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Estimating growing-finishing cattle performance with the net energy system

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Quick Facts

The California Energy System is the best present system for predicting growing-finishing cattle performance from the rations they are being fed.

The net energy requirements of growing cattle are related to body weight, stage of growth for a given weight, rate of gain, sex, environmental conditions, age and nutritional history.

To use this system accurately, one must know NEm and NEg of the ration, animal sex, weight and feed intake.

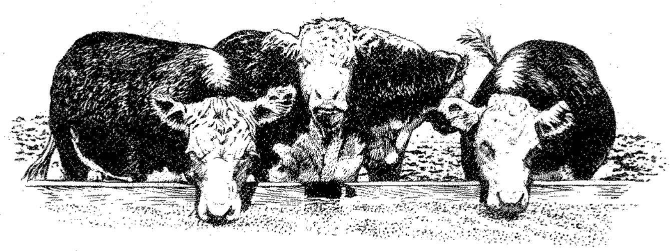
What is Net Energy?

Net energy is the net quality of energy recovered or retained in an animal product. Retained energy can be a negative quantity for animals fed below their maintenance requirements. The use of net energy as a base for feed evaluation is complicated by available metabolizable energy from the animal's diet. Such available energy is used at different levels of efficiency and depends on the physiological state of the animal (maintenance, growth, lactation, pregnancy) and the make-up of the diet. These complications have been partially accounted for in a net energy system for beef cattle by the convention that assigns two net energy values to each feedstuff. Animal requirements for energy are similarly subdivided. Net energy available or required for maintenance is termed NEm, and net energy available or required for growth is termed NEg (Lofgreen and Garrett, 1968). Two major advantages of the net energy system are: a) animal requirements stated as net energy are independent of the diet, i.e., they do not have to be adjusted for different roughage-concentrate ratios, and; b) feed requirements for maintenance are estimated separately from feed needed for the productive functions.

Net Energy for Maintenance

The maintenance requirement for energy can be defined as the amount of feed energy that will result in no loss or gain in body energy. For some beef animals near their mature size (adult bulls) maintenance may be the usual physiological state and the practical feeding goal. Maintenance in most other beef animals is more a theoretical condition that differs from the usual physiological state. Nevertheless, it is convenient and appropriate to consider maintenance energy requirements separately from any production requirement.

Net energy required for maintenance is the amount of energy equivalent to the fasting heat production. The NE requirements for maintenance of beef cattle have been estimated as 77 kcal per $W^{.75}$; capital W is body weight in kilograms. Maintenance requirements estimated by this expression are more applicable for penned animals in nonstressful environments based on sex, breed and physiological age. The magnitude of these effects appears to be from 3 to 14 percent. In general, breeds and individuals maturing at heavier weights may require more, and *bos indicus* breeds and crosses may require less energy for maintenance than would be estimated by the expression 77 kcal per $W^{.75}$.



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Net Energy for Gain

The NE requirements for growth (NEg) are estimated as the amount of energy deposited as non-fat organic matter (mostly protein) plus that deposited as fat. The caloric value of fat is 9.4 kcal per gram and 5.6 kcal per gram for non-fat organic matter. The quantities of deposited protein and fat are related to: a) the intake of energy above the maintenance requirement (assuming all other nutrient requirements are also satisfied), and; b) the impetus to grow (i.e., the phase of growth or weight obtained relative to mature weight).

The use of net energy in evaluating feeds for cattle and sheep was renewed with the development of the California energy system. The main reason for this was the improved predictability of results depending on whether feed energy is being used for maintenance, growth or lactation. The major problem in using these NE values is predicting feed intake and the proportion of feed that will be used for maintenance or growth. Some only use NEg values in formulating rations, however, NEg will overestimate feeding value of concentrates relative to roughages.

Others use the average of the two NE values, but this would be true only for cattle or sheep eating twice the maintenance requirement. The most accurate way to use NE values to formulate rations would be the NEm value plus a multiplier times the NEg value, all divided by one plus a multiplier. The multiplier is the level of feed intake above maintenance relative to maintenance. For example, if 700-pound cattle are expected to eat 18 pounds of feed, 8 pounds of which are required for maintenance, then the NE value of the ration would be:

$$NE = \frac{NEm + (10/8)\,(NEg)}{1 + (10/8)}$$

Such a calculation could be easily introduced into computerized programs designed to formulate rations and predict performance.

Estimating NEm and NEg of a Ration

When deciding on an energy system to use to formulate rations, there is no question on the theoretical superiority of net energy over digestible energy, or total digestable nutrients, when predicting animal performance. This superiority is lost if only NEg is used in formulating rations. If NE is used, some combination of NEm and NEg is required. The first step in estimating performance is to determine how much energy is in the ration. There are several ways this can be accomplished. Take a sample of the complete ration and send it in to a laboratory for analysis or take book values and calculate NEm and NEg as illustrated in Table 1.

Estimating Performance with Net Energy System

The following example is based on an average 600-pound steer consuming 14.5 pounds of ration dry matter that contains .75 MCal NEm and .40 MCal. NEg per pound. (1) Divide the net energy required daily for maintenance (see Table 2) for the weight of the cattle (600 pounds) by the NEm value of the ration per pound to get pound of the ration required daily for maintenance (5.21 ÷ .75 = 6.9 pounds of ration dry matter for maintenance for the example steer.) (2) Subtract pounds needed for maintenance from total pounds consumed to get pound of ration left for gain (14.5 - 6.9 = 7.6 pounds left for gain for the example 600-pound steer). (3) Multiply pounds left for gain times NEg value of the ration per pound to get energy available for gain per day (7.6 x .40 = 3.04 MCal. left for gain). (4) Look down the NEg column under the weight and sex of the cattle for the value nearest the energy left for gain. Find the expected rate of gain in the pounds daily gain column across from this value (3.04 is near 3.00, which gives a 1.7 pound-per-day gain for the example 600-pound steer). This projected gain is for implanted cattle only.

The expected rate of gain can be determined on various combinations of feeds available, cost of the ration, plus overhead cost divided by the expected rate of gain to find the least cost ration.

References

Nutrient Requirements of Beef Cattle, National Research Center, Fifth revised edition, 1976, National Academy of Sciences, Washington, D.C.

Table 1: Calculation of NEm and NEg from ingredients in a ration.

Body Wt., Lb.	700		800		900		1000	
	NEm		NEm		NEm		NEm	
	5.85		6.47		7.06		7.65	
Daily Gain Lb.	NEg		NEg		NEg		NEg	
	Steers	Heifers	Steers	Heifers —Mcal/day—	Steers	Heifers	Steers	Heifers
.5	.93	1.01	1.02	1.11	1.12	1.22	1.21	1.32
.6	1.12	1.22	1.24	1.35	1.35	1.47	1.46	1.59
.7	1.31	1.44	1.45	1.59	1.58	1.73	1.71	1.88
.8	1.51	1.66	1.67	1.83	1.82	2.00	1.97	2.17
.9	1.71	1.88	1.89	2.08	2.06	2.27	2.23	2.46
1.0	1.91	2.11	2.11	2.33	2.30	2.55	2.49	2.76
1.1	2.11	2.34	2.33	2.59	2.55	2.83	2.76	3.06
1.2	2.31	2.58	2.56	2.85	2.79	3.11	3.02	3.37
1.3	2.52	2.82	2.78	3.12	3.04	3.40	3.29	3.68
1.4	2.73	3.06	3.01	3.39	3.29	3.70	3.56	4.00
1.5	2.94	3.31	3.25	3.66	3.55	4.00	3.84	4.33
1.6	3.15	3.56	3.48	3.94	3.80	4.30	4.12	4.66
1.7	3.37	3.82	3.72	4.22	4.06	4.61	4.40	4.99
1.8	3.58	4.08	3.96	4.51	4.33	4.92	4.68	5.33
1.9	3.80	4.34	4.20	4.80	4.59	5.24	4.97	5.67
2.0	4.02	4.61	4.45	5.09	4.86	5.57	5.26	6.02
2.1	4.25	4.88	4.69	5.39	5.13	5.89	5.55	6.38
2.2	4.47	5.16	4.94	5.70	5.40	6.23	5.84	6.74
2.3	4.70	5.44	5.19	6.01	5.67	6.56	6.14	7.10
2.4	4.93	5.72	5.45	6.32	5.59	6.90	6.44	7.47
2.5	5.16	6.01	5.70	6.64	6.23	7.25	6.74	7.85
2.6	5.39	6.30	5.96	6.96	6.51	7.60	7.05	8.23
2.7	5.63	6.59	6.22	7.28	6.80	7.96	7.35	8.61
2.8	5.87	6.89	6.48	7.61	7.08	8.32	7.67	9.00
2.9	6.11	7.19	6.75	7.95	7.37	8.68	7.98	9.40
3.0	6.35	7.50	7.02	8.29	7.67	9.05	8.30	9.80
3.1	6.59	7.81	7.29	8.63	7.96	9.43	8.61	10.20
3.2	6.84	8.12	7.56	8.98	8.26	9.81	8.94	10.61
3.3	7.09	8.44	7.83	9.33	8.56	10.19	9.26	11.03
3.4	7.34	8.76	8.11	9.68	8.86	10.58	9.59	11.45

(Tables were adapted from National Research Council Publication, "Nutrient Requirements of Beef Cattle," by Danny G. Fox, Beef Specialist, Michigan State University.)

Table 2: Net energy requirement tables for growing and finishing cattle.

Body Wt., Lb.	300 NEm 3.10		400 NEm 3.85		500 NEm 4.55		600 NEm 5.21	
Daily Gain Lb.	NEg Steers	NEg Heifers	NEg Steers	NEg Heifers	NEg Steers	NEg Heifers	NEg Steers	NEg Heifers
	—Mcal/day—							
.5	.47	.52	.59	.64	.72	.78	.83	.90
.6	.59	.64	.73	.80	.87	.95	1.00	1.09
.7	.68	.78	.84	.92	1.02	1.12	1.17	1.28
.8	.79	.87	.98	1.08	1.17	1.29	1.34	1.48
.9	.88	.97	1.10	1.21	1.33	1.46	1.52	1.68
1.0	1.00	1.11	1.24	1.38	1.48	1.64	1.70	1.88
1.1	1.12	1.24	1.39	1.54	1.64	1.82	1.88	2.09
1.2	1.21	1.35	1.51	1.68	1.80	2.00	2.06	2.30
1.3	1.33	1.49	1.66	1.86	1.96	2.19	2.24	2.51
1.4	1.43	1.61	1.78	2.00	2.12	2.38	2.43	2.73
1.5	1.55	1.75	1.93	2.18	2.28	2.57	2.62	2.95
1.6	1.65	1.87	2.06	2.32	2.45	2.77	2.81	3.17
1.7	1.78	2.02	2.21	2.51	2.61	2.97	3.00	3.40
1.8	1.88	2.14	2.34	2.66	2.78	3.17	3.19	3.63
1.9	2.01	2.29	2.50	2.85	2.95	3.37	3.39	3.87
2.0	2.14	2.42	2.63	3.01	3.12	3.58	3.58	4.11
2.1	2.24	2.57	2.79	3.20	3.30	3.79	3.78	4.35
2.2	2.37	2.74	2.95	3.40	3.47	4.01	3.98	4.59
2.3	2.48	2.87	3.08	3.57	3.65	4.22	4.18	4.84
2.4	2.61	3.03	3.25	3.77	3.83	4.44	4.39	5.09
2.5	2.72	3.17	3.38	3.93	4.01	4.66	4.59	5.35
2.6	2.86	3.33	3.55	4.15	4.19	4.89	4.80	5.61
2.7	2.97	3.47	3.69	4.32	4.37	5.12	5.01	5.87
2.8	3.11	3.65	3.86	4.54	4.56	5.35	5.22	6.14
2.9	3.22	3.79	4.00	4.71	4.74	5.59	5.44	6.40
3.0	3.36	3.97	4.18	4.94	4.93	5.82	5.65	6.68
3.1	3.47	4.11	4.32	5.12	5.12	6.06	5.87	6.95
3.2	3.62	4.30	4.50	5.34	5.31	6.31	6.09	7.23
3.3	3.76	4.48	4.68	5.51	5.51	6.56	6.31	7.52
3.4	3.88	4.63	4.83	5.76	5.70	6.81	6.54	7.80