ffects of ROUGHAGE LEVELS

n Fattening Cattle

n Arizona

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Cover picture is of the Crowder Cattle Company feeding unit near Tolleson. Photo by The Arizona Republic.

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Summary

1. Four lots of yearling steers, 154 head in all, made creditable gains on all of the test rations.

2. Test rations with concentrate to roughage ratios of 2:1, 1:1, 1:2 and 1:3 were compared. Each ration contained about 10 per cent digestible protein. About 53 per cent of the roughage fed was in the form of cereal hay, cereal straw and cottonseed hulls.

3. Average daily gains, over 105-day period, for steers on the various rations were:

   a. 2.71 pounds on concentrate to roughage ratio of 2:1.
   b. 2.66 pounds on concentrate to roughage ratio of 1:1.
   c. 2.52 pounds on concentrate to roughage ratio of 1:2.
   d. 2.46 pounds on concentrate to roughage ratio of 1:3.

4. Daily gains decreased slightly as the proportion of roughage in the rations increased, but this difference was not significant except between the 2:1 and 1:3 ratios and between the 1:1 and 1:3 ratios.

5. The initial weights of the steers appeared to have no significant effect on the overall gains made on any of the rations.

6. Daily feed consumption ranged from 24.7 to 27.2 pounds. The least feed was consumed by the lot receiving two pounds of concentrates to each pound of roughage.

7. Although all rations produced satisfactory gains, the increase in the roughage content of the rations was accompained by a decrease in digestibility. Thus, the feed required per 100 pounds of gain increased somewhat with the increase in the proportion of roughage.

8. The relative differences in the digestibilities of the different rations were comparable, whether determined on the basis of Morrison's TDN values or on the basis of the energy values (in therms) obtained from actual digestibility studies.

9. As shown below, the least digestible nutrients per pound of gain were required by the steers on the concentrate-roughage ratio of 1:3, and the most were required by the animals on the 1:1 ration.

	Requirements Per Lb. of Gain	
Ratio	Lbs. TDN	Therms
2:1	6.15	13.168
1:1	6.36	13.258
1:2	6.11	13.181
1:3	5.92	12.503

10. A quick estimation of the cost of feed required to produce 100 pounds of gain is possible with the aid of the nomograph on page 8 of this bulletin.

EFFECTS OF ROUGHAGE LEVELS ON FATTENING CATTLE IN ARIZONA

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Variations in the price and supply of feeds commonly used in Arizona cattle-fattening rations sometimes force a substitution of ration constituents or a change in the proportions of the feed normally used. Cattle feeders recently found alfalfa hay, one of the principle Arizona roughages, in short supply because cotton was a strong competitor for irrigated land. At present, the spotted alfalfa aphid is infesting the alfalfa fields, and alfalfa producers are searching for substitute crops.

Since the supply of roughage is variable, the experiment reported in this bulletin was conducted to determine the rate and cost of yearling steer gains on rations containing different concentrate-roughage combinations. It also shows the gains that may be obtained when a substantial portion of the alfalfa hay is replaced by other roughage feeds.

Concentrates and roughages, as the terms apply to this study, are defined as follows:

1. Concentrates — feed grains, citrus meal, protein supplement and molasses.

2. Roughages — alfalfa hay, cereal hay, cereal straw, and cottonseed hulls.

There is no positive assurance that the responses to the different ratios of concentrates to roughage, as reported in this bulletin, will serve as a satisfactory guide when other ration constituents are used or when cattle in other age classes are fed.

Experimental Procedure

One hundred fifty-four yearling Hereford steers, produced under range conditions, were placed on three successive conditioning rations prior to the feed lot test. Table 1 shows the composition of the three conditioning rations and the period of time that each was fed. Note that the third ration contained 53 per cent concentrates. From this level, it was possible to change abruptly to the levels used in the test rations without evidence of digestive disturbances.

At the beginning of the test period, the 154 steers were divided into four lots. Each lot then received fixed proportions of concentrates and roughage for a test

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TABLE 1—Pretest Rations: Rations Fed Immediately Prior to the Start of the Experimental Feeding Period

	Ration 1	Ration 2	Ration 3
Number of Days Fed	6	10	16
Ration composition[1]:	%	%	%
Cereal hay	30	43	34
Cottonseed hulls	50	13	13
Grain (barley and hegari)		20	25
Dried citrus meal		7	8
Cottonseed meal	10	7	10
Molasses (cane)	10	10	10

[1] By percentage of actual weight basis.

period of 105 days (Table 2). Barley and hegari grain were fed in equal amounts in a given ration (Table 2). Each ration contained five per cent molasses. The percentage of cottonseed meal differed from ration to ration so that the percentage of digestible protein would be about the same in all.

Alfalfa hay constituted less than 50 per cent of the roughage fraction in each ration; the roughage fractions were of about the same percentage composition in all rations fed. The grain content of the cereal hay was negligible as determined by separating the grain from samples taken periodically.

The percentages of alfalfa hay and cereal hay are averages for the 105-day test period. The proportions of these two constituents varied during the test period with the availability of alfalfa hay. Cereal straw was substituted for the cereal hay during one period of 10 days after scouring was observed in lots 2 and 3. The cereal straw was used at no other time.

The ratios of concentrates to roughage were calculated on a dry matter basis; nevertheless, the rations used were sufficiently low in moisture content to allow calculations on an actual weight basis without altering the ratios materially. The percentages shown in Table 2 were computed from actual weights.

Each ration was mill-mixed and enough was fed twice daily to keep feed before the steers all the time. Since the ground hay and the cottonseed hulls were thoroughly mixed with concentrates in the rolled, cracked, or meal form (and with the molasses), the steers were given little opportunity to sort out individual ration components. Salt, in block form, was always available.

Individual steer weights were taken at the beginning and end of the experiment. Since identifying brands were applied prior to the test, individual gains for the 105-day test were available for consideration. Group weights were obtained on each lot at 30-day intervals after the test began.

Nutrient requirements per pound of gain were calculated from the total digestible nutrients reported by Morrison (5) and also from energy values obtained by laboratory analyses at the Arizona Station.

TABLE 2—Experimental Rations

Lot Lumber	1	2	3	4
Steers per lot	39	39	38	38
Concentrate-Roughage Ratio	2C:1R	1C:1R	1C:2R	1C:3R
Ration composition [1]:	%	%	%	%
Barley (rolled)	26.94	18.00	8.36	3.70
Hegari grain (cracked)	26.94	18.00	8.36	3.70
Cottonseed meal	8.00	10.00	12.00	13.00
Molasses (cane)	5.00	5.00	5.00	5.00
Roughage	33.12	49.00	66.28	74.60
Roughage Composition (Av. %)[1]:				
Alfalfa hay (chopped)	47.35	47.18	47.03	46.99
Cereal hay (chopped)	18.93	18.90	19.02	18.89
Cereal straw (chopped)[2]	3.10	3.31	3.34	3.50
Cottonseed hulls	30.62	30.61	30.61	30.62

[1] By percentage on actual weight basis.

[2] Fed only 10 days as corrective for scouring.

Results and Conclusions

Feedlot Gains

Creditable gains were made by the steers on all rations, and the maximum difference in average daily gains was 0.25 pounds (Table 3). The highest average daily gain, 2.71 pounds, was recorded for the steers receiving two parts of concentrates to one part of roughage (lot 1). The gains decreased slightly with each increase in the amount of roughage fed, but variance analyses of total gains indicated significant differences only between lots 1 and 4 (2:1 and 1:3 rations) and between lots 2 and 4 (1:1 and 1:3 rations).

Although scouring was observed in lots 2 and 3 on the 90th day, this condition was alleviated by substituting straw for the cereal hay. When the periodic gains were plotted graphically, it appeared that this disorder had no material effect on the overall gains for the 105-day test.

Covariance analyses (method outlined by Snedecor, 6) showed no evidence that the differences in initial weights accounted for the differences in the gains obtained.

Feed Consumption

The steers on the ration containing two parts of concentrates to one part of roughage (lot 1) consumed about 2.0 to 2.5 pounds less feed per day than did the steers in the other three lots (Table 3). Although this was quite consistent throughout the test, the explanation for the lower consumption was not apparent. Since the experimental lots were group fed, the differences in feed consumption could not be evaluated statistically. Rather striking, however, is the fact that the steers of lot 2, on the 1:1 ration, consumed the most feed per day. Keith and others (2) also found this to be true when either calves or yearlings were used as experimental animals.

The feed required per 100 pounds of gain increased as the proportion of roughage increased (Table 3). These figures, however, offer a rather vague picture of ration utilization because the rations differed in nutritive value.

TABLE 3—The Response Of Yearling Steers To Fattening Rations With Different Levels of Roughages.

Lot Number	1	2	3	4
Concentrate-roughage ratios	2C:1R	1C:1R	1C:2R	1C:3R
Steers per lot	39	39	38	38
Averages per head:	lbs.	lbs.	lbs.	lbs.
Final weight	975	993	983	941
Initial weight	691	713	718	683
Total gain (105 days)	284	280	265	258
Daily gain	2.71	2.66	2.52	2.46
Daily Ration:				
Barley (Rolled)	6.66	4.89	2.25	.99
Hegari Grain (Cracked)	6.66	4.89	2.25	.99
Cottonseed Meal (43%)	1.98	2.72	3.23	3.48
Molasses (Cane)	1.24	1.36	1.35	1.34
Roughage	8.19	13.3	17.86	19.94
Feed consumption per day	24.73	27.15	26.95	26.73
Total feed consumed (105 days)	2597	2851	2830	2897
Feed per cwt. gain	914	1019	1070	1088

For this reason, digestibility studies were conducted, and the results are summarized in Table 4.

Digestible protein

The test rations contained about 10 per cent digestible protein, with a maximum difference of approximately one-half of one per cent (Table 4). To keep the digestible protein levels about the same in all rations, the percentage of cottonseed meal was increased progressively from the low roughage rations to the high roughage ration (Table 2).

Digestible energy (Total energy minus fecal energy)

Laboratory analyses were run on the feed and feces samples collected during the course of the experiment, and the results (Table 4) were expressed in terms of energy (Therms). Each ration contained about two therms of combustible energy per pound of feed, but the percentage digestibility of this energy decreased progressively from the 2:1 to the 1:3 rations. Thus, an increasingly greater proportion of the total energy passed through the digestive tract as the roughage content of the ration increased. This was found relatively consistent when the analyses of the samples collected during each sampling period were compared.

The number of therms of digestible energy required per pound of gain were approximately the same for lots 1, 2, and 3 on the 2:1, 1.1 and 1:2 rations respectively. A difference of only about 0.1 therms per pound of gain was found. On the other hand, 12.5 therms, about 0.67 therms less than on the 2:1 ration, were required to produce a pound of gain on the 1:3 ration in lot 4. While this difference was found, the digestibility values could not be analyzed statistically. Consequently, it cannot be said whether this is a true difference caused by the differences in the rations fed.

Total digestible nutrients (TDN)

The digestibilities of the four experimental rations are expressed in terms of TDN at the bottom of Table 4. Cattle feeders are usually more familiar with TDN

TABLE 4—Digestibility OF The Experimental Rations and Nutritional Requirements Per Pound of Gain

Lot Number	1	2	3	4
Concentrate-Roughage Ratio:	2C:1R	1C:1R	1C:2R	1C:3R
Results of chemical analyses[1]:				
Total protein in ration (%)	14.79	15.03	15.62	15.88
Digestible protein in ration (%)	10.37	9.83	10.22	10.12
Combustible energy per lb. of feed (Therms)	2.017	2.008	2.017	2.006
Digestibility of combustible energy (%)	71.48	64.79	61.06	57.31
Digestible energy per lb. of feed (Therms)	1.441	1.301	1.231	1.149
Digestible energy per lb. of gain (Therms)	13.168	13.258	13.181	12.503
Digestibility based on TDN values:				
TDN in ration (%)	67.37	62.43	57.04	54.42
TDN per lb. of gain (lbs.)	6.15	6.36	6.11	5.92

1 Protein determined by micro-Kjeldahl method described by Kirk (3). Heats of combustion on feed and feces samples determined in bomb calorimeter. Lignin ratio technique for calculation of digestibility was essentially that of Ellis and others (1).

values than with energy values, and the TDN values are more readily available in the form of the feeding standards published by Morrison (5).

The steers in lot 2, fed equal parts of concentrates and roughage, required slightly more TDN per pound of gain than did any of the other lots. The steers in lots 1 and 3, on the 2:1 and 1:2 rations respectively, required a little less TDN per pound of gain and were about equal in their requirements. The steers of lot 4, on the 1:3 ration, required less TDN per unit of gain than did any of the other lots. As was true of the energy values, these TDN values were not subject to statistical evaluation.

Since the TDN values applied to the Arizona rations were obtained from the standards of Morrison rather than from actual analyses, the energy determinations were used as an indirect means of verification. Table 4 shows that the trends in the requirements per pound of gain were much alike when either the energy or TDN values were considered.

Feed costs per 100 pounds of gain

Feed costs per unit of gain, calculated when a feeding trial is conducted, are seldom of value over an extended period. The prices of the feeds change continually. For this reason, a nomograph that will assist in estimating the cost of feed required per 100 pounds of gain at any time has been developed (Figure 1). A method described by Mitchell (4) was used in constructing the nomograph. This nomograph should be used as a tool only when yearling steers are to be fed the rations previously discussed.

The extreme left-hand scale of the nomograph shows the cost of 100 pounds of concentrate mixture. On the extreme right-hand scale is the cost of one ton of the rough-

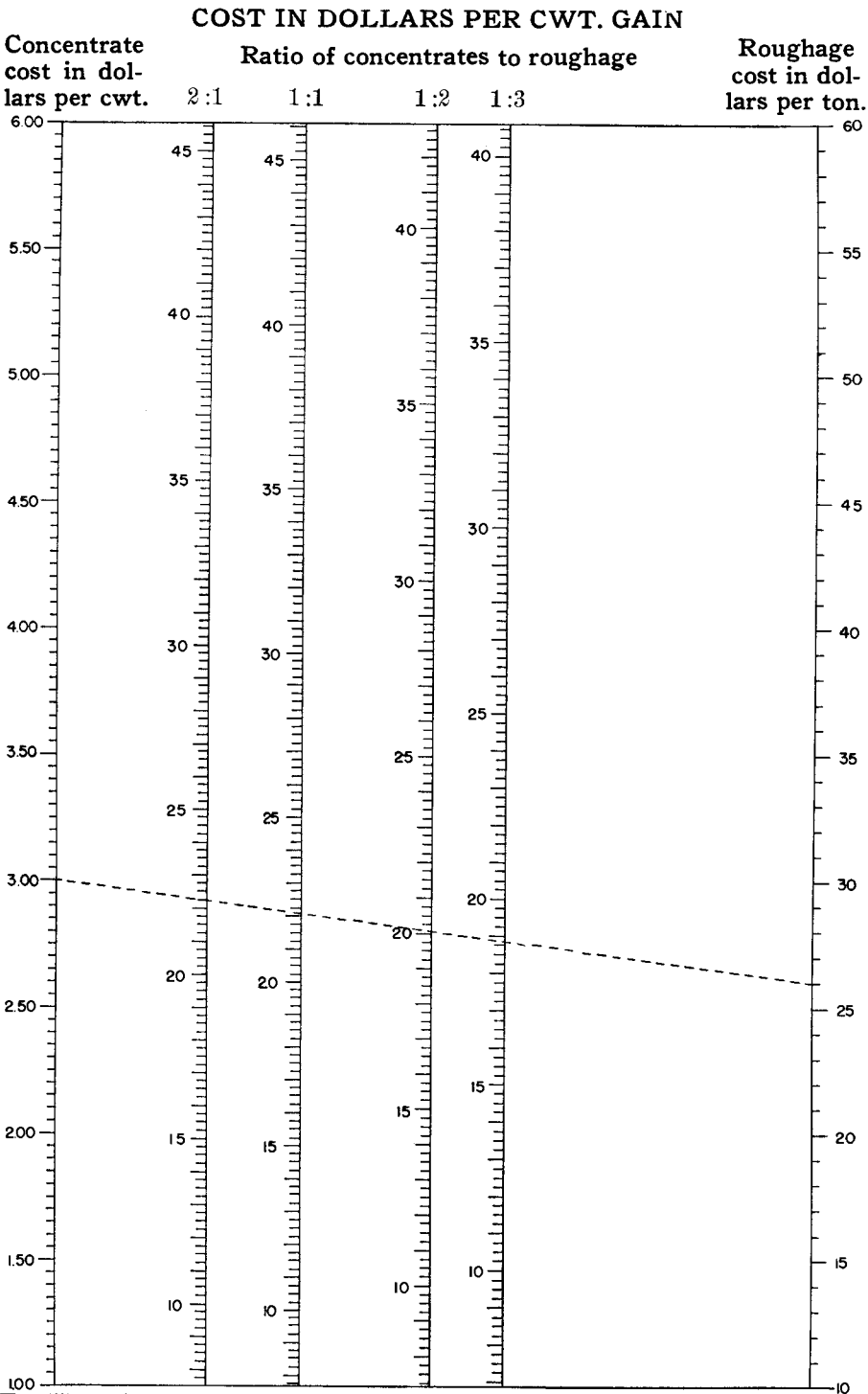

FIGURE 1—A nomograph for estimating the feed cost per 100 pounds of gain by yearling steers fed four different ratios of concentrate to roughage.

age mixture. From the four intermediate scales, one for each of the four rations, the estimated cost of the feed required to produce 100 pounds of gain may be read.

One might begin by calculating the cost of 100 pounds of concentrate mixture. Note that this value must be calculated separately for each of the four rations because the composition of the four mixes differ. The costs of the concentrate mixes may vary $0.30 or more per 100 pounds. The cost of one ton of roughage mixture should next be determined. The roughage cost per ton will be the same for all four rations.

Assuming that the concentrate mixture used in the 2:1 ration costs $3.00 per 100 pounds and the roughage mixture costs $26.00 per ton, a straight edge should be placed at $3.00 on the left scale and at $26.00 on the right scale. The straight edge crosses the 2:1 line at $22.25, the estimated cost of 100 pounds of gain when the 2:1 ration is fed. To estimate the cost of 100 pounds of gain on the other rations at the same time, hold the straight edge at the $26.00 point on the right-hand scale, and move it to the appropriate concentrate cost on the left-hand scale; then, read the cost of gains from the 1:1, 1:2, or 1:3 scales as appropriate.

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