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Predicting cattle performance from mathematical models

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Abstract
Tables based on a mathematical model are presented that allow cost of gains by steers at various weights to be calculated. An example illustrate how to use the tables to help with economic decisions.

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Predicting Cattle Performance from Mathematical Models

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Summary

Tables based on a mathematical model are presented that allow cost of gains by steers at various weights to be calculated. An example illustrates how to use the tables to help with economic decisions.

Introduction

Daily gain and feed efficiency are generally calculated for feedlot cattle at the end of the feeding period, but that gives no information on how performance changed during the feeding period. We used a mathematical model to compute gain, feed efficiency, and intake on a set of Hereford steers after each 25 pounds gained during the feeding period. Using the figures, a feeder can estimate cost of each additional unit of gain and when to sell cattle for maximum profit or minimum loss.

Experimental Procedure

Twenty Hereford steers averaging 623 lbs. were individually fed the 10 rations in Table 24.1. Feed consumption and weekly weights were used to derive mathematical models of the steers' performance. The mathematical models were translated to tables of feed intake (Table 24.2), gain (Table 24.3), and feed efficiency (Table 24.4).

Calculating costs:

The cost of each pound of gain is composed of direct feed costs and such fixed costs as interest and yardage. Thus, if an animal were fed a long period on a low-cost ration, total cost per pound of gain might be higher, because of fixed costs, than if the animal gained faster on a more expensive ration.

Ration 8 (see Table 24.1) was composed of 20.2% silage, 68.10% corn, and 11.7% supplement, all on a dry-matter basis. Assuming silage costs $25 per ton and contains 40% dry matter, cost per pound of dry matter is 3.13¢/lb. If corn costs $2.27 per bu. and is 90% dry matter, it costs 4.50¢/lb. of dry matter. If the supplement costs $200 per ton and is 90% dry matter, it costs 11.1¢/lb. of dry matter. Thus, the ration costs 5.0¢ per lb. of dry matter.

Table 24.4 shows that on ration 8, an 800-lb. steer requires 5.7 lbs. of dry matter per lb. of gain. Thus, the feed cost per pound of gain is 28.5¢. No interest costs were added to the feed.

If the steer were purchased at 700 lbs. for 45¢ per lb. with money borrowed at 9.5%, the steer uses 8.31¢ per day in interest. Assuming yardage costs of 5¢ per head per day, daily fixed costs are 13.31¢ daily. In Table 24.3, the 800-lb. steer on ration 8 is predicted to gain 3.34 lbs. per day, so fixed costs are 3.99¢ per lb. of gain. Feed cost of gain was 28.50¢ per lb., so total cost of gain is 32.49¢ per lb., but only for an 800-lb. steer. For an 1100-lb. steer, 5¢/lb. ration x 7.7 lbs. feed per lb. gain, and 13.31¢/day fixed costs ÷ 2.46 lbs. gain per day gives 43.91¢/lb. total costs of gain.

Table 24.5. shows incremental total costs of gain at various body weights for a steer fed from 650 lb. to 1200 lb. on ration 8 (20% corn silage, a fairly typical feedlot ration). Ingredient costs in footnote 1 Cost of gain is economical early in the feeding period but quite expensive at heavy weights.

You could use the gain and feed efficiency tables to construct similar tables for other combinations of corn and corn silage.

As cow slaughter decreases and percentage of beef consumed as hamburger increases, demand for good-grade beef should increase. Information contained in Tables 24.4 and 24.5 should aid in deciding when feeding cattle to the Good grade instead of Choice is financially feasible.

The model was developed using Hereford steers, fed neither DES nor Rumensin. We shall develop models for heifers and larger-framed cattle. Adjustments can be made to the basic formula to account for feed additives.

Table 24.1. Ration fed steers to develop a mathematical model of feedlot performance.

Ration no.	%, dry matter basis			NEm	NEp
	Corn silage	Cracked corn	Supplement[1]	Therms/100 lbs.	
1	90.40	0.00	9.60	71.76	45.8
2	80.40	9.70	9.90	74.92	48.0
3	70.40	19.40	10.20	78.10	50.1
4	60.40	29.10	10.50	81.26	52.3
5	50.40	38.80	10.80	84.43	54.3
6	40.30	48.60	11.10	87.60	56.6
7	30.20	58.40	11.40	90.77	58.8
8	20.20	68.10	11.70	93.93	63.1
9	10.10	77.90	12.00	97.10	63.1
10	0.00	87.60	12.40	98.36	65.3

[1]Supplement composition was varied to assure adequate protein. Ingredients included soybean meal, ground limestone, dicalcium phosphate, salt, trace minerals, and vitamins.

Table 24.2. Daily dry matter intake (lbs.) computed from a steer performance model.

Steer weight (lbs.)	Ration number (see Table)									
	1	2	3	4	5	6	7	8	9	10
650	15.6	16.3	17.2	18.4	19.3	20.0	19.6	18.8	17.4	14.5
675	15.9	16.3	17.5	18.5	19.3	19.9	19.6	18.9	17.4	14.6
700	16.0	16.5	17.3	18.3	19.3	19.9	19.6	18.9	17.3	14.6
725	16.0	16.6	17.5	18.4	19.4	19.8	19.5	18.8	17.5	14.4
750	16.1	16.8	17.3	18.4	19.3	19.7	19.5	18.8	17.4	14.4
775	16.4	16.7	17.6	18.2	19.2	19.9	19.7	19.1	17.4	14.4
800	16.5	16.8	17.3	18.3	19.0	19.7	19.5	19.0	17.4	14.4
825	16.7	16.9	17.5	18.5	19.1	19.8	19.4	18.9	17.3	14.8
850	16.9	17.0	17.6	18.6	19.0	19.7	19.6	18.8	17.2	14.8
875	16.9	17.0	17.4	18.3	19.1	19.5	19.5	19.0	17.4	14.8
900	16.9	17.2	17.7	18.5	19.3	19.7	19.6	18.8	17.6	14.7
925	17.4	17.3	17.7	18.6	19.1	19.7	19.7	18.7	17.7	14.7
950	17.4	17.4	17.7	18.5	19.0	19.8	19.8	18.9	17.9	14.9
975	17.5	17.3	17.8	18.6	19.0	19.7	19.6	19.0	18.0	15.1
1000	17.7	17.4	17.8	18.5	18.9	19.7	19.7	18.7	18.2	14.9
1025	18.0	17.6	17.8	18.4	19.1	19.4	19.5	18.8	18.0	15.0
1050	18.0	17.7	17.8	18.4	19.1	19.3	19.3	19.1	17.6	14.9
1075	18.0	17.8	18.0	18.4	19.0	19.3	19.4	19.0	17.4	14.9
1100	18.9	18.0	18.1	18.6	19.0	19.4	19.6	18.9	17.4	15.0
1125	18.8	17.7	18.1	18.5	19.0	19.4	19.5	19.0	17.6	15.3
1150	19.1	18.0	18.2	18.5	18.8	19.5	19.6	18.7	17.5	15.3
1175	19.0	18.1	18.4	18.7	18.9	19.2	19.4	18.8	17.6	15.2
1200	19.1	18.3	18.4	18.8	19.0	19.2	19.3	18.7	17.7	15.1

Table 24.3. Daily weight gain (lbs.) at various body weights, computed from a steer performance model.

Steer weight (lbs.)	Ration number (see Table)									
	1	2	3	4	5	6	7	8	9	10
650	2.11	2.44	2.77	2.97	3.17	3.39	3.56	3.76	3.70	3.72
675	2.07	2.40	2.73	2.93	3.12	3.32	3.50	3.70	3.63	3.65
700	2.02	2.35	2.66	2.86	3.06	3.26	3.43	3.63	3.54	3.56
725	1.98	2.31	2.61	2.79	2.99	3.19	3.37	3.54	3.50	3.50
750	1.94	2.27	2.55	2.75	2.93	3.12	3.30	3.48	3.41	3.43
775	1.91	2.20	2.51	2.68	2.86	3.06	3.23	3.41	3.34	3.34
800	1.87	2.16	2.44	2.62	2.79	2.99	3.15	3.34	3.28	3.28
825	1.83	2.11	2.40	2.57	2.73	2.95	3.08	3.26	3.21	3.21
850	1.78	2.07	2.35	2.51	2.68	2.86	3.01	3.19	3.12	3.15
875	1.74	2.02	2.29	2.44	2.61	2.79	2.95	3.12	3.06	3.08
900	1.69	1.98	2.24	2.40	2.57	2.74	2.88	3.04	2.99	3.01
925	1.67	1.94	2.18	2.35	2.51	2.66	2.82	2.97	2.90	2.93
950	1.63	1.89	2.13	2.29	2.44	2.60	2.75	2.90	2.84	2.86
975	1.58	1.82	2.07	2.24	2.38	2.53	2.68	2.84	2.77	2.79
1000	1.54	1.78	2.02	2.18	2.31	2.46	2.62	2.75	2.71	2.71
1025	1.50	1.74	1.98	2.11	2.27	2.40	2.53	2.68	2.64	2.64
1050	1.45	1.69	1.91	2.07	2.20	2.33	2.44	2.62	2.55	2.57
1075	1.41	1.65	1.87	2.00	2.13	2.27	2.40	2.53	2.49	2.49
1100	1.39	1.61	1.83	1.96	2.07	2.20	2.33	2.46	2.42	2.42
1125	1.34	1.54	1.76	1.89	2.00	2.13	2.27	2.40	2.35	2.35
1150	1.30	1.50	1.72	1.83	1.94	2.07	2.20	2.31	2.27	2.29
1175	1.25	1.45	1.67	1.78	1.89	2.00	2.13	2.24	2.20	2.20
1200	1.21	1.41	1.63	1.74	1.83	1.94	2.05	2.18	2.13	2.13

Table 24.4. Feed efficiency (units dry feed per unit of body weight gain) computed from a steer performance model.

Steer weight (lbs.)	Ration number (see Table)									
	1	2	3	4	5	6	7	8	9	10
650	7.4	6.7	6.2	6.2	6.1	5.9	5.5	5.0	4.7	3.9
675	7.7	6.8	6.4	6.3	6.2	6.0	5.6	5.1	4.8	4.0
700	7.9	7.0	6.5	6.4	6.3	6.1	5.7	5.2	4.9	4.1
725	8.1	7.2	6.7	6.6	6.5	6.2	5.8	5.3	5.0	4.1
750	8.3	7.4	6.8	6.7	6.6	6.3	5.9	5.4	5.1	4.2
775	8.6	7.6	7.0	6.8	6.7	6.5	6.1	5.6	5.2	4.3
800	8.8	7.8	7.1	7.0	6.8	6.6	6.2	5.7	5.3	4.4
825	9.1	8.0	7.3	7.2	7.0	6.7	6.3	5.8	5.4	4.6
850	9.5	8.2	7.5	7.4	7.1	6.9	6.5	5.9	5.5	4.7
875	9.7	8.4	7.6	7.5	7.3	7.0	6.6	6.1	5.7	4.8
900	10.0	8.7	7.9	7.7	7.5	7.2	6.8	6.2	5.9	4.9
925	10.4	8.9	8.1	7.9	7.6	7.4	7.0	6.3	6.1	5.0
950	10.7	9.2	8.3	8.1	7.8	7.6	7.2	6.5	6.3	5.2
975	11.1	9.5	8.6	8.3	8.0	7.8	7.3	6.7	6.5	5.4
1000	11.6	9.8	8.8	8.5	8.2	8.0	7.5	6.8	6.7	5.5
1025	12.0	10.1	9.0	8.7	8.4	8.1	7.7	7.0	6.8	5.7
1050	12.4	10.5	9.3	8.9	8.7	8.3	7.9	7.3	6.9	5.8
1075	12.8	10.8	9.6	9.2	8.9	8.5	8.1	7.5	7.0	6.0
1100	13.6	11.2	9.9	9.5	9.2	8.8	8.4	7.7	7.2	6.2
1125	14.0	11.5	10.3	9.8	9.5	9.1	8.6	7.9	7.5	6.5
1150	14.7	12.0	10.6	10.1	9.7	9.4	8.9	8.1	7.7	6.7
1175	15.2	12.5	11.0	10.5	10.0	9.6	9.1	8.4	8.0	6.9
1200	15.8	13.0	11.3	10.8	10.4	9.9	9.4	8.6	8.3	7.1

Table 24.5. Economic data computed from steer performance model.

Animal wt., lbs.	Lbs. feed D.M. per lb. gain	Feed cost[1] per lb. gain, ¢	Lbs. gain per day	Fixed[2] cost per lb. gain, ¢	Total cost per lb. gain, ¢
650	5.0	25.00	3.76	3.43	28.43
675	5.1	25.50	3.70	3.48	28.98
700	5.2	26.00	3.63	3.55	29.55
725	5.3	26.50	3.54	3.64	30.14
750	5.4	27.00	3.48	3.70	30.70
775	5.6	28.00	3.41	3.78	31.78
800	5.7	28.50	3.34	3.86	32.36
825	5.8	29.00	3.26	3.95	32.95
850	5.9	29.50	3.19	4.04	33.54
875	6.1	30.50	3.12	4.13	34.63
900	6.2	31.00	3.04	4.24	35.24
925	6.3	31.50	2.97	4.34	35.84
950	6.5	32.50	2.90	4.44	36.94
975	6.7	33.50	2.84	4.54	38.04
1000	6.8	34.00	2.75	4.69	38.69
1025	7.0	35.00	2.68	4.81	39.81
1050	7.3	36.50	2.62	4.92	41.42
1075	7.5	37.50	2.53	5.09	42.59
1100	7.7	38.50	2.46	5.24	43.74
1125	7.9	39.50	2.40	5.37	44.87
1150	8.1	40.50	2.31	5.58	46.08
1175	8.4	42.00	2.24	5.75	47.75
1200	8.6	43.00	2.18	5.91	48.91

[1]Silage at $20 per ton, 40% dry matter. Corn at $2.27 per bu., 90% dry matter. Supplement at $200 per ton, 90% dry matter.

[2]Assume 5¢/day yardage, and 650 lb. steer purchased for $46/cwt. at 9.5% interest. 12.89¢/day fixed costs.