Protein Requirements for Growing and Finishing Beef
Michigan Beef Productions
Michigan State University Extension Service
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Issued November 1982
4 pages

EXETENSION BULLETIN E-1628
REVISED NOVEMBER 1982

# MICHIGAN BEEF PRODUCTION

COOPERATIVE EXTENSION SERVICE • MICHIGAN STATE UNIVERSITY

## Protein Requirements for Growing and Finishing Beef



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The amount of protein required daily by growing and finishing cattle is the sum of the protein needed for maintenance, that needed for growth of body tissues and an amount required by the rumen microorganisms for fermentation. Other factors that must be considered in formulating rations to meet protein requirements are the variations in protein content of feedstuffs, the digestibility of the protein, metabolic efficiency of protein utilization, and the previous nutritional treatment of the cattle. Age, genetic background and health may influence efficiency of protein utilization. Therefore, requirement tables can only give estimates of the protein requirements, based on research and experience. Because of the many factors that affect protein requirements, it is usually advisable to include a safety factor when balancing for protein. The recommendations given here were developed with this in mind. Excess protein in the ration can be partly utilized for energy, but each 1% increase in protein above that required may increase cost of gain ¼ to ½-cent per lb. However, underfeeding protein can cost much more than overfeeding protein due to slow gains and poor feed efficiency. The cost of this safety factor may be justified in situations where the nutritional history is not known and requirements for the type of cattle, such as large type breeds, at a given weight are not well documented. Furthermore, proper use of urea can keep the cost of supplemental protein at a minimum in most beef rations.

### Protein Requirement for Maintenance

Cattle require protein for maintenance to replace or repair muscle tissue and in sustaining vital functions that are necessary for life. The weight of this vital tissue is called the metabolic size of the animal, and as an animal increases in size the growth of this type of tissue increases at a proportion of the total increase in weight. The amount of total protein that must be consumed daily to meet this need depends on the digestibility of the protein in the feed and how efficient the animal is in converting the protein in the feed to protein they can utilize in the body. When adjustments are made for digestive and metabolic losses, the protein that must be fed daily to meet the maintenance requirement is estimated to be 0.0047 lb. of total protein or 0.0033 lb. of digestible protein per unit of metabolic weight, which is the ¾ power of the actual weight of the cattle. These values were used to develop the protein requirements for maintenance as presented in Tables 1 and 2.

### Protein Requirement for Weight Gain

The protein requirement for weight gain is related to the amount of muscle tissue being synthesized daily, which in turn is related to the type of cattle, stage of growth and rate of gain. There are several other factors that apparently influence the amount of protein that must be fed at a given size for the desired rate of gain, such as source of energy and protein, the needs of rumen microbes for ammonia in fermenting feeds and the biological efficiency of the cattle.

When all of the factors are evaluated, it appears that using the value of 0.55 lb. of total protein or 0.40 lb. of digestible protein per lb. of weight gain as the requirement results in ration protein levels that agree reasonably well with those shown to give optimum performance in most research trials to date. These values were used to develop the protein requirements for gain as presented in Tables 1 and 2.

### Converting To a Percentage Requirement

These tables can be used to calculate the per cent protein required in the ration dry matter by dividing the lb. of protein required by the expected feed intake. Table 3 gives expected dry matter intakes that can be used as a guide. If available, it would be preferable to use dry matter intakes that experience indicates can be expected for a certain type of cattle under

your conditions, and then use Table 1 or Table 2 to determine the per cent protein needed in the ration.

For example, Table 1 shows that the digestible protein required for a 900 lb. steer to gain 3 lb. per day is = 1.76 lb. per day. The per cent *digestible protein* required in the ration dry matter at this weight would be 1.76/20 = 8.85%. If balancing on a total protein basis, the *total protein* requirement for the same conditions would be 2.49/20 = 12.4% total protein in the dry matter. If under your conditions 900 lb. cattle consume, for example, 22 lbs. of dry matter on a particular ration in obtaining a 3 lb. per day gain, then the *digestible protein* requirement would be 1.76/22 = 8.00% and the total protein requirement would be 2.49/22 = 11.3% total protein in the dry matter.

Using these methods and the feed intakes shown in Table 3, Table 4 was developed to give the per cent total or digestible protein needed for various net energy levels in the ration dry matter. The energy levels required for various rates of gain were determined by calculating expected rates of gain at the various net energy for maintenance and gain levels per 100 lb. of ration dry matter shown in Table 4 when steers consume the average pounds of dry matter shown in Table 3. The per cent protein needed in the ration dry matter was then determined by dividing the amount of protein needed for these rates of gain at different live weights (Table 1 and 2) by the expected dry matter intake shown in Table 3.

Table 4 is based on average feedlot steers and age, sex and physiological stage of growth at the different weights should be considered when using these values. Yearling steers previously fed for slow rates of gain or larger type cattle can be expected to gain 10 to 15 per cent faster than the rates of gain shown for the various energy levels. Heifers of the same weight can be expected to have a 10 to 15 per cent lower rate of gain when fed rations containing the same energy level as steers. Also cattle not given one of the growth stimulating compounds can be expected to have 10 to 15 per cent lower rate of gain on these rations.

Our experience indicates that using the protein levels shown for the various energy levels will result in satisfactory performance under most conditions. They are also useful in evaluating a ration to determine if it is adequate in protein for the energy level it contains.

These tables indicate that the ration should be balanced for protein every 100 lbs. It may be desirable to have on file each type of ration used balanced for protein in 100 lb. increments and then identified by body weights. Then the ration can be changed as the cattle increase in weight as often as practical, considering the variation in weight of the cattle within pens and practical limitation on the number of rations that can be handled at one time.

**TABLE 1. SUGGESTED DIGESTIBLE PROTEIN REQUIREMENTS FOR MAINTENANCE, GAIN OF BEEF CATTLE[1]**

| Lb. Daily Gain | Body Weight (lb.) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 |
| | Required Digestible Protein, Lb./head/day | | | | | | | | |
| 0.5 | 0.44 | 0.50 | 0.56 | 0.61 | 0.66 | 0.71 | 0.76 | 0.80 | 0.85 |
| 0.6 | 0.48 | 0.54 | 0.60 | 0.65 | 0.70 | 0.75 | 0.80 | 0.84 | 0.89 |
| 0.7 | 0.52 | 0.58 | 0.64 | 0.69 | 0.74 | 0.79 | 0.84 | 0.88 | 0.93 |
| 0.8 | 0.56 | 0.62 | 0.68 | 0.73 | 0.78 | 0.83 | 0.88 | 0.92 | 0.97 |
| 0.9 | 0.60 | 0.66 | 0.72 | 0.77 | 0.82 | 0.87 | 0.92 | 0.96 | 1.01 |
| 1.0 | 0.64 | 0.70 | 0.76 | 0.81 | 0.86 | 0.91 | 0.96 | 1.00 | 1.05 |
| 1.1 | 0.68 | 0.74 | 0.80 | 0.85 | 0.90 | 0.95 | 1.00 | 1.04 | 1.09 |
| 1.2 | 0.72 | 0.78 | 0.84 | 0.89 | 0.94 | 0.99 | 1.04 | 1.08 | 1.13 |
| 1.3 | 0.76 | 0.82 | 0.88 | 0.93 | 0.98 | 1.03 | 1.08 | 1.12 | 1.17 |
| 1.4 | 0.80 | 0.86 | 0.92 | 0.97 | 1.02 | 1.07 | 1.12 | 1.16 | 1.21 |
| 1.5 | 0.84 | 0.90 | 0.96 | 1.01 | 1.06 | 1.11 | 1.16 | 1.20 | 1.25 |
| 1.6 | 0.88 | 0.94 | 1.00 | 1.05 | 1.10 | 1.15 | 1.20 | 1.24 | 1.29 |
| 1.7 | 0.92 | 0.98 | 1.04 | 1.09 | 1.14 | 1.19 | 1.24 | 1.28 | 1.33 |
| 1.8 | 0.96 | 1.02 | 1.08 | 1.13 | 1.18 | 1.23 | 1.28 | 1.32 | 1.37 |
| 1.9 | 1.00 | 1.06 | 1.12 | 1.17 | 1.22 | 1.27 | 1.32 | 1.36 | 1.41 |
| 2.0 | 1.04 | 1.10 | 1.16 | 1.21 | 1.26 | 1.31 | 1.36 | 1.40 | 1.45 |
| 2.1 | 1.08 | 1.14 | 1.20 | 1.25 | 1.30 | 1.35 | 1.40 | 1.44 | 1.49 |
| 2.2 | 1.12 | 1.18 | 1.24 | 1.29 | 1.34 | 1.39 | 1.44 | 1.48 | 1.53 |
| 2.3 | 1.16 | 1.22 | 1.28 | 1.33 | 1.38 | 1.43 | 1.48 | 1.52 | 1.57 |
| 2.4 | 1.20 | 1.26 | 1.32 | 1.37 | 1.42 | 1.47 | 1.52 | 1.56 | 1.61 |
| 2.5 | 1.24 | 1.30 | 1.36 | 1.41 | 1.46 | 1.51 | 1.56 | 1.60 | 1.65 |
| 2.6 | 1.28 | 1.34 | 1.40 | 1.45 | 1.50 | 1.55 | 1.60 | 1.64 | 1.69 |
| 2.7 | 1.32 | 1.38 | 1.44 | 1.49 | 1.54 | 1.59 | 1.64 | 1.68 | 1.73 |
| 2.8 | 1.36 | 1.42 | 1.48 | 1.53 | 1.58 | 1.63 | 1.68 | 1.72 | 1.77 |
| 2.9 | 1.40 | 1.46 | 1.52 | 1.57 | 1.62 | 1.67 | 1.72 | 1.76 | 1.81 |
| 3.0 | 1.44 | 1.50 | 1.56 | 1.61 | 1.66 | 1.71 | 1.76 | 1.80 | 1.85 |
| 3.1 | 1.48 | 1.54 | 1.60 | 1.65 | 1.70 | 1.75 | 1.80 | 1.84 | 1.89 |
| 3.2 | 1.52 | 1.58 | 1.64 | 1.69 | 1.74 | 1.79 | 1.84 | 1.88 | 1.93 |
| 3.3 | 1.56 | 1.62 | 1.68 | 1.73 | 1.78 | 1.83 | 1.88 | 1.92 | 1.97 |
| 3.4 | 1.60 | 1.66 | 1.72 | 1.77 | 1.82 | 1.87 | 1.92 | 1.96 | 2.01 |
| 3.5 | 1.64 | 1.70 | 1.76 | 1.81 | 1.86 | 1.91 | 1.96 | 2.00 | 2.05 |

[1]Adapted from University of California

## TABLE 2. SUGGESTED TOTAL PROTEIN REQUIREMENTS FOR MAINTENANCE AND GAIN OF BEEF CATTLE[1]

| Lb. Daily Gain | Body Weight (lb.) 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 |
|---|---|---|---|---|---|---|---|---|---|
| | Required Total Protein, Lb./head/day | | | | | | | | |
| 0.5 | 0.64 | 0.73 | 0.82 | 0.89 | 0.97 | 1.04 | 1.12 | 1.18 | 1.25 |
| 0.6 | 0.69 | 0.78 | 0.87 | 0.94 | 1.02 | 1.09 | 1.17 | 1.23 | 1.30 |
| 0.7 | 0.75 | 0.84 | 0.93 | 1.00 | 1.08 | 1.15 | 1.23 | 1.29 | 1.36 |
| 0.8 | 0.80 | 0.89 | 0.98 | 1.05 | 1.13 | 1.20 | 1.28 | 1.34 | 1.41 |
| 0.9 | 0.86 | 0.95 | 1.04 | 1.11 | 1.19 | 1.26 | 1.34 | 1.40 | 1.47 |
| 1.0 | 0.91 | 1.00 | 1.09 | 1.16 | 1.24 | 1.31 | 1.39 | 1.45 | 1.52 |
| 1.1 | 0.97 | 1.06 | 1.15 | 1.22 | 1.30 | 1.37 | 1.45 | 1.51 | 1.58 |
| 1.2 | 1.03 | 1.12 | 1.21 | 1.28 | 1.36 | 1.43 | 1.51 | 1.57 | 1.64 |
| 1.3 | 1.08 | 1.17 | 1.26 | 1.33 | 1.41 | 1.48 | 1.56 | 1.62 | 1.69 |
| 1.4 | 1.13 | 1.22 | 1.31 | 1.38 | 1.46 | 1.53 | 1.61 | 1.67 | 1.74 |
| 1.5 | 1.19 | 1.28 | 1.37 | 1.44 | 1.52 | 1.59 | 1.67 | 1.73 | 1.80 |
| 1.6 | 1.25 | 1.34 | 1.43 | 1.50 | 1.58 | 1.65 | 1.73 | 1.79 | 1.86 |
| 1.7 | 1.30 | 1.39 | 1.48 | 1.55 | 1.63 | 1.70 | 1.78 | 1.84 | 1.91 |
| 1.8 | 1.36 | 1.45 | 1.54 | 1.61 | 1.69 | 1.76 | 1.84 | 1.90 | 1.97 |
| 1.9 | 1.41 | 1.50 | 1.59 | 1.66 | 1.74 | 1.81 | 1.89 | 1.95 | 2.02 |
| 2.0 | 1.46 | 1.55 | 1.64 | 1.71 | 1.79 | 1.86 | 1.94 | 2.00 | 2.07 |
| 2.1 | 1.52 | 1.61 | 1.70 | 1.77 | 1.85 | 1.92 | 2.00 | 2.06 | 2.13 |
| 2.2 | 1.57 | 1.66 | 1.75 | 1.82 | 1.90 | 1.97 | 2.05 | 2.11 | 2.19 |
| 2.3 | 1.63 | 1.72 | 1.81 | 1.88 | 1.96 | 2.03 | 2.11 | 2.17 | 2.24 |
| 2.4 | 1.68 | 1.77 | 1.86 | 1.93 | 2.01 | 2.08 | 2.16 | 2.22 | 2.29 |
| 2.5 | 1.74 | 1.83 | 1.92 | 1.99 | 2.07 | 2.14 | 2.22 | 2.28 | 2.35 |
| 2.6 | 1.79 | 1.88 | 1.97 | 2.04 | 2.12 | 2.19 | 2.27 | 2.33 | 2.40 |
| 2.7 | 1.85 | 1.94 | 2.03 | 2.10 | 2.18 | 2.25 | 2.33 | 2.39 | 2.46 |
| 2.8 | 1.90 | 1.99 | 2.08 | 2.15 | 2.23 | 2.30 | 2.38 | 2.44 | 2.51 |
| 2.9 | 1.96 | 2.05 | 2.14 | 2.21 | 2.29 | 2.36 | 2.44 | 2.50 | 2.57 |
| 3.0 | 2.01 | 2.10 | 2.19 | 2.26 | 2.34 | 2.41 | 2.49 | 2.55 | 2.62 |
| 3.1 | 2.07 | 2.16 | 2.25 | 2.32 | 2.40 | 2.47 | 2.55 | 2.61 | 2.68 |
| 3.2 | 2.12 | 2.21 | 2.30 | 2.37 | 2.45 | 2.52 | 2.60 | 2.66 | 2.73 |
| 3.3 | 2.18 | 2.27 | 2.36 | 2.43 | 2.51 | 2.58 | 2.66 | 2.72 | 2.79 |
| 3.4 | 2.23 | 2.32 | 2.41 | 2.48 | 2.56 | 2.63 | 2.71 | 2.77 | 2.84 |
| 3.5 | 2.28 | 2.37 | 2.46 | 2.53 | 2.61 | 2.68 | 2.76 | 2.82 | 2.89 |

[1]Adapted from University of California

For example, if the feeding program is to grow calves from 400 to 700 lbs. on corn silage and then finish on 10% corn silage dry matter plus a full feed of shelled corn plus supplemental protein to balance the ration, then it might be practical to have a grower 400, 500 and 600, and a finisher 700 and 900. The only difference between the grower 400, 500 and 600 rations would be a decrease in protein level as the cattle increase in weight. Similarly the only difference between the finisher 700 and 900 would be a decrease in protein level as the cattle increase in weight.

If feeding the protein supplement on a lb. per head basis, the ration can be balanced for the average weight of the cattle over the period of time the cattle are to be on a particular ration, and then the amount of protein supplement required at this average weight can be fed over the period of time the ration is fed. This will result in a higher per cent protein intake when the cattle are lighter and consuming less feed, which is as it should be. Then as the cattle get heavier and consume more feed, the proportion of supplement in the ration decreases, reducing the per cent protein in the ration. For example, if cattle are to be fed from 700 to 1100 lbs. on 5 lbs. of corn silage per head daily and a full feed of corn plus supplement to balance the ration, the expected rate of gain is about 3 lb. per day. The *total protein* requirement for the average weight of 900 lb. is 2.49 lb., and the expected *total protein intake* is 1.97 lb. from the shelled corn and silage at the average weight of 900 lb. The supplemental total protein required would be 2.49 – 1.97 = 0.52 lb., and if a high urea 60% protein supplement is to be used to balance the ration,

the amount needed would be $\frac{0.52}{60} \times 100 = 0.87$ lb. per head

daily, and this amount could be fed from 700 to 1100 lb.

*Recent studies in Ohio and Iowa suggest that moderate sized cattle in average condition previously fed a high grain ration for 60 to 90 days prior to reaching 75% of their optimum slaughter weight (about 750 to 800 lb. for average size cattle), may require only about 10% protein in the ration dry matter beyond this weight. If the protein supplement is withdrawn at that time, however, be sure adequate levels of minerals, vitamins and feed additives are provided. However, since NPN can be economically fed to cattle over 600 to 700 lb., it is less risky to include NPN in the ration than to withdraw supplemental protein altogether.*

## TABLE 3. AVERAGE EXPECTED DRY MATTER INTAKES PER HEAD DAILY FOR BEEF CATTLE[1]

| Body Weight | Expected dry matter intake |
|---|---|
| 300 | 9.0 |
| 400 | 11.0 |
| 500 | 12.5 |
| 600 | 14.5 |
| 700 | 16.5 |
| 800 | 18.5 |
| 900 | 20.0 |
| 1000 | 21.5 |
| 1100 | 23.0 |
| 1200 | 24.0 |

[1]Intakes will average 10% less if Rumesin is fed.

## TABLE 4. NET ENERGY (GAIN) AND PROTEIN REQUIREMENTS FOR VARIOUS RATES OF GAIN IN GROWING AND FINISHING RATIONS.

| Expected lbs. Dly. gain, Steers[2] | NE(g) MCal/cwt. of dry matter | Mean Body Weight, Lb.[1] 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | % digestible protein required, 100% dry matter basis[3] | | | | | | | | |
| 1.0 | 35 | 7.1 | 6.3 | 6.0 | 5.6 | --- | --- | --- | --- | --- |
| 1.4 | 40 | 8.9 | 7.8 | 7.3 | 6.7 | --- | --- | --- | --- | --- |
| 1.8 | 45 | 10.6 | 9.3 | 8.6 | 7.8 | 7.1 | 6.6 | 6.4 | 6.1 | 5.9 |
| 2.2 | 50 | 12.4 | 10.7 | 9.9 | 8.9 | 8.1 | 7.5 | 7.2 | 6.9 | 6.6 |
| 2.6 | 55 | 14.2 | 12.2 | 11.2 | 10.0 | 9.1 | 8.4 | 8.0 | 7.6 | 7.3 |
| 2.9 | 60 | 15.6 | 13.7 | 12.1 | 10.8 | 9.8 | 9.0 | 8.6 | 8.2 | 7.8 |
| | | % total protein required, 100% dry matter basis[3] | | | | | | | | |
| 1.0 | 35 | 10.1 | 9.1 | 8.7 | 8.0 | --- | --- | --- | --- | --- |
| 1.4 | 40 | 12.5 | 11.1 | 10.5 | 9.5 | --- | --- | --- | --- | --- |
| 1.8 | 45 | 15.1 | 13.2 | 12.3 | 11.1 | 10.2 | 9.5 | 9.2 | 8.8 | 8.5 |
| 2.2 | 50 | 17.4 | 15.1 | 14.0 | 12.5 | 11.5 | 10.6 | 10.2 | 9.8 | 9.5 |
| 2.6 | 55 | 19.9 | 17.0 | 15.7 | 14.1 | 12.8 | 11.8 | 11.3 | 10.8 | 10.4 |
| 2.9 | 60 | 21.7 | 18.6 | 17.1 | 15.2 | 13.8 | 12.7 | 12.2 | 11.6 | 11.2 |

[1]These tables are based on average feedlot steers, and age and physiological stage of maturity should be considered when using these values.

[2]Calculated from rations having NEm values of 55, 63, 70, 78, 85 and 93, respectively with the NE(g) values shown above. Yearling steers previously fed for slow rates of gain can be expected to gain 10 to 15 percent faster than the rates of gain shown for the various energy levels. Heifers of the same weight can be expected to have a 10 to 15 percent lower rate of gain when fed rations containing the same energy level as steers. Also cattle not given one of the growth stimulating compounds can be expected to have a 10 to 15 percent lower rate of gain on these rations.

[3]Based on the average expected dry matter intakes for the various weights of cattle shown in Table 3.

Below are estimated equivalent weights. For example, a 700 lb. large frame steer should be fed the same protein level as a 600 lb. average frame steer.

## ESTIMATED EQUIVALENT WEIGHTS WHERE PROPORTION OF BODY FAT AND PROTEIN ARE SIMILAR

| **Steers** | **Weight, lb.** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Small frame | 240 | 320 | 400 | 480 | 560 | 640 | 720 | 800 | 880 | 1140 |
| Average frame | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1430 |
| Large frame | 360 | 480 | 600 | 720 | 840 | 960 | 1080 | 1200 | 1320 | 1720 |
| **Heifers** | | | | | | | | | | |
| Small frame | 200 | 260 | 330 | 390 | 460 | 530 | 590 | 660 | 720 | 940 |
| Average frame | 240 | 320 | 400 | 480 | 560 | 640 | 720 | 800 | 880 | 1140 |
| Large frame | 280 | 375 | 470 | 560 | 660 | 750 | 840 | 940 | 1030 | 1340 |
| % of mature wt. | 21 | 28 | 35 | 42 | 49 | 56 | 63 | 70 | 77 | 100 |

*Mature weight* = point where no additional weight of muscle tissue is deposited.

*Small Frame* = will reach fatness of low choice—yield grade 2 1/2-3 at 800-880 lb. for steers and 660-720 lb. for heifers.

*Average Frame* = will reach fatness of low choice and yield grade 1 1/2-3 at 1000-1100 for steers and 800-880 for heifers.

*Large Frame* = will reach fatness of low choice and yield grade 2 1/2-3 at 1200-1320 for steers and 940-1030 for heifers.

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