Pitfalls to Forage and Grain Analysis

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Abstract

A dairyman's success depends on efficient utilization of forages and grains. Consequently, the progressive dairy practitioner has become interactively involved with feed testing. This presentation will deal with some common pitfalls in feed analyses. The presenter will discuss three tests in detail: TMR testing, fat evaluation, and feed microscopy. The lecture will use case studies to illustrate key principles. It is the objective of this exposition that these principles are clarified and their truths applied in the real dairy world. The ultimate goal is that the dairy cow is the supreme beneficiary.

Introduction

The success of any dairy operation depends on the ability of a farmer to grow, harvest, and preserve high quality forage and to supplement it with the right "balance" of grains that will support efficient and economical milk production. Many astute dairymen have been achieving these goals by using comprehensive feed evaluation programs. It is essential that one know what he is feeding, and to know this he has to test his feeds; otherwise, he is just guessing on which nutrients his are consuming, and smart dairymen don't guess.

The progressive, forward-thinking, dairy practitioner is a key player in this process. Two dairy surveys (i.e., Arm & Hammer, *NutriNews*, 1990 and Ellen Jordan, Texas A&M University, 1992 ADSA Meeting) have shown dairy veterinarians to be the most trusted and preferred choice for nutritional information.

NutriNews reported, "Dairy producers considering a new additive often look to several professionals for advice. But they value their veterinarian's opinions most, according to a study for Church & Dwight Co., Inc. by Rockwook Research."

Similarly, Dr. Jordan's survey found veterinarians as most trusted advisers. Dairymen ranked veterinarians as their primary source of information. They were followed by magazines, other producers, extension, consultants, university research, DHI supervisor and industry representatives.

This is not a surprising finding when one considers that dairy production programs have always been geared toward education and motivation. The premise has been, and continues to be, the more you know the more you can help your clients. Stated differently, adequate knowledge is the basis of intelligent cooperation. Thus, the dairy vet shares what he knows today and strives to learn more for tomorrow.

The purpose of this paper is not to render an extensive treatment of feed evaluation; it is to focus on three specific areas: TMR testing, fat evaluation, and feed microscopy. The author hopes to show the following: (1) TMR testing is a valuable check on the accuracy of weighing, mixing, sampling, lab analysis and commodity database. (2) Fat testing can be used to decide the type of fat and the level of feeding. (3) Feed microscopy yields additional ingredient information about concentrates and supplements.

The ultimate objective is that the science of these tests is clarified and their truth applied in the real world with the modern, high producing dairy cow being the ultimate beneficiary.

TMR Testing

There are two schools of thought about the value of TMR testing. One holds that it is unreliable and worthless; and other contends that it is reliable and very valuable. This individual agrees with the latter viewpoint.

Much of the difference about TMR testing revolves around interpretation of test results. Specifically, opponents argue that the nutrient values vary considerably when duplicate samples are submitted, and that the energy values are in serious error. This writer agrees with the latter argument but disagrees with the former.

TMR Sampling

Total mixed rations are a challenge to sample. There are several factors that make sampling difficult.

- Particle Size — Consider the variation: chopped hay, corn silage, haylage, whole cottonseed, carrots, soybeans, SBM, cracked corn, rolled barley, and minerals. This variation allows for (1) incomplete mixing and (2) separation. Obviously, the greater particle size, the more difficult it is to get a representative sample. Allow adequate time for mixing.
- Moisture — A dry TMR will separate faster than a wet one. It is desirable to formulate rations that have 45-55% moisture content.
- Sampling Technique — TMRs should be sampled fresh as they are fed to cows. Avoid sampling feed that has been in front of the cows for a while. Sample 10-15 sites from the feed bunk. Mix thoroughly in a plastic bucket. Sub sample 1-2 lbs. from this mix.

Energy Estimations

The energy values generated by the most laboratories for TMRs are derived from energy prediction equations based on the fiber content of the sample. For example, the following formula is used in the NC State Feed Testing program: NE1=0.866 - (0.007) (%ADF). Note that energy varies inversely with fiber. Also, additional dietary fat is not included in these predictive equations.

The caloric estimates given for TMRs without byproduct feeds (i.e., whole cottonseed, distillers grains, soy hulls, corn gluten feed, etc.) and supplemental fat will be accurate. For TMRs containing byproduct feeds and additional fat, calculated energy values should be used. It is this writer's opinion that testing laboratories should defer to estimate energy values for TMRs and instead suggest that they be calculated from individual ingredients.

Other Nutrients

The other nutrients generated by certified laboratories are generally quite accurate and repeatable. There is, however, a certain degree of variation that is permissible. For example, the Northeast DHIA gives the following typical ranges of analytical variation:

Nutrient	Variation (+/-)
CP	1 unit
ADF	1.8 units
NDF	2.5 units
FAT	1 unit
SP	5 units
Minerals	5 %

For example, if ADF = 35, then the expected range is 35 +/- 1.8. If calcium = .80, then the expected range is .80 +/- (.80 X .05) = .80 +/- .04.

The National Forage Testing Association offers a voluntary certification program to help the hay industry. Laboratories are certified by correctly testing three out of four unknown forage samples. They allow 1.5 units variation for CP, ADF, and DM.

Again, one cause of variation in laboratory tests is particle length. If the sample is made of very long, coarse forage particles, then the variation is greater than a sample that is composed of finely chopped, uniform forage materials.

Troubleshooting TMRs

In summary, TMR testing is accurate and it can provide valuable information about TMRs. There are five basic areas of performance that TMR testing might help pinpoint: (1) inadequate mixing, (2) inaccurate weighing, (3) incorrect sampling, (4) incorrect analyses, and (5) incorrect calculations. When TMR test results are erratic or erroneous, these areas must be investigated in detail.

- Inadequate Mixing — Old, worn equipment, overloading equipment, clumping of feed ingredients, and not allowing sufficient time for mixing are common causes of mixing error. Overmixing can also be a problem.
- Inaccurate Weighing — This may be operator error or a problem with the scales. Check scales for accuracy at least weekly. This may be done by weighing a known object. Do this at both ends of the scales, empty and fully loaded.
- Incorrect Sampling — Farmers tend to pick the best looking portions of a TMR to sample, avoiding those that may have long fodder, cob, and stems. The best way is to take "blind" grab samples throughout the feed bunk. This technique insures a representative sample for laboratory analysis. (Technique is described in detail above.)
- Incorrect Analyses — All labs are not equal. Thus, one should be sure that he is using a qualified lab. One way is to always use a certified testing laboratory. The National Forage Testing Association {Phone: (402) 333-7485} has a voluntary certification program designed to help the hay industry identify laboratories that are performing acceptably. Another way of checking a lab is to send duplicate samples and compare the results. Also, ask for lab about the repeatability of their results.
- Incorrect Calculations — Often TMR testing does not match up to the calculated values because the ingredient database is not accurate, particularly the database on commodities. Book values are generally not very accurate for commodity ingredients. The Northeast DHIA Forage Lab analyzed 139 samples of WCS in 1990. They ranged from 21 to 28.3% crude protein (DM basis).

Some labs publish a yearly summary of all the feeds that they have tested for the prior year, and these are very helpful. However, it is this practitioner's field experience that the most reliable method is to establish a personal database for commodity ingredients. A minimum of five, but preferably 10, samples should be analyzed over a 12- to 18-month period. The average value is then used in the database. A rolling average is maintained, with the oldest dropped when the newest test result is added.

Fat Evaluation

The purpose of fat testing is to learn the type of fat and, consequently, the level at which it can be included in the ration. Ideally, cows should be fed saturated fats and total lipid content should not exceed 8% of DM. There are three practical concerns in evaluating fat: (1) rumen inertness, (2) oxidative rancidity, and digestibility.

Basic Chemistry

The degree of saturation of a fat is a critical factor affecting its role in rumen dynamics and total gut digestibility. Lipids are made of fatty acids. Fatty acids that have a carbon chain length of 16 or greater are called long chained fatty acids (LCFA). They may be saturated (e.g., C16:0 and C18:0), no double bonds; or they may be unsaturated (e.g., C16:1, C18:1, C18:2, C18:3). Fats that are solid at room temperature are largely saturated, e.g., tallow. Fats that are soft or liquid at room temperature are largely unsaturated, e.g., soybean oil. All plant lipids are primarily unsaturated.

Large amounts of unsaturated LCFA in the diet can cause severe rumen dysfunction. These acids are biohydrogenated, i.e., hydrogen added to the double bonds, by the rumen microorganisms. If large quantities of unsaturated LCFA are presented to the rumen, the capacity of rumen bacteria to hydrogenate the double bonds may be exceeded. This overload results in reduced fiber digestion and acetate production. Consequently, milk fat percent decreases. In moderate cases, the fat percent is decreased 0.1 to .30.

Excessive amounts of saturated LCFA may also adversely affect rumen microflora. This condition is far less common than that of excessive unsaturated fat, but it is possible to produce in rations where lipid content exceeds 8% of DM. The mechanism for this disturbance is not as clear. Excess saturated LCFA may interfere with the ability of rumen bacteria to coat fiber particles, or it may simply be that large quantities of saturated LCFA are toxic to rumen organisms. In either case, fiber digestion and acetate production is inhibited.

The goal in feeding fat is to add 4 to 5 % lipid without disturbing rumen function. This can easily be accomplished by solely using specialty or protected fats: however, this approach is not economically feasible. Selection of fat sources for ration formulation should include type of fat, respective dietary levels, and economic cost. It is at this point that certain analytical tests may be beneficial.

Tests for Unsaturation

In short, cattle should be fed saturated fats. The more saturated the fat, the harder it will be, and the more rumen inert. The following tests may be used to figure out the degree of saturation.

- Iodine Value (IV) measures the degree of unsaturation of a fat. It is defined as the grams of iodine absorbed by 100 grams of fat. Unsaturated fats have high IVs; saturated fats have low IVs.

Note the following:

Lipid	Iodine Value (IV)
Soybean Oil	120 - 141
Corn Oil	103 - 128
Cottonseed Oil	99 - 113
Lard	53 - 77
Palm Oil	44 - 58
Beef Tallow	35 - 48
Goat Tallow	33.5
Mutton Tallow	41.2
Coconut Oil	7.5 - 10.5

- Titre — This value is learned by melting the fatty acids after a fat has been hydrolyzed. The fatty acids are slowly cooled and the congealing temperature (Centigrade) is the titre. Animal fats with titre over 40 are considered tallow; those with titre under 40 are grease.

Lipid	Titre C°
Beef Tallow	40 - 47
Lard	32 - 43
Cottonseed Oil	30 - 37
Peanut Oil	26 - 32
Palm Kernel Oil	20 - 28
Olive Oil	17 - 26
Soybean Oil	21 - 23
Corn Oil	14 - 20

- Fat Acid Profile — This allows one to compute the percentage of each fatty acid and the unsaturated-to-saturated ratios (U/S). The following U/S ratios for tallow, white grease, yellow grease, and soybean oil, respectively: 1, 1.65, 2.38 and 5.45.

Tests for Oxidative Rancidity

Animal feeds destined for feed use are stabilized to prevent the development of oxidative rancidity and high peroxide values. High levels of peroxides in animal feeds tend to reduce palatability and simultaneously destroy the fat-soluble vitamins (A, D and E). The following tests may be used to confirm the stability of a fat.

- Peroxide Value — This test measures the millequivalents (mEq) of peroxide per kg and reveals the current state of oxidative rancidity. A PV of 5 or less is desirable. Most manufacturers report no problems with fats testing 6 and 7, and some have set 10 as the maximum permitted.
- Test for Antioxidant — Determine the type and level of antioxidant that has been added to the fat. Analyze for the proper PPM of antioxidant.
- Free Fatty Acids (FFA) — Oxidation of fat produces FFA as a by-product. High FFA accompanies rancidity. High quality animal fat should have less than 10% FFA.

Test for Digestibility

There are no simple tests for digestibility. University feeding trials offer the best measure for figuring out the digestibility of a fat.

Practical Application

Common commodity fats are tallow, poultry fat, yellow grease, vegetable oils, and animal-vegetable blends. Animal fats are largely saturated; plant lipids are largely unsaturated. Thus animal fats are more desirable for feeding dairy cattle. Tallow is the animal fat of choice, as can be evidenced by the high-producing herds in Wisconsin that are approaching 30,000 rolling herd average (RHA) milk.

A note of caution: All tallow is not equal. The best tallow is hard, high-titre tallow. Titre, the point at which a fat solidifies, should be 42 to 45°C; iodine value (IV), an indication of the quantity of unsaturated fatty acids in a fat, should be 45 to 55; and free fatty acids should be less than 5%. In short, it must be very highly saturated fat for best results.

Feed Microscopy

Feed microscopy is enjoying a renewed wave of popularity. It is organized as the American Association of Feed Microscopists. This organization offers many opportunities to anyone seeking to know more about feed microscopy.

Feed microscopy is literally the microscopic examination and evaluation of a feedstuff. There are two types of microscopy: qualitative and quantitative.

Qualitative Microscopy

Determines the presence of ingredients (e.g., corn, soybean meal, etc.), contaminants (e.g., Salmonella, mold, rat feces, hair, etc.), or foreign materials (e.g., iron filings, dirt, etc.). Qualitative microscopy also recognizes the quality of the ingredients and the degree of processing. This type of microscopy does not enumerate the feed components. It just simply lists their presence.

This test is sometimes called the "Filth Test." This is because it identifies the presence of such things as larvae, rodent hair, rodent feces, molds, spores, etc.

Quantitative Microscopy

Specifies the item (e.g., Salmonella) and enumerates how much is present. This test is very beneficial in the field. Figuring out the economic or nutrient value of a concentrate or a supplement can be very difficult. However, quantitative feed microscopy can greatly simplify this task, this shows in the following case studies.

- **Case 1:** Dairyman John is buying a custom grain mix. The grain is used in a TMR. John's cows are doing well.

John receives a lower bid on his custom grain mix and switches to another company. The new grain is much bulkier. It appears to contain mostly hulls and little corn.

The weather becomes hotter. A drop in milk production follows. Dairyman John thinks the grain mix is to blame, and that the feed company owes him for damages. The feed company says the grain is okay.

Feed microscopy is used to clarify the problem. Results are summarized in the table below. The calculated grain formula is compared to the original grain (mix A) and the subsequent grain (mix B). Note how Mix B differs.

Feed Microscopy Results: Case Study 1

INGREDIENT	FORMULA	MIX A	MIX B
	(%)	(%)	(%)
Corn	53	55	1
SBM	16	20	20
DDGS	9	8	0
Mids	9	7	50
S Hulls	0	0	25
P Hulls	0	0	1
Minerals	13	10	3
Total	100	100	100

- **Case 2:** Salesman has a new bypass protein supplement that he "guarantees" will increase milk production five lbs/cow/day.

The dairyman asks that one assess its value. The feed company gladly provides a guaranteed analysis (feed tag), but the company will give little additional information.

Feed microscopy was performed and the results are summarized below. The additional information now allows calculation of feed value.

Feed Microscopy Results: Case Study 2

INGREDIENT	FORMULA (%)
Corn Gluten Meal	40
Blood Meal	40
Wheat Mids	10
Soybean Meal	5
Distillers Grains	5
Total	100

Summary

A dairyman's success depends on optimum forage utilization. This requires feed testing and scientific expertise. Dairy practitioners can help their clients in this area. Surveys show that dairymen depend on their veterinarians as their primary source of information.

This paper has presented three types of testing that veterinarians can use to help their clients. They are as follows: (1) TMR testing, (2) fat testing, and (3) feed microscopy.

TMR testing allows checking for (1) inadequate mixing (2) inaccurate weighing, (3) incorrect sampling, (4) incorrect analyses, and (5) incorrect calculations. Total mixed rations are a challenge to sample. The energy values generated for TMRs are generally not accurate. Values for the other nutrients are generally accurate. An accurate ingredient database, based on analyzed samples, should be established.

Fat testing can be useful to decide the type of fat and the level of feeding. Practical concerns of fat testing are (1) degree of rumen inertness, (2) oxidative rancidity, and (3) digestibility. Tests for saturation include iodine value, titre and % saturation. Tests for rancidity include peroxide value and testing for the antioxidant. There is no practical chemical test for figuring out the digestibility of a fat.

Feed microscopy is an old science that is enjoying a renewed wave of popularity. There are two types: (1) qualitative and (2) quantitative. Qualitative is also know as the "filth test," because it identifies such things as larvae, molds, rodent hair, rodent feces, etc. Quantitative microscopy can identify and proportion the ingredients in grain mixes. This additional information is very valuable.

References

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