P<0.05$) slaughter grade scores at 112 and 140 days of feeding, significantly less ($P<0.05$) fat thickness over the 12th rib, and significantly lower ($P<0.05$) cold dressing percentage compared to the corn-and-cob-meal dried molasses beet pulp fed steers. No significant differences were found ($P>0.05$) for such carcass traits as

USDA carcass grade, degree of marbling, conformation, or cooler shrinkage between these two groups.

The roughage-fed group of steers (lot 1) had a significantly lower ($P<0.05$) slaughter grade at 112 and 140 days of feeding and less fat thickness over the loin eye compared to the corn-and-cob-meal fed group of lot 2.

The three groups of steers fed the steam-rolled barley plus dried molasses beet pulp showed an increase in slaughter grade, degree of marbling, loin-eye area, fat thickness, and cooler shrinkage compared to the steers fed steam-rolled barley without dried molasses beet pulp.

No significant ($P>0.05$) differences were found in the feeder grades at the beginning of the feeding period.

Yield Comparison of Retail Cuts from Corn-and-Cob-Meal and Barley Fed Steer Carcasses

Five carcasses of the steers that received corn-and-cob meal with 30 percent dried molasses beet pulp (lot 2) and the carcasses of five steers from the group that received steam-rolled barley (lot 3) were compared for cutability (yield of trimmed retail cuts). These carcasses were processed by Safeway Stores, Inc., at their warehouse in Bellevue, Washintgon. The carcass yields and cutting

Table 6. The percentatge of primal cuts from 5 steers fed corn-and-cob meal with 30 percent DMBP* and 5 steers fed steam-rolled barley.

Cuts	Corn-and-cob meal	Barley
	percent	percent
Forequarters	51.1	52.5
Hind quarters	48.9	47.5
Salvage and shrinkage		
Kidney knob fat	1.4	1.1
Edible	3.8	3.2
Inedibles	3.5	3.5
Dehydration loss	.7	.8
Cutting loss	.7	.8
Total salvage and shrinkage	10.1	9.4
Trimmed primal cuts		
Chucks	27.9	29.1
Rounds	23.4	23.9
Loins	14.0	13.1
Ribs	4.7	4.7
Plates	4.6	4.7
Brisket boneless	1.7	1.6
Shanks	2.7	2.9
Flank steaks	.5	.5
Lean trim to ground beef	9.9	10.0
Total primal cuts	89.4	90.5

*Dried molasses beet pulp

losses for the two groups are compared in table 6. No statistical analysis was made because of the small sample size.

The carcasses from the barley fed steers yielded 1.4 percent more of the total carcass weight in the hind quarters. This was probably coincidental and was not attributed to a ration difference. The barley fed steers yielded 0.3 percent (of the total body weight) less kidney knob, 0.6 percent less edible or trimmed fat, and 0.7 percent less salvage and shrinkage.

The yield of trimmed wholesale cuts was similar for both lots of steers (89.4 percent for the corn-and-cob-meal and 90.5 percent for the barley steers).

Series II

The objectives of the studies outlined in Series II were: (1) to determine the effect of feeding a small quantity of straw per steer per day with all of the concentrate mixture they would consume as measured by rate and economy of gains; and (2) to compare the rate of gain of steers fed a non-roughage ration to the rate of gain of steers fed a high roughage ration during the initial feeding stages and non-roughage ration during a later phase of the finishing time of steers.

Table 7. Outline of the experimental feeding for series II.

Lot. No.	No. steers	Ration
1	10	2 lb. concentrate plus roughage 84 days; non-roughage 133 days
2	10	2 lb. concentrate and roughage 112 days; non-roughage 105 days
3	9*	6 lb. concentrate and roughage 84 days; non-roughage 133 days
4	10	6 lb. concentrate and roughage 112 days; non-roughage 105 days
5	10	Non-roughage 217 days
6	10	Concentrate and straw 217 days

*One steer died shortly after being transferred to the non-roughage ration.

Table 8. The concentrate mixture used in the experiment.

Feedstuff	Percent
Coarsely ground barley	65
Dried molasses beet pulp	30
Soybean oil meal	2.5
Sodium chloride	1.0
Steamed bone meal	1.5
Vitamin A concentrate	+

Procedure

Sixty heavy Hereford steer calves weighing an average of 525 pounds were purchased and assigned to six groups on the basis of weight and feeder grade. They were fed 217 days from Decem-

ber 6 to July 11, 1961. The outline of the feeding method is shown in table 7. The ingredients and parts per 100 pounds of the concentrate mixture are presented in table 8. Dry rolled (Krumper-Krocher) barley was used in the concentrate mixture in the series II feeding instead of the steam-rolled barley. Total protein content in the concentrate mixture averaged 13 percent.

The roughage allowance consisted of a mixture of 6 pounds corn silage (on wet basis) and 1 pound baled alfalfa hay. The baled barley straw was fed at one end of the feed manger. The steers were allowed all the straw they would consume up to an average of 2 pounds per steer per day.

Results (Series II)

The steers were fed to a final weight of 1032 to 1084 pounds. The average initial weights, final weights, and feed per 100 pounds gain of the six groups of steers are presented in table 9. The accumulative average daily gain of the steers fed each ration for each weight period are presented in table 10. Steers fed a roughage during the initial phases of the finishing period (lots 1, 2, 3 and 4) had a gradual increase in average daily gain as the feed period progressed. Steers fed 2 pounds of the concentrate mixture during the initial 84 and 112 days had an increase in the average daily gain from 1.94 pounds during the first 56 days to 2.38 and 2.36 for the 217-day feeding period. Steers fed the non-roughage ration during the entire finishing period of 217 days had a reduction in rate of gain as the feed period progressed.

There was no significant difference ($P>0.05$) in the average daily gain of the steers of the six groups for the entire period of

Table 9. Average initial weights, final weights, and feed per 100 pounds gain.

Lot No.	Treatment	Average weight initial	Average weight final	Feed per 100 lb. gain	Average daily gain	Cost per 100 lb. gain
		lb.	lb.	lb.	lb.	dollars
1	2 lb. concentrate with roughage 84 days, non-roughage 133 days	516	1032	897	2.38	13.39
2	2 lb. concentrate with roughage 112 days, non-roughage 105 days	532	1044	987	2.36	12.88
3	6 lb. concentrate with roughage 84 days, non-roughage 133 days	521	1070	822	2.52	13.03
4	6 lb. concentrate with roughage 112 days, non-roughage 105 days	522	1084	907	2.59	13.47
5	Non-roughage ration 217 days	522	1056	710	2.46	15.10
6	Concentrate plus straw 217 days	547	1048	696	2.41	14.15

217 days. The feed required per 100 pounds gain ranged from 696 to 710 pounds (lots 6 and 5, respectively) to 987 pounds (lot 2). However, the cost of the gains was the cheapest for the lot 2 steers ($12.88) as compared to the steers in lots 5 and 6, $15.10 and $14.15, respectively.

Even though there was no significant difference in gains, there was a difference in cost of 100 pounds of gain. The most expensive rations were the non-roughage ration (lots 5 and 6). The most economical gains were made by the steers in lot 2. These steers were fed the roughage mixture with 2 pounds of the concentrate mixture per day for a period of 112 days, after which they were fed the concentrate mixture without roughage for 105 days.

Table 10. Accumulative average daily gains of the steers fed each ration for weight period. (December 6, 1960, to July 11, 1961)

Lot No.	Ration	Average daily gain to date on feed, days						
		56	84	112	140	168	196	217
1	2 lb. concentrate with roughage 84 days, non-roughage 133 days	1.94	2.08	2.20	2.29	2.38	2.37	2.38
2	2 lb. concentrate with roughage 112 days, non-roughage 105 days	1.94	1.98	2.27	2.09	2.32	2.33	2.36
3	6 lb. concentrate with roughage 84 days, non-roughage 133 days	2.38	2.42	2.24	2.41	2.50	2.49	2.52
4	6 lb. concentrate with roughage 112 days, non-roughage 105 days	2.62	2.59	2.45	2.49	2.65	2.63	2.59
5	Non-roughage ration 216 days	2.82	2.82	2.74	2.68	2.65	2.58	2.46
6	Concentrate plus straw 217 days	2.52	2.54	2.60	2.57	2.57	2.47	2.41

The average daily feed consumption by total ration, concentrate mixture, alfalfa hay, corn silage, and fiber is reported in table 11. The total daily feed consumption was highest for steers fed the roughage mixture 112 days of the feeding period (lots 2 and 4). These steers also received the highest fiber content in their rations. The steers fed the 2 pounds of concentrate mixture with all the roughage they would consume for 112 days (lot 2) made the most economical gains.

The data relating to the carcass values of the steers fed the various concentrate levels are shown in table 12. The coded numerical values of the various measurements of live animal and carcasses used in this series are the same as in series I. The steers in lot 4, fed 6 pounds of the concentrate mixture for 112 days, followed by 105 days feeding of the concentrate mixture without roughage had a slaughter grade significantly higher ($P<0.05$) than the slaughter grades of all other groups except those steers fed the non-roughage ration. No significant differences were ob-

served in the average values for the feeder grade, USDA carcass grade, degree of marbling, conformation score, rib-eye area, fat thickness over the rib-eye, dressing percentage, or cooler shrinkage of any of the six groups.

Table 11. Average daily feed consumption of the concentrate mixture, alfalfa hay, corn silage and total fiber.

Lot No.	Total daily Av. ration	Concentrate mixture	Alfalfa hay	Corn silage	Daily fiber intake	Percent fiber
	lb.	lb.	lb.	lb.	lb.	percent
1	21.3	11.5	1.7	8.1	1.90	11.9
2	23.3	9.8	2.6	10.9	2.18	13.5
3	20.7	12.3	1.4	7.0	1.80	11.4
4	23.5	11.9	2.1	8.9	2.10	12.4
5	17.5	16.1	.2	1.2	1.39	8.6
6	16.8	14.3	1.3*	1.2	1.63	11.4

*Straw

Observations (Series II)

One steer in lot 3 scoured severely and appeared to be foundered soon after being transferred to the non-roughage ration. This steer died. The cause of death was not determined.

One steer in lot 5 became foundered after 91 days of feeding.

Table 12. Summary of average numerical scores of feeder grades, live slaughter grades, carcass grades, degree of marbling, conformation scores, rib-eye areas, fat depth, dressing percentages, and cooler shrinkage percentages*. (series II)

Lot No.	1	2	3	4	5	6
	2 lb. conc. 84 da., non-roughage 133 days	2 lb. conc. 112 da., roughage 105 days	6 lb. conc. 84 da., non-roughage 133 days	6 lb. conc. 112 da., non-roughage 105 days	Non-roughage 217 days	Conc. straw 217 days
Feeder grade	9.2	9.1	8.3	9.2	9.8	8.2
Live slaughter grade	8.8	8.6	7.6	10.1	9.5	8.2
Carcass grade	10.0	9.5	9.0	10.4	10.7	9.0
Degree of marbling	5.7	5.3	4.9	6.1	5.9	5.1
Conformation score	10.2	10.6	9.7	10.8	10.6	9.2
Rib-eye area, sq. in	12.31	11.49	11.25	11.54	11.96	12.41
Fat depth, mm	15.80	14.84	16.60	20.19	20.86	18.86
Dressing percentage	58.9	58.7	59.1	59.2	59.8	59.8
Cooler shrinkage percentage	1.68	1.71	1.74	1.72	1.60	1.60

*Same numerical scores as used in table 5, page 9

Series III

The objective of the experiments outlined in Series III was: (1) to determine the quantity and kind of roughage to feed fattening steer calves that are to be fed a non-roughage ration.

Procedure

The roughage mixture contained 6 parts of corn silage and one part of chopped alfalfa hay. The concentrate mixture was composed of the following parts per 100 pounds: 65 pounds steam-rolled barley, 30 pounds of dried molasses beet pulp, 2.5 pounds of soybean oil meal, 1 pound of sodium chloride, and 1.5 pounds of bonemeal. Each 100 pounds of feed had 75,000 IU of vitamin A concentrate. This is the same mixture as was fed to steers of lot 5 in series I. Each steer was implanted with 12 mg. of diethylstilbestrol. Outlne of the experiment is shown in table 13.

Table 13. Outline of the feeding methods of series III. (1961-1962)

Lot No.	No. steers	Methods of feeding
1	10-9[1]	All-concentrate mixture
2	10-9[2]	Concentrate mixture plus 2 lb. alfalfa hay per steer per day.
3	10	Concentrate mixture plus 7 lb. of corn silage per steer per day.
4	10	Concentrate mixture plus 7 lb. alfalfa hay and 42 lb. of corn silage per day for 10 steers.
5	10	Concentrate mixture plus 7 lb. alfalfa hay and 42 lb. of corn silage. (The concentrate was increased periodically, the roughage gradually decreased.)
6	10	6 lb. of the concentrate per day with all the roughage they would consume (1 part alfalfa hay and 6 parts corn silage) for 84 days, then fed the concentrate mixture without roughage for 83 days.

[1]One steer had urinary calculi and was removed at the end of 106 days of feeding.
[2]One steer had urinary calculi and was removed at the end of 164 days of feeding.

The steers were fed to a final weight of 1096 to 1189 pounds, table 15. Those steers of lot 1 that received the roughage mixture throughout the entire feeding period of 167 days were lightest in weight and had made the slowest gains. These steers were ready for slaughter a month before the groups of steers fed any of the other five rations.

Table 14. Concentrate consumption of each feeding method.

Lot No.	Periods				
	First (56 days)	Third (28 days)	Fourth (28 days)	Fifth (28 days)	Sixth (27 days)
	lb.	lb.	lb.	lb.	lb.
1	16.6	20.0	19.6	21.0	20.4
2	17.6	19.7	19.0	19.4	18.9
3	16.6	20.3	19.5	19.6	19.7
4	17.3	20.7	19.1	19.4	19.5
5	5.5	10.5	15.0	18.2	19.7
6	6.0	6.0	15.0	22.1	23.6

The average daily gains of the steers of each group for the periods of 56, 84, 140 and 167 days of feeding are presented in table 15. The most rapid gains were made by those steers of the lots fed the highest levels of concentrate during the initial periods of the test. The group of steers fed the high roughage ration with 6 pounds of concentrate during the first 84 days and the non-roughage ration during the last 83 days made most rapid gains during the last month. This group had the highest total consumption during the last two periods, table 14. This group of steers had the greatest total average feed consumption of 35.7 pounds, of which 13.2 pounds was the concentrate mixture, 3.3 pounds was alfalfa hay and 19.5 pounds was corn silage.

The lowest total average feed consumption, of 19.7 pounds, was made by the groups fed the non-roughage ration, lot 1, throughout the 167 days, table 16. The highest intake of feed made by the steers fed the non-roughage (lot 1) was 21.0 pounds during the fifth period, table 14, while the steers of lot 6 consumed 23.6 pounds during the sixth period. This would indicate that feeding a high roughage ration during the early stages of feeding tends to develop a physiological need to consume larger quantities of the concentrate mixture during the later periods of feeding. This would account for the increase in rate of gains during the later periods of the test.

The differences in the average daily gains of the steers of the six groups were not statistically significant ($P>0.05$). In other

Table 15. Accumulative average daily gains at the end of 56, 94, 140 and 167 days.

Lot No.	Weight		Average daily gains at the end of:			
	initial	final	56	84	140	167
	lb.	lb.	lb.	lb.	lb.	lb.
1	678	1096	2.86	3.04	2.69	2.59
2	678	1124	3.64	3.37	2.86	2.67
3	688	1153	3.34	3.24	2.99	2.78
4	690	1152	3.26	3.42	2.68	2.77
5	676	1106	3.27	2.95	2.85	2.61
6	711	1189	2.38	2.95	2.84	2.91

Table 16. Feed consumption, feed requirements, and feed costs at the end of 167 days of feeding

Lot No.	Average daily ration				Feed per	Cost per	
	Total	Conc.	Hay	Silage	100 lb. gain	100 lb. gain	
	lb.	lb.	lb.	lb.	lb.	$26 Hay	$20 Hay
1	19.7	18.1	0.4	1.3	762	$17.85	$17.80
2	22.1	18.7	2.2	1.2	828	18.78	16.28
3	26.7	18.7	0.3	7.6	959	18.19	18.16
4	25.0	18.7	1.0	5.2	902	18.72	18.61
5	33.0	11.4	3.2	18.4	1261	15.65	12.44
6	35.7	13.2	3.3	19.5	1226	15.55	15.27

words, as far as the application of the results to commercial feedlot conditions is concerned, any of the feeding methods studied in the six lots will give approximately the same rate of gain. The differences in the rates of gain obtained are considered to be because of differences in individual steer performances. There was a difference in feed costs per unit of gain. The cheapest gains were made by the groups of steers fed the largest quantity of roughage. These were the steers of lots 5 and 6. As shown in table 16 the price of roughage would determine the relative cost of gains.

The feed cost for each 100 pounds gain was calculated from feed costs as follows: Alfalfa hay, $26.00 per ton; corn silage, $9.00 per ton; dried molasses beet pulp, $37.00 per ton; steam-rolled barley, $54.00 per ton; soybean oil meal, $95.00 per ton; bonemeal, $115.00 per ton, and sodium chloride, $36.00 per ton.

If the feed costs were calculated with the value of $20.00 for alfalfa hay instead of $26.00 as shown in table 16, the feed cost of 100 pounds of gain of the steer calves of lots 2 would have been $16.28 instead of $18.78. The feed costs of 100 pounds gain of steer calves of lot 5 would have been the most economical—$12.44 instead of $15.65.

Data relating to carcass values are presented in table 17. The ration and method of feeding did not affect the feeder grade, degree of marbling, conformation score, or cooler shrinkage. The steers fed a high roughage ration at the beginning of the test with a gradual increase in the concentrate allowance during the test (lot 5) had a significantly ($P<0.05$) lower live slaughter grade and dressing percentage than the other 5 groups of steers. The

Table 17. Summary of average numerical scores* of feeder grades, live slaughter grades, carcass grades, degree of marbling, conformation scores, dressing percentage, rib-eye areas, fat depth, and cooler shrinkage percentages of the steers fed each ration. (series III)*

Lot No.	1	2	3	4	5	6
	All conc.	Conc. + 7 lbs. hay	Conc. + 7 lbs. silage	Conc. + hay + silage	Gradual increase in conc.	Non-roughage, 84 days
Feeder grade	9.6	9.4	9.3	9.1	9.1	9.1
Live slaughter grade	10.8	10.8	10.7	10.5	9.4	11.2
Dressing percent	59.8	61.2	60.3	60.6	58.6	59.6
Carcass grade	12.0	10.9	10.4	10.6	10.1	10.2
Degree of marbling	6.9	6.2	5.9	6.2	5.6	5.9
Conformation score	12.2	11.2	11.9	11.3	10.9	11.7
Rib-eye area, sq. in.	12.78	12.52	12.84	12.92	12.60	13.09
Fat depth, mm	21.5	22.8	24.6	23.1	17.4	24.8
Cooler shrinkage, percent	1.58	1.67	1.59	1.64	1.80	1.58

*Same numerical scores as used in table 5, page 9.

steers fed the non-roughage ration during the last 84 days (lot 6) had a significantly higher rib-eye area ($P<0.05$) than all of the other groups except those steers fed the concentrate mixture with alfalfa and corn silage (lot 4). The steers fed the high roughage ration at the beginning of the test with a gradual increase in the concentrate allowance (lot 5) had the least fat depth over the rib-eye. No significant differences were observed among the 6 groups in cooler shrinkage.

Observations (Series III)

One steer in lot 1 developed urinary calculi after 106 days on feed. One steer in lot 2 developed urinary calculi after 164 days on feed. Both were slaughtered. One steer in lot 1 was severely foundered. One steer in lot 6 had peritonitis at the time of slaughter. A study of the presence of stones in the kidney and bladder of all steers at time of slaughter indicated there was no relationship of the calculi development to the ration fed in this study.

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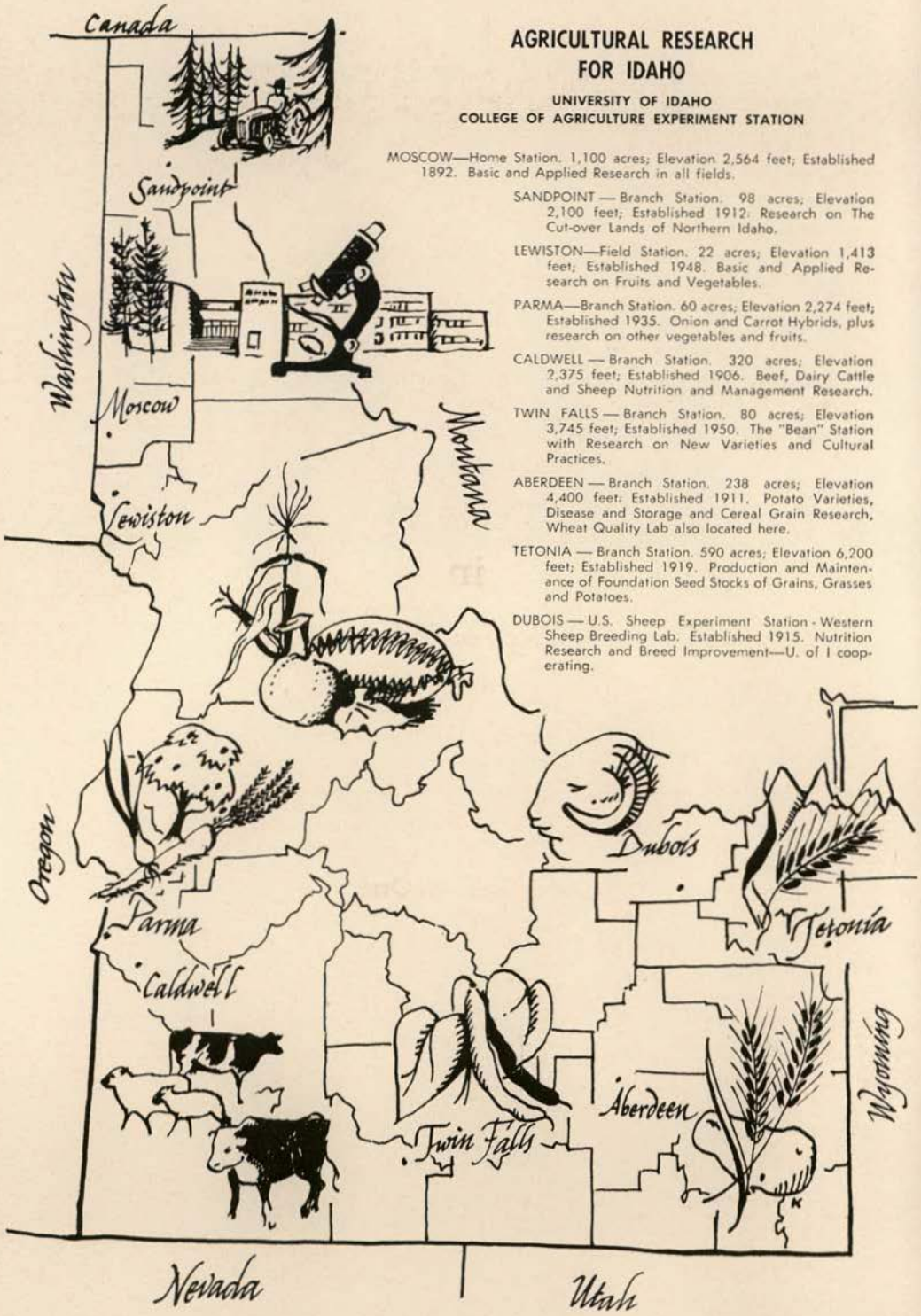

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