Nutritional Health Program for High Producing Dairy Herds

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Introduction

A sound nutritional program provides the foundation for a successful herd health program. Dairy clients of the Michigan State University Ambulatory Clinic indicated in a market survey that improving the level of nutrition in their herds was a high priority item for increasing production and profits (9). The purpose of this article is to outline the procedures followed to develop a nutritional health program for these clients, define the program and indicate the results achieved. The basic concepts of this program can be implemented for any species of animals with minor modifications by the local veterinarian.

Nutritional Health Program

I. Client Education

The place to begin a nutritional health program is with client education which provides the foundation for all herd health programs (10). The Ambulatory Clinic clients had already participated in five meetings devoted to discussing diseases important in their herds. In one meeting nutritionally related diseases such as milk fever, ketosis, indigestion, displaced abomasum, and fat cow problems were discussed along with the effects of nutrition on reproduction in cattle.

The proposed nutritional health program was outlined to the clients in the monthly ambulatory newsletter and discussed at a client education meeting. The local county extension agent who had helped develop a computerized program for least-cost dairy rations also participated in the meeting and played a key role in implementing the program. Extension specialists, private and industrial nutritionists should also be included when applicable.

II. Raising Dairy Replacements

The initial goal in raising dairy replacements is to keep calf mortality under 5% by proper feeding and management of the dry cow, close observation at parturition, and approved feeding and management practices for calves and heifers. In a Michigan survey, 6.4% of the calves died at birth and 11.3% died from birth to two months of age for a total loss of 17.7% (12). Recently completed research at Michigan State University indicated that a dry isolated maternity area and early feeding of colostrum were major factors in reducing early calf mortality (3). The newborn calf should receive four pounds of colostrum immediately after birth with a total of 18 to 24 pounds being fed within 36 to 48 hours. Colostrum, whole milk or high quality milk replacer should be fed until the calf is consuming approximately 1.5 pounds of calf starter at four to eight weeks of age. A 16% protein grain ration is fed at the rate of approximately one pound per month of age until six months. High quality hay should be available free-choice and can be supplemented with corn silage or haylage after six months of age. Since corn silage is deficient in protein, vitamins, and minerals, and a dilute energy source because of the high water content, calves have difficulty consuming enough to meet their nutritional needs. The amount of grain fed after this time can be minimal depending on forage quality and type of forage.

The onset of puberty is dependent upon size rather than age. Holstein heifers reach puberty at approximately 600 pounds (14). The age may vary from less than 9 months to 20 months, depending on the plane of nutrition.

The goal of a good nutritional program for replacements is 800-pound Holstein heifers at 15 months when breeding should occur and 1,200 pounds at 24 months when calving should occur. Heifers must gain approximately 1.5 pounds daily to achieve this goal (Table 1). Those calving at 24 months will consume approximately 1,700 fewer megacalories than those calving at 36 months because of reduced maintenance requirements prior to parturition.

The approximate cost of raising a heifer to 24 months of age is $400. Delayed calving beyond 24 months costs the dairymen approximately $60 monthly per heifer in increased feed, labor, housing, reduced milk production. Economics dictate rapid and economical growth for herd replacements in a profitable nutritional health program.

III. Forage Testing

The primary objective of testing a feed sample in the laboratory is to obtain a more accurate estimate of forage feeding value from chemical composition than could be obtained from feeding tables, identification of feed, date of cutting and results of previous chemical analyses of forages from the same farm or field. It is also difficult to predict the composition of grass-legume mixtures and weather-damaged forages. The composition of the same type of forage is highly variable (Table 2).

The trend on many farms toward the use of fewer ingredients in the dairy ration has eliminated the possibility of nutrient compensation between ingredients. The ingredients in corn and alfalfa complement each other; however, the use of corn silage, high moisture corn, and ear corn all grown on the same farm as the major source of nutrients could lead to potential problems without proper supplementation.

The custom of providing a wide margin of safety when formulating concentrate mixtures to allow for variation in forage composition can no longer be tolerated due to the increased cost of energy, protein and phosphorus. Laboratory analysis also provides an objective indication of the annual variation which occurs in forages harvested on the same fields or farm. These results can be used to change fertilization and harvesting practices, resulting in improved forage quality.

Sampling Procedures. Although veterinarians will not likely be actively involved in collecting samples, they should be in a position to advise the dairyman or technician about proper procedures. The results of the chemical analysis are a direct reflection of the sample submitted. The ideal time to collect samples of hay or silage is at harvest in order to receive the results prior to using the feed. Sampling at feeding time results in a forage analysis on material already fed. When an additive such as urea is added to corn silage at time of storage, an analysis of samples collected both at the time of storage and feeding is necessary to show the amount of added nutrient present in the resulting silage. Samples of stored silage can also be used to determine if heat damage has occurred.

Random samples of equal size should be collected from each load of haylage or silage, placed in a plastic bag and refrigerated or frozen. Separate bags should be kept for different fields, forages, soil types, or different qualities of the same forage. The contents of each bag should be mixed thoroughly, subsampled for analysis and placed in the air-tight shipping container. The silage sample should not be dried to avoid heat damage and ideally shipped in an insulated bag at the beginning of the week to avoid spoilage. One laboratory collects samples in a refrigerated truck which is also used to collect milk samples for the DHIA testing laboratory.

The Penn State Forage Sampler* should be used to collect samples from silage in bunkers or baled hay. This equipment consists of a stainless steel barrel with cutting head, plunger, and adapter for an electric drill. Samples should be collected from 10 to 12 bales of hay selected at random from the same lot of hay by taking core samples from the end of the bales (Figure 1). These samples should be mixed and a subsample placed in the shipping container.

Each dairyman should submit one sample from each major field, forage type and cutting, resulting in 5 or 10 samples per season for most farms.

Each sample should be identified with owner's name and address, type and variety of forage, plant maturity, cutting and cutting date, fertilizer applied, and field of origin. This information can be used by both the laboratory and farmer for purposes of comparison. Feeding and production information should be included along with an indication of the analyses desired and payment. The owner should receive the results in about two weeks. Copies of the report can be sent to the county extension agent and local veterinarian by including their names and addresses on the report.

Chemical Analysis. The basic analyses offered vary with the laboratory; however, procedures such as dry matter, crude protein, and crude fiber are standard. Estimates of energy expressed in terms of TDN or net energy for lactation are usually available but subject to error. Dry matter can be determined more

*Available from Scientific Systems, Inc., 1120 W. College Ave., State College, PA 16801.

Table 1
Effects of Age and Rate of Gain on
Energy Requirements in Holstein Heifers*

Age at 1,200 lbs. (Months)	Rate of Gain (Daily)	Total Mcal. $NE_{maint.}$ Req.
24	1.53	3,422
30	1.22	4,278
36	1.01	5,133

*Adapted from 1971 NRC Nutrient Requirements of Dairy Cattle.

Table 2
Variation in Nutrient Content of
Legume-Grass Forage (1)

Component	Mean*	Range*
		---(%)---
Crude protein	16.4	5.5 - 40.3
Potassium	2.26	0.42 - 9.63
Calcium	1.02	0.01 - 2.61
Phosphorus	0.29	0.07 - 0.74
Magnesium	0.22	0.07 - 0.75
Sulfur	0.23	0.04 - 0.38
		---(ppm)---
Manganese	48.1	6.0 - 265
Iron	222	10.0 - 2,599
Copper	13.1	2.0 - 92
Zinc	27.2	8.0 - 300

*All values expressed on a dry matter basis.

Figure 1. Samples of hay being collected for laboratory analysis. They should be collected at harvest from at least 10 bales of each type of hay being fed. (Photograph courtesy of Dr. Don Hillman.)

accurately on the farm with a forage moisture tester since some moisture may be lost in shipment to the laboratory. Hay or silages which have heated due to being too dry at harvest time and appear brown in color should always be analyzed for acid detergent fiber nitrogen (ADFN). This test is not available from some laboratories. This value multiplied by 6.25 gives the amount of bound unavailable protein in the sample. Surveys of forages from Minnesota, Michigan, and Pennsylvania indicate that one-third of the hay crop silages for these states have undergone some heat damage (6). Corn and hay crop silages should contain 50 to 70% moisture to prevent heat damage in the silo.

Forages should be analyzed for the important mineral elements due to the wide variation in levels present in the same forage from different farms (1). Analyses are frequently available for calcium, phosphorus, potassium, magnesium, sodium, manganese, iron, copper and zinc and sulfur. Nitrates, urea, and ammonium can frequently be tested on an optional basis. The analyses selected will depend on the herd history, feeding program or the type of problem present.

The cost of the combined basic and mineral analyses usually varies from $12.00 to $18.00 per feed sample. The samples analyzed for Ambulatory Clinic clients at Michigan State University are sent to the Ohio Livestock Ration Evaluation Program, Williams Hall, Wooster, Ohio 44691.

Interpretation of Results. The laboratory results are frequently reported on both a dry matter and as sampled basis. One method of reporting lists normal values which are the mean plus and minus two standard deviations. This range includes approximately 95 percent of the results. The values above or below this range are designated as high or low. Another method of reporting uses consumption and production data provided by the dairyman and compares consumption based on the laboratory analysis with recommended intake.

Veterinarians should secure the advice of the county extension agent, extension specialist or commercial nutritionist to assist them in interpreting the results and implementing the recommended changes based on the forage analysis. Forage testing increases the precision of evaluating forages and facilitates the development of balanced rations. This knowledge permits more accurate and economical supplementation to achieve higher production and prevent disease.

IV. Least-cost, Balanced Rations

The forage analysis data should be used to formulate a computerized least-cost balanced ration which will result in maximum growth of replacements, maximum milk production, and healthy cattle. Substantial savings in feed costs can be achieved, especially when feed ingredients are expensive and large quantities are being purchased.

The Least-cost Dairy Ration Formulation Program developed at Michigan State University was designed to formulate rations that meet recognized nutrient requirements, using home-grown feeds and purchasing ingredients necessary to balance the ration (15) This program utilizes a shared time computer located at the University of Michigan, Ann Arbor, Michigan. Input and output are accomplished via a touch-tone telephone or teletype terminal. This equipment is available in the county extension agent's office and can be used on the farm by connecting it to the telephone (Figure 2).

The computer estimates feed consumption and determines the amount of nutrients required daily or

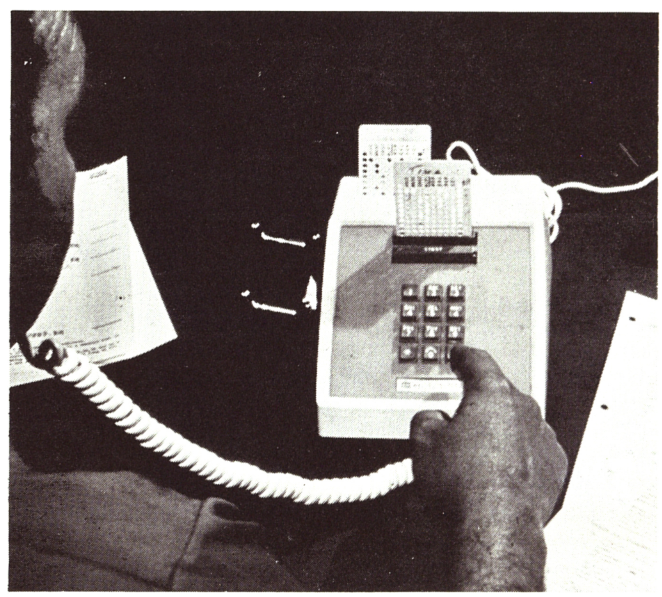

Figure 2. A telephone is used to contact the computer in Ann Arbor, Michigan, with information on analysis and cost of available feeds along with animal consumption and production data. The computer formulates a least-cost balanced ration based on the data supplied and provides the dairyman with specific recommendations for feeding his herd including the cost of the ration. (Photograph courtesy of Dr. Don Hillman.)

concentration of nutrients required in the ration for the body weight, milk production and fat test. The ration is balanced for energy, protein, crude fiber, calcium, phosphorus, magnesium, salt, potassium, sulfur and nonprotein nitrogen. It also controls the calcium:phosphorus ratio at approximately 2:1.

The nutrient values for 200 feedstuffs are stored in the computer for use when the laboratory analysis of ingredients is not available. The dairyman can select the available feeds and indicate the current price in order to determine the least expensive ingredients.

The computer then formulates a nutritionally balanced, least-cost ration for the class of cattle requested. It prescribes the amount of each ingredient to be included in a given amount of grain mixture and indicates the amount of grain, hay, haylage and silage to be fed daily for different production levels.

The feed cost per head daily, pounds of dry matter and protein, units of energy, calcium, phosphorus, and percent fiber in the balanced ration are listed. Break-even prices are computed for each feed considered in the problem which makes it possible to determine the relative value of other feeds and the price at which they would be substituted for in order to keep the ration least-cost.

When the computer was used to formulate a least-cost balanced ration, one-third of the herds received an average increase of 200 pounds of milk daily. Feed costs are frequently reduced 7 to 10 cents per cow daily by selecting the least-cost combination of feed ingredients. Feeding the correct amount of a balanced ration helps to reduce metabolic, digestive and reproductive diseases in early lactation. Feeding the appropriate amount of feed often reduces feed cost for cows in late lactation or dry.

Some computer programs have been developed that not only determine a least-cost balanced ration, but also indicate the amount of the ration which should be fed for maximum profits (2). One group of cows fed this ration returned $21 more income above feed cost per cow.

V. Feeding-Management Programs for the Lactating and Dry Cow

In order to gain full benefit from the forage analysis and formulation of a least-cost, balanced ration, high producing cows must be fed and managed properly. Several key areas will be discussed.

Feeding the Lactating Cow. The objective in feeding the postpartum cow is to reduce nutritional stress to a minimum. This objective can be accomplished by feeding the cow all the required nutrients that she will consume in early lactation; however, the appetite is usually not sufficient for the cow to meet energy requirements. Although peak production may occur in the high-producing cow at three to four weeks, maximum energy intake frequently does not occur until about eight weeks. The high-producing cow is required to use energy reserves from her body to make up this difference, resulting in added stress and possibly ketosis.

The best way of meeting the cow's postpartum requirements is by challenge feeding. This method of feeding is defined as the practice of offering to the cow in good physical condition approximately five pounds of grain daily for at least two weeks prior to calving to allow the rumen bacteria and protozoa to adjust to the concentrate. After calving the concentrate is increased at the rate of two pounds daily until the cow peaks in production or grain intake. The method of feeding is called challenge feeding because it challenges the cow to her maximum genetic production potential. Challenge feeding results in higher production, profits, and fewer health problems than lead feeding which is the practice of gradually increasing grain beginning two to three weeks prepartum to a level of 1 to 1.5 percent of body weight by the predicted parturition date. The results of feeding differing levels of energy before and after calving are compared (Table 3).

Table 3
Effects of Energy Level Prepartum and Postpartum on Milk and Milk Fat Production (4)

Energy Level*	Milk	Milk Fat
	---lbs/lactation---	
Low - Low	12,346	427
Low - High	15,437	496
High - Low	13,719	465
High - High	14,405	465

*Low was 115% of maintenance and high was 160% of maintenance based on 1958 NRC Nutrient Requirements of Dairy Cattle.

Cows in good physical condition fed a low-energy prepartum and high-energy postpartum diet produced the greatest amount of milk and milk fat, and had lower ketone levels in early lactation than those fed high-energy rations prepartum (4). The results of this and other studies indicate the best approach is to feed a low-energy ration before calving following by high-energy after calving.

The high-producing cow's requirement for nutrients other than energy can be met by adjusting their concentration in the diet. Protein is a critical nutrient since the cow has limited ability to store protein and mobilize it later for use in milk secretion. As a result, the first limiting nutritional factor for the high-producing cow may be protein rather than energy.

Grouping cows in loose housing is essential to attempt to meet nutrient requirements in early lactation and to avoid overfeeding in late lactation, resulting in dry cows which are too fat and predisposed to periparturient diseases.

Generally, grain feeding should not be restricted until after conception occurs since research data indicate that cows gaining weight have a higher conception rate than cows losing weight (8). It is essential with either lead or preferably challenge feeding that

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grain intake be restricted during the latter half of lactation and replaced with high-quality forage.

Fat mobilization in early lactation for milk production and replacement in late lactation is almost as efficient as direct conversion of feed energy to milk by the lactating cow. Since fattening during the dry period is not as efficient as during lactation, cows should be permitted to replenish body reserves lost during early lactation during late lactation rather than during the dry period. A cow dried off in good condition has a modest energy requirement which can be met by forage alone. Overconditioning during the dry period depresses appetite during early lactation (16).

Feeding the Dry Cow. The dry cow should be separated from the rest of the herd in order to control feed intake. The dry cow in good physical condition should be fed hay, haylage or pasture which is low in legumes to reduce the calcium intake and to help prevent milk fever (5,7). These forages can be supplemented with up to 30 pounds of corn silage daily. When corn silage is the only forage, the intake should be limited to 1.5 pounds of dry matter per 100 pounds of body weight daily. This diet must be supplemented with protein, minerals, and vitamins to balance the ration.

Mineral and Vitamin Feeding. Cows will not eat minerals and vitamins free-choice in relation to their requirements. The actual mineral composition in the forage must be determined by laboratory analysis. Then mineral intake from forages can be calculated using the laboratory analysis and consumption data. The additional mineral requirements should be met by fortifying the concentrate or total mixed ration rather than relying on free-choice feeding.

The requirements of the dry cow must be met by fortifying the silage or placing high concentrations in a limited amount of grain or salt in an attempt to meet the daily mineral requirements recommended by the National Research Council (11). Vitamins A, D, and E are added at a rate to equal the daily recommended requirement (11).

VI. Metabolic Profile Test

This test refers to a series of laboratory procedures performed on blood collected from a sample of cows. The blood chemistry results are used to assess the nutritional and metabolic status of a dairy herd. This test is based on the premise that the blood metabolites are a reflection of the relationship between the diet and milk production. The blood values provide a quality control check on the forage analysis, ration balancing, and feeding-management programs of the lactating and dry cow.

In the Ambulatory Clinic at Michigan State University, these procedures are used on preventive medicine program herds to get an early warning of impending disease problems and to achieve a diagnosis in problem herds.

The herd sampling procedure as described by Payne consists of collecting jugular blood from 21 cows with 7 in peak lactation, 7 in midlactation, and 7 dry (13). The ideal time to collect the blood is spring and fall after the herd has been on the same diet for at least one month to allow the blood parameters with slow adjustment time to come into equilibrium. The problem herd should be sampled during the period when the condition is prevalent to the greatest degree.

The chemical tests in the blood profile include the following electrolytes: calcium, phosphorus, magnesium, sodium and potassium. The nonelectrolyte parameters include glucose, urea nitrogen, total protein (albumin and globulin) and hemoglobin or packed cell volume.

Interpretation of the test results is the most difficult part of the metabolic profile procedure. A mean value and standard deviation are calculated by herd for each chemical test. Results which exceed two standard deviations are considered abnormally high or low. The results from an individual herd are also compared with the mean and standard deviation for all herds on which data is available.

The metabolic profile results collected from 500 cows in 24 herds in the Ambulatory Clinic at Michigan State University are listed (Table 4). The equipment available analyzed some parameters considered nonessential and unfortunately omitted magnesium, sodium, and potassium.

Table 4

Metabolic Profiles Collected from 500 Cows in 24 Herds in the Michigan State University Ambulatory Clinic

Component	Average ± S.D.
Packed cell volume, %	30.30 ± 4.40
Hemoglobin, gm/100 ml	10.00 ± 1.22
Creatinine, mg/100 ml*	1.08 ± 0.40
Calcium, mg/100 ml*	9.35 ± 0.68
Phosphorus, mg/100 ml*	6.00 ± 1.18
Alkaline phosphatase, U/L*	14.16 ± 10.90
SGPT, U/L*	52.83 ± 13.12
Cholesterol, mg/100 mg*	172.39 ± 54.83
CPK enzyme, U/L*	52.89 ± 37.34
SGOT, U/L*	113.48 ± 91.25
Urea nitrogen, mg/100 ml*	9.82 ± 3.08
Glucose, mg/100 ml*	64.50 ± 43.30
Total protein, gm/100 ml	7.17 ± 0.96
Albumin, gm/100 ml	3.14 ± 0.81
Globulin, gm/100 ml	3.02 ± 0.80

*Analysis completed on Hycel Mark X Machine by Dr. Hiram Kitchen. Other procedures performed by Ms. Roberta Milar.

Interpretation of these results indicated that blood glucose was below normal in one of 24 herds. This problem was corrected by using challenge feeding to increase the energy intake in early lactation which also corrected the ketosis problem. Hemoglobin levels below 10.0 gm/100 ml were detected in seven of 24 herds. These herds were experiencing infertility problems characterized by difficulty in detecting estrus, increased numbers of cystic follicles, and repeat breedings. This metabolic profile study is continuing in the Ambulatory Clinic in order to keep the metabolic and nutritional status of these herds under surveillance and to achieve maximum production and profits.

Results of Nutritional Health Program. This paper can best be summarized by listing the results of a nutritional health program in 24 herds serviced by the Michigan State University Ambulatory Clinic.

The parts of a nutritional health program discussed and recommended to these dairymen included: client education, raising replacements rapidly and economically, forage testing in order to accurately develop least-cost balanced rations, feeding-management programs for the lactating and dry cow, and metabolic profile testing to assess the effectiveness of the other parts of the program.

There were 23 Holstein and one Jersey herd which followed all or part of these recommendations. These 24 herds represented 1,502 cows with an average production of 13,788 pounds of milk and 560 pounds of butterfat. The occurrence of nutritionally related diseases in these herds during a 12-month period is listed (Table 5). The future adoption in these herds of all recommended practices outlined in this paper should be helpful in approaching the desired goal of practically eliminating nutritionally related diseases.

Table 5
Occurrence of Nutritionally Related Diseases in 1502 Cows in 24 Herds Serviced by the Michigan State University Ambulatory Clinic, July 1, 1974, to June 30, 1975

Disease	Occurrence (%)
Milk Fever	5
Ketosis	4
Displaced Abomasum	2
Indigestion	7
Internal Parasites	2
Fat Cows	1
Retained Fetal Membranes	5
Inactive Ovaries	4

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