A Practitioner's Approach to Nutrition

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The Case For Nutrition

A dairyman's success depends on a number of factors. Among these are genetic improvement, accounting principles, forage production, ration formulation, replacement heifer rearing, economic awareness, labor management, disease prevention and parasite control, quality milk production, marketing concepts, and reproductive efficiency. Any attempt to rank these is debatable; however, I believe Dr. Charlie Jarrett, professor emeritus, University of Georgia, is correct when he says, "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." Here two key areas of management are stressed:

1. "To grow, harvest, and preserve high quality forage"
2. "To supplement it with the 'balance' of grains that will support efficient and economical milk production."

Point one could be referred to as optimum forage production, and point two as optimum forage utilization. Obviously, these points are so interrelated it is difficult to consider them singly. Thus, in the broadest sense, they both may be included under the "umbrella" of nutrition.

How does veterinary medicine relate to nutrition? First, veterinarians have long recognized that nutrition plays a prominent part in the prevention of disease. Because of this relationship, we have a vital stake in the field of nutrition. The second reason relates to the restructuring of food animal medicine from the traditional role of "medicine and surgery" to that of "production medicine," where the primary goal is to increase animal productivity and maximize profit. To achieve this objective, today's dairy practitioner must be active in the field of nutrition, as well as the other key areas of dairy farm management, in an effort to help his clients produce milk more efficiently and economically. Thus, it is apparent that the more involved the dairy veterinarian is in the field of nutrition, the more valuable he is to the dairyman.

The Levels of Participation

How do you get into nutrition? My answer is that it is a growth process: it takes time and occurs in stages. In discussions with colleagues, I find that they have had similar experiences. As seen from this viewpoint, one develops a nutritional practice along three stages.

1. Diagnostic nutrition—This stage involves a problem that is diet related. One evaluates the problem and concludes that it can best be solved by nutrition and nutrition management. A typical solution involves collecting feed and blood samples for laboratory analysis (investigation), determining the quantity and quality of diet (evaluation), and recommending corrective changes (recommendation). Table 1 lists some examples.

TABLE 1. Problems related to nutrition and nutritional management.

Problem	Consideration
Milk fever	Ca. P, Mg, vit. D
Retained placenta	Body condition, vit. A&E, Se
Udder edema	Body condition, Na, K
Fat cow syndrome	Body condition
Displaced abomasum	Effective fiber
Ketosis	Body condition, energy, niacin
Laminitis	Energy, effective fiber, Zn
Grass tetany	Mg, K

Diagnostic nutrition follows the traditional role of veterinary medicine. Veterinarians are well trained for problem solving; dairy clients expect performance in this regard. This is one of the ways to get started nutritionally. One can gain experience and confidence in the field, while establishing the trust of dairymen.

2. Ration balancing—This stage is a logical development from stage one. In this stage specific feeding recommendations are made on a productive basis. This approach involves analyzing the available feedstuffs and recommending specific amounts of each to be fed for a desired performance (ration formulation).

In its simplest form, a ration may be balanced with little integration of vertical and horizontal aspects of milk production. Such programs of ration balancing may be offered by feed and mineral companies, university extensionists, and private individuals. With little or no on-farm visitation, rations are offered solely on the basis of feed samples and owner input. This type of approach to nutrition seems dangerous and should be avoided. Successful nutrition consultation is best accomplished by an intimate working relationship with the dairy operation.

3. Comprehensive nutrition—This stage is expanded or integrated form of ration balancing. It involves a systematic, highly organized, goal-oriented approach to nutrition. Appointments are scheduled regularly, specific tasks are defined, and performance results are closely evaluated. In recent years, many veterinarians have combined comprehensive nutrition with mastitis control, replacement rearing, reproductive efficiency, and general herd health into an approach that is being called "production medicine." (For a detailed description of the approach of production medicine, refer to "Performance Evaluation as an Integral Part of Dairy Health Programs" by Dr. Leon Weaver, *The Bovine Proceedings—No. 18.)*

A veterinarian may have clients participating at all three levels in his practice. At first, he may mostly work in diagnostic nutrition; with time clients will be acquired for ration balancing and comprehensive nutrition. In due time one may be working almost exclusively on a comprehensive nutritional transition; no doubt others will in the future.

The Influence of Computers

A rapidly changing technology has aided veterinarians in this transition. Most began doing rations with a slide rule or calculator and a legal pad. Programmable calculators and then computers soon followed. The advent of the microcomputer has afforded the dairy practitioner not only the ability to do ration formulation, but more importantly the tool to monitor and evaluate herd performance. No doubt, future trends in dairying and dairy practice will increase computer utilization.

It is difficult and frustrating to stay abreast of rapidly changing technology. One of the worst things about the computer industry is the breakneck speed with which things change. In this regard, Gregg Platt of PeopleTalk Associates makes a telling comment: "To put this in perspective, if the auto industry had achieved the same degree of improvement in the last twenty years, an '87 car would be able to circle the globe on a tank of gas, weigh fifteen pounds, and cost just eighty-three cents." Because of such constant change people will often wait to buy a computer. My point is, in spite of rapid change, don't wait; buy a computer!

One final thought about computers: ration formulation requires many more calculations than most people are willing to do by hand. For this reason, computers have become the tool for "number crunching." Many people, including nutritionists, often have the idea that rations calculated by a computer are perfect and can be used without question. This is far from the truth. The old adage of "garbage in, garbage out" (GIGO) is often associated with our programs when we are not diligent in what we enter into our computers. In other words, *rations formulated by computer are no better that the information provided the computer for the formulation.*

The "Plain Vanilla" Approach

With this thought in mind, I have tried to develop an approach to working with rations that would minimize GIGO. I refer to the approach as "The Plain Vanilla Approach to Working with Dairy Rations." As the name implies, it is very simple and involves making only five key definitions. They are (1) define the animal, (2) define the requirements, (3) define the dry matter intake, (4) define the feeds, and (5) define the ration.

1. Define the animal.—We need to describe the type of animal and the expected or desired performance. This is usually expressed as size, age and condition when growing, fattening or milking at different rates. Table 2 contains some typical examples.

TABLE 2. Examples of defining the animal.

Size (Lb.)	Age	Class	Body Cond. Score	Performance
1350	Mature	Lact. cow	3+	55 lbs. milk at 3.8% BF
1400	Mature	Dry-pregnant cow	4—	Maintenance
100	3 week	Heifer calf	2.5	Gain of 1.25 lbs./day
300	3 month	Heifer calf	3	Gain of 1.75 lbs./day

One should be very exact in this regard. The animals should be weighed if possible; otherwise, weight tapes should be used. It may also be useful to monitor livestock sale receipts of culled animals. The use of heifer growth charts is very beneficial.

Also, we need to score these animals to compare the actual condition versus the desired condition. They should be scored from 1 to 5—with 1,3, and 5 representing thin, average, and fat, respectively.

In practice we are generally working with groups of animals, not individuals. Thus it should be noted that we can define a group just the same as an individual, as long as they are of uniform type and performance. Here the importance of proper grouping is evident if the group is to be definable.

2. Define the requirements.—The daily amount of nutrients required for the specific animal or group of animals must be determined. A key reference is the *Nutrient Requirements of Dairy Cattle,* issued under the direction of the National Research Council (NRC), National Academy of Sciences. This publication, due to its widespread acceptance as a reference, is oftentimes referred to as the "nutritionist's bible."

The NRC bulletin contains two tables of nutrient requirements for all classes of dairy cattle. Table 1 lists the requirements of growing cattle and bulls at several rates of growth for a given body size. Table 2 presents the daily nutrient requirements of mature dairy cows for maintenance and milk production. These tables are presented both in the metric system (Tables 1 and 2) and in the avoirdupois system (Tables 1A and 2A). With the advent of the microcomputer, formulas are available to duplicate these tables. However, when first starting in nutrition, before using a computer, one ought to be able to use the tables and a calculator to determine nutrient requirements. Such hand calculations will greatly enhance one's understanding of nutrient requirements and deficiencies.

Calculating the nutrient requirements is not just a matter of abstracting data from the various tables. There are a

Heat Detection and Efficiency

n Accuracy

Combined objectives that add up to more profitable A.I.

While the sport of archery is rather remote from the subject of catching cows in heat, it helps to illustrate the relationship between accuracy and efficiency for more successful heat detection management. Hitting the target's bull's eye (accuracy) is the archer's primary objective. However, placing the maximum number of arrows in the bull's eye (efficiency) is equally important. Accuracy without efficiency doesn't add up to a winning score!

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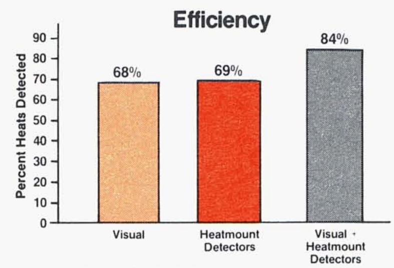

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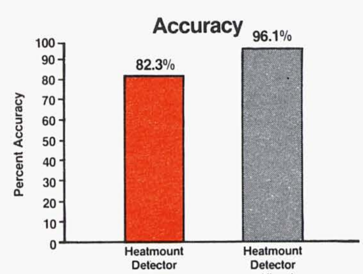
to increase heat detection efficiency while maintaining a high degree of accuracy. Individually, these methods offer average heat detection efficiency but when combined, efficiency improves significantly. The strength of visual observation's accuracy plus the efficiency contribution of Kamar detectors support the concept of combining these heat detection methods to increase overall heat detection effectiveness.



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number of factors which merit special consideration and must also be included:

A. Rumen function—It is possible to calculate requirements for certain groups of animals, such as large bred heifers and dry cows, where the daily requirement of protein is less than that necessary for normal rumen function. Thus, it is suggested that an allowance of 10 to 11% protein be provided in the total ration.

B. Activity—The amount of energy required for maintenance increases with the amount of activity. The energy values for maintenance (NRC, Table 2) are sufficient for the usual activity of lactating cows fed in drylot systems or individual stalls. In fact, an activity allowance of 10% has been included in Table 2; however, if cattle are required to move unusually long distances additional energy should be appropriated. Accordingly, the NRC suggests the requirements be increased 5% for each added mile walked; to support grazing, they should be increased by 10% for lush pasture and up to 20% for sparse pasture

C. Temperature—Cattle have a thermoneutral zone in which they are comfortable. This is from 59 to 77 degrees Farenheit. Any time the temperature gets out of this zone, the nutrient requirements increase. Severe winter conditions increase the maintenance requirements for energy. The NRC suggests that the total feed needs (maintenance and production) be increased by as much as 8% for lactating cows during such conditions. It is possible to calculate a 90% increase in maintenance energy for young growing animals during periods of extreme cold. Practically speaking, one needs to increase feed from 10 to 15-20% of body weight for young calves if exposed to severe cold. With hot weather, the requirements also increase. An example is the practice of feeding additional potassium, sodium, and magnesium to dairy cows during periods of heat.

D. Dry, nonpregnant cows—With the advent of embryo transfer, it is not uncommon to be confronted with "small herds" of dry, nonpregnant cows. Due to the need to increase the numbers of embryos, optimum nutrition for this group is important. In fact, the problem is usually to feed these cows so that they will lose weight down to a more desirable body condition (score 3). Thus it is noteworthy that the maintenance needs for energy of dry, nonpregnant cows is only about 85 to 90% of that for lactating cows.

E. Immature cows—The NRC suggests, "To allow for growth of young lactating cows, increase the maintenance allowances for all nutrients except vitamin A by 20 percent during the first lactation and 10 percent during the second lactation." This has resulted in the common practice among dairymen of feeding an additional 4 pounds of grain to first-lactating cows and 2 pounds to second-lactation cows.

F. Weight gain or loss—It is desirable for high-producing cows to use some of their body fat to supply energy needs during early lactation and to replace it in late lactation. The following allowance for body weight change during lactation is recommended: for each pound of weight gain, increase net energy and total protein by 2.33 Mcal and 0.50 pound, respectively; for each pound of weight loss, decrease by 2.25 Mcal and 0.33 pound. Any feeding program for fresh cows, to be most successful, must capture this advantage of mobilizing fat during early lactation. Likewise it is necessary to redeposit body fat before the next lactation ensues.

G. Grouping—Where cows are fed according to average milk production of the group, consideration should be given to the fact that, if fed for the average, then half of the cows will be underfed. To compensate for this, "lead factors" are used. The following lead factors are suggested:

1/4 herd	1.05 - 1.10
1/3 herd	1.10 - 1.15
1/2 herd	1.10 - 1.20
complete herd	1.20 - 1.40

Of practical significance is the difference between a requirement and an allowance. A requirement is what the animal needs if everything is perfect. An allowance includes an extra "safety factor" due to some of the aforementioned considerations. In short, an allowance is what we should actually be feeding.

This concept should be kept in mind when using "Table 3 Recommended Nutrient Content of Rations for Dairy Cattle" in the 1978 NRC bulletin. It states, "Recommended nutrient concentrations in Table 3 include safety factors to ensure that requirements are fulfilled under a wide variety of practical conditions. Therefore, they should be considered as practical allowances rather than minimum requirements."

3. Define the dry matter intake.—The maximum dry matter intake for the animal must be determined. Dry matter intake is the most important single item in balancing rations for dairy cattle. Certainly the words of Dr. Larry Chase, speaking at the 1985 Cornell Nutrition Conference, are noteworthy: "Dry matter intake is the foundation upon which dairy rations are built. It is essential that the total daily nutrients required to support milk production be provided within a quantity of feed that the animal can realistically be expected to consume."

This requires an accurate measure of dry matter intake. With such, we may: (A) determine whether a proposed ration is conceivable, (B) determine the nutrient density needed, and (C) determine the absolute amounts of certain nutrients.

The importance of dry matter intake, or more importantly of maximizing dry matter intake, cannot be over-emphasized. Maximizing dry matter intake permits the highest level of production at the lowest level of cost; thus it is the point of maximum profit or minimum loss. Dr. Fred Troutt, speaking at the third annual Eastern States Veterinary Conference, aptly expressed the idea: "The name of the game in dairy cattle rations so far as the high-producing cow is concerned is to try to be as consistent as possible with dry matter intake. So anything you're doing to retard dry matter intake, in my judgment, is to be discouraged."

How do we determine the dry matter intake? There are several equations or tables for predicting feed intake (NRC, Georgia, Ohio, California, etc.). Predictions for dairy cows range widely from 3 to 4% of body weight. Thus, if at all possible, it is best actually to measure feed intake at the farm. This requires a concerted effort. Equipment typically needed includes scales, tape measure, bucket, on-farm moisture tester, and a shovel. The principles involved are as follows: (A) determine the amount fed of each feed, (B) determine the amount not consumer, including wastage, (C) figure the difference, which equals total feed consumed on an as-fed basis, (D) multiply by percent dry matter to determine the amount of dry matter consumed, (E) repeat steps 1 through 4 for each feed, and (F) add the values from each feed to establish the total dry matter intake.

The following may help explain how to measure feed intake for a herd. Assume a milking herd of 100 cows which are being fed 18 rectangular bales of hay per day, all the corn silage they will eat twice a day, and a grain mix fed free-choice in the parlor.

A. Hay—Weigh 10 randomly selected bales; total weight (500 pounds) divided by 10 bales equals 50 pounds per bale; 50 pounds per bale times 18 bales fed equals 900 pounds; 900 pounds times .90 (wastage/refusal of 10%) equals 810 pounds; 810 pounds consumed per day divided by 100 cows equals 8.10 pounds per cow per day; 8.10 pounds times 0.90 (percent dry matter) equals 7.29 pounds dry matter per cow per day from hay.

B. Silage—Measure and weigh five one-foot sections of a full bunk of silage; 20 pounds (average weight of sections) times 120 (length of feed bunk) equals 2400 pounds per feeding or 4800 pounds per day; 4800 pounds times .95 (wastage/refusal of 5%) equals 4560 pounds consumed per day; 4560 pounds per day divided by 100 cows equals 45.6 pounds per cow per day; 45.6 pounds times .35 (percent dry matter) equals 15.96 pounds dry matter per day from silage.

C. Grain—A batch of grain weighing 12000 pounds lasts five days; 12000 pounds divided by 5 days equals 2400 pounds fed per day; 2400 pounds times .95 (wasteage/refusal of 5%) equals 2280 pounds consumed per day; 2280 pounds divided by 100 cows equals 22.80 pounds per cow; 22.80 pounds times .90 (percent dry matter) equals 20.52 pounds dry matter per cow per day from grain.

D. Total—Summation of 7.29 (hay dry matter, pounds), 15.96 (silage dry matter, pounds), and 20.52 (grain dry matter, pounds) equals 43.77 pounds dry matter per cow per day. This total represents 3.37 percent of the body weight of a 1300-pound cow.

From the aforementioned, it becomes obvious that a total mixed ration allows for easy measurement total dry matter intake. On the other hand, it is equally obvious, that a feeding system in which both grain and forage are fed in two or three locations is difficult to measure and monitor.

4. Define the feeds.—The quality, quantity, and cost of all available feeds need to be determined. It is necessary to know the nutrient content to balance rations, the quantity to optimize allocation, the cost to maximize profit.

A. Grains and grain by-products—Standard "book values" such as found in "Table 4 Composition of Feeds Commonly Used in Dairy Cattle Rations" of the 1978 NRC publication can be used for grains. By-product feeds, due to their variability, should be chemically analyzed. Many labs provide summaries of all tests performed on grains and grain by-products during the previous year. These are usually much more accurate than values of feed composition tables.

Due to the ever-growing problem of mycotoxins, these feeds should be tested for such from time to time. Concern should also be given to contamination.

B. Forages—These crops vary widely in nutritional value and cannot be used optimally without forage analysis. Differences in species, stage of maturity, moisture content, and method of handling and storage can cause wide variations in the nutrient content.

When to sample? Ideally, these samples should be taken at harvest time. By sampling feed as it is going into storage, you can get results from the lab and balance the ration before the feed is fed. Otherwise, samples should be tested immediately upon starting to feed the crop.

For most forages, tests for crude protein, acid detergent fiber (ADF) and/or neutral detergent fiber (NDF), and some basic minerals (calcium, phosphorus, magnesium, potassium, sodium, sulfur, iron, copper, zinc, manganese, and molybdenum) are sufficient to predict forage quality and to balance rations. However, if the forage has undergone excessive heating, becoming brown or carmelized, then it is likely that the digestibility of the protein has been decreased; so a test for available protein should be requested. Special situations might require testing for nitrates, urea, ammonia, pH, chloride, and soluble protein. For routine monitoring of forages, tests for crude protein, ADF, and moisture may be sufficient.

It is important to sample feeds often. Though paradoxical, as one colleague likes to say, "The more you sample, the less you need to." Thus by past experience you can predict with reasonable confidence the values of feeds as you are sampling them.

As part of routine monitoring of forages on the farm, the moisture content of forages should periodically be tested. This may be done by the use of a microwave oven and a small scale, or an on-farm moisture tester.

It is importnt to be mindful of the differences among labs relative to the expressed values for energy. These values, derived from regression formulas, are based on fiber content and are not acutal energy analysis determinations. In short, they are *estimates only and may not accurately reflect the energy content of a feedstuff.* Furthermore, the formulas used vary widely from lab to lab. My point is that one should be aware of the formulas being used at a given testing facility. Most will readily provide you with them.

Analytical results are only as good as the samples that are submitted. Representative samples are critical. Remember: the quart of material submitted for testing may represent thousands of tons of forage. It is therefore very important to take utmost care in collecting a sample. Plastic gloves or at least clean hands are recommended when taking samples to avoid contamination. Hay should be drilled, cores should be taken from at least 12 bales selected at random. Silage should be taken from various spots, thoroughly mixed, and a representative sample from the mixture sent to the lab.

In addition to chemical analysis, one should visually examine forages. Is the color normal? Is it weedy? Is there any mold or spoilage? Do fermented feeds have a "pickled" smell? Is the length of cut adequate? (Silages should have a particle length of ⅜ to ½ inch; haylages should be cut so that 20 percent of the particles are 1 inch or longer.)

It would be remiss not to again mention the critical importance of forage quality. As stated in the opening paragraph of this paper, the basis of a profitable dairy farm business is the *production and utilization of high quality forages*. Thus the cropping program sets the stage for the feeding program, and the very success or failure of the dairy enterprise is dependent upon the integration of the cropping and feeding systems. The key to the success of the feeding program then becomes planting the crops that will yield the most milk per acre.

In addition to quality, we need to be aware of the quantity of forages available. To utilize forages optimally, one must know the quantity and qualities of all feedstuffs in inventory. Accordingly, an inventory of barns and silos should be made at the completion of harvest. Tables reflecting silo capacities may be utilized. The main purpose of a feed inventory is to determine quantities of forages and grains available on the farm. The basic questions to be addressed are as follows: How much feed is available? How much do I need? How can it best be allocated?

Optimal allocation of feeds, particularly forages, is crucial to maximize productivity and profit. First, the highest quality feeds should be allocated to the groups with the highest nutrient needs, such as young calves and high-producing cows. Secondly, allocation should be made through the year to avoid shortages or unnecessary carryover.

C. Water—Last but not least, we must not forget water. Perhaps because it is such a common feed and nutrient, it is often forgotten when defining feeds. However, since dry matter intake follows water intake, an adequate supply of good quality water is very important for dairy production. It is easy to determine by water meters when the quantity of water becomes inadequate. On the other hand, it is more difficult to determine water quality. I suggest the following simple test. How do you know if the water is suitable for your cows? It is okay if *you* will drink it!

5. Define the ration.—The specific amounts of each feed to be fed comprise a ration. It has been said that there are often three rations on a farm: (1) the ration that is on paper, (2) the ration that is delivered to the cow, and (3) the ration that is actually consumed by the cow. Our efforts should be directed toward reducing any discrepancies in this regard. In other words, we need to be sure that the cow actually consumes the ration that is outlined on paper. Some discussion of potential problems is appropriate.

A. Forage preference—Studies have shown that some cows prefer hay over silage and others vice versa. Feeding forages free-choice gives cattle the opportunity to eat what they prefer, but not necessarily what they need. Accordingly, forages should be limit-fed.

B. Inaccurate calibration—If the amounts and proportions of feeds dispensed are to be correct, feeding equipment must be calibrated. Mix mills, parlor grain feeders, supplement meters, variable speed motors for dispensing grain, and computerized grain feeders all need to be calibrated when feeds change. Unfortunately, some equipment, such as a magnetic feeder, has no means for calibration, and its use should be discouraged.

C. Improper weighing—Mixing devices should be equipped with scales. It is suggested that they be checked weekly for accuracy by weighing a known object. Accuracy should be checked at both ends of the scale by weighing when empty and full.

D. Inadequate mixing—Feed mixing should follow the equipment manufacturer's recommended procedure. It is important not to overmix, as this may cause settling out of particles. If mixing equipment becomes excessively worn, it may not properly mix. Also, the equipment may not be able to adequately mix small amounts, such as 5 to 10 pounds of minerals. Therefore, it is suggested that premixing minerals and grains will result in better distribution. The adequacy of mixes should be checked by analyzing a sample.

E. Feed bunk management—A feed trough should be cleaned daily to enhance feed intake. It should be of adequate length, so all of the animals can eat at the same time; for cows, 2 to 2.5 feet per head is optimum; somewhat less is needed for heifers and calves. It is also important to group animals according to size, and not to overcrowd, so that they all will be able to compete equally and not be "rooted out" at the feed bunk.

F. Feeding system—The type of feeding system is important. Probably none allows for clearer definition of the ration than the conventional system of individualized feeding of cows in stanchion barns still practiced in many areas of the country. This system allows specific amounts of forages and grains to be delivered to each individual cow. This method has always been popular with dedicated lovers of dairy cattle and their production averages usually affirm the practice of individualized feeding; however, more labor is usually needed than with other systems.

Total mixed rations require less labor and offer many of the advantages of individualized feeding. Each feed is actually weighed and mixed; then the mix is delivered to the group or individual. This way the cow does not have a choice between consuming forage or grain. In short, man, and not the cow, controls what she consumes. On the other hand, computerized grain feeders allow for a well defined allocation of daily grain but not forage. Some other systems offer even less control over what the cow consumes.

The Approach in Retrospect

From the aforementioned discussion, the motive for establishing the five basic definitions was the institution of a successful feeding program. They are also the key to reviewing and reevaluating a program.

Remember, there is more to nutrition consulting than plugging in numbers and making recommendations. You have to get out and see the cows. They will tell you if the program is working. Do they have proper body conditon scores? Do their haircoats gloss? Is performance on target? Is dry matter intake adequate for calculated daily nutrients? Are there any feed changes? Are feeds being optimally allocated?

In conclusion, looking over the approach described herein, its truth may be summarized as follows:

1. It centers around the concept that successful dairying depends on the production and utilization of high quality forages.

2. It can be used for nutrition consulting at any level of involvement.

3. It is a simple method that requires making five key definitions for establishing and monitoring feeding programs.

4. It is equally applicable for use in other species as well as the bovine.

5. It recognizes that proper nutrition is simple and basic, with no frills, thrills or magic.

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