The Oklahoma Cooperative Extension Service
Bringing the University to You!

The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; family and consumer sciences; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of the Cooperative Extension system are:

- The federal, state, and local governments cooperatively share in its financial support and program direction.
- It is administered by the land-grant university as designated by the state legislature through an Extension director.
- Extension programs are nonpolitical, objective, and research-based information.
- It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.
- It utilizes research from university, government, and other sources to help people make their own decisions.
- More than a million volunteers help multiply the impact of the Extension professional staff.
- It dispenses no funds to the public.
- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
- Local programs are developed and carried out in full recognition of national problems and goals.
- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
- Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.

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Nutritive Value of Feeds for Beef Cattle

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Animals require consumption of chemical elements and compounds to sustain bodily functions, for skeletal and tissue growth, and to support the reproductive process. The necessary chemical elements and compounds are referred to as nutrients and can be classified into six categories: water, carbohydrates, lipids or fats, proteins, minerals, and vitamins. The objective of feed evaluation is to provide a rapid and economical method to determine the nutrients available (nutritional value) in a feed. For well over 100 years, the proximate analysis system has been used to describe the chemical composition of feeds. Components of proximate analysis are shown in Figure 1.

Nutritional value is determined by nutrient concentration and nutrient digestibility. Proximate analysis is one method used to determine nutrient concentration, although very little information about nutrient digestibility is gained. True nutrient digestibility information is determined using digestion trials, but it is not practical to test digestibility on all feeds. Therefore, previous digestibility information from similar feeds and previous relationships between digestibility and some nutrient concentration measures is commonly used to estimate digestibility. Table 1 contains average nutrient concentration values for numerous feeds that are common in Oklahoma. Values in the table represent averages from numerous different sources, such as the National Research Council's Nutrient Requirements of Beef and Dairy Cattle publications, commercial laboratories, research trials, and other publications. Beef magazine also publishes a Feed Composition Guide that is updated annually. The 2008 guide can be found at http://beefmagazine.com/images/2008_feed_comp_cattle_sheep.html.

Producers must recognize that values published in any table are merely typical averages and that variation among grains, oilseeds, byproducts, and in particular forages and roughages can be extreme. Furthermore, various processing methods may also alter the digestibility. For this reason, producers are advised to have their feeds and forages tested for nutrient composition by commercial laboratories. To improve quality control and standardization among commercial laboratories, the National Forage Testing Association (NFTA), found at http://www.foragetesting.org, provides a unique certification service. At this Web site, one can also view the NFTA's recommendations for laboratory procedures and equations for use in predicting energy availability for different forage types. One of the primary decisions you will have to make is to have a Near Infrared Reflectance Spectrophotometer (NIRS) or wet chemistry. Generally NIRS is less costly as it estimates wet chemistry values by bouncing light through samples. With this type of analysis, the lab should have a list of types of feed samples that they can analyze by this method. For instance, most labs can perform quality NIRS analysis on alfalfa samples. For samples that the lab does not specify they have NIRS capabilities, you should consider having wet chemistry analysis completed.

Dry Matter

Dry matter (DM) expresses the proportion of the feed that is not water. The moisture concentration is determined by weighing the feed sample soon after the sample has been collected. Next, the sample is placed in a drying oven until all of the water has been evaporated. Finally, the dried sample is weighed again and the DM content is calculated by difference. Other than physical characteristics of the feed, moisture content has little to no bearing on the availability of nutrients within that feed.

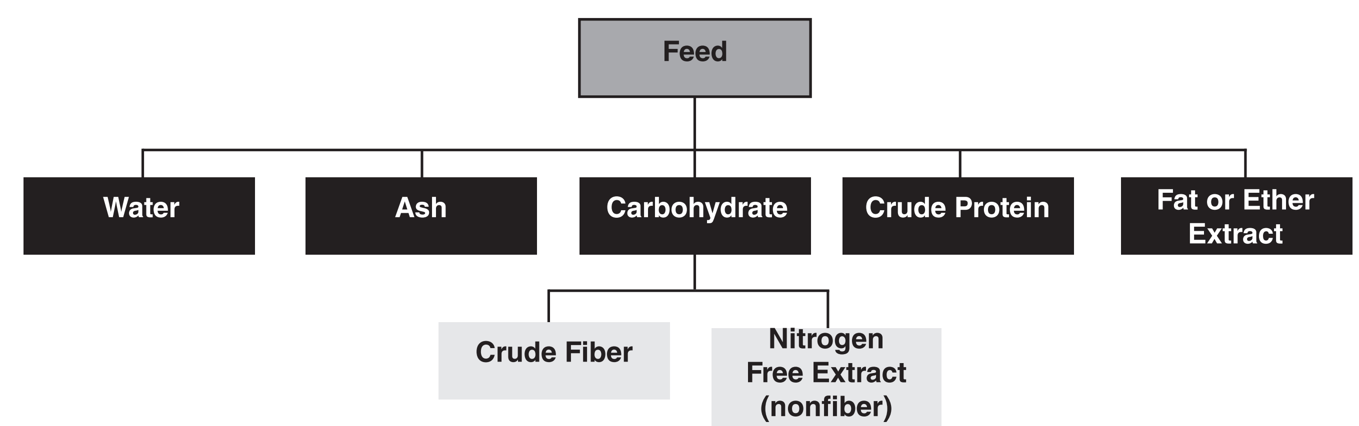

Figure 1. Nutrient concentrations of feed determined from proximate analysis.

Dry matter is an extremely variable component among and within types of feeds. Fresh forages, silages and wet by-product feeds are likely to vary the most in DM content. Some silages and byproduct feeds contain as little as 25 percent DM (75 percent moisture). A good rule of thumb is that dry feeds should contain no more than about 12 percent moisture for safe storage in overhead bins.

Fiber

The original proximate analysis system separated carbohydrates into crude fiber and nitrogen free extract (NFE) fractions. The crude fiber portion of the feedstuff was intended to represent the indigestible fiber fraction and NFE was supposed to represent the more readily digestible carbohydrates, such as sugars and starches. However, it was soon discovered that this system had serious limitations, particularly for fibrous feeds like forages.

Because of the wide variation in chemical analyses for crude fiber and NFE, a new system called the detergent fiber system was developed, which better reflects true carbohydrate digestibility in ruminants (Figure 2). The neutral detergent solubles (NDS) fraction is comprised of cell contents that are nearly 100% digestible. The neutral detergent insoluble fiber (NDF) fraction is made up of primarily cell wall tissue, which consists of hemicellulose, cellulose, and lignin. The NDF fraction also contains small amounts of silica and fiber-bound or heat-damaged protein. The NDF fraction of feeds and forages is quite variable in digestibility. Using an acid solution, the NDF residue can be further separated into acid detergent solubles (ADS; primarily hemicellulose) and acid detergent insoluble fiber (Figure 3). The acid detergent insoluble fiber fraction

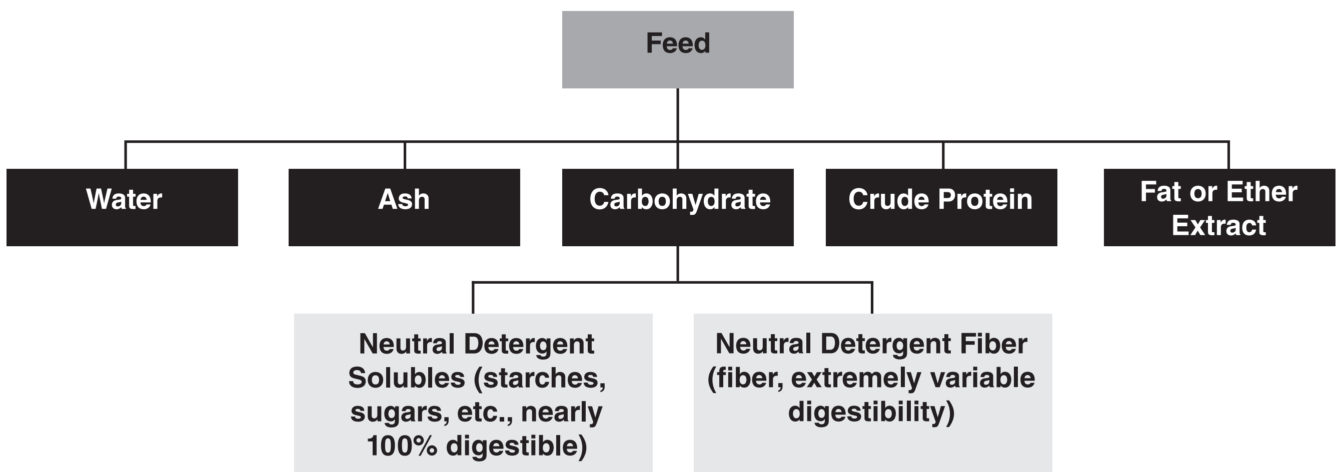

Figure 2. The detergent fiber system.

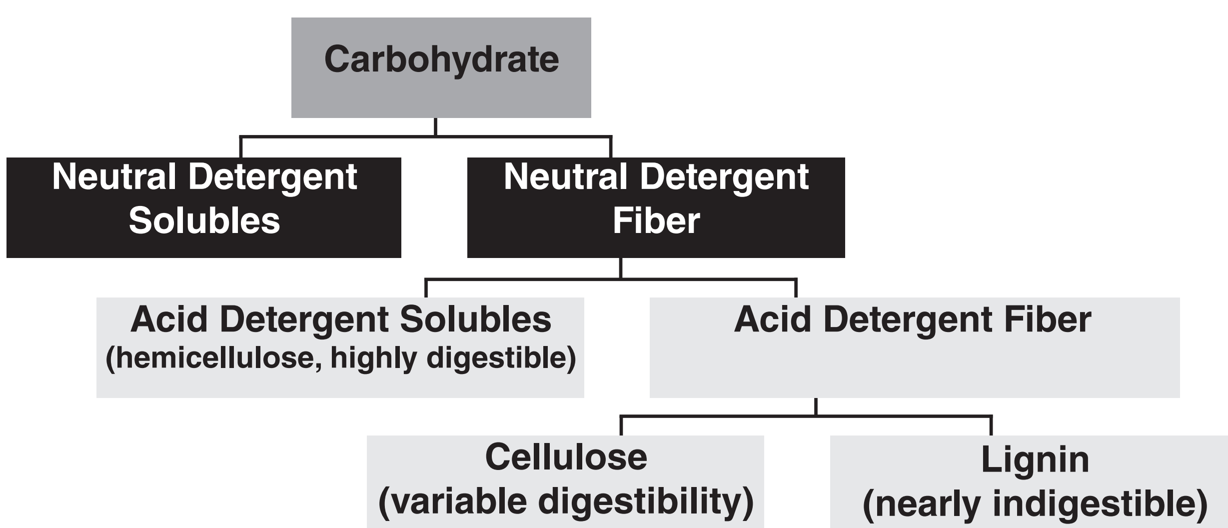

Figure 3. Fiber fractions in the detergent fiber system.

Conclusion

Producers have to ensure that their animals' diets include the proper balance of the six essential nutrients in a physical form that maintains digestive system health and function. To accomplish this, producers must have good knowledge of available feed nutrient composition, physical and digestive characteristics, and the animal's nutrient requirements.

Nutrient concentration and digestibility data can be determined by using digestion trials or measuring chemical composition and applying this information to estimate digestibility. It is imperative that producers recognize that values published in any table are merely averages and that variation among feed commodities, oilseeds, and in particular forages and roughages can be extreme. For this reason, producers are advised to have their feeds and forages tested for nutrient composition by commercial laboratories.

References

2008 Feed Composition Guide. (2008) Beef. Retrieved from http:// at http://beefmagazine.com/images/2008_feed_comp_cattle_sheep.html

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contains cellulose, which has variable digestibility, and lignin, which is nearly indigestible.

With purchased feeds that come with a feed tag, crude fiber is the only fiber analysis that is required. Unfortunately, this provides little assistance in determining the nutrient value or digestibility of the feed. However, it may be possible for your feed representative to provide you with NDF and ADF values. NDF concentration is highly inversely related to the amount of the feed the cattle will eat. Because digestibility of fiber is proportional to the amount of lignin in the plant material, ADF is inversely related to the digestibility of feed ingredients. This relationship explains why some forages and feeds contain high NDF concentrations, but remain high in digestibility, while others may contain moderate or low NDF concentrations, yet are low in digestible energy.

Effective NDF

The effective NDF (eNDF) value shown in Table 1 is a measure of the feed NDF that is effective in stimulating rumen motility or churning. The layman term for eNDF is the scratch value of the feed. If the rumen stops churning, acidic gasses build up causing the pH to drop. The result is bloat, acidosis, and/or founder, as well as reduced diet digestibility. The table expresses eNDF as a percentage of NDF. This value is determined by several factors including particle size, density, hydration, and degree of lignification. To maintain optimal forage digestion, the diet should contain a minimum of 20 percent eNDF on a DM basis.

Protein

Protein values in the Table 1 reflect CP, which is simply nitrogen concentration multiplied by 6.25. The degradable intake protein (DIP) column is an estimate of the proportion of the crude protein that is actually degradable in the rumen and is expressed as a percentage of CP. Undegradable protein (percent of CP) can be calculated by subtracting the DIP value from one hundred.

Feed Energy Values

Feed energy values are expressed on a DM basis as percent total digestible nutrients (TDN), net energy for maintenance (NEm), and net energy for gain (NEg) units (mega calories per 100 lbs of feed). TDN is determined by carrying out a digestion trial and summing the digestible protein and carbohydrates plus 2.25 times digestible ether extract. Ether extract (EE) is the fat or lipid portion of the feed. The net energy system is generally thought to be more precise in estimating the energy value of feeds, particularly roughages. The net energy of feed is the portion that is available to the animal for maintenance or various productive purposes. The portion used for maintenance (NEm) is used for muscular work, maintenance and repair of tissues, maintaining a stable body temperature, and other body functions. Most of this energy that was digested will leave the animal's body as heat. The energy that is used for productive purposes (NEg) may be recovered as growth through retaining energy in tissues. Energy for productive purposes is less efficient than energy used for maintenance. Milk production is unique because its energy efficiency is similar to maintenance uses.

Minerals

Minerals that are needed by animals in larger quantities are referred to as macro minerals. These minerals are shown in Table 1 and feed concentration is expressed on a percent of DM basis. Minerals that are needed by animals in much smaller quantities are referred to as micro minerals and feed concentration is expressed in parts per million (ppm) in the table. To convert ppm to percent, simply move the decimal place four places to the left. For example, if a feed contained 12 ppm copper, the copper concentration expressed as a percentage would be 0.0012 percent.

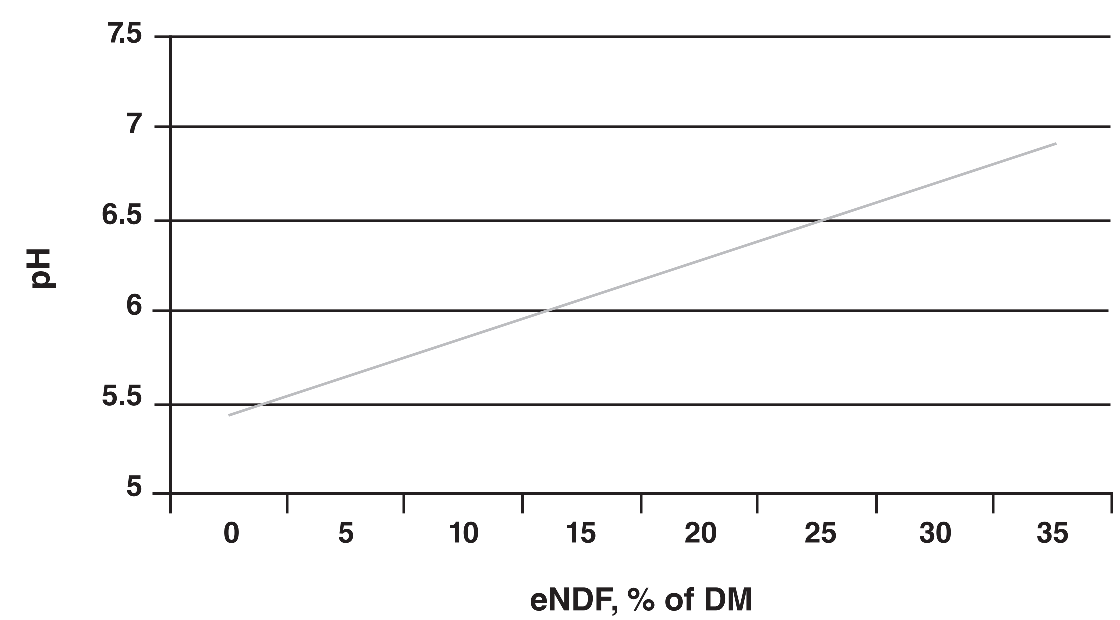

Figure 4. The relationship of effective NDF and rumen pH.

Table 1. Typical composition of feeds and forages.

Feed No.	Type of Feed	Dry Matter %	Dry Matter Basis: NDF %	eNDF[a] % of NDF	CP %	DIP[b] % of CP	TDN %	NEm Mcal/cwt	NEg Mcal/cwt	EE %	Ca %	P %	K %	S %	Cu ppm	Mn ppm	Zn ppm
Roughage																	
1	Alfalfa Hay, Early Bloom	90	39	92	25	88	60	59	33	2.5	1.41	0.22	2.51	0.30	13	36	30
2	Alfalfa Hay, Mid Bloom	90	47	92	22	84	58	56	31	2.6	1.37	0.22	1.56	0.28	11	28	31
3	Alfalfa Hay, Full Bloom	90	49	92	17	82	55	52	26	2.3	1.19	0.24	1.56	0.27	10	28	26
4	Alfalfa Cubes	91	46	40	18	70	57	55	29	2.0	1.30	0.23	1.90	0.35	9	32	18
5	Alfalfa Dehydrated 17% CP	92	45	6	19	41	61	61	35	3.0	1.42	0.25	2.50	0.24	9	34	21
6	Bermuda Hay, Vegetative	90	69	80	15	80	57	55	29	2.3	0.59	0.28	1.90	0.30	12	170	36
7	Bermuda Hay, Early Bloom	90	75	90	10	72	53	49	24	1.9	0.51	0.20	1.60	0.25	8	140	31
8	Bermuda Hay, Full Bloom	90	79	98	8	68	47	39	15	1.8	0.43	0.18	1.40	0.21	8	110	26
9	Corn Silage	35	46	70	8	72	72	77	49	3.1	0.28	0.23	1.10	0.12	4	24	22
10	Cotton Seed Hulls	90	87	100	4	55	45	45	3	1.9	0.15	0.09	1.10	0.05	13	119	10
11	Fescue Hay, Early Bloom	87	68	98	13	72	57	55	29	4.8	0.45	0.37	2.50	0.21	11	200	34
12	Fescue Hay, Full Bloom	88	73	98	9	68	50	52	16	3.5	0.40	0.26	1.70	0.17	7	100	23
13	Peanut Hulls	91	74	98	8	40	22	36	0	1.5	0.20	0.07	0.90	0.07	11	38	20
14	Prairie Hay	91	73	98	6	63	52	50	12	2.0	0.40	0.15	1.10	0.06	4	59	34
15	Rice Hulls	92	81	90	3	45	13	35	0	0.9	0.14	0.07	0.50	0.08	3	320	24
16	Sorghum Silage	32	59	70	9	71	59	58	32	2.7	0.49	0.22	1.72	0.12	9	69	30
17	Sudan Grass Silage	31	64	61	10	72	58	56	31	3.0	0.58	0.27	2.40	0.14	37	99	29
18	Sunflower Seed Hulls	90	73	90	4	35	40	42	0	2.2	0.00	0.11	0.20	0.19			200
19	Wheat Silage	33	62	61	13	79	59	58	32	3.2	0.40	0.28	2.10	0.21	9	80	27
20	Wheat Straw	91	81	98	3	40	42	43	0	1.8	0.16	0.05	1.30	0.17	5	35	6
21	Wheat Straw, Ammoniated	85	76	98	9	75	50	50	12	1.5	0.15	0.05	1.30	0.16	5	35	6
Grazed Forage																	
27	Bermuda, Vegetative	30	68	80	16	85	65	67	40	3.0	0.46	0.31	1.90	0.33	13	185	32
28	Bermuda, Boot Stage	35	72	100	13	75	60	59	33	2.7	0.59	0.28	1.90	0.30	12	160	36
29	Bermuda, Fall, Mature	80	77	100	8	60	48	41	16	2.1	0.26	0.18	1.30	0.21	9	140	20
30	Bermuda, Winter, Mature	90	80	100	5	55	44	34	10	1.5	0.30	0.15	1.00	0.15	7	45	15
31	Bermuda, Stockpiled, Sept.-Oct.	35	70	100	13	70	57	55	29	2.5	0.66	0.24	0.88	0.26	6	151	27
32	Bermuda, Stockpiled, Nov.-Dec.	85	74	100	11	65	54	50	25	2.1	0.52	0.22	0.55	0.27	5	117	26
33	Bermuda, Stockpiled, Jan.-Feb.	90	77	100	7	60	47	39	15	1.5	0.48	0.18	0.32	0.25	4	116	26
34	Fescue, Vegetative	29	60	40	18	80	64	65	39	4.5	0.50	0.40	2.50	0.24	13	175	36
35	Fescue, Boot Stage	33	65	100	12	75	57	55	29	3.8	0.45	0.30	1.80	0.21	10	150	32
36	Fescue, Mature	70	74	100	8	70	49	42	18	3.2	0.38	0.20	1.40	0.18	7	120	26
37	Fescue, Stockpiled, Nov.-Dec.	40	72	100	13	75	52	47	22	2.7	0.45	0.30	1.80	0.21	12	150	32
38	Fescue, Stockpiled, Jan.-Feb.	60	75	100	11	68	40	27	3	2.2	0.38	0.20	1.40	0.18	7	120	26
39	Native Range, April-June	30	68	100	14	75	70	74	47	3.2	0.30	0.20	1.60	0.15	11		
40	Native Range, July-August	35	71	100	10	70	64	65	39	3.0	0.33	0.15	1.50				
41	Native Range, Sept.-Oct.	46	75	100	7	65	59	58	32	2.5	0.28	0.12	1.10				
42	Native Range, Nov.-Dec.	75	78	100	5	65	55	52	26	2.2	0.25	0.09	0.80				
43	Native Range, Jan.-March	85	80	100	4	55	49	42	18	1.7	0.23	0.07	0.60				
44	Wheat Forage, Vegetative	21	50	41	22	84	71	76	48	4.0	0.35	0.36	3.10	0.22	10	85	35
Byproduct Feeds																	
47	Barley Malt Pellets with Hulls	90	50	34	18	64	68	71	44	1.9	0.21	0.59	1.20	0.32	10	44	61
48	Corn Gluten Feed	90	40	36	24	75	80	88	59	3.2	0.14	1.07	1.50	0.53	7	22	67
49	Distillers Grains with Solubles, Corn	89	33	4	31	33	89	100	69	13.0	0.07	0.87	1.10	0.65	5	21	68
50	Distillers Grains with Solubles, Sorghum	92	46	4	31	47	88	99	68	10.0	0.25	0.65	0.50	0.40			68
51	Grain Screenings	90			14	65	65	67	40	5.5	0.25	0.34					30
52	Rice Bran, Full Fat	91	23	0	14	70	72	77	49	19.0	0.66	1.70	1.80	0.19	12	396	40
53	Rice Mill Byproduct	91	60	0	7	60	42	43	0	5.7	0.40	0.31	2.20	0.30			31
54	Soybean Hulls	90	64	28	12	72	77	84	55	2.6	0.53	0.18	1.40	0.12	18	10	38
55	Wheat Bran	89	46	4	17	72	70	74	47	4.5	0.13	1.29	1.40	0.24	14		96
56	Wheat Middlings	89	36	2	19	78	79	87	58	4.6	0.15	1.00	1.40	0.24	11	128	96
57	Wheat Mill Run	90	37	0	17	72	75	81	53	4.4	0.12	1.00	1.20	0.22	21		90
58	Wheat Shorts	89	30	0	20	75	80	88	59	5.4	0.10	0.95	1.10	0.20	13		118
Feed Grains																	
64	Corn Grain, Cracked, Rolled, or Ground	88	9	60	10	42	88	99	68	4.3	0.02	0.30	0.40	0.12	3	8	18
65	Corn Grain, Steam Flaked	85	9	40	10	41	93	106	74	4.1	0.02	0.27	0.40	0.12	3	8	18
66	Wheat	89	12	0	14	77	89	100	69	2.3	0.05	0.44	0.40	0.14	6	37	40
67	Milo, Ground	89	16	5	11	45	82	91	61	3.1	0.04	0.32	0.40	0.14	5	15	18
68	Milo, Steam Flaked	82	20	38	11	38	90	102	70	3.1	0.04	0.28	0.40	0.14	5	15	18
High Protein Meals and Seeds																	
69	Cottonseed, Whole	91	47	100	23	62	95	108	76	17.8	0.16	0.62	1.22	0.26	8	12	38
70	Cottonseed Meal, 41%	90	25	23	48	58	77	84	55	1.8	0.22	1.25	1.70	0.44	17	57	66
71	Peanut Meal, Solvent	91	27	23	50	73	77	84	55	3.6	0.24	0.58	1.00	0.30	16	29	38
72	Soybean Meal, 48%	91	9	23	54	64	87	98	67	1.2	0.28	0.71	2.20	0.47	23	41	61
73	Soybeans, Whole	88	15	100	40	72	93	106	74	18.8	0.27	0.64	2.00	0.34	15	35	59
74	Sunflower Seed Meal, Solvent	91	24	80	19	75	122	142	103	42	0.71	0.51	1.06	0.21	20	35	53
75	Sunflower Seed Meal with Hulls	91	40	23	26	80	60	68	42	2.9	0.45	1.02	1.27	0.33	4	20	105
76	Mung Beans	90			23	25	79	87	58		1.19	0.68	1.40	0.25			
77	Feather Meal	92	44	23	86	27	69	73	45	6.5	0.60	0.62	0.20	1.85	14	12	95

a Effective neutral detergent insoluble fiber.

b Degradable intake protein.