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Optimum Ratio of Concentrate to Alfalfa Hay for Steers as Affected by Protein Level and Method of Feeding

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Optimum Ratio of Concentrate to Alfalfa Hay for Steers as Affected by Protein Level and Method of Feeding

T. B. Keith¹, R. F. Johnson², and W. P. Lehrer, Jr.³

Investigations on factors affecting the digestibility of protein have demonstrated that when the fiber content of a steer ration is increased, there is a decrease in the apparent digestibility, but not the true digestibility, of the crude protein content of the rations (2). This would indicate that the protein requirement of steers increases with increased intake of alfalfa hay.

It is a common practice throughout many steer-feeding areas to begin the feeding period with a ration containing a maximum allowance of hay and a minimum allowance of concentrate, increasing the concentrate and reducing the hay as the feeding period progresses until the steers are receiving a minimum intake of roughage and a maximum intake of concentrate at the end of the feeding period. Therefore, it is desirable to have information on the protein needs of steers fed different ratios of concentrate to alfalfa hay.

Objectives

The objectives of this study were to: (1) determine whether to include 10 or 13 percent protein in a concentrate mixture for steer calves for most rapid and economical gains when each of the following proportions of concentrate and alfalfa hay is fed: 1 : 2, 1 : 1, 2 : 1, 3 : 1, and 4 : 1; (2) evaluate the effect of a periodical change in the ratio of concentrate to alfalfa hay allowances when each of the five proportions of concentrate and alfalfa hay is fed; and (3) determine the effect of a periodical change in the ratios of concentrate and alfalfa hay on the protein needs of growing and fattening steer calves.

Procedure

Sixty grade Hereford steer calves were purchased at nearby auction sale yards in the fall of 1951 and randomly assigned to six groups of ten calves each, on the basis of weight and fed

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the weight ratios of concentrate to alfalfa hay of 1 : 2, 1 : 1 and 2 : 1. A second group of 60 steer calves were purchased at local sale yards during the autumn of 1952 and assigned in the same manner as were those of 1951 and fed weight ratios of 2 : 1, 3 : 1 and 4 : 1. All feeding was done at the University of Idaho, Caldwell Branch Experiment Station, Caldwell, Idaho.

The steer calves were fed twice daily in individual stalls. They were permitted to exercise in lots adjacent to these stalls during the day and night between feedings. Water and salt were available in the exercise lots at all times.

A 3 x 2 x 2 factorial design was employed in both years of the experiment. An outline of the experimental design for each of the 2 years is shown in Table 1. The feeding for the first series of tests began on December 28, 1951, and continued through June 6, 1952, a period of 161 days. The second series of tests began November 26, 1952, and was completed on May 13, 1953, a feeding period of 168 days.

Table I. An outline of the method of feeding

| Ratio Concentrate to Hay | Number of Steers | Protein in Concentrate Percent | Number of Steers | Method of Feeding | Number of Steers |
|--------------------------|------------------|--------------------------------|------------------|-------------------|------------------|
| 1951-1952 | | | | | |
| 1 : 2 | 20 | 10 | 10 | Graduated* | 5 |
| | | | | Constant** | 5 |
| | | 13 | 10 | Graduated | 5 |
| | | | | Constant | 5 |
| 1 : 1 | 20 | 10 | 10 | Graduated | 5 |
| | | | | Constant | 5 |
| | | 13 | 10 | Graduated | 5 |
| | | | | Constant | 5 |
| 2 : 1 | 20 | 10 | 10 | Graduated | 5 |
| | | | | Constant | 5 |
| | | 13 | 10 | Graduated | 5 |
| | | | | Constant | 5 |
| 1952-1953 | | | | | |
| 2 : 1 | 20 | 10 | 10 | Graduated | 5 |
| | | | | Constant | 5 |
| | | 13 | 10 | Graduated | 5 |
| | | | | Constant | 5 |
| 3 : 1 | 20 | 10 | 10 | Graduated | 5 |
| | | | | Constant | 5 |
| | | 13 | 10 | Graduated | 5 |
| | | | | Constant | 5 |
| 4 : 1 | 20 | 10 | 10 | Graduated | 5 |
| | | | | Constant | 5 |
| | | 13 | 10 | Graduated | 5 |
| | | | | Constant | 5 |

* Graduated—The steers were started on a maximum instake of hay and a minimum intake of concentrate. The concentrate was increased and the hay reduced at regular intervals (Table 3) until each steer was consuming a maximum of concentrate and a minimum of hay.

** Constant—The steers were fed the same ratio each day throughout the experiment.

Table 2. Concentrate mixtures used (parts per 100 lb.)

| | Low Protein | High Protein |
|--------------------------|-------------|--------------|
| Barley, ground | 50 | 42 |
| Oats, ground | 24 | 22 |
| Dried molasses beet pulp | 24 | 22 |
| Soybean oil meal | | 12 |
| Salt | 2 | 2 |
| Total | 100 | 100 |
| Protein percent | 10 | 13 |

The ingredients of concentrate mixtures used in this study are given in Table 2. The alfalfa hay was chopped in 1- to 2-inch lengths. The concentrate and alfalfa hay were weighed at each feeding for each individual to the nearest tenth of a pound, mixed, and fed together.

Table 3: Ratios of concentrate to alfalfa hay offered by 14-day periods and consumed to date for each of the various groups of 5 steer calves.

| Period (14 days) | Graduated | | | | Constant* | | | | Graduated | | | | Constant* | | | | Graduated | | | | Constant* | | | | | | | |
|------------------------|--------------------|-------|---|-----|----------------------------------|-------|----------|-----|---|-------|----------------------------------|-----|-----------|-------|---|-----|----------------------------------|-------|----------|-----|---|-------|----------------------------------|-----|-----|-------|-------|-----|
| | Offered* | | Con- 10 and 13% 13% pro- tein | | Con- 10 and 13% Protein | | Offered* | | Con- 10 and 13% 13% pro- tein | | Con- 10 and 13% Protein | | Offered* | | Con- 10 and 13% 13% pro- tein | | Con- 10 and 13% Protein | | Offered* | | Con- 10 and 13% 13% pro- tein | | Con- 10 and 13% Protein | | | | | |
| 1951 - 52 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Ratio 1 : 2 | | | | | | | | Ratio 1 : 1 | | | | | | | | Ratio 2 : 1 | | | | | | | | | | | |
| 1 | 1:3 | 1:3 | 1:3 | 1:2 | 1:3 | 1:3 | 1:3 | 1:1 | 1:2 | 1:2 | 1:2 | 2:1 | 1:3 | 1:3 | 1:3 | 1:1 | 1:1 | 1:1.4 | 1:1.4 | 2:1 | 1:2 | 1:2 | 1:2 | 2:1 | 2:1 | 1.2:1 | 1:1 | 2:1 |
| 2 | 1:3 | 1:3.2 | 1:3 | 1:2 | 1:3 | 1:3 | 1:3 | 1:1 | 1:2 | 1:2.6 | 1:2.6 | 1:1 | 2:1 | 1.4:1 | 1.2:1 | 2:1 | 3:1 | 1.4:1 | 1.4:1 | 2:1 | 3:1 | 1.6:1 | 1.6:1 | 2:1 | 3:1 | 1.7:1 | 1.8:1 | 2:1 |
| 3 | 1:3 | 1:3 | 1:3 | 1:2 | 1:2 | 1:2.4 | 1:2.4 | 1:1 | 1:1 | 1:1.9 | 1:2 | 1:1 | 4:1 | 2.0:1 | 2.0:1 | 2:1 | 4:1 | 2.2:1 | 2.2:1 | 2:1 | 5:1 | 2.3:1 | 2.3:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 |
| 4 | 1:3 | 1:3 | 1:3 | 1:2 | 1:2 | 1:2.3 | 1:2.3 | 1:1 | 1:1 | 1:1.7 | 1:1.8 | 1:1 | 5:1 | 2.3:1 | 2.3:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 |
| 5 | 1:2 | 1:2.7 | 1:2.7 | 1:2 | 1:1 | 1:1.6 | 1:1.6 | 1:1 | 3:1 | 1:1.4 | 1:1.4 | 1:1 | 5:1 | 2.3:1 | 2.3:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 |
| 6 | 1:2 | 1:2.5 | 1:2.6 | 1:2 | 3:1 | 1:1.2 | 1:1.2 | 1:1 | 3:1 | 1:1.2 | 1:1.2 | 1:1 | 5:1 | 2.3:1 | 2.3:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 |
| 7 | 1:2 | 1:2.4 | 1:2.4 | 1:2 | 3:1 | 1:1.1 | 1:1.1 | 1:1 | 3:1 | 1:1.1 | 1:1.1 | 1:1 | 5:1 | 2.3:1 | 2.3:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 |
| 8 | 1:2 | 1:2.4 | 1:2.4 | 1:2 | 3:1 | 1:1.1 | 1:1.1 | 1:1 | 3:1 | 1:1.1 | 1:1.1 | 1:1 | 5:1 | 2.3:1 | 2.3:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 |
| 9 | 1:2 | 1:2.3 | 1:2.3 | 1:2 | 3:1 | 1:1.1 | 1:1.1 | 1:1 | 3:1 | 1:1.1 | 1:1.1 | 1:1 | 5:1 | 2.3:1 | 2.3:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 |
| 10 | 1:1 | 1:2 | 1:2.1 | 1:2 | 3:1 | 1:1.1 | 1:1.1 | 1:1 | 3:1 | 1:1.1 | 1:1.1 | 1:1 | 5:1 | 2.3:1 | 2.3:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 |
| 11 | 1:1 | 1:1.9 | 1:1.9 | 1:2 | 3:1 | 1:1.1 | 1:1.1 | 1:1 | 3:1 | 1:1.1 | 1:1.1 | 1:1 | 5:1 | 2.3:1 | 2.3:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 |
| 12*** | 1:1 | 1:1.8 | 1:1.8 | 1:2 | 3:1 | 1:1.1 | 1:1.1 | 1:1 | 3:1 | 1:1.1 | 1:1.1 | 1:1 | 5:1 | 2.3:1 | 2.3:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 | 5:1 | 2.4:1 | 2.4:1 | 2:1 |
| 1952 - 53 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Ratio 2 : 1 | | | | | | | | Ratio 3 : 1 | | | | | | | | Ratio 4 : 1 | | | | | | | | | | | |
| 1 | 1:3 | 1:3 | 1:3 | 2:1 | 1:2 | 1:2 | 1:2 | 3:1 | 2:1 | 1:1 | 1:1 | 4:1 | 1:1 | 1:1 | 1:1 | 4:1 | 1:1 | 1:1 | 1:1 | 4:1 | 1:1 | 1:1 | 1:1 | 4:1 | 1:1 | 1:1 | 1:1 | 4:1 |
| 2 | 1:2 | 1:0.4 | 1:2.4 | 2:1 | 1:1 | 1:1.4 | 1:1.4 | 3:1 | 2:1 | 1:1 | 1:1 | 3:1 | 2:1 | 1.4:1 | 1.4:1 | 4:1 | 2:1 | 1.4:1 | 1.4:1 | 4:1 | 2:1 | 1.4:1 | 1.4:1 | 4:1 | 2:1 | 1.4:1 | 1.4:1 | 4:1 |
| 3 | 1:1 | 1:1.7 | 1:1.7 | 2:1 | 2:1 | 1:1 | 1:1 | 3:1 | 3:1 | 1.4:1 | 1.4:1 | 3:1 | 3:1 | 1.8:1 | 1.8:1 | 4:1 | 3:1 | 1.8:1 | 1.8:1 | 4:1 | 3:1 | 1.8:1 | 1.8:1 | 4:1 | 3:1 | 1.8:1 | 1.8:1 | 4:1 |
| 4 | 2:1 | 1:1.2 | 1:1.2 | 2:1 | 3:1 | 1.6:1 | 1.6:1 | 3:1 | 3:1 | 1.6:1 | 1.6:1 | 3:1 | 4:1 | 2.2:1 | 2.2:1 | 4:1 | 4:1 | 2.2:1 | 2.2:1 | 4:1 | 4:1 | 2.2:1 | 2.2:1 | 4:1 | 4:1 | 2.2:1 | 2.2:1 | 4:1 |
| 5 | 2:1 | 1:1 | 1:1 | 2:1 | 3:1 | 1.6:1 | 1.6:1 | 3:1 | 3:1 | 1.6:1 | 1.6:1 | 3:1 | 4:1 | 2.5:1 | 2.5:1 | 4:1 | 4:1 | 2.5:1 | 2.5:1 | 4:1 | 4:1 | 2.5:1 | 2.5:1 | 4:1 | 4:1 | 2.5:1 | 2.5:1 | 4:1 |
| 6 | 2:1 | 1.2:1 | 1.2:1 | 2:1 | 4:1 | 1.8:1 | 1.8:1 | 3:1 | 4:1 | 1.8:1 | 1.8:1 | 3:1 | 4:1 | 2.7:1 | 2.7:1 | 4:1 | 4:1 | 2.7:1 | 2.7:1 | 4:1 | 4:1 | 2.7:1 | 2.7:1 | 4:1 | 4:1 | 2.7:1 | 2.7:1 | 4:1 |
| 7 | 3:1 | 1.3:1 | 1.4:1 | 2:1 | 4:1 | 2.0:1 | 2.1:1 | 3:1 | 4:1 | 2.0:1 | 2.1:1 | 3:1 | 4:1 | 2.9:1 | 2.8:1 | 4:1 | 4:1 | 2.9:1 | 2.8:1 | 4:1 | 4:1 | 2.9:1 | 2.8:1 | 4:1 | 4:1 | 2.9:1 | 2.8:1 | 4:1 |
| 8 | 3:1 | 1.4:1 | 1.5:1 | 2:1 | 4:1 | 2.2:1 | 2.2:1 | 3:1 | 4:1 | 2.2:1 | 2.2:1 | 3:1 | 5:1 | 3.1:1 | 3.0:1 | 4:1 | 5:1 | 3.1:1 | 3.0:1 | 4:1 | 5:1 | 3.1:1 | 3.0:1 | 4:1 | 5:1 | 3.1:1 | 3.0:1 | 4:1 |
| 9 | 4:1 | 1.6:1 | 1.7:1 | 2:1 | 4:1 | 2.4:1 | 2.4:1 | 3:1 | 4:1 | 2.4:1 | 2.4:1 | 3:1 | 5:1 | 3.2:1 | 3.2:1 | 4:1 | 5:1 | 3.2:1 | 3.2:1 | 4:1 | 5:1 | 3.2:1 | 3.2:1 | 4:1 | 5:1 | 3.2:1 | 3.2:1 | 4:1 |
| 10 | 4:1 | 1.7:1 | 1.8:1 | 2:1 | 4:1 | 2.5:1 | 2.2:1 | 3:1 | 4:1 | 2.5:1 | 2.2:1 | 3:1 | 5:1 | 3.4:1 | 3.3:1 | 4:1 | 5:1 | 3.4:1 | 3.3:1 | 4:1 | 5:1 | 3.4:1 | 3.3:1 | 4:1 | 5:1 | 3.4:1 | 3.3:1 | 4:1 |
| 11 | 4:1 | 1.8:1 | 2.0:1 | 2:1 | 4:1 | 2.6:1 | 2.4:1 | 3:1 | 4:1 | 2.6:1 | 2.4:1 | 3:1 | 5:1 | 3.5:1 | 3.5:1 | 4:1 | 5:1 | 3.5:1 | 3.5:1 | 4:1 | 5:1 | 3.5:1 | 3.5:1 | 4:1 | 5:1 | 3.5:1 | 3.5:1 | 4:1 |
| 12 | 5:1 | 2.0:1 | 2.1:1 | 2:1 | 5:1 | 2.8:1 | 2.5:1 | 3:1 | 5:1 | 2.8:1 | 2.5:1 | 3:1 | 5:1 | 3.6:1 | 3.6:1 | 4:1 | 5:1 | 3.6:1 | 3.6:1 | 4:1 | 5:1 | 3.6:1 | 3.6:1 | 4:1 | 5:1 | 3.6:1 | 3.6:1 | 4:1 |

* Periodic values
 ** Accumulative values
 ***7 day period

Experimental Results

The data of each individual steer have been used for seven different summaries as indicated in Tables 4, 5, 6, 7, 8, 9, and 10. These summaries are as follows:

(1) The data of five steers fed the same ratio of concentrate to alfalfa hay, the same protein level, with the same method of feeding the ratios, are grouped in Table 4.

Table 4. Data relating to gains and feed requirements of steer calves fed 5 ratios of concentrate to hay, 2 levels of protein with 2 methods of feeding.

| Ratio | Method | Protein | No. of Steers | Total Days | Average | | Average | | Feed per 100 lb. Gain*** |
|------------------|-----------|----------------|---------------|------------|----------------|--------------|------------|--------------|--------------------------|
| | | in Concentrate | | | Initial Weight | Final Weight | Daily Gain | Daily Ration | |
| | | Percent | | | lb. | lb. | lb. | lb. | lb. |
| 1951 - 52 | | | | | | | | | |
| 1 : 2 | Graduated | 10 | 5 | 161 | 559 | 817 | 1.60 | 14.9 | 928 |
| 1 : 2 | Constant | 10 | 5 | 161 | 520 | 792 | 1.69 | 14.2 | 841 |
| 1 : 2 | Graduated | 13 | 5 | 161 | 565 | 844 | 1.73 | 15.6 | 898 |
| 1 : 2 | Constant | 13 | 5 | 161 | 545 | 795 | 1.55 | 15.5 | 997 |
| 1 : 1 | Graduated | 10 | 5 | 161 | 537 | 834 | 1.85 | 14.2 | 780 |
| 1 : 1 | Constant | 10 | 5 | 161 | 526 | 827 | 1.87 | 15.1 | 809 |
| 1 : 1 | Graduated | 13 | 5 | 161 | 580 | 853 | 1.70 | 14.9 | 881 |
| 1 : 1 | Constant | 13 | 4* | 161 | 540 | 790 | 1.55 | 14.1 | 905 |
| 2 : 1 | Graduated | 10 | 5 | 161 | 546 | 833 | 1.78 | 13.8 | 772 |
| 2 : 1 | Constant | 10 | 5 | 161 | 532 | 884 | 2.17 | 15.7 | 719 |
| 2 : 1 | Graduated | 13 | 5 | 161 | 560 | 882 | 2.07 | 16.3 | 782 |
| 2 : 1 | Constant | 13 | 5-4** | 161 | 536 | 872 | 2.09 | 15.2 | 731 |
| 1952 - 53 | | | | | | | | | |
| 2 : 1 | Graduated | 10 | 5 | 168 | 585 | 855 | 1.61 | 14.7 | 917 |
| 2 : 1 | Constant | 10 | 5 | 168 | 552 | 864 | 1.86 | 14.4 | 775 |
| 2 : 1 | Graduated | 13 | 5 | 168 | 580 | 840 | 1.55 | 14.3 | 923 |
| 2 : 1 | Constant | 13 | 5 | 168 | 553 | 865 | 1.86 | 14.9 | 802 |
| 3 : 1 | Graduated | 10 | 5 | 168 | 572 | 891 | 1.90 | 15.8 | 834 |
| 3 : 1 | Constant | 10 | 5 | 168 | 539 | 840 | 1.79 | 14.3 | 798 |
| 3 : 1 | Graduated | 13 | 5 | 168 | 551 | 856 | 1.82 | 14.2 | 780 |
| 3 : 1 | Constant | 13 | 5 | 168 | 552 | 857 | 1.82 | 14.4 | 792 |
| 4 : 1 | Graduated | 10 | 5 | 168 | 559 | 866 | 1.83 | 14.9 | 816 |
| 4 : 1 | Constant | 10 | 5 | 168 | 553 | 843 | 1.73 | 13.3 | 770 |
| 4 : 1 | Graduated | 13 | 5 | 168 | 568 | 894 | 1.94 | 15.1 | 776 |
| 4 : 1 | Constant | 13 | 5 | 168 | 567 | 862 | 1.76 | 13.8 | 785 |

* One steer died at end of the first 30 days, data not included.

** One steer died at the end of 114 days of the test, data included.

***Least significant difference at .05 level for differences in average daily gains are .38 lb. and 117 lb. feed per 100 lb. gain 1951-52; and an average of .34 lb. daily gain and 134 lb. feed per 100 lb. gain 1952-53.

(2) The data of 10 steers fed the same ratio of concentrate to alfalfa hay and the same protein level, are grouped in Table 5. Five of each of these 10 steer groups were fed by the graduated and five by the constant method of feeding the ratios of concentrate to alfalfa hay, Table 3.

Table 5. A summary of the data on the comparison of the rate and economy of gains of the steer calves fed the two levels of protein with each ratio of concentrate and hay.

| Ratio | Protein in Concentrate | Number of Steers | Average Daily Gain* | Average Daily Ration | Feed for Each 100 lb. Gain* |
|-------------|------------------------------|------------------------|---------------------------|----------------------------|-----------------------------------|
| | Percent | | lb. | lb. | lb. |
| 1951 - 1952 | | | | | |
| 1 : 2 | 10 | 10 | 1.64 | 14.5 | 884 |
| 1 : 2 | 13 | 10 | 1.64 | 15.5 | 944 |
| 1 : 1 | 10 | 10 | 1.86 | 14.7 | 793 |
| 1 : 1 | 13 | 9 | 1.63 | 14.6 | 891 |
| 2 : 1 | 10 | 10 | 1.98 | 15.1 | 762 |
| 2 : 1 | 13 | 10-9 | 2.09 | 15.8 | 756 |
| 1952 - 53 | | | | | |
| 2 : 1 | 10 | 10 | 1.73 | 14.6 | 841 |
| 2 : 1 | 13 | 10 | 1.70 | 14.7 | 861 |
| 3 : 1 | 10 | 10 | 1.84 | 15.1 | 816 |
| 3 : 1 | 13 | 10 | 1.82 | 14.3 | 786 |
| 4 : 1 | 10 | 10 | 1.78 | 14.1 | 793 |
| 4 : 1 | 13 | 10 | 1.85 | 14.4 | 781 |

* Least significant differences at .05 level: .28 lb. av. daily gain and 82 lb. feed per 100 lb. gain, 1951-52; .26 lb. av. daily gain and 95 lb. feed per 100 lb. gain, 1952-53.

(3) The data of 10 steers fed one ratio of concentrate to alfalfa hay and one method of feeding are shown in Table 6. Five steers or each one-half of these 10 steer groups were fed a different protein level.

Table 6. Data relative to gains and feed requirements of steer calves fed five ratios of concentrate to hay and two methods of feeding

| Ratio | Method | Number of Steers | Average Daily Gain* | Average Daily Ration | Feed for 100 lb. Gain* |
|-----------|-----------|---------------------|---------------------------|----------------------------|------------------------------|
| | | | lb. | lb. | lb. |
| 1951 - 52 | | | | | |
| 1 : 2 | Graduated | 10 | 1.67 | 15.2 | 912 |
| 1 : 2 | Constant | 10 | 1.62 | 14.9 | 915 |
| 1 : 1 | Graduated | 10 | 1.77 | 14.7 | 828 |
| 1 : 1 | Constant | 9 | 1.73 | 14.6 | 846 |
| 2 : 1 | Graduated | 10-9 | 1.93 | 15.1 | 779 |
| 2 : 1 | Constant | 10 | 2.15 | 15.5 | 725 |
| 1952 - 53 | | | | | |
| 2 : 1 | Graduated | 10 | 1.57 | 14.5 | 920 |
| 2 : 1 | Constant | 10 | 1.85 | 14.6 | 788 |
| 3 : 1 | Graduated | 10 | 1.86 | 15.0 | 808 |
| 3 : 1 | Constant | 10 | 1.80 | 14.3 | 795 |
| 4 : 1 | Graduated | 10 | 1.88 | 15.0 | 795 |
| 4 : 1 | Constant | 10 | 1.74 | 13.5 | 778 |

* Least significant differences at .05 level: .28 lb. av. daily gain and 82 lb. feed per 100 lb. gain, 1951-52; .26 lb. av. daily gain and 95 lb. feed per 100 lb. gain, 1952-53.

(4) The data of 15 steers fed one protein level and one method of feeding are shown in Table 7. Five steers or each one-third of these 15 steer groups were fed a different ratio of concentrate to alfalfa hay.

Table 7. A summary of the data on a comparison of the rate and economy of gains of steer calves fed the different methods of feeding for each level of protein.

| Method | Protein in Concentrate | Number of Steers | Average Daily Gain* | Average Daily Ration | Feed for Each 100 lb. Gain* |
|---------------------------------|------------------------|------------------|---------------------|----------------------|-----------------------------|
| | Percent | | lb. | lb. | lb. |
| 1951 - 52 | | | | | |
| (Ratios of 1 : 2, 1 : 1, 2 : 1) | | | | | |
| Graduated | 10 | 15 | 1.74 | 14.3 | 823 |
| Constant | 10 | 15 | 1.92 | 15.0 | 783 |
| Graduated | 13 | 15 | 1.81 | 15.6 | 850 |
| Constant | 13 | 14-13 | 1.73 | 15.0 | 860 |
| 1952 - 53 | | | | | |
| (Ratios 2 : 1, 3 : 1, 4 : 1) | | | | | |
| Graduated | 10 | 15 | 1.73 | 15.2 | 853 |
| Constant | 10 | 15 | 1.79 | 14.0 | 784 |
| Graduated | 13 | 15 | 1.77 | 14.5 | 820 |
| Constant | 13 | 15 | 1.81 | 14.4 | 794 |

* Least significant differences at .05 level: .28 lb. av. daily gain and 66 lb. feed per 100 lb. gain, 1951-52; .19 lb. av. daily gain and 78 lb. feed per 100 lb. gain, 1952-53

(5) The data of 20 steer calves fed a specific ratio of concentrate to hay are shown in Table 8. Ten or one-half of these 20 steer groups were fed a different protein level with five or one-half of each ten steer groups being fed their proportions of concentrate and hay by a different method.

Table 8. A summary of the data on a comparison of the rate and economy of gains of steer calves fed the five ratios

| Ratio | Number of Steers | Average Daily Gain* | Average Daily Ration | Feed for Each 100 lb. Gain* |
|------------------|------------------|---------------------|----------------------|-----------------------------|
| | | lb. | lb. | lb. |
| 1951 - 52 | | | | |
| 1 : 2 | 20 | 1.64 | 15.0 | 914 |
| 1 : 1 | 19 | 1.75 | 14.6 | 837 |
| 2 : 1 | 20-19 | 2.04 | 15.5 | 759 |
| 1952 - 53 | | | | |
| 2 : 1 | 20 | 1.72 | 14.6 | 851 |
| 3 : 1 | 20 | 1.83 | 14.7 | 801 |
| 4 : 1 | 20 | 1.81 | 14.3 | 787 |

* Least significant differences at .05 level: .22 lb. av. daily gain and 50 lb. feed per 100 lb. gain, 1951-52; .17 lb. av. daily gain and 67 lb. feed per 100 lb. gain, 1952-53

(6) The data of 30 steer calves fed one protein level are shown in Table 9. Ten steers or each one-third of this group were fed a different ratio of concentrate to hay. Five or one-half of each 10-steer group received the ratio of concentrate to alfalfa hay by the same method.

Table 9. A summary of the data on a comparison of rate and economy of gains of steer calves fed the two levels of protein

| Protein in Concentrate Percent | Number of Steers | Average Daily Gain* lb. | Average Daily Ration lb. | Feed for Each 100 lb. Gain* lb. |
|--------------------------------|------------------|-------------------------|--------------------------|---------------------------------|
| 1951 - 52 | | | | |
| (Ratios 1 : 2, 1 : 1, 2 : 1) | | | | |
| 10 | 30-29 | 1.83 | 14.8 | 809 |
| 13 | 29 | 1.79 | 15.3 | 854 |
| 1952 - 53 | | | | |
| (Ratios 2 : 1, 3 : 1, 4 : 1) | | | | |
| 10 | 30 | 1.78 | 14.6 | 816 |
| 13 | 30 | 1.79 | 14.4 | 808 |

* Least significant differences at .05 level: .18 lb. av. daily gain and 47 lb. feed per 100 lb. gain, 1951-52; .14 lb. av. daily gain and 17 lb. feed per 100 lb. gain, 1952-53

(7) The data of 30 steer calves fed the ratio of concentrate to alfalfa hay by a specific method are shown in Table 10. One-sixth of these 30 steer groups received a different level of protein and a different ratio of concentrate to alfalfa hay.

Table 10. A summary of the data on the comparison of rate and economy of gains of steer calves fed the two methods of feeding concentrate and hay.

| Method | Number of Steers | Average Daily Gain* lb. | Average Daily Ration lb. | Feed for Each 100 lb. Gain* lb. |
|-----------------------------|------------------|-------------------------|--------------------------|---------------------------------|
| 1951 - 52 | | | | |
| (Ratio 2 : 1, 3 : 1, 4 : 1) | | | | |
| Graduated | 30-29 | 1.79 | 15.0 | 836 |
| Constant | 29 | 1.85 | 15.0 | 818 |
| 1952 - 53 | | | | |
| (Ratio 2 : 1, 3 : 1, 4 : 1) | | | | |
| Graduated | 30 | 1.77 | 14.8 | 837 |
| Constant | 30 | 1.80 | 14.2 | 787 |

* Least significant differences at .05 level: .18 lb. av. daily gain and 47 lb. feed per 100 lb. gain, 1951-52; .14 lb. av. daily gain and 17 lb. feed per 100 lb. gain, 1952-53.

Two steers died of bloat during the progress of the 1951-52 tests. The data of the steer on the 1 : 1 ratio of concentrate and hay and the high-protein ration, that died within 30 days, were not included in the study. The data obtained previous to death of the steer fed for a period of 114 days the 2 : 1 ratio of concen-

trate to hay and the high-protein ration were included in the calculation of results.

In the tests of 1951-52, the steer calves fed the 2 : 1 ratio of concentrate to alfalfa hay made 17 percent greater average daily gain and required 15 percent less feed for each 100 pounds gain than those fed the ration containing equal parts concentrate and alfalfa hay, Table 8. Those steer calves fed equal parts concentrate and alfalfa hay gained an average of 7 percent more rapidly and required 8 percent less total feed than those fed 1 part concentrate and 2 parts alfalfa hay.

Since the available equipment did not permit the feeding of steers five ratios of concentrate to alfalfa hay during 1 experimental year, it was necessary to conduct two series of studies during 2 different years. The differences in the rate and economy of gains of the steers fed the 2 : 1 ratio in 1951-52 and the 2 : 1 ratio of concentrate to alfalfa hay in 1952-53 were probably due to environmental conditions, source, and history of the steers. The differences in rate and economy of gains of the groups of steers fed the higher levels of concentrate were not so great as those fed the high levels of alfalfa hay.

The relative differences in the rate and economy of gains of the groups of steer calves fed the various ratios of concentrate to alfalfa hay in these tests are in agreement with the results of previous similar studies at this station (1).

The inclusion of 12 percent soybean oil meal in the concentrate mixture did not increase the rate of gain or the efficiency of feed utilization. The differences in the average daily gain and feed required for 100 pounds gain were 45 pounds in favor of the steers fed the 10 percent concentrate mixture over those fed the 13 percent concentrate mixture when the high levels of alfalfa hay were fed (1 : 2, 1 : 1, 2 : 1).

When the comparisons of the two levels of protein were made with higher levels of concentrate intake (2 : 1, 3 : 1, 4 : 1) the average daily gains were approximately the same. The steers fed the 13 percent protein concentrate mixture required 8 pounds less feed for 100 pounds gain. The least difference required for significance at the .05 level of probability is 14 pounds. Whether it would be advisable to include a 12 percent protein supplement in this concentrate mixture when fed with alfalfa hay would depend upon feed price relationships.

Differences in rates and economies of gains between the groups of steers fed the ratio of concentrate to alfalfa hay with the two different methods (graduated and constant) were not large enough to be due to anything but experimental error.

An analysis of variance of the data indicated a ratio-protein-method inter-action of feed required for each 100 pounds gain for those steers fed the ratios of concentrate to alfalfa hay of 1 : 2,

1 : 1, and 2 : 1 during 1951-52. The cause of this interaction may be explained on the basis that the protein intake varied with the level of concentrate intake. The study of the effect of differences in protein intake was controlled by changing the percentages of total protein in the concentrate mixture. For that reason, those steers receiving the 2 : 1 ratio of the 13 percent concentrate to alfalfa hay mixture fed at a constant rate required 190 pounds or 21 percent less total feed for each 100 pounds gain than those steers fed the 1 : 2 ratio of the 10 percent concentrate to alfalfa hay mixture fed in graduated quantities, Table 4.

A significant ratio-protein-method interaction was not observed among the groups of steer calves fed the ratios of concentrate and alfalfa hay of 2 : 1, 3 : 1 and 4 : 1, 1952-53, because a change in the ratio of concentrate and alfalfa hay accounted for a small percentage total change in the differences in the intakes of the concentrate and alfalfa hay.

Summary and Conclusions

One hundred-twenty steer calves were used to: (1) study the effect of the level of protein intake on rate and economy of gains of steer calves fed various levels of a concentrate mixture with alfalfa hay; (2) evaluate the effect of a periodical change in the ratio of the concentrate and alfalfa hay during the period of fattening; and (3) determine the effect of the quantity of protein in the concentrate mixture of steer calves fed increasing levels of concentrate during the feeding period. Five different ratios of concentrate and alfalfa hay, each with two levels of protein and two methods of feeding the ratios, were studied over a period of 2 years, 1951-52 and 1952-53.

The total feed required for each 100 pounds gain decreased with an increase in the proportion of concentrate in the total ration. The differences in total feed requirements were greater among the groups fed the ratios of concentrate to hay of 1 : 2, 1 : 1 and 2 : 1 than among those groups fed the ratios of 2 : 1, 3 : 1 and 4 : 1.

A constant allowance of the proportions of concentrate and alfalfa hay produced as economical gains as was made by those steers fed a graduated intake of the concentrate throughout the period of feeding.

The increase of the percent protein from 10 to 13 by the addition of 12 percent soybean oil meal to the concentrate mixture did not increase the efficiency of the utilization of the rations used in this study. Alfalfa hay contains sufficient protein to fulfill the protein requirements of growing and fattening steer calves when fed with a concentrate mixture containing barley, oats and dried molasses beet pulp.

The relative differences in the rate of gain among the steered groups were not so great as the relative differences in the feed required for each 100 pounds of gain. However, these differences were of the same order.

Literature Cited

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