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Predicting feedlot performance using mathematical models

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Predicting feedlot performance using mathematical models

Abstract
Tables based on mathematical models illustrate how feed intake, rate of gain, and feed efficiency change during the feeding period and in response to different wing-chill temperatures. The tables wert used to calculate costs or gain.

Keywords
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Predicting Feedlot Performance Using Mathematical Models

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Summary

Tables based on mathematical models illustrate how feed intake, rate of gain, and feed efficiency change during the feeding period and in response to different wind-chill temperatures. The tables were used to calculate costs of gain.

Introduction

Daily gain and feed efficiency are generally calculated for feedlot cattle at the end of the feeding period but they do not show the gradual deterioration in performance during the feeding period. We used mathematical models to compute tables of gain, intake, and feed efficiency on a set of Hereford steers after each 50 pounds gained during the feeding period. Using the tables, a feeder can estimate the cost of each additional unit of gain and when to sell cattle for most profit or least loss.

Experimental Procedure

Twenty Hereford steers averaging 749 lbs. were individually fed the rations listed in Table 14.1. After a 7-day adjustment period, weekly feed consumption, weight, and weather data were collected and used to derive mathematical models of the steers' performance. The mathematical models were translated to tables of intake (Table 14.2), gain (Table 14.3), and feed efficiency (Table 14.4) at constant wind-chill temperatures of 41°F and 5°F.

Results

The cost of each additional pound of gain includes feed costs, yardage costs and interest. Thus, if an animal were fed a long time on a low-cost ration, total cost per pound of gain might be higher, because of yardage and interest costs, than if the animal gained faster on a more expensive ration.

The cost of gain table (Table 14.5) assumes that corn silage costs $25 per ton at 40% dry matter; corn, $2.40 per bu. (90% dry matter), and soybean meal supplement , $200 per ton (90% dry matter), or, respectively, 3.13¢, 4.76¢, and 11.1¢ per pound on a dry matter basis. Ration 8 (Table 14.1) composed of 20.05% corn silage, 67.75% cracked corn, and 12.20% supplement would cost 5.21¢/lb. of dry matter.

Interest on a 700-lb. steer purchased for 70¢/lb. with money borrowed at 10.0% would be 13.42¢ per day, so a yardage cost of 6¢ per head per day would make fixed costs total 19.42¢ a day. Table 14.5 illustrates that as feed efficiency deteriorates with increased steer weight, cost for each additional unit of gain increases. Thus, cost of gain is economical early in the feeding period but increases dramatically at heavier weights. A 900-lb. steer (41°F) on ration 8 is predicted to gain 3.12 lbs. a day, so fixed costs are 6.22¢ per lb. of gain. Feed costs are 29.64¢ per lb. of gain, and total cost is 35.86¢ per lb. of gain. But an 1100-lb. steer (41°F) on ration 8 is predicted to gain 2.39 lbs. per day, so fixed costs are 8.13¢ and feed costs, 41.90¢, so total cost is 50.03¢ per lb. of gain.

A steer's performance declines under heat or cold stress because either kind of stress increases requirements for maintenance. A decrease in temperature increases intake and generally decreases gain for less efficient and more costly gain. The tables compare steer performance and cost of gain at wind-chills of 41°F and 5°F and should help feeders project increased feeding costs and decreased gain during periods of extreme cold. High costs of gain due to cold temperatures usually will not continue for long periods. Gain and feed efficiency tables can be constructed for other combinations of corn and corn silage and wind-chills.

The model was developed with Hereford steers, fed neither DES nor Rumensin. Future trials will let us construct models describing performance of heifers and larger-framed cattle and include adjustments for feed additives.

Table 14.1. Ration fed steers to develop a mathematical model of feedlot performance.

Ration no.	%, dry matter basis			NEm	NEp[2]
	Corn silage	Cracked corn	Supplement[1]	Mcal/100 lb. dry matter	
1	89.95	0.00	10.05	71.8	45.8
2	80.01	9.64	10.35	74.9	48.0
3	70.07	19.30	10.63	78.1	50.1
4	60.13	28.94	10.93	81.3	52.3
5	50.13	38.64	11.23	84.4	54.5
6	40.10	48.34	11.55	87.6	56.6
7	30.08	58.05	11.87	90.8	58.8
8	20.05	67.75	12.20	93.9	61.0
9	10.13	77.47	12.50	97.1	63.1
10	0.00	87.16	12.84	100.3	65.3

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

[2]NEm = net energy for maintenance; NEp = net energy for production; Mcal = megacalories.

Table 14.2. Daily dry matter intake (lbs) computed from a steer performance model.

Wind-chill temp. °F	Steer wt., lbs.	Ration 1	2	3	4	5	6	7	8	9	10
41	700	18.76	18.24	17.73	17.21	16.70	16.18	15.66	15.15	14.63	14.59
5		21.01	20.49	19.98	19.46	18.95	18.43	17.92	17.40	16.89	16.84
41	750	19.55	19.03	18.52	18.00	17.49	16.97	16.46	15.94	15.43	15.38
5		21.80	21.29	20.77	20.25	19.74	19.22	18.71	18.19	17.68	17.63
41	800	20.24	19.72	19.21	18.69	18.18	17.66	17.15	16.63	16.12	16.07
5		22.49	21.97	21.46	20.94	20.43	19.91	19.40	18.88	18.37	18.32
41	850	20.83	20.32	19.80	19.29	18.77	18.26	17.74	17.23	16.71	16.67
5		23.09	22.57	22.06	21.54	21.02	20.51	19.99	19.48	18.96	18.92
41	900	21.35	20.84	20.32	19.81	19.29	18.78	18.26	17.75	17.23	17.18
5		23.60	23.09	22.57	22.06	21.54	21.03	20.51	20.00	19.48	19.44
41	950	21.80	21.29	20.77	20.26	19.74	19.23	18.71	18.20	17.68	17.63
5		24.05	23.54	23.02	22.51	21.99	21.48	20.96	20.45	19.93	19.89
41	1000	22.19	21.68	21.16	20.65	20.13	19.62	19.10	18.59	18.07	18.03
5		24.44	23.93	23.41	22.90	22.38	21.87	21.35	20.84	20.32	20.28
41	1050	22.53	22.02	21.50	20.99	20.47	19.96	19.44	18.93	18.41	18.36
5		24.78	24.27	23.75	23.24	22.72	22.21	21.69	21.18	20.66	20.62
41	1100	22.83	22.31	21.80	21.28	20.77	20.25	19.73	19.22	18.70	18.66
5		25.08	24.56	24.05	23.53	23.02	22.50	21.99	21.47	20.96	20.91
41	1150	23.08	22.57	22.05	21.54	21.02	20.51	19.99	19.47	18.96	18.91
5		25.33	24.82	24.30	23.79	23.27	22.76	22.24	21.73	21.21	21.71
41	1200	23.30	22.79	22.27	21.76	21.24	20.73	20.21	19.70	19.18	19.14
5		25.55	25.04	24.52	24.01	23.49	22.98	22.46	21.95	21.43	21.39

Table 14.3. Average daily gain (lbs.) computed from steer performance model.

Wind-chill temp. °F	Steer wt., lbs.	Ration 1	2	3	4	5	6	7	8	9	10
41	700	3.05	3.09	3.14	3.19	3.24	3.29	3.34	3.38	3.43	3.44
5		2.15	2.20	2.25	2.30	2.35	2.40	2.44	2.49	2.54	2.54
41	750	3.06	3.11	3.15	3.20	3.24	3.29	3.34	3.38	3.43	3.43
5		2.22	2.27	2.31	2.36	2.40	2.45	2.50	2.54	2.59	2.59
41	800	3.03	3.07	3.12	3.16	3.20	3.25	3.29	3.33	3.37	3.38
5		2.24	2.29	2.33	2.37	2.41	2.46	2.50	2.54	2.59	2.59
41	850	2.96	3.00	3.04	3.08	3.12	3.16	3.20	3.24	3.28	3.29
5		2.22	2.26	2.30	2.34	2.38	2.42	2.46	2.50	2.54	2.55
41	900	2.86	2.90	2.93	2.97	3.01	3.04	3.08	3.12	3.16	3.16
5		2.17	2.21	2.25	2.28	2.32	2.36	2.40	2.43	2.47	2.47
41	950	2.73	2.76	2.80	2.83	2.86	2.90	2.93	2.97	3.00	3.01
5		2.09	2.13	2.16	2.20	2.23	2.26	2.30	2.33	2.37	2.37
41	1000	2.57	2.60	2.64	2.67	2.70	2.73	2.76	2.79	2.82	2.83
5		1.99	2.02	2.05	2.08	2.12	2.15	2.18	2.21	2.24	2.24
41	1050	2.40	2.43	2.45	2.48	2.51	2.54	2.57	2.60	2.63	2.63
5		1.87	1.89	1.92	1.95	1.98	2.01	2.04	2.07	2.10	2.10
41	1100	2.21	2.23	2.26	2.28	2.31	2.34	2.36	2.39	2.42	2.42
5		1.73	1.75	1.78	1.80	1.83	1.86	1.88	1.91	1.93	1.94
41	1150	2.00	2.03	2.05	2.07	2.10	2.12	2.14	2.17	2.19	2.19
5		1.57	1.60	1.62	1.64	1.67	1.69	1.71	1.74	1.76	1.76
41	1200	1.79	1.81	1.83	1.85	1.87	1.89	1.91	1.93	1.95	1.95
5		1.41	1.43	1.45	1.47	1.49	1.51	1.53	1.55	1.57	1.57

Table 14.4. Feed efficiency (units of dry matter per unit of body weight gain) computed from a steer performance model.

Wind-chill temp. °F	Steer wt., lbs.	Ration 1	2	3	4	5	6	7	8	9	10
41	700	6.16	5.90	5.64	5.39	5.16	4.92	4.70	4.48	4.26	4.25
5		9.75	9.31	8.88	8.47	8.07	7.69	7.33	6.98	6.65	6.62
41	750	6.38	6.12	5.87	5.63	5.39	5.16	4.93	4.72	4.50	4.48
5		9.81	9.39	8.98	8.59	8.21	7.85	7.50	7.16	6.83	6.81
41	800	6.67	6.41	6.16	5.91	5.67	5.44	5.21	4.99	4.78	4.76
5		10.03	9.61	9.21	8.83	8.46	8.10	7.76	7.43	7.10	7.08
41	850	7.03	6.77	6.51	6.26	6.01	5.77	5.54	5.31	5.09	5.07
5		10.38	9.97	9.57	9.19	8.82	8.46	8.11	7.78	7.45	7.42
41	900	7.47	7.20	6.93	6.67	6.42	6.17	5.93	5.69	5.46	5.44
5		10.87	10.45	10.05	9.66	9.28	8.92	8.56	8.22	7.89	7.86
41	950	8.00	7.71	7.43	7.16	6.89	6.63	6.38	6.13	5.89	5.87
5		11.50	11.07	10.65	10.25	9.86	9.49	9.12	8.76	8.42	8.39
41	1000	8.63	8.33	8.03	7.74	7.46	7.19	6.92	6.65	6.40	6.37
5		12.29	11.85	11.41	10.99	10.58	10.19	9.80	9.43	9.07	9.03
41	1050	9.40	9.07	8.76	8.45	8.15	7.85	7.56	7.28	7.01	6.98
5		13.29	12.81	12.35	11.90	11.47	11.05	10.64	10.24	9.86	9.82
41	1100	10.34	9.99	9.65	9.31	8.99	8.67	8.35	8.04	7.74	7.72
5		14.53	14.02	13.52	13.04	12.57	12.12	11.68	11.25	10.83	10.80
41	1150	11.53	11.14	10.76	10.39	10.03	9.68	9.33	8.99	8.66	8.63
5		16.10	15.55	15.00	14.48	13.97	13.47	12.98	12.51	12.06	12.02
41	1200	13.04	12.61	12.19	11.77	11.37	10.97	10.58	10.20	9.83	9.80
5		18.14	17.52	16.91	16.33	15.76	15.20	14.66	14.14	13.63	13.58

Table 14.5. Cost of gain[1] and computed from steer performance model.

Wind-chill temp. °F	Steer wt., lbs.	Ration 1	2	3	4	5	6	7	8	9	10
41	700	30.62	30.56	30.43	30.25	30.03	29.76	29.45	29.09	28.69	29.35
5		47.41	47.14	46.78	46.37	45.91	45.39	44.82	44.20	43.54	44.58
41	750	31.47	31.47	31.40	31.28	31.11	30.90	30.64	30.33	29.98	30.69
5		47.35	47.21	46.98	46.69	46.35	45.95	45.49	44.98	44.42	45.50
41	800	32.68	32.73	32.71	32.64	32.52	32.35	32.13	31.86	31.55	32.31
5		48.12	48.07	47.94	47.74	47.49	47.17	46.80	46.36	45.88	47.01
41	850	34.24	34.34	34.36	34.34	34.25	34.12	33.94	33.70	33.42	34.24
5		49.58	49.62	49.56	49.44	49.25	49.00	48.69	48.32	47.89	49.08
41	900	36.20	36.34	36.40	36.41	36.36	36.26	36.11	35.86	35.54	36.52
5		51.71	51.82	51.82	51.76	51.63	51.44	51.18	50.85	50.46	51.73
41	950	38.59	38.78	38.88	38.92	38.91	38.84	38.71	38.52	38.28	39.23
5		54.53	54.71	54.77	54.77	54.69	54.54	54.32	54.03	53.67	55.03
41	1000	41.51	41.74	41.88	41.96	41.98	41.93	41.82	41.65	41.42	42.46
5		58.15	58.38	58.50	58.55	58.51	58.40	58.22	57.96	57.63	59.09
41	1050	45.09	45.37	45.55	45.66	45.71	45.69	45.60	45.44	45.22	46.36
5		62.70	63.00	63.17	63.27	63.27	63.20	63.05	62.81	62.49	64.09
41	1100	49.51	49.84	50.07	50.22	50.29	50.30	50.23	50.03	49.87	51.13
5		68.43	68.80	69.03	69.18	69.23	69.19	69.06	68.84	68.54	70.30
41	1150	55.07	55.46	55.73	55.92	56.03	56.06	56.01	55.87	55.66	57.07
5		75.72	76.17	76.47	76.66	76.76	76.75	76.65	76.44	76.15	78.11
41	1200	62.20	62.66	62.99	63.23	63.38	63.44	63.40	63.28	63.05	64.66
5		85.16	85.70	86.07	86.33	86.47	86.51	86.43	86.23	85.93	88.15

[1]Corn silage at $25 per ton, 40% dry matter; corn, $2.40 per bu., 90% dry matter; supplement $200 per ton, 90% dry matter. Assume 6¢ per day yardage, and a 700-lb. steer purchased at $70/cwt at 10.0% interest, for 19.42¢ per day fixed cost.