Factors Influencing Feed and Energy Intake of Steers Fed Conventional and High Concentrate Rations

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During recent years, the high cost of energy from roughage relative to that from grain has been a significant item in formulating least-cost rations for finishing cattle in the Southwest. The demand for alfalfa hay in dairy operations, periodic drouth conditions and increased demand for cottonseed hulls have resulted in the commercial feeder paying nearly as much for cottonseed hulls or other processed roughage as for grain sorghum.

Roughages are relatively low in net energy, which is the energy remaining for production after all losses to the body in digestion and metabolism of food nutrients are accounted for. Although roughages often supply significant amounts of protein, minerals and carotene to the diet, these can be replaced by adding balanced supplements to high-grain rations. However, a significant question is how the presence of bulk in the diet influences energy consumption and performance of ruminants.

Numerous experiments have shown that if roughage is removed from the ration and replaced by grain, the fattening steer eats less total feed and actually consumes only slightly more energy. All the factors governing feed intake of ruminants on finishing rations are still obscure, but among the most important are:

1. **Inheritance.** Recent studies show that appetite may be rather highly heritable.
2. **Type of ration.** The physical nature and bulk of the diet tends to influence rate of feed passage from the rumen and as a result may influence appetite.
3. **The caloric content of the diet.** Presumably this is due to the end products of digestion which may, in some way, regulate appetite.
4. **Rumen pH.** The lowered pH of the rumen associated with finishing rations may also influence feed intake.

Among other factors, the environmental temperature to which the finishing steer is exposed has been observed at this station to exert an important influence on daily feed intake.

Further, roughages initiate or lead to a rather high "heat increment" due to the energy released during digestion and metabolism. It seems possible that this heat load could be reduced by the use of high-energy and low roughage rations in the Southwest during the hot summer months.

The factors that influence feed intake in ruminants have been investigated in a series of trials. A part of the initial study was reported in the 1963 Feeder's Day report.[1] The studies were concerned with the effects of the physical make-up of the ration and the source of calories on total feed and energy consumed.

TRIAL 1 (FALL 1962)

In this preliminary trial started in the fall of 1962, five lots of 6 yearling steers were self-fed the different experimental rations to determine the influence of high concentrate rations, fat additions, ration density per unit of volume, and the addition of inert bulk on feed and caloric intake of finishing steers as well as the resulting performance in terms of daily gain.

The rations fed the various lots were:

Lot 1: Conventional finishing ration (65% concentrate).

Lot 2: High-concentrate ration (95% concentrate).

Lot 3: The conventional finishing ration with 5% stabilized animal fat.

Lot 4: The conventional diet plus approximately 16% added fine sand to increase ration density and to simulate the weight per unit of volume of the high concentrate diet.

Lot 5: The high-concentrate diet plus inert bulk supplied by an indigestible polyethylene resin in order to increase the dietary bulk without adding nutrient value.

The steers were self-fed the above rations for a period of 193 days in paved lots bedded with sand to prevent the consumption of other roughage. The average daily feed consumption and daily gain over this period are shown in Table 1 along with daily net energy intake calculated from published values for the feeds used.

The results show a marked reduction in total feed consumed by steers consuming the high concentrate ration (Lot 2), as well as some reduction in caloric intake. When fat was added to the conventional ration (Lot 3), the total feed intake remained almost constant with that observed in Lot 1. However, the caloric intake was increased due to the presence of fat which supplies approximately 2.25 times as much energy per unit of weight as carbohydrate or protein. The addition of a dense, inert material such as fine sand to the ration (Lot 4) at levels providing as high as 5-6 lb. per steer daily resulted in an increase in the total mixture consumed. This suggests that the density of the diet has little effect in depressing appetite. When the inert plastic material was added to the high concentrate diet (Lot 5), greater con-

[1] Oklahoma Agricultural Exp. Station Misc. Pub. MP-70.

Table 1: Composition of Rations Fed, and Average Daily Feed and Energy Intake of Finishing Steers
(Trial 1)

Lot Designation	1	2	3	4	5
Ration Designation	A	B	C	D	E
Ration Composition, %[1]					
Steam Rolled Milo	51.4	83.9	46.4	Same As	Same As
Cottonseed Meal	8.0	5.0	8.0	A Plus	B
Dehyd. Alf. Meal	5.0	5.0	5.0	500 Lbs.	plus 400
Urea	1.5	1.5	1.5	Sand Added	Lbs. Inert
Molasses	3.0	3.0	3.0	to 1 Ton	Bulk Added
Stabilized Animal Tallow	--	--	5.0	Feed	To 1 Ton
Cottonseed Hulls	30.0	--	30.0		Feed[2]
Salt	0.5	0.5	0.5		
Calcium Carbonate	0.5	1.0	0.5		
Av. Daily Feed Intake, Lbs.	28.73	21.46	29.59	33.12	27.94
Ave. Net Energy Intake/da., Therms[3]	17.5	15.5	19.3	16.1	16.8
Ave. Daily Gain, Lbs. (148 Days)	2.50	2.56	3.15	2.90	2.95

[1] All mixtures supplied 30,000 I.U. Vit. A and 3 gm. trace mineral per steer daily.
[2] Polyethylene resin, DuPont, used as filler.
[3] Calculated from Morrison's *Feed and Feeding*, 22nd Ed., Appendix Table 2.

sumption was obtained than on the high concentrate ration fed to Lot 2. Upon slaughter, no abnormalities were noted in the digestive tract.

It appeared that the steers would consume quantities of the different rations that would provide a similar caloric intake, irregardless of the physical density or bulk of the ration. The only exception appeared to be in the case of the fat-containing ration. More total calories were consumed from this ration than from the other rations fed. This suggests that the mechanisms controlling feed intake may be more sensitive to carbohydrates than fat.

TRIAL 2 (SUMMER 1963)

In order to test the influence of increased ration density and added inert bulk to finishing rations during the hot summer months, a trial was started during the summer of 1963. Twenty-seven yearling steers were allotted to nine lots of three steers each and self-fed three experimental rations as shown in Table 2.

The basal diet contained 74% concentrate, and as in Trial 1, the ration fed Lot 2 contained approximately 16% sand. The ration fed Lot 3 contained 13% inert bulk from polyethylene resin. The additions were made to alter the density or level of bulk fed.

Table 2: Composition of Rations Fed and Average Daily Feed And Net Energy Intake of Steers During Summer Months
(Trial 2)

Lot Designation	1	2	3
Ration Designation	A	B	C
Ration Composition, %			
Steam Rolled Milo	61.15	Same As	Same As
Cottonseed Meal	7.00	A Plus	A Plus
Dehyd. Alf. Meal	6.00	400 Lbs.	300 Lbs.
Molasses	3.00	Sand Added	Inert Bulk
Urea	1.00	to 1 Ton	Added to 1
Cottonseed Hulls	20.00	Feed	Ton Feed[2]
Salt	1.00		
Calcium Carbonate	.80		
Vit. A Premix[1]	.03		
Trace Mineral	.02		
Ave. Daily Feed Intake, Lbs.	26.7	31.1	27.1
Ave. Net Energy Intake/ Da., Therms[3]	16.55	16.17	14.63
Ave. Daily Gain, Lbs.	2.65	2.57	2.50

[1] 10,000 I.U. per gram.
[2] Polyethylene resin, DuPont, used as filler.
[3] Calculated from Morrison's *Feeds and Feeding*, 22nd Ed., Appendix Table 2.

The animals were maintained in paved lots bedded with sand during the 110 day feeding period. An open shed provided shade for all lots. In addition to composition of the rations fed, the average daily feed intake, caloric intake and daily gain are shown in Table 2.

The results indicate that under summer conditions, finishing steers can adjust to the increased density of the diet in that more of the sand-containing ration was consumed and thus provided a caloric intake essentially equal to that observed in Lot 1. This same pattern was noted in the previous trial conducted during the winter months.

It is interesting, however, in this preliminary trial that steers of Lot 3, fed the ration containing inert bulk, did not appear to be able to compensate by increasing their feed intake in order to maintain a caloric intake equal to that for the other rations. Possibly, a higher heat increment resulted from the bulkier diet. This would be the expected case when the level of normally fed roughage is increased in the ration and is presumably due to altered end products of digestion. The influence of inert bulk in the diet is presently being studied further.

Large amounts of bulk or roughage during the hot summer months may be disadvantageous to finishing cattle. For summer-type rations, the "all-concentrate" approach may have merit. Such a pattern has been apparent from recent California trials. In the Southwest, cattle feeders

may well use two different rations—one containing approximately 20% roughage such as cottonseed hulls for winter feeding, and the other one designed for more efficient summer feeding by eliminating most of the roughage, thus reducing the heat produced by roughage utilization.

TRIAL 3 (WINTER 1963)

To further study the influence of bulk in the ration or the presence of additional fat on the feed and energy intake of steers, a test was designed for the 1963-64 winter study. Five different rations containing varying levels of roughage, fat, or bulk were formulated. The composition of the diets used is shown in Table 3. A brief description of the experimental rations appears below:

A—Basal ration containing 20% cottonseed hulls.
B—High-concentrate ration (95% concentrate).
C—Basal ration with 5% stabilized fat.
D—High-concentrate ration with 5% stabilized fat.
E—High-concentrate ration with 5% stabilized fat plus 13% polyethylene resin to increase the bulk in the diet.

Five lots of 7 yearling Hereford steers each were self-fed the above rations during five 25-day feed intake tests. This design permitted all lots of steers to receive each ration during the trial. The steers were fed for a 7-day preliminary period, and then feed consumption records were maintained during the 25-day test period. About midway through each feeding period, rumen samples were taken from at least 2 steers on each treatment to study ruminal pH and volatile fatty acid levels in the rumen fluid.

Table 3: Composition of Rations Fed to Finishing Steers
(Trial 3)

Ration Designation	A	B	C	D	E
Ration Composition, %					
Steam Rolled Milo	60.85	83.95	55.85	78.95	Same As
Cottonseed Meal (41%)	8.00	5.00	8.00	5.00	D Plus
Dehyd. Alf. Meal (17%)	6.00	5.00	6.00	5.00	300 Lbs.
Molasses	3.00	3.00	3.00	3.00	Inert Bulk
Urea	1.00	1.50	1.00	1.50	Added To
Stabilized Animal Tallow	---	---	5.00	5.00	1 Ton Feed[2]
Cottonseed Hulls	20.00	---	20.00	---	
Salt	0.50	0.50	0.50	0.50	
Calcium Carbonate	0.60	1.00	0.60	1.00	
Vit. A Premix[1]	0.03	0.03	0.03	0.03	
Trace Mineral	0.02	0.02	0.02	0.02	

[1] 10,000 I.U. per gram.
[2] Polyethylene resin, DuPont, used as filler.

Preliminary results from three trials (25-day feed intake periods) have been obtained and are shown in Figure 1. The net energy in each ration was calculated from published values.

The results to date indicate the same pattern observed in other studies, with reduced feed and caloric intake on the high-concentrate ration (B) vs. the conventional diet (A). Adding fat to each of these rations (C and D) had little effect on feed intake, however caloric intake was higher in each case. The greater improvement in caloric intake resulted from the addition of fat to the high-concentrate ration. Hence, there may be considerable advantage to the inclusion of fat in finishing rations of this type. In other words, more energy can be crowded into the finishing steer diet when supplied as fat than when made up predominately of the carbohydrate-containing grains. However, there is a limit to the amount of fat that can be used. Most studies show that levels above 6-8% cause a reduction in appetite and effect the digestibility of other constituents in the rations.

A limitation to the experimental design used here is that the long-term effects of such rations cannot be determined. Over a long feeding period, cattle may tire of fat containing diets devoid of roughage and thus nullify the effects obtained over a shorter feeding period.

It is apparent from the data that the addition of inert bulk to the high-concentrate diet containing fat (E), fed during the winter, was compensated for by increased feed intake of the steers. The possibility of maximizing energy intake during the hot summer months by employing an all-concentrate type diet plus added fat will be investigated in further trials.

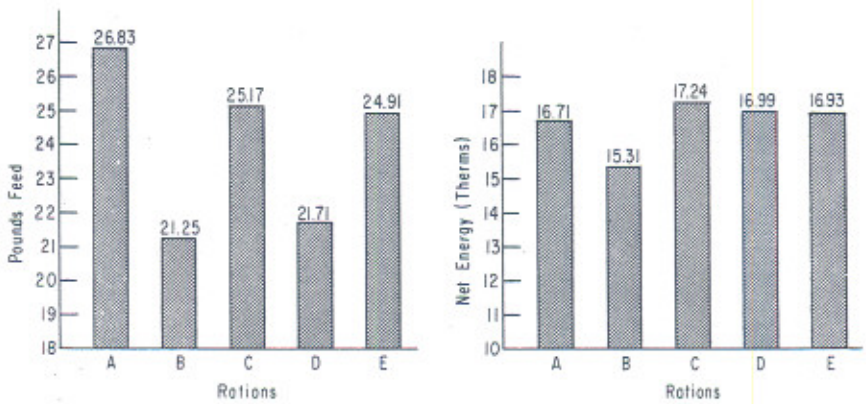

Figure 1. Average Daily Feed and Net Energy Intake Obtained From Three Trials with Steers (Trial 3).

One possibility for the reduced feed intake on high-concentrate diets is that there is a difference in the volatile fatty acids produced by rumen bacteria from each type of ration. To study this, 8 yearling steers were divided into two groups of four steers each and fed a conventional diet containing 30% cottonseed hulls (Ration A) and the ninety-five percent concentrate ration (Ration B). After a preliminary period of 10 days on each ration, rumen samples were taken by stomach-tube. Rumen pH readings were recorded and volatile fatty acid determinations were made by the gas chromatograph procedure. The groups were then reversed with respect to treatment, and further samples were taken for analyses after a 10-day preliminary period. The results of the fatty acid determinations are shown in Table 4. The ratio of acetic to propionic acid in rumen fluid was lower in the case of the high-concentrate ration. Higher levels of propionic acid are often associated with more efficient energy utilization.

SUMMARY

A series of trials, using yearling steers confined in paved lots with sand bedding, was initiated to study the effects of density or bulk and the addition of fat on feed and energy intake. The results demonstrate the ability of finishing cattle to overcome differences in the physical nature of the ration and to equalize their caloric intake. The addition of 5% fat appears to offer promise as a means of increasing the total calories consumed. Results of a summer trial indicate that fattening steers can tolerate greater density of the ration, but not an increase in bulk. This tends to suggest the need for different rations for summer and winter feeding.

Table 4: Volatile Fatty Acid Content of Rumen Fluid From Steers Fed Conventional and High-Concentrate Rations

	m moles VFA/liter				Acetic: Propionic Ratio
	Acetic	Propionic	Butyric	Valeric	
Trial 1					
Ration A[1]	51.52	38.22	8.47	2.36	1.35:1
Ration B[2]	35.02	36.01	5.44	1.27	0.97:1
Trial 2					
Ration A[1]	60.98	30.42	14.47	1.66	2.00:1
Ration B[2]	56.03	58.03	7.39	1.12	0.97:1

[1] Conventional ration containing 30% cottonseed hulls.

[2] 95% concentrate ration.