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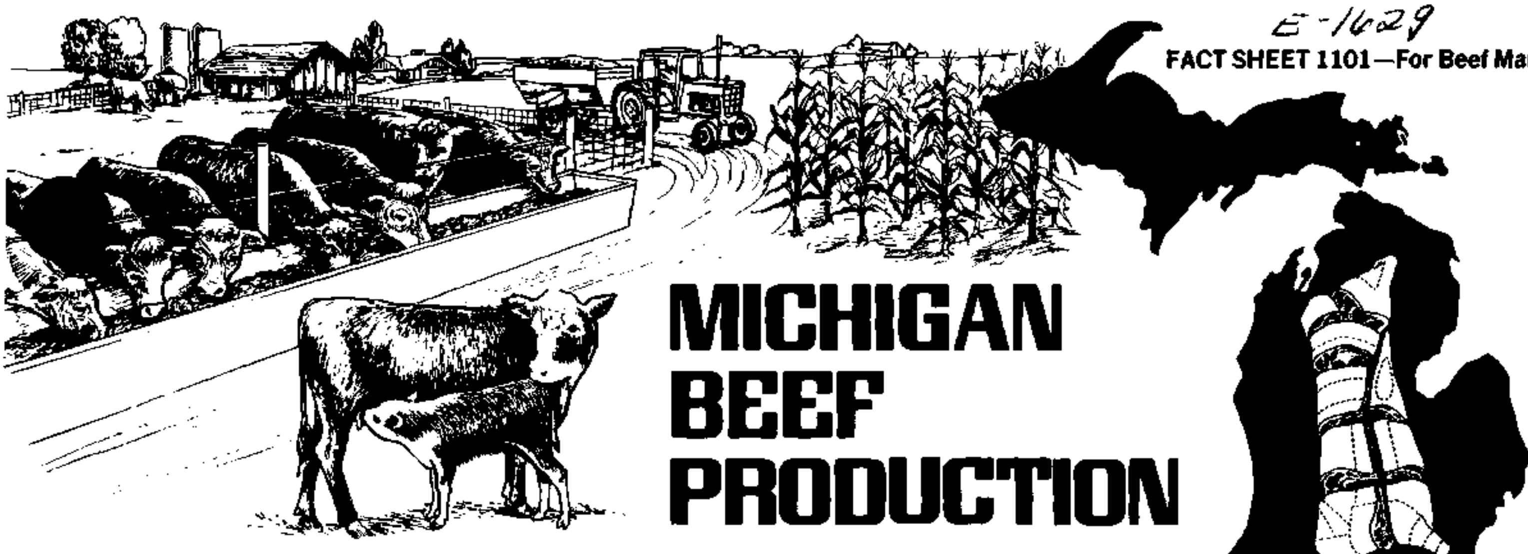
FACT SHEET 1101—For Beef Manual



Cooperative Extension Service · Michigan State University

The Meaning and Use of Feed Analysis

Dan G. Fox, Beef Specialist, Animal Husbandry Department

An animal's nutrient requirements must be met if optimum performance is to be obtained. Thus, the first step in developing a feeding system is to properly identify energy, protein, mineral, and vitamin requirements. These are outlined in Fact Sheets 1000-1097. The next step is to calculate the combination of feeds among those available that will economically meet the requirements. This is accomplished through ration balancing as discussed in Fact Sheets 1200 through 1215.

The nutrients required are compared to nutrients available, and the deficiencies are met by adding feeds containing high concentrations of the deficient nutrients. Therefore, to accurately assess supplemental nutrient needs, accurate estimates of the nutrients in the home grown feeds are needed. Large numbers of feeds have been tested across the U.S.; averages of these tests have been used by the National Research Council to build *Feed Composition Tables*. We adjusted these tables based upon tests on feeds grown in Michigan and from values obtained at the MSU Beef and Dairy Research Centers. These values are summarized in Fact Sheet 1102,"Feed Composition Values." These values should provide reasonable guides for most conditions in Michigan.

Nutrient values for individual feeds vary considerably from farm to farm and from year to year, as a result of differences in variety, soil fertility, weather, date of harvest, and harvesting and storage procedures. Table 1 presents the low, average, and high values for several nutrients in selected feeds that were sampled on a number of Michigan farms. Shown at the top of the table are the requirements of feedlot cattle. These values can be compared to those for individual feeds to see which are deficient in various nutrients. It is clear that silage is more variable than grain in nutrient composition.

In 1975, to further illustrate the variability, 21 corn silage samples grown in a crop variety trial in Gratiot County, Michigan varied from 4.4% to 7.6% total protein (dry matter basis). All were below the average given in Table 1.

Thus it is obvious that feed analysis is important. The problem is to decide what it is practical to test for; when and how often to sample your own feeds; and how to get a representative sample. Nutrients of concern include energy, protein, calcium, phosphorus, Vitamin A and some of the trace minerals. In deciding what to test for, the variability of the nutrient, the cost of analysis, and the cost of supplementation must be considered.

THE VALUE OF ANALYSIS FOR VARIOUS NUTRIENTS

ENERGY: The primary source of energy in home grown feeds is carbohydrates. Carbohydrates include sugar, starch, cellulose and hemicellulose. The cellulose and hemicellulose are contained in plant cell walls in a complex with lignin, an indigestable compound, while the sugars and starchs are found in the cell contents. The cell walls are the lowest in digestibility, and cell contents highest. Thus, the higher the proportion of cell walls, the lower the TDN and net energy value of the feed.

The following laboratory procedures are used to estimate the usable energy content of a feed sample sent in for analysis.

1. *Crude fiber*. This is the standard analysis for the fibrous parts of the plant. Its development dates back to 1864. Digestibility and thus energy value typically decreases as the crude fiber percentage increases. However, it is only a rough guide to differences in fiber across feeds. The fiber of immature plants contains mostly cellulose, and little lignin; the cellulose is highly digestible. In contrast, the fiber of mature plants contains large amounts of lignin, which is indigestible. Another shortcoming is that the crude fiber procedure does not measure accurately all of the lignin.

2. *Nitrogen Free Extract (NFE)*. NFE represents the energy in the highly digestible cell contents, or sugars and starchs. NFE however is not directly determined. It is estimated by subtracting the amount of moisture, crude fiber,fat, protein and minerals- items directly determined by analysis-- from the total weight (on an as-fed basis) of the sample. It contains, as a consequence, the measurement errors of estimating each item, including the lignin missed in the crude fiber determination. Thus NFE is only a rough estimate of sugar and starch content.

3. *Fat*. Fat has 2.25 times as much energy as carbohydrates and is a valuable nutrient. However, most home grown feeds contain less than 5% fat. It is measured as ether extract, a reasonably accurate procedure.

4. *Total Digestible Nutrients (TDN)*. TDN represents the proportion of the energy sources-- fiber, protein, sugars, starchs, and fat-- that are digestible. TDN is calculated by determining the moisture, crude fiber, NFE, protein, fat, and minerals in the feed, multiplying each item by its digestibility, and adding up the percentages. Usually, average digestibilities from many experiments are used. The fat value is multiplied by 2.25 in the calculations to adjust for its higher energy value.

The example on the following page shows how this is done:

Component	% in Feed	Average Digest-ibility	% of Digestible Components of Feed
Water	10	--	
Crude fiber	10	50	50 x 10% = 5.00
Ether extract (fat)	3	90	3 x 90% x 2.25 = 6.08
Protein	10	75	10 x 75% = 7.50
Minerals	2	--	
NFE	65	90	65 x 90% = 58.50
Total	100		77.08

For this example, TDN is 77.08%. Since the feed contains 10% moisture (or is 90% dry matter) the TDN content of the dry matter is 85.7.
That's 77.08 ÷ .9.

If you have a total feed analysis of a feed sample, the estimated TDN value would be calculated in this manner. Because of the errors in this system discussed previously and in Fact Sheet 1010, "Energy Utilization by cattle, and the use of energy values in ration formulation" it is only an estimate of the energy content. Feeds high in TDN will also be high in net energy, however. TDN values can be used to rank feeds in order of their net energy content.

5. *Newer Methods*. Newer methods potentially more accurate, are being tested. Acid detergent fiber (ADF) appears to be the most promising. This procedure accurately measures the amount of poorly digestible cell wall components, primarily lignin; formulas are under development that can be used to estimate net energy content of a feed from an analysis for ADF.

6. *Other Means of Estimating Energy Content*. There are methods of estimating energy content of the feed that probably are more useful in identifying the energy content of a feed than chemical analysis.

a. Plant maturity - Early cut, immature plants are much higher in energy than late cut, mature plants due to a lower fiber (cell wall) content. Therefore, comparing the maturity of your forage with those listed in Fact Sheet 1102, "Feed Composition Values,"provides a reasonable estimate of the energy content.

b. Weather damage - Weather damaged hay, even though early cut, is lower in energy because rain leaches out some of the cell contents, primarily soluble sugars. As a result, weather damaged early cut hay becomes like undamaged hay cut later in energy content. The same is true of corn stalks or grass left for winter grazing. They will have the highest energy content early in the season.

c. Grain Content of Silage -Although not carefully studied in research trials, experience suggests corn silage with a high grain content, such as short stalked, high grain yielding varieties is higher in energy than tall corn varieties with a similar grain yield. Athough the latter would likely give more energy per acre, the energy content/lb. dry matter will be lower. Fact Sheet 1102, "Feed Composition Values" gives estimates of the energyvalue of corn silage with various grain contents, based on research at State Universities in Nebraska, Iowa,Minnesota, Ohio and Michigan. To estimate the grain content of your silage, divide the bushels of no. of corn/acre by the tons of 32% dry matter silage/acre.

PROTEIN: The (crude) total protein content of a feed sample can be accurately determined by laboratory analysis. It is determined by measuring the nitrogen in the feed, and converting it to protein by multiplying by 6.25. The basis for this is protein contains 16% nitrogen, or 1 part of nitrogen/6.25 parts protein. Thus if a shelled corn sample was found to have 1.61% nitrogen in the dry matter, it would be estimated to have 1.61 x 6.25 = 10.06 % total protein. Use of this procedure also results in an estimate of the amount of protein that can be synthesized in the rumen of cattle from the ammonia or urea in a feed, such as in treated silage. *However, it does not tell the amount of protein that will be available to the animal for maintenance, growth or milk production because part of the protein will not be digestible or will be lost as ammonia when it is degraded in the rumen.* The amount of loss varies with the feedstuff. A higher proportion of the protein in fermented feed will not be digestible as compared to dry feeds due to changes that occur in the structure of the protein during fermentation. Therefore, a ration based on corn silage with 8% total protein will need more total ration protein than a ration with comparable net energy content containing c grain and hay. Fact Sheets 1097 and 1204, which outline supplementation programs for corn-corn silage rations, make adjustments for the lower protein quality of corn silage. Protein sources in the supplement such as urea and other NPN products will also normally have higher losses than protein from natural sources because the rate at which these products are normally broken down to ammonia in the rumen exceeds the rate at which the rumen bacteria cán incorporate the ammonia into protein. In spite of the variation in quality, analysis for total protein is the most important because it is one of the most expensive nutrients and because the protein content of corn and corn silage is inadequate to meet the needs of growing and finishing cattle. Further, there is substantial variation in the protein content of corn silage. As a result of this protein variability we have added a 10 to 20% safety factor in our protein recommendations in Fact Sheets 1097, "Summary of Nutrient requirments of growing and finishing cattle" and 1204, "Protein Supplemnts for Corn corn silage rations". If accurate nutrient values are obtained by feed analysis the safety factor used in determining the amount of protein supplement to feed can be reduced. Even though analysis does not give us the *usable* protein it does tell us whether our silage is 4.4 or 10.8% protein.

MINERALS: Accurate methods are available for mineral analysis, and these are valuable as most Michigan rations need some supplemental minerals. The most important one, however, is the phosphorus content of silage and hay since it is the most expensive to supplement and most rations, particularly high forage rations, are deficient in phosphorus. However, many forages will be adequate in phosphorus; and less expensive supplementation programs can be developed.

Calcium can be cheaply supplemented with calcium carbonate (ground limestone), and it is therefore of no great concern to obtain an analysis in order to save supplemental calcium.

As shown in Table 1, most Michigan feeds are adequate, or nearly adequate in trace minerals. Although trace mineral analyses are helpful in pinpointing specific deficiencies, feeding trace mineral salt will usually provide enough safety factor to cover any trace mineral deficiencies that might exist in the home grown feed.

VITAMINS: The only vitamins normally of concern in Michigan rations are A and D, and sometimes E. Vitamin A content can be determined through an analysis for carotene content, as cattle convert carotene to vitamin A. However, it is not of great concern, because typical Michigan management practices provide adequate quantities of Vitamin A. New feeder cattle are usually injected with 1-2 million I.U. of Vitamin A to aid in combating stress. Also most Michigan rations are high in corn silage, which is usually high in carotene content. Further, the cost of providing supplemental Vitamin A is minimal. The guides given in Fact Sheets 1060, "Vitamin Requirements of Cattle", 1097, "Summary of Nutrient Requirements of growing and feeding cattle", 1102, "Feed Composition Values", can be used to figure supplemental Vitamin A, D, and E needs.

Under most conditions it is not practical to analyze for Vitamins A and D. Cattle synthesize adequate quantities of Vitamin D when exposed to light. Therefore, the only time it is necessary to supplement with Vitamin D is when cattle are fed in complete confinement. Supplemental Vitamin E should be provided if grains are heat processed before feeding. Otherwise most natural feedstuff contains adequate amounts of Vitamin E.

SAMPLING FEEDS FOR ANALYSIS

Inaccurate sampling can lead to greater errors than using average values from feed composition Tables. The sample must be representative of all the feed in question. The important factors to consider are when and how to sample feeds for analysis. Your local county agent has sample bags and information on obtaining feed analysis through the Ohio State University feed analysis service. Also most reputable feed companies will analyze your feed. There are also private laboratories that offer this service. After obtaining sample bags, the following guides can be used to obtain a representative sample.

HIGH MOISTURE CORN, CORN SILAGE AND HAYLAGE:

Sampling at harvest: Collect 3 to 5 handfuls of silage from one or two loads each day. For example, you might sample the last load before lunch and the last load of the day. Place the sample in a plastic bag and put in a freezer immediately. Then mix samples together after the silo is filled, and place about one quart in a plastic bag and send it in for analysis. Keep separate samples from different silos if they are filled with silage from different varieties and/or at different maturities. When they are fed, some adjustments in supplement can then be made if they are different.

Taking samples from the silo: (Silage needs to be sampled after filling if treated with NPN).

A. Upright silo - collect a one to two quart sample from the discharge of the silo unloader when you are about through feeding. Be sure two to three feet have been removed before sampling to avoid spoiled or exceptionally dry material.

B. Bunker silos - or piles - Take 15 or more handfulls from all over the face of the silo after it is opened and you are into well packed, good quality silage. Mix the samples in a clean pail, then place about one quart in a plastic bag and either freeze it or send immediately for analysis. It is desirable to sample several times during the feeding period, particularly if there is any great variation in plant maturity, variety or soil type.

DRY GRAIN SAMPLING: Take a minimum of 5 grain samples, with a grain probe if possible, from various places in the bin or truck. Mix them in a clean pail, then place about one pint in a plastic bag, seal and send in for analysis.

HAY SAMPLING: To sample loose or chopped hay, take samples from various locations in the pile or stack, using a core forage sampler. To sample baled hay, take core samples from the end of a dozen or more bales taken from various places in the mow or stack. Mix samples together, then send in about one quart in a sealed plastic bag for analysis.

USING THE RESULTS OF A FEED ANALYSIS

It is of little value to analyze your feeds if you don't make use of the results. There are three ways MSU can help you use the values obtained to balance your ration.

1. Use the results to balance your own ration. Fact sheets 1097,"Summary of Nutrient Requirements of Growing and Finishing Cattle," 1098 "Ration Evaluation Worksheet", 1102,"Feed Composition Values," and 1200, "Formulating Rations for Growing and Finishing Cattle" were designed to be used by cattle feeders to balance their rations. If your values are similar to those in fact sheet 1102, "Feed composition values", you can use the guideline rations given in Fact Sheets 1204, 1204A and 1204B, "Protein-Mineral Supplements for Shelled Corn - Corn Silage Rations,; 1201, "High Roughage Rations for Growing Beef," and 1202, "High Grain Rations for Finishing Beef."

2. Have your local county agent help you balance your rations. He will likely use the above fact sheets to do this.

3. Have your local county agent balance your rations on the computer. There is a service now available for having your rations balanced by computer. It will evaluate your present feeding prpgram. It can also build you a new set of rations and a protein mineral supplement will give you the expected feed intake and rate of gain on the rations, and a "feedsheet" that gives you the amount of ingredients for each batch size or amount to feed of each ingredient/head/day. It will also give you the expected weight of your cattle after different lengths of time on your ration and the amount of feed that will be used after different lengths of time on feed. *See Fact Sheet 1210, Computer Ration Formulation for details.*

4. Know how to use the recommendations from the Ohio State feed analysis. It may tell you to feed more or less grain than is profitable for your operation. For example, you asked for a ration for a 3 lb/day gain when you are feeding an all silage ration. Normally, your ration could be expected to give a 1.8 to 2.2 lb./day gain. If you wanted it balanced as an all silage ration, you should have indicated the rate of gain you can normally expect on this ration. You first have to decide which level of grain feeding is most profitable, then indicate the rate of gain you can expect from it to have the ration properly balanced through the Ohio State feed analysis service. Use fact sheet 1097 to estimate expected gains from different levels of grain feeding.

TABLE 1. Nutrient Composition of Feeds from some Michigan Farms in 1974.

Feed	D.M.	C.P.	P	K	Ca	Mg	S	Mn	Fe	Cu	Zn
	Requirement of Feedlot Cattle[1]										
	------------%							------ppm			
		10-13	.24-.34	.6	.28-.46	.1	.15	30	30	10	30
	Composition of feed samples[2,3]										
Legume-Grass Hay (15 samples)											
Average	88.5	12.5	.28	2.11	.90	.23	.15	30	92	10	28
Minimum	81.4	7.3	.18	1.44	.56	.12	.11	<10	63	7	21
Maximum	92.8	18.2	.39	2.94	1.31	.33	.25	76	165	17	34
Legume-Grass Silage (20 samples)											
Average	40.0	13.6	.32	2.37	1.13	.26	.24	31	261	9	25
Minimum	27.1	6.7	.23	1.12	.63	.11	.13	<10	100	7	21
Maximum	72.5	18.6	.40	4.01	1.51	.36	.30	55	702	13	81
Corn Silage (22 samples)											
Average	36.2	8.3	.29	1.08	.28	.23	.11	38	368	10	37
Minimum	25.4	5.7	.20	.61	.13	.13	.08	<10	132	7	27
Maximum	55.0	10.8	.37	1.72	.75	.37	.13	125	1005	16	59
Corn Silage (NPN) (20 samples)											
Average	36.1	11.8	.34	1.21	.42	.27	.14	24	324	9	46
Minimum	30.1	8.8	.25	.91	.20	.19	.08	<10	143	8	23
Maximum	50.3	15.9	.44	2.21	1.88	.34	.21	55	853	12	73
Shelled Corn (7 samples)											
Average	73.1	10.1	.49	.52	<.10	.19	12	<10	65	7	35
Minimum	63.9	9.3	.39	.43	<.10	.15	--	--	57	6	29
Maximum	78.8	10.9	.55	.56	<.10	.22	--	<10	83	7	48
Ground Ear Corn (10 samples)											
Average	70.1	9.4	.43	.61	<.10	.16	.13	<10	89	7	35
Minimum	65.3	8.4	.32	.51		.11	.12	<10	45	6	27
Maximum	78.8	11.0	.56	.70	<.10	.23	.14	22	186	9	47

[1] The low value is for heavy cattle and the high value is for calves.

[2] The following abbreviations are used for trace minerals: S=Sulfur; Mn = Manganese; Fe = iron; Cu=Copper; Zn = Zinc.

[3] < = less than