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Using Forage Analysis to Formulate Winter Rations for Beef Cattle in Mid-Columbia Counties

The feed cost for wintering cattle is the single greatest expense for cattle producers. From 80 to 100% of the feed consumed on many beef cattle farms and ranches is forage in one form or another.

Formulating rations is a matter of assembling feeds in amounts that will meet the nutrient requirements of your animals. To do this, you need to know the nutrient contents of the various feeds available. It's a good idea to have your forages analyzed for nutrient content.

Dryland cereal grain production is predominant in the mid-Columbia area. Cattle producers have long included cereal crop residues in beef cattle rations to reduce feed expenses. This low-cost feed resource is one of the principal reasons why the cow-calf enterprise has been successful in and near the dryland cereal grain-producing areas.

During the past few years, researchers at Oregon State University have analyzed several hundred samples of forage from mid-Columbia counties (appendix, page 4). These included cereal straw, chaff, cereal hay, alfalfa-grass hay, and grass hay.

The results show a wide variation in nutrient content of the forage analyzed. Some of these feeds provide an adequate ration alone, and some need to be supplemented.

The OSU researchers also drew blood samples from representative animals on several ranches involved in the forage analysis program.

Because blood carries nutrients to the body tissues, analyses of blood samples can give a useful indication of the nutrient status of animals at any given time. These analyses provide particularly useful information on some of the trace nutrients (those needed in very small quantities).

At OSU, the blood samples were analyzed to determine the levels of copper (Cu), zinc (Zn), and selenium (Se). The results indicate that supplements are essential.

Nutritional requirements of cattle

You need to understand the nutritional requirements of your cattle. These requirements have been calculated from research data gathered in numerous animal feeding experiments. A useful summary for beef cattle has been published by the National Research Council as *Nutrient Requirements for Beef Cattle* (available at $10.75 a copy from National Academy of Sciences, 2101 Constitution Ave., Washington, DC 20418).

Cattle of different classes and ages vary in nutrient requirements. For example, mature, dry pregnant cows (whose nutrient requirements are fairly low during the first two-thirds of gestation) make the most efficient use of low-quality forages.

Some nutrient requirements of cattle are shown in table 1.

General guidelines

Total digestible nutrients (TDN) —especially digestible *protein*—are usually limited in rations composed largely of cereal residues.

If you're feeding your cattle rations like these, they need added protein such as soybean meal or liquid supplements. However, if you add too much protein, you're being inefficient—and you're wasting money.

Furthermore, if your cattle seriously lack protein, they digest their food poorly and can't fully use the energy it *does* provide.

Feed your cows to gain about 100 pounds during the last 3 to 4 months of pregnancy. This essentially means that they neither gain nor lose weight—they use the nutrients for growth of the developing calf.

Inadequate nutrition during the last 3 months of pregnancy and after calving reduces the percentage of cows coming into heat and conceiving early in the breeding season. Poor nutrition in late gestation also means a greater number of weak calves and increased calf mortality.

Feed analyses

A number of forage and feed materials available for winter feeding of cattle in mid-Columbia counties have been sampled by county Extension agents and analyzed by researchers in the Department of Agricultural Chemistry at Oregon State University.

Overall usefulness of feeds can be estimated by TDN (total digestible nutrients is the sum of all the digestible nutrients). The fiber portion of feeds is the least digestible part, so measures of fiber content are *inverse indicators* of feed nutrient availability.

(An inverse indicator or correlation means that when factor A goes up, factor B goes down—*and* when A goes down, B goes up. In our example, an *increase* in the fiber portion means a *decrease* in feed nutrient availability.)

Fiber is commonly measured by detergent extraction of the feed and is reported as ADF (acid-detergent fiber, the least digestible part of the fiber) and NDF (neutral-detergent fiber, the more digestible part of the fiber). NDF is usually inversely related to feed intake.

Crude protein is a measure of the body-building part of the feed. Certain mineral elements play specific roles in nutrition (calcium and phosphorus in skeletal growth; selenium and zinc in enzymes that catalyze metabolic reactions).

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Table 1.—*Nutrient (concentration in the diet dry matter) requirements for various classes of beef cattle*

Class and weight of cattle	Nutrient						
	Crude protein %	TDN[a] %	Calcium %	Phos-phorus %	Zinc ppm[b]	Se ppm[b]	Vitamin A IU's/lb dry feed
Growing heifer calf to gain 1.1 lb/day; 551 lb	9.5	58	0.20	0.20			1,000
Preg. yrl. heifer— last ⅓ of preg. to gain 0.9 lb/day; 827 lb	8.7	52	0.21	0.21			1,273
Mature, dry, preg. cows; 1,000 lb:							
Middle ⅓ of preg.	5.9	52	0.18	0.18	20-30	0.1	1,273
Last ⅓ of preg.	5.9	52	0.18	0.18	20-30	0.1	1,273
Cows nursing calves	9.2	55	0.28	0.28	20-30	0.1	1,273

[a]Total digestible nutrients.
[b]Parts per million.

Table 2.—*Straw and chaff analysis for the mid-Columbia Basin*

	Crude protein %	TDN[a] %	ADF %	NDF %	Ca %	P %	Zn ppm	Se ppm	DDM[b] %
Average	2.4	54.1	48.2	75.1	.14	.20	4.9	.05	43.4

[a]Dry matter basis.
[b]Digestible dry matter.

Straw and chaff

Straw and chaff samples were characteristically low in protein and high in fiber. Digestibility of these kinds of forage tends to be very low, limiting their usefulness. Average nutrient content of straw and chaff samples are shown in table 2.

The protein in all the straw and chaff samples averages only 2.4%. This is well below beef cattle requirements, so it requires a feed supplement.

Because of the low energy value of straw and chaff, it is better to supplement with a complete protein, such as alfalfa, soybean meal, or cottonseed meal. (Nonprotein nitrogen, such as urea, would be a poor supplement to the low and slowly available energy in straw or chaff.)

Most of the samples had very low nitrate-nitrogen (NO_3-N) levels, so they would present no hazard in feeding.

Digestible dry matter (DDM) is inversely correlated to acid-detergent fiber (ADF). DDM corresponds rather closely to total digestible nutrients (TDN). The difference is that DDM includes ash (minerals), not included in TDN. DDM is roughly 2% higher than TDN, or 50% DDM is equivalent to 48% TDN.

TDN and ADF data show most of these straws to be too low in energy to maintain beef cattle. This means you would have to add an energy feed. Consider alfalfa, wheat, beet pulp, molasses, and other feeds, based on how cheaply they will furnish supplemental energy.

NDF at an average of 75% is at a high level. It indicates these straws will not be consumed in large amounts.

Calcium and phosphorus were both low in most of the samples and should be supplied by supplement such as steamed bonemeal or dicalcium phosphate fed free-choice with salt. Also, several samples tested had higher phosphorus than calcium.

Grass and cereal hay

Both grass hay and cereal hay have sufficient protein to maintain a dry beef cow. However, more than half the samples were low in protein for lactating cows and would have to be supplemented.

A summary of these test results showing average figures is presented in table 3.

Acid-detergent fiber (ADF) data and dry matter digestibility (DDM) indicate that these hays (except possibly the poorest grass hay) had sufficient energy to maintain a cow. Most of the cereal hays and about half the grass hays included in the averages had enough energy to support lactation if supplemented with protein.

As noted earlier, neutral-detergent fiber (NDF) is negatively (inversely) correlated with feed intake. Grass or cereal hays with an NDF of less than 60 usually are consumed in sufficient quantities for a maintenance ration.

Calcium and phosphorus analysis showed that about 50% of the grass hays and cereal hays contain more phosphorus than calcium and should be supplemented accordingly.

Supplement both grass and cereal hays with calcium (you'll need to supplement some of them with phosphorus). Alfalfa is an excellent calcium source.

Both grass hay and cereal hay in the mid-Columbia area tend to be low in zinc. Feed zinc in a protein or mineral supplement

Alfalfa and grass-alfalfa hay

There was a high degree of variation within the alfalfa hays sampled. All samples had ample crude protein to maintain beef cows before they calve. However, do not use hay with less than 12% crude protein as a protein supplement to straw.

A summary of tests giving average figures is shown in table 4.

The alfalfas with 35% ADF or less are excellent quality dairy hays. Those with

Table 3.—*Grass hay and cereal hay analysis for the mid-Columbia Basin*

	Crude protein %	TDN[a] %	ADF %	NDF %	Ca %	P %	Zn ppm	Se ppm	DDM %
Grass hay average	8.0	60	40.7	64.8	.3	.31	10		57.1
Cereal hay average	8.7	65	34.5	56.7	.26	.27	17	.12	63.8

[a]Dry matter basis.

Table 4.—*Analytical data for alfalfa and alfalfa-grass hays*

	Crude protein %	TDN[a] %	ADF %	NDF %	Ca %	P %	Zn ppm	Se ppm	DDM %
Average	16.8	64	33.0	45.0	1.02	.35	20	.06	66.8

[a]Dry matter basis.

more than 35% ADF will be best used for beef cattle or sheep production. Alfalfa hay with 45% or less NDF should be readily accepted by cattle. The hays with higher NDF will be eaten in lesser amounts.

These chemical tests will not detect mold or foreign material in hay, so it is possible to have hay that tests well but is poorly accepted by cattle because of mold or weeds.

Calcium and phosphorus must meet minimum dietary levels to maintain the best calcium-phosphorus ratio in the animal. Forty percent of the samples were low in calcium for legume hay, and 20% were lower in calcium than phosphorus. You can correct these unusual conditions with a properly balanced mineral supplement.

Zinc requirements for beef cows are listed by the National Research Council as 20 to 30 ppm in the ration. The samples analyzed for zinc averaged a borderline 20 ppm. Therefore, zinc should be a constituent of a mineral supplement.

The approved level for adding selenium to supplement cattle rations is 0.1 ppm. Samples analyzed for selenium were lower than this. Cattle fed this alfalfa should be supplemented either by a commercial injectable form or through a feed supplement.

In general, these alfalfa hays were good quality from a chemical standpoint. Some of the high protein hays have a low relative feed value (RFV). This indicated that hay to be marketed or purchased should be tested for dry matter, crude protein, acid-detergent fiber, and neutral-detergent fiber.

Blood analyses

Following the forage analytical program conducted in the mid-Columbia counties, OSU researchers tried to define the status of several herds of beef cattle with respect to the trace mineral elements copper (Cu), Zinc (Zn), and selenium (Se).

From previous work, it was believed these trace elements might be deficient and thereby reduce optimum livestock production. In addition, the analyses of animal tissues is definitive for the state of the cattle and more reliable than forage analysis in this regard.

Blood samples also were taken to determine glutathione peroxidase (GSH-Px) levels; they ranged from 3.14 to 11.13 enzyme units of GSH-Px.

The minimum level for this selenium-dependent enzyme should be 25 enzyme units. So, despite the injection of selenium 3 months earlier, these cattle were deficient in selenium as measured by this selenium-containing enzyme.

Conclusions

Selenium. The levels of all blood samples tested were low. The minimum acceptable whole blood level for beef cows should be 0.05 ppm. The GSH-Px results also indicate a deficiency of this trace mineral nutrient. The consequences of a selenium deficiency are widespread, and they may involve:

- *The incidence of a nutritional disorder* known as "white muscle disease" in young calves.
- *The livability (vitality, vigor) of newborn calves.* An inadequate amount of selenium reduces the GSH-Px level in blood. It now appears this enzyme has an effect on the thyroid gland. Impaired thyroid function influences the newborn calf's ability to cope with the stress of calving and the cold environment in which they are often born. Selenium-deficient calves are also more prone to calf scours.
- *The immune response of animals.* Selenium-deficient animals are impaired in their ability to develop adequate circulating antibody. This is important in their ability to prevent disease following vaccination and also their ability to recover from infectious diseases.
- *The health of the digestive tract.* Some selenium-deficient animals develop enteritis, and because they use feed very poorly, their growth rate and performance is reduced.

Copper. The blood levels were low. Work at Oregon State University suggests that for best performance in cattle, the blood plasma copper levels should be 0.8 ppm or higher.

Low copper levels contribute to poor growth and performance in cattle, which is often accompanied by scouring or diarrhea and a bleached and rough hair coat. Copper deficiency can contribute to bone fractures and nerve problems in young animals.

Zinc. The blood values were generally within the normal range of 1.5 to 3.0 ppm. This is interesting, since the National Research Council suggests beef cattle should have from 20 to 30 ppm zinc in their diets. Most of the forages analyzed were slightly below this level.

Suggested rations for the Columbia Basin

Based on the analytical data assembled for the area, the following feed combinations should be satisfactory for cattle in the mid-Columbia counties (all figures are in pounds).

Rations for 1000-lb pregnant cows

A. 16 oat, barley, or wheat hays
2 alfalfa
18

B. 11 oat, barley, or wheat straw
5 barley, wheat, or corn
1 cottonseed meal, soybean oil meal, or 36% protein supplement (liquid or dry)
17

C. 18 barley, oat, or wheat straw
2 cottonseed meal, soybean oil meal, or 36% protein supplement (liquid or dry)
20

D. 16 wheat, barley, or oat straw
4 alfalfa
20

E. 11 wheat chaff
5 wheat, barley, or corn
1 cottonseed meal, soybean oil meal, or 36% protein supplement (liquid or dry)
17

Rations for 1000-lb lactating cows

A. 12 alfalfa
8 oat, barley, or wheat hay
20

B. 10 oat, barley, or wheat straw
5 native meadow grass hay
5 wheat, barley, or corn
20

C. 3 oat, barley, or wheat straw
48 corn silage (28% dry matter)
2 cottonseed meal, soybean oil meal, or 36% protein supplement (liquid or dry)
53

D. 5 wheat chaff
45 corn silage (28% dry matter)
2 cottonseed meal, soybean oil meal, or 36% protein supplement (liquid or dry)
52

Rations for 850- to 900-lb growing pregnant heifers gaining 0.9 to 1.0 lb per day

A. 15 wheat, oat, or barley hay
2 alfalfa
17

B. 16 wheat, oat or barley hay
1 cottonseed meal, soybean oil meal, or 36% protein supplement (liquid or dry)
17

C. 7 wheat hay
7 wheat, barley, or corn
14

D. 10 wheat, oat, or barley hay
5 oats or beet pulp
15

E. 5 wheat, oat, or barley hay
36 corn silage (28% dry matter)
1 cottonseed meal, soybean oil meal, or 36% protein supplement (liquid or dry)
—
42

Rations for 450- to 500-lb weaner calf gaining 0.8 to 1.0 lb per day

A. 8 oat or barley hay
4 oats or beet pulp
1 cottonseed meal, soybean oil meal, or 36% protein supplement (liquid or dry)
—
13

B. 5 wheat hay
5 oats or beet pulp
1 cottonseed meal, soybean oil meal, or 36% protein supplement (liquid or dry)
—
11

C. 5 oat, barley, or wheat hay
10 corn silage (28% dry matter)
1 cottonseed meal, soybean oil meal, or 36% protein supplement (liquid or dry)
—
16

D. 10 alfalfa
2 oats or beet pulp
—
12

Summary

Knowing the nutrient requirements of different classes of cattle and knowing the nutritional value of available feeds makes it possible to feed a balanced ration. Feeding a balanced ration improves efficiency of production.

Forage testing should be a continuing process. Producers are growing improved forage varieties, using more fertilizers, following new recommendations on time of cutting, and using new machines to harvest and dry the crop. All of these affect the nutrient content at feeding time—and they may render old data obsolete.

Forage testing (or forage analysis) answers the question, "What's the nutrient value in my forage?" This is what today's business-minded cattle producer wants to know—and *has* to know to make a profit.

Appendix—*Analysis of representative forage samples from mid-Columbia counties*

Forage	County	Crude prot. %	ADF %	NDF %	Ca %	P %	Zn ppm	Se ppm	DDM %	TDN %
Alfalfa	Klickitat[a]	20.8	21.9	29.4	1.68	.38			73.5	70.9
Alfalfa	Wasco	20.7	32.3						68.1	64.1
Alfalfa	Wasco	19.9	27.0	40.6				.08	71.6	67.6
Alfalfa	Sherman	19.7	33.8						66.8	63.2
Alfalfa	Wasco	19.5	32.7	39.2	1.36	.41	28		67.7	63.9
Alfalfa	Wasco	19.4	36.8	50.8	.79	.32	27		63.8	61.2
Alfalfa	Sherman	19.4	36.4	43.7					64.2	61.5
Alfalfa	Wasco	19.1	31.7	39.6	1.14	.37	21	.02	68.5	64.5
Alfalfa	Wasco	18.4	30.0	42.5	1.03	.40	21	.06	69.8	65.6
Alfalfa	Wasco	18.1	28.1	40.8				.08	71.0	66.9
Alfalfa	Sherman	18.1	35.5						65.2	62.1
Alfalfa	Morrow	17.8	35.4	43.6					65.3	62.1
Alfalfa	Wasco	17.7	32.8						67.6	63.8
Alfalfa	Wasco	17.7	28.4	36.5					70.8	66.7
Alfalfa	Wasco	17.6	32.4	40.7					68.0	64.1
Alfalfa	Morrow	17.1	34.3	45.4					66.3	62.8
Alfalfa	Morrow	16.9	34.1	45.7					66.5	63.0
Alf-O.G.[b]	Wasco	16.8	44.8	64.2					53.5	55.4
Alfalfa	Wasco	16.7	32.9	41.7	1.25	.36	16	.06	67.7	63.7
Alfalfa	Wasco	16.0	25.8	34.1	1.95	.27	18	.07	72.2	68.4
Alf-O.G.[b]	Wasco	15.9	30.9	39.6					69.1	65.2
Alfalfa	Wasco	15.7	28.6						70.6	66.6
Alf-grass	Wasco	13.4	37.2		.24	.33	18		63.4	60.8
Alf-grass	Wasco	12.2	40.8	61.3	.26	.37	18		59.1	58.2
Alfalfa	Wasco	12.1						.09	62.6	62.3
Alf-barley	Wasco	9.0	32.9	51.8	.54	.37	18	.05	67.7	63.7
Alfalfa	Wasco	8.7	37.1	61.9				.06	63.5	61.0
Grass hay	Wasco	10.1	37.0	58.4	.22	.36	13		62.3	62.1
Grass hay	Wasco	10.0	40.0						58.6	60.0
Grass hay	Wasco	7.9	43.0	63.1	.55	.37			54.1	57.9
Grass hay	Sherman	7.4	42.7	71.1	.33	.32			54.5	58.1
Grass hay	Wasco	6.8	37.0	66.8	.1	.22	7		62.3	62.1
Grass hay	Wasco	6.0	44.7						51.1	56.7
Grain hay	Wasco	9.5	33.5	59.1	.14	.29		.15	65.4	64.5
Grain hay	Wasco	11.3	31.9	52.9				.10	66.4	65.6
Grain hay	Wasco	9.4	37.6	54.7	.56	.26	17		61.6	61.7
Grain hay	Sherman	8.7	32.1						66.3	65.5
Grain hay	Sherman	7.9	32.6	60.2					66.0	65.2
Grain hay	Wasco	7.5	31.7		.08	.27			66.6	65.8
Grain hay	Wasco	6.8	42.6						54.7	58.2
Oat Ch/Str.	Sherman	3.3	46.3	73.4				.05	48.0	48.0
Wheat chaff	Sherman	3.1	47.2		.14	.25			46.2	46.2
Wheat chaff	Wasco	3.1	48.8						42.7	42.7
Wheat chaff	Wasco	3.0	52.5		.28	.29			33.8	33.8
Barley chaff	Sherman	2.8	47.8	78.9	.08	.13	4.9		44.9	44.9
Sp. bly hay	Sherman	2.7	47.5						45.6	45.6
Wheat chaff	Wasco	2.7	44.8						50.9	50.9
Wheat chaff	Morrow	2.3	42.2	74.5					55.3	55.3
Wheat chaff	Sherman	1.9	51.1						37.4	37.4
Wheat chaff	Sherman	1.6	50.5						38.8	38.8
Wheat chaff	Sherman	1.4	52.3	73.8	.06	.13			34.3	34.3

[a] Washington.
[b] Alfalfa-orchardgrass.

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