Strategies for feeding cattle: It all depends on your goal

by Raymond O. P. Farrish and John A. Marchello*

Producing the largest possible animals, or the greatest number in a given amount of time are not the goals of the cattle feeder. Rather, his aim is the greatest possible return on his investment, and to get such a return the feeder has to be a good strategist.

He may not have control over the market price of finished cattle, he may not have control over the cost of the various feed rations. But he can take into account such factors as the difference in price between certain types of feed, varying the time he feeds and how much he feeds against the cost of the feed and the added value that a heavier animal will bring.

With this in mind, we experimented with cattle at the University of Arizona to determine optimum feeding strategies for state cattle feeders.

To begin with, since the price of grain sorghum rose 100 per cent in Arizona between the first quarter of 1971 and the middle of 1975, while the price of alfalfa hay rose only 50-60 per cent, we wanted to compare the growth of cattle fed high-grain rations with cattle fed low-grain.

Drawing on the results of this experiment, we then developed tables detailing what the optimum market weight of cattle was at different market prices and for different rations of grain. We proceeded as follows:

The first decision in feeding cattle is to pinpoint what the profit objective is. Most commonly, cattle are fed either to maximize the profit on each lot of cattle produced or fed in a pre-planned number of lots, at less than maximum profit per lot, but perhaps feeding more lots for a larger total profit.

For example, maximizing profits on each lot of cattle separately might result in five lots being produced over a span of, say, three years at a profit of $1000 per lot, or a total of $5000. An alternate strategy might involve producing six lots during the same time span, accepting a $900 profit per lot for a total of $5,400 for the three years.

Clearly, the two example strategies would involve feeding cattle to different weights, and for differing lengths of time. Equally important, each of the two strategies would require different types and amounts of information in order to succeed.

Maximizing profits on each lot separately would require estimating feed costs and cattle prices from one to seven months in advance, while the alternative would involve making price forecasts for up to three years. The availability of certain types of information and his confidence in forecast information may influence the feeder's (as entrepreneur) choice of a particular strategy.

Initial results here are based on the strategy of maximizing profits for each lot of cattle. The objective is to achieve the highest level of profits from the current lot of cattle without worrying about the effect such a strategy might have on overall profits over some longer period. It's a fairly conservative strategy, since the additional returns which might possibly occur in the long run are abandoned in favor of, a generally smaller but surer addition to profits in the near future. Further research is being done on the problem of maximizing profits from a succession of several lots of cattle and will be reported in future publications.

Fixed and Variable Costs

When feeding any given lot of cattle, certain costs may be regarded as "fixed" in the sense that they do not vary regardless of how long the cattle are fed. Chief among these is the cost of the feeder animal. If a person purchases a 500-pound steer with intent to feed the steer for profit, and if the purchase price were $40 per hundredweight, then the initial cost of the steer is fixed at $200. It matters not whether the steer is fed for 180, 200, or 220 days or longer, the steer still costs $200 to begin with.

Fixed costs are obviously important to persons feeding cattle, since the fixed costs must be deducted from gross returns when the cattle are sold in order to determine the net profit or loss. On the other hand, they can and should be disregarded when deciding how long to feed the cattle.

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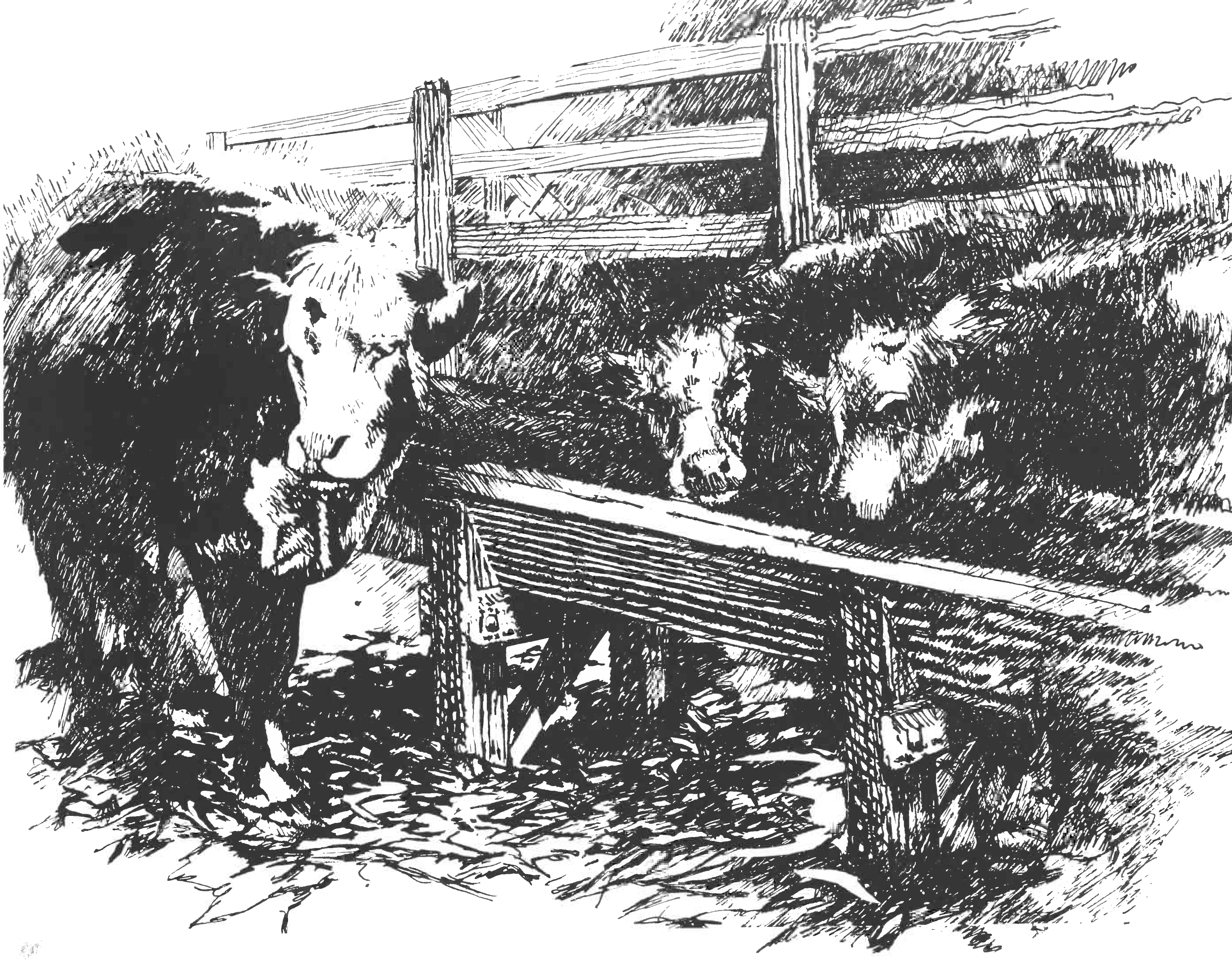


Since, in our example, the $200 cost of the steer would have to be deducted from the sales proceeds whether the steer is fed for 180, 200, or 220 days, the initial cost of the steer obviously makes no difference when deciding on the length of the feeding period.

Variable costs, as distinct from fixed costs, are those costs which *do* vary depending on how long the cattle are fed. An obvious example is the cost of feed. Our feeder steer which initially weighed 500 pounds certainly would consume more feed and gain more weight if kept for 220 rather than 180 days, and the total cost of the feed and the gross sales proceeds would both vary accordingly.

Like fixed costs, variable costs must be deducted from gross returns in order to determine net profit or loss. But more important, the variable costs, together with the price at which the cattle are sold, directly determine the optimum length of the feeding period. Two examples will illustrate the rationale.

Assume a steer has been on feed for a short time and the owner is deciding whether to continue feeding or to sell now. The owner estimates that if he gives another 500 pounds of feed to the steer, the additional cost of the feed and other variable inputs will amount to $25. He also estimates, however, that the steer will gain an additional 90 pounds, and thus if fed cattle sell for, say, $40 per hundredweight, his gross returns will increase by $36. The owner in this case would decide to go ahead and invest the additional 500 pounds of feed, because doing so would increase his net return by $11.

On the other hand, assume the steer has been on feed longer and consequently is not gaining weight so rapidly. The owner estimates that an additional 500 pounds of feed will result in the steer gaining only 60 pounds in weight. Thus gross revenue would increase by only $24, and since the additional cost of the feed and other variable inputs would be $25, net revenue would decrease by a dollar. The owner thus would decide to not feed any longer, but instead to sell the steer immediately.

The guiding principle in determining the optimum length of time to continue feeding, therefore, is to continue as long as the value of the *additional* weight gained is greater than the cost of the *additional* feed and other variable inputs. Following this principle will result in obtaining the maximum net profit from a given lot of cattle.

Type of Feed and Carcass Quality

Not only the amount of variable inputs—such as feed—but also the *type* of such inputs are important in determining the optimum length of feeding. High and low grain rations customarily will sell for different prices, and steers convert such rations into body weight at different rates. Likewise, the quality of resulting carcasses might or might not vary with the type of feed.

In order to determine the effects, if any, of variations in grain levels on carcass quality, randomly selected groups of heifers and steers were fed high and low grain rations. The high grain ration consisted of a starting diet for 14 days and a finishing diet (Table 1) until the animals reached target weights of 850 pounds for the heifers and 1000 pounds for the steers. The low grain ration consisted of a growing diet (Table 2) throughout the feeding period. Table 3 presents basic performance data for the various groups of experimental animals.

The effect of type of feed on carcass quality was investigated by examining various carcass quality characteristics (Table 4). Both groups of heifers marbled to about the same degree and therefore possessed similar quality grades. The same was true for steers. Yield grades and cutability percentages were not materially influenced by type of feed. Likewise, fat thickness, percentage of kidney fat, and ribeye area were substantially the same under both high and low grain rations.

Since carcass quality is substantially unaffected by type of feed, the decision on whether to use a high or low grain ration rests primarily on their relative economic efficiency in the feedlot. This follows, since if the two types of feed yield the same carcass quality, both carcasses can be presumed to fetch the same price in the market.

Is High Grain or Low Grain More Profitable?

There is no single answer to the question of whether high or low grain rations are more profitable. Rather, the answer depends on the relative price of the two rations, the rate at which each is transformed from feed into meat, and the weight of the fed cattle produced. Under some conditions low grain may be more profitable, while under other conditions high grain may yield greater net returns. Tables 5 and 6 therefore are presented in order that interested persons may compare the profitability of each for producing fed steers under a range of different conditions.

Several comments will aid the reader in interpreting and using the data in Tables 5 and 6.

First, an example using Table 5 will show how to read the tables. For steers fed a high grain ration—if fed cattle are selling for $45 a hundredweight and variable costs amount to $100 per ton of feed—profits will be maximized and or losses minimized by producing an 889 pound steer, using 1,952 pounds of feed. This will yield a return of $302.45 above variable costs which may be used by the owner to cover his fixed costs and provide any profit. If fixed costs are less than $302.45, the owner will realize a profit. *This profit will be the maximum he can achieve in the sense that any other weight of animal produced would yield a smaller net return.* On the other hand, if fixed costs exceed $302.45, the owner will experience a loss, but this loss will be the smallest loss possible. Producing any other weight of animal, either lighter or heavier, would result in a larger loss. Similar interpretations hold for the other entries in Tables 5 and 6.

Second, in order to compare whether high or low grain is more profitable, the reader should compare appropriate entries in Tables 5 and 6. For example, assume that fed cattle are selling for $50 per hundredweight, that variable costs associated with the high grain ration amount to $120 per ton of feed, and that variable costs for low grain amount to $80 per ton. Under such assumed price and cost conditions, the maximum returns above variable costs with the high grain ration would be $328.38 per steer (Table 5), while low grain would yield $331.58 (Table 6). Hence the owner would choose the low grain ration and produce an animal weighing 1,015 pounds, using 4,398 pounds of feed.

Third, several of the cells in the tables contain no entries. In such cases, it does not pay to feed any amount at all under the respective price and cost conditions.

Fourth, while it is difficult to generalize from the results in Tables 5 and 6 as to whether high or low grain is more profitable, we can attempt a rule of thumb which may be useful in decision-making. Scanning the two tables, it can be seen that whenever variable costs per ton of low grain are less than 60 percent of the variable costs per ton of high grain, then the low grain ration is generally more profitable. On the other hand, if variable costs per ton are equal for the two rations, it pays to use the high grain.

Now, the cost of the feed itself is the major component of variable costs, and the other variable costs per ton reasonably may be expected to differ by little for the two types of feed. Accepting this as an approximation, therefore, yields the following rule of thumb: *If the price of low grain is 60 percent or less than the price of high grain, use the low grain ration. If the price of low grain is more than 60 percent but less than 100 percent of the price of high grain, consult the tables. If the price of low grain is equal to or greater than the price of high grain, use the high grain ration.*

Fifth: A word of caution to those interested in utilizing the results. The entries in Tables 5 and 6 all were derived from the observed feed lot performance of the experimental animals, and assume the steers initially weigh 588 pounds and are fed to the weights indicated in the tables. Owners of feeder cattle whose animals perform similarly to the experimental animals can use the tables as a general guide. Those whose animals show substantially different performance rates, however, would want to derive another set of tables based on the performance rates of their own cattle.

For purposes of comparison, the relationships between the amount of feed fed and the weight of the fed animal achieved with the experimental animals are shown in the accompanying figure. The method for deriving tables such as Tables 5 and 6 may be obtained by writing the Department of Agricultural Economics, University of Arizona, Tucson, and requesting the publication entitled "Economics of Alternative Grain Levels for Feeding Cattle."

Table 1.
Composition of Starting and Finishing Diets.

Ingredient	Starting	Finishing
	(%)	(%)
Ground Alfalfa Hay	30.00	15.00
Cottonseed Hulls	10.00	5.00
Steam Processed Milo	51.65	70.95
Molasses	4.00	4.00
Tallow	3.00	3.00
Urea	0.45	0.65
Biofos	0.40	0.40
Salt	0.50	0.50
Ground Limestone	0.00	0.50
TOTAL	100.00	100.00
Vitamin A-10-P, gm.	10.00	10.00
Analysis:		
Protein	11.60	11.40
Calcium	0.55	0.53
Phosphorus	0.30	0.31

Table 2.
Composition of Growing Diet.

Ingredient	Proportion of Ration
	%
Creep Feed Pellets[1]	33.3
Alfalfa Hay	33.3
Cottonseed Hulls	33.3
TOTAL	100.0

[1]Composed of ground barley, ground sorghum grain, wheat bran, cottonseed meal, can molasses, ground corn, sun cured alfalfa meal, limestone flour, salt, dicalcium phosphate, vitamin A supplement.

Table 3.
Performance Data for the Experimental Animals

Item	Heifers High Grain	Heifers Low Grain	Steers High Grain	Steers Low Grain
Average initial weight lbs.	572	569	513	516
Average final weight, lbs.	855	842	979	1015
Average gain per animal, lbs.	283	273	466	499
Days on feed	91	112	160	160
Average daily gain, lbs. per animal	3.1	2.4	2.9	3.1

Table 4.
Carcass Data for the Experimental Animals

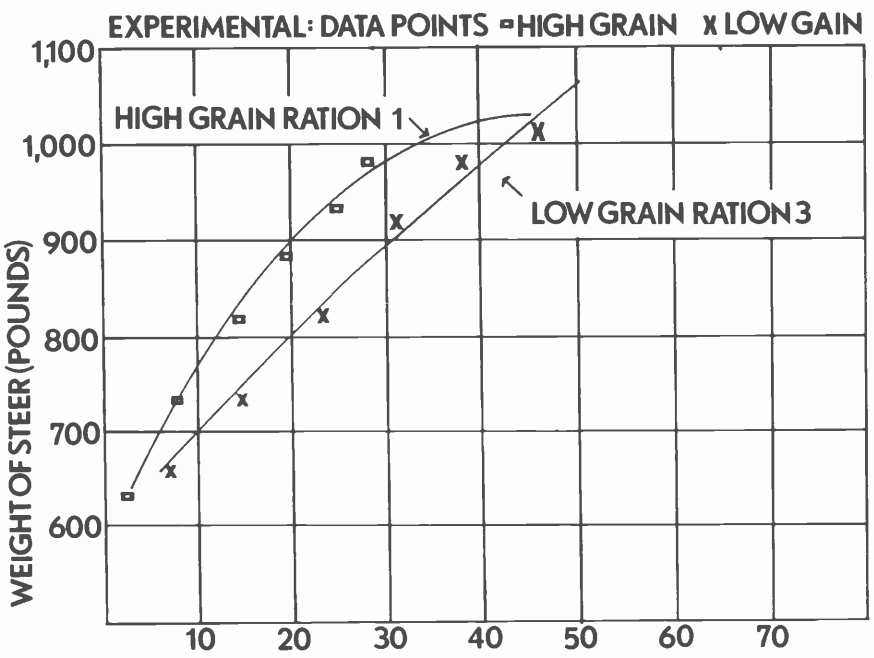
Trait	Heifers High Grain	Heifers Low Grain	Steers High Grain	Steers Low Grain
Hot carcass weight, lbs.	494	500	593	612
Marbling score	Slight+	Slight+	Small	Small
Quality grade	Good+	Good+	Choice	Choice
Fat thickness, inches	0.45	0.40	0.44	0.51
Kidney fat, percent	3.3	3.4	2.6	2.7
Ribeye area, sq. in.	10.3	10.3	11.5	11.3
Yield grade	2.9	2.8	2.7	3.0
Cutability percent	50.2	50.5	50.7	50.0

Table 5.
Steers Fed a High-Grain Ration: Returns Above Variable Costs, Optimum Weight Steer to Produce, and Optimum Amount of Feed Input to Maximize Profits or Minimize Losses.

Variable Costs	Item	Price of fed cattle ($ per cwt) 25	30	35	40	45	50	55	60
($ per ton of feed)									
70	Optimum Weight (lbs)	808	876	916	942	961	973	983	990
	Amount of Feed (lbs)	1302	1827	2202	2483	2702	2877	3020	3139
	Returns Above Variable Cost ($)	156.43	198.85	243.53	289.89	337.88	385.80	434.95	484.13
80	Optimum Weight (lbs)	741	828	881	916	939	957	969	978
	Amount of Feed (lbs)	852	1452	1881	2202	2452	2652	2815	2952
	Returns Above Variable Cost ($)	151.17	190.32	233.11	278.32	324.47	372.42	420.35	468.72
90	Optimum Weight (lbs)	664	775	843	886	916	937	953	965
	Amount of Feed (lbs)	403	1077	1559	1921	2202	2427	2611	2764
	Returns Above Variable Cost ($)	147.86	184.03	224.89	267.95	313.28	359.28	406.65	454.62
100	Optimum Weight (lbs)	–	716	799	853	889	916	935	950
	Amount of Feed (lbs)	–	703	1238	1640	1952	2202	2406	2577
	Returns Above Variable Cost ($)	–	179.65	217.75	259.20	302.45	347.90	393.95	441.15
110	Optimum Weight (lbs)	–	651	750	816	861	892	916	934
	Amount of Feed (lbs)	–	328	917	1359	1702	1977	2202	2389
	Returns Above Variable Cost (S)	–	177.26	212.06	251.65	293.84	337.26	382.69	429.00
120	Optimum Weight (lbs)	–	–	698	775	828	867	894	916
	Amount of Feed (lbs)	–	–	595	1077	1452	1752	1998	2202
	Returns Above Variable Cost ($)	–	–	208.60	245.38	285.48	328.38	371.82	417.48
130	Optimum Weight (lbs)	–	–	640	732	794	838	872	897
	Amount of Feed (lbs)	–	–	274	796	1202	1527	1793	2015
	Returns Above Variable Cost ($)	–	–	206.19	241.06	279.17	319.74	363.05	407.22
140	Optimum Weight (lbs)	–	–	–	684	756	808	846	876
	Amount of Feed (lbs)	–	–	–	515	952	1302	1589	1827
	Returns Above Variable Cost (S)	–	–	–	237.55	273.56	312.86	354.07	397.71
150	Optimum Weight (lbs)	–	–	–	633	716	775	819	853
	Amount of Feed (lbs)	–	–	–	234	703	1077	1384	1640
	Returns Above Variable Cost (S)	–	–	–	235.65	269.47	306.72	346.65	388.80

Table 6.
Steers Fed a Low-Grain Ration: Returns Above Variable Costs, Optimum Weight to Produce, and Optimum Amount of Feed Input to Maximize Profits or Minimize Losses.

Variable Costs	Item	Price of fed cattle ($ per cwt) 25	30	35	40	45	50	55	60
($ per ton of feed)									
50	Optimum Weight (lbs)	783	980	1098	1176	1228	1266	1294	1315
	Amount of Feed (lbs)	1820	3968	5502	6653	7548	8264	8850	9338
	Returns Above Variable Cost ($)	150.25	194.80	246.75	304.07	363.90	426.40	490.45	555.55
60	Optimum Weight (lbs)	–	783	954	1065	1140	1195	1236	1266
	Amount of Feed (lbs)	–	1820	3661	5042	6116	6975	7678	8264
	Returns Above Variable Cost ($)	–	180.30	224.07	274.74	329.52	388.25	449.46	511.68
70	Optimum Weight (lbs)	–	–	783	934	1038	1112	1166	1208
	Amount of Feed (lbs)	–	–	1820	3431	4684	5686	6507	7190
	Returns Above Variable Cost ($)	–	–	210.35	253.51	303.16	356.99	413.55	473.15
80	Optimum Weight (lbs)	–	–	–	783	918	1015	1087	1140
	Amount of Feed (lbs)	–	–	–	1820	3252	4398	5335	6116
	Returns Above Variable Cost ($)	–	–	–	240.40	283.02	331.58	384.45	439.36
90	Optimum Weight (lbs)	–	–	–	611	783	905	996	1065
	Amount of Feed (lbs)	–	–	–	210	1820	3109	4164	5042
	Returns Above Variable Cost ($)	–	–	–	234.95	270.45	312.59	360.42	412.11
100	Optimum Weight (lbs)	–	–	–	–	632	783	895	980
	Amount of Feed (lbs)	–	–	–	–	389	1820	2992	3968
	Returns Above Variable Cost ($)	–	–	–	–	264.95	300.50	342.65	389.60
110	Optimum Weight (lbs)	–	–	–	–	–	648	783	886
	Amount of Feed (lbs)	–	–	–	–	–	532	1820	2894
	Returns Above Variable Cost ($)	–	–	–	–	–	294.74	330.55	372.43
120	Optimum Weight (lbs)	–	–	–	–	–	–	660	783
	Amount of Feed (lbs)	–	–	–	–	–	–	649	1820
	Returns Above Variable Cost ($)	–	–	–	–	–	–	323.06	360.60
130	Optimum Weight (lbs)	–	–	–	–	–	–	–	671
	Amount of Feed (lbs)	–	–	–	–	–	–	–	747
	Returns Above Variable Cost ($)	–	–	–	–	–	–	–	354.04



COMPARISON OF PRODUCTION FUNCTIONS FOR EXPERIMENTAL STEERS FED HIGH AND LOW GRAIN RATIONS, ARIZONA, 1975

To compare performance of cattle in commercial feedlots with that of the experimental steers, care should be taken to make the comparison over the entire range of quantities of rations fed. In particular, it would be misleading and inappropriate to base a comparison on a single factor, such as "pounds of feed per pound of gain."

This is so because the feed-to-gain ratio varies greatly as cattle are fed to heavier weights. With the experimental steers on high grain, for example, it took only 5.69 pounds of feed per pound of gain to put on the first 175 pounds of weight. But by the time the steers had gained the next 175 pounds, the average pounds of feed per pound of gain had risen to 7.03. This highlights the fact that the average feed-to-gain ratio increases steadily as the cattle are fed to heavier weights. Thus, the owner of the cattle can control substantially the feed-to-gain ratio he will obtain from his animals simply through his decision on how long to feed.

Sixth: Another word of caution. The entries in Tables 5 and 6 indicate that extremely lightweight steers are often the optimum weight to produce. For example, if fed cattle are selling for $40 per hundredweight, and if variable costs for cattle fed high grain are over $110 per ton fed, Table 5 shows the optimum-weight steer to produce is usually less than 800 pounds. Such a situation might conceivably present a dilemma to the owner. For while fed cattle may be selling for $40 per hundred pounds generally, those weighing less than 800 pounds might be discounted in price.

To illustrate how to deal with this sort of contingency, assume variable costs are $110 per ton fed, that steers weighing 800 pounds or more are selling for $40, while those weighing less than 800 pounds are selling for $35 per hundredweight, and the ration fed is high grain (Table 5). The owner would need to compare the entries in two cells of Table 5. On the one hand, if he decides to accept a price of $35, the maximum returns above variable costs he can earn are $212.06 per steer by using 917 pounds of feed to produce a 750-pound animal. On the other hand, if he decides to feed to a heavier weight in order to obtain the $40 price, the maximum returns above variable costs are $251.65, given by using 1,359 pounds of feed to produce an 816-pound steer. Clearly, in this case, he would opt to feed to a heavier weight.

Seventh, although Tables 5 and 6 indicate that relatively lightweight steers are the optimum size animal to produce in many instances, this finding is not the result of the type of profit objective chosen, namely maximizing profits for one, given lot of cattle. On the contrary, if the goal is to maximize profits over some longer time period, the optimum weight to produce would be even lighter than indicated by the entries in the tables.

Eighth: A word about some practical implications of the results. Feedlots in Arizona customarily have been feeding what would be called a high-grain ration, as the terms high and low-grain are used in this article. Table 5 indicates that for all price and cost combinations considered it never pays to feed steers to more than 1,000 pounds in weight, and rarely if ever pays to use more than 2,900 pounds of feed. Yet, a 1973 study of Arizona's commercial feedlot industry indicated that the *average* quantity of feed input per animal was 1.49 tons, or 2,980 pounds, when the starting weight of the cattle was 500 pounds or more.[1]

Now, the use of such large quantities of feed would be financially advantageous to the owner of the cattle only if his cattle achieve more efficient rates of transformation of feed into body weight than was achieved by the experimental animals. Such may be the case and, indeed, further replications of the experiments performed in this study may yield significantly different input-output relations. The results to date, however, at least suggest that owners of feeder steers well might investigate further whether reduced amounts of feed might result in increased profits.

As a final note on practical implications: Cattle feeders in Arizona well might investigate the possibility of utilizing low-grain rations. With grain prices rising relative to forage prices, the price relations between high and low-grain rations well may be such as to yield higher profits with low-grain. The use of tables such as tables 5 and 6 in this article should be a useful guide in deciding which path to pursue.

The results are based on observed input-output relations derived from data on experimental animals at the University of Arizona. The relative profitability of high and low-grain rations may be ascertained by comparing appropriate entries in Tables 5 and 6.

Carcasses resulting from cattle fed high and low-grain rations were found to be substantially equal in quality characteristics. Hence the market price received may reasonably be expected to be unaffected by whether the cattle were fed high or low-grain. Given recent price relations between grain and forage, Arizona cattle feeders well might investigate whether low grain rations may increase net returns.

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[1]Menzie, E. L., Hanekamp, W. J., and Phillips, G. W., *The Economics of the Cattle Feeding Industry in Arizona*, Technical Bulletin 207, Agricultural Experiment Station, University of Arizona, Tucson (October, 1973) p. 72.