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Interpreting Forage Test Results

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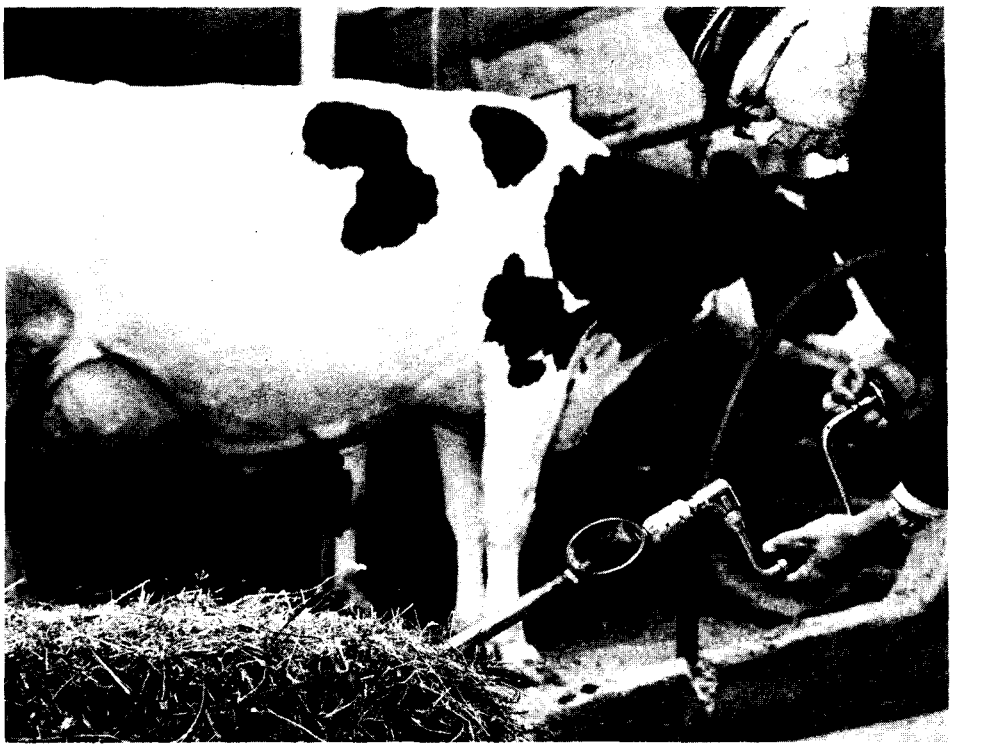
Tests for protein, fiber, and dry matter content help evaluate forage quality and balance livestock rations. Your county extension agent has a list of commercial laboratories which test forage.



To determine forage quality, sample hay or silage at harvest or before feeding. Your county extension agent may have a hay probe and will have information about sampling procedures.

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Importance of forage testing

By testing representative samples, you can effectively determine your forage quality. You must know your forage's nutrient and dry matter content to balance livestock rations. Dairymen, especially, will be interested in the protein and energy considerations discussed here. Underfeeding or overfeeding protein and energy feeds is costly.

Chemical tests to determine your forage's protein and fiber levels are available from commercial laboratories (see your county extension agent for a list of laboratories). These laboratories can also determine dry matter content, or this can be measured by following the procedures in Agronomy Fact Sheet 24, "Determining Moisture Content of Forages."

Representative samples are essential, and you must handle these samples properly. Different cuttings of hay and silage should be tested separately. Request the right combination of tests to determine the feed nutrients you are interested in. Most hay and silage samples should be tested for dry matter, crude protein, and fiber. If stored forage has heated or caramelized excessively, you may also need a digestible protein test. For sampling suggestions, refer to Agronomy Fact Sheet 25, "Sampling and Testing Forages for Feeding Value."

Understanding and using the forage test results

When you obtain the test results, it is important to: (1) understand them and be able to convert them from wet to dry matter basis; (2) use them to balance your dairy rations; and (3) use this information to improve future crops if your forage is not now satisfactory. If you are on the Dairy Herd Improvement (DHI) testing program, forage tests can help determine quality codes of your forage. In addition, you may want to use the test results in a least-cost ration or ration balancer computer program.

Conversion of forage tests to "dry" or "wet" basis

Many laboratories report test results both on an "as received (wet or as fed)" and on a "dry" basis. However if they do not, you can convert from one form to the other as shown in the following examples.

Pounds of forage consumed by an animal are computed from an "as fed" or "wet" basis. Each animal is fed a quantity of "wet" hay or silage just as it comes from storage. With test results on a wet basis, you can calculate pounds of protein or fiber fed to the animal.

For example, a laboratory report on corn silage may have this information:

Corn silage, (sample 1)	
Moisture	67.5%
Protein	3.1%
Fiber	6.1%

Unless otherwise stated, these test results are on an "as received" or wet basis. Values are for crude protein and crude fiber. A cow fed 50 pounds of this corn silage each day will receive 50 x 0.031 (3.1 percent expressed as a decimal) = 1.55 pounds of crude protein per day from the corn silage.

Protein and fiber values should be on a dry basis when used to balance dairy rations. Test results must also be on a dry basis when using a formula to determine total digestible nutrients (TDN) or estimated net energy (ENE). Remember, nutrient value is in the dry matter portion, not in the water. To convert the above corn silage test results from wet to dry basis, perform these steps:

1. Subtract the moisture percentage from 100 to get the dry matter percentage (example, 100.0 - 67.5 = 32.5 percent dry matter).
2. Divide the wet protein and fiber values by the dry matter percentage expressed as a decimal.

$$\frac{3.1\% \text{ crude protein}}{.325} = 9.5\% \text{ crude protein (dry basis)}$$

$$\frac{6.1\% \text{ crude fiber}}{.325} = 18.8\% \text{ crude fiber (dry basis)}$$

For the same corn silage, the laboratory may report test results on the dry matter basis.

Corn silage, (sample 1)	
Dry matter	32.5%
Crude protein (dry basis)	9.5%
Crude fiber (dry basis)	18.8%

To convert these dry protein and fiber values to wet basis to calculate pounds of forage nutrients fed to an animal, multiply the protein or fiber value by the dry matter percentage.

Example:

9.5% protein (dry basis) x .325 = 3.1% protein (wet basis)

18.8% fiber (dry basis) x .325 = 6.1% fiber (wet basis)

Formulas to determine digestibility of forages

For these formulas, crude protein and fiber values must be on a dry matter basis:

1. If the forage has not heated excessively or caramelized in storage, the following formula can approximate digestible protein from a crude protein test.

   For all forages, use: D.P. (%) = C.P. (%) x 0.93 - 3.5. Protein in corn silage is about 50 percent digestible; and alfalfa-grass hay or haylage protein is about 65 percent digestible.

   Hay or haylage which shows evidence of excessive heating or caramelization in storage (brown or black in color, dry or sweet smelling) will have lower digestibility. A digestible protein test will be needed to predict the extent of this loss. The digestible protein test utilizes an acid detergent fiber or pepsin test. Such tests are more expensive, but they are worth the cost to determine whether additional protein is needed.

2. An estimate of the total digestible nutrient (TDN) content of alfalfa or legume grass hay or haylage can be made by using the crude fiber (C. F.) percentage of the forage and the following (California) formula:

   TDN (%) = 78.7 - (C. F. x 0.8)

   To determine the TDN content of corn silage, use this (Minnesota) formula:

   TDN (%) = 72.1 - (C. F. x 0.34)

   Using the above formula and the previous corn silage sample (18.8 percent crude fiber on a dry basis), compute the TDN content as follows:

   TDN (%) = 72.1 - (18.8 x 0.34)
   TDN (%) = 72.1 - 6.4
   TDN (%) = 65.7

3. A livestock feeder may wish to balance rations using an estimated net energy (ENE) value for his forage. This is a measure of mega-calories (MCal) or therms of net energy per 100 pounds of feed. To convert TDN to estimated net energy (ENE), use the TDN percentage in the following formula:

   ENE (MCal) = (TDN x 1.4) - 34.6

   Example: (Using our TDN value of 65.7)

   ENE (MCal) = (65.7 x 1.4) - 34.6
   ENE (MCal) = 92.0 - 34.6
   ENE (MCal) = 57.4

Using your forage test results in your livestock feeding program

1. Calculate the protein and energy content of your forage. The estimated net energy or total digestible nutrient content of your forage, together with the crude or digestible protein percentage, can be used to balance your livestock rations.

2. To determine forage quality codes for use in the DHI program, compute the ENE using the previously mentioned formulas. Or, you can determine it by using the following tables: table 1 for corn silage, table 2 for haylage, and table 3 for hay.

   For corn silage and haylage:
   ENE is used on a dry matter basis as the quality code.
   For hay:
   ENE is used on an air dry (90 percent dry matter) basis as the quality code. Barn-stored hay averages about 90 percent dry matter. To convert ENE 100 percent dry matter basis to ENE 90 percent dry matter basis, multiply ENE (100 percent dry basis) by 0.9.

Table 1. Estimated net energy values (quality codes) of corn silage (100 percent dry matter basis).

Crude fiber percentage of sample (wet basis)	Percent dry matter of sample								
	60	55	50	45	40	35	30	25	20
4	63	62	62	62	61	60	59	58	56
6	61	61	60	59	59	58	56	54	51
8	59	59	58	57	56	55	53	50	47
10	58	57	56	55	54	52	50	47	42
12	56	55	54	53	52	49	47	43	37
14	55	54	52	51	49	47	44	39	32
16	53	52	50	49	47	44	40	35	28
18	52	50	49	47	44	41	37	31	23
20	50	48	47	45	42	38	34	28	18
22	48	47	45	43	40	36	31	24	13
24	47	45	43	40	37	33	28	20	
26	45	43	41	38	35	30	24		
28	44	42	39	36	32	28			
30	42	40	37	34	30				
32	40	38	35	32					
34	39	36	33						
36	37	35							
38	36								

Table 2. Estimated net energy values (quality codes) of alfalfa and mixed legume-grass silage (100 percent dry matter basis).

Crude fiber percentage of sample (wet basis)	Percent dry matter of sample								
	70	65	60	55	50	45	40	35	30
4	69	68	68	67	66	65	64	62	60
6	65	65	64	63	62	60	58	56	53
8	62	61	60	59	57	55	53	49	45
10	59	58	56	55	53	50	47	43	38
12	56	54	53	51	48	45	42	37	30
14	53	51	49	46	44	40	36	30	23
16	49	48	45	42	39	35	30	24	
18	46	44	42	38	35	30	25		
20	43	41	38	34	30	25			
22	40	37	34	30	26				
24	37	34	30	26					
26	34	30	26						
28	30	27							
30	27								

Table 3. Estimated net energy values (quality codes) of alfalfa and mixed legume-grass hay (90 percent dry matter basis).

Crude fiber percentage of sample (wet basis)	Percent dry matter of sample					
	95	90	85	80	75	70
10	57	56	56	55	54	53
12	55	54	53	52	51	50
14	53	52	51	50	49	47
16	51	50	49	47	46	45
18	48	47	46	45	43	42
20	46	45	44	42	41	39
22	44	43	42	40	38	36
24	42	41	39	37	35	33
26	40	38	37	35	33	30
28	38	36	34	32	30	27
30	36	34	32	30	27	24
32	34	32	30	27	25	
34	32	30	27	25		
36	29	27	25			
38	27	25				
40	25					

3. You can use your forage test results in a ration balancer or least-cost ration computer program. For each forage tested, substitute dry matter percentage, crude protein percentage (dry basis), and crude fiber percentage (dry basis) in place of the estimated values in the tables.

4. The tests can help you improve forage quality. Protein, fiber, and dry matter test results indicate a great deal about your forage harvesting and storage program. Protein and fiber contents of alfalfa and grass forage are closely correlated to time of cutting. As forage crops mature, fiber content increases, and protein content decreases. Early cut alfalfa (late bud stage) may have a crude protein content of at least 20 percent. Late cut alfalfa (full bloom), on the other hand, may be as low as 10 to 14 percent protein. Grasses cut before heading may contain up to 20 percent crude protein or more if the field has received adequate nitrogen. Late cut and unfertilized grasses may contain 8 to 12 percent protein or less.

   On a dry basis, good quality, early cut alfalfa hay should range from 55 to 60 percent TDN. Good quality grass hay should be about the same or slightly lower.

   Compare your forage test results with average values from Morrison's Feeds and Feeding (table 4). Average values tend to be low because proper cutting time, fertilizer use, and other forage management may not have been met in all instances.

Table 4. Average forage test values. (Source, Morrison's Feeds and Feeding).

Feed	Dry matter (%)	Crop stage at harvest	100% dry basis Crude protein (%)	Crude fiber (%)	TDN (%)
Alfalfa hay or haylage	85-90 (hay) 30-70 (haylage)	First bloom	18	30	55
		Half bloom	16	35	51
		Full bloom	14	37	49
		After bloom	12	40	47
Mixed grass and legume hay or haylage	85-90 (hay) 30-70 (haylage)	Early cut	16	32	53
		Late cut	12	36	50
Corn silage	25-50	Dented corn	8	26	63
		10 lb. urea per ton	12	26	63
Oat silage	30-70	Boot stage	15	30	53
		Dough stage	12	40	45

If your hay or haylage is low in quality, cut at an earlier stage of maturity next year. Both quality and quantity can often be improved by fertilizing as indicated by a soil test.

Stored hay will normally contain 10 to 15 percent moisture. Higher moisture hay is likely to become musty, moldy, and of low quality.

Haylage and corn silage moisture content at the time of ensiling is important for proper preservation and storage. Haylage moisture content should range from 40 to 60 percent, and whole plant corn silage should be about 65 to 68 percent. Use the middle of these ranges to fill a conventional silo. Use the lower moisture contents for an oxygen-limiting silo and the higher moisture contents if silage is stored in a trench, bunker, or stack.

If your silage and haylage moisture content was not satisfactory this year, you can wilt it more if it was too wet. If it was too dry, ensile it at a higher moisture content or add water at silo filling time. Adequate moisture insures good fermentation, packing, and storage. Too much moisture, however, results in excessive leaching losses. Also, wet, sour silage is likely to freeze and is low in animal acceptability.

Other references:

Extension Bulletin 218, Feeding the Dairy Herd
Extension Folder 269, Thumb Rules for Dairy Cow Feeding
Extension Folder 292, Minnesota Dairy Ration Balancer

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