Changes in Feeding Dairy Cows During The Last 20 Years and What's Ahead

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Summary

Making correct feed selection and management decisions in 1970 to 2011 were and will be critical as feed and milk prices fluctuate. Changes over the last 20 years reflect new feed ingredient availability, forage storage and quality changes, and the need for more defined nutrients as dairy cow requirements based on research result as milk production increases. Nutrient requirements do not change in relation to feed and milk prices (the need to stay the course). Monitoring feed related values, including feed cost per pound of dry matter **(DM)**, feed cost per cwt (100 lb of milk), feed efficiency, and income over feed costs, allow dairy managers to evaluate their feeding program. Higher forage-based rations and strategic use of by-product feeds will be considered. New technologies, including precision feeding, rumen additives, plant and animal genomics, and consumer focused dairy products, will improve dairy cow productivity and milk value in the future.

Introduction

After working and interacting with dairy managers, Extension educators, and dairy researchers for 39 years as an Extension dairy specialist in Minnesota and Illinois, new approaches and changes in dairy nutrition have occurred, while many principles remain the same. This paper will look back 20 to 30 years, focusing on feeding changes, feeding challenges in 2011, and future feeding strategies and opportunities.

Lessons Learned from the 1970's and 1980's

Joining the University of Minnesota dairy Extension staff in 1971 to 1979 allowed me to monitor changes in the dairy industry, benchmarking Midwest dairy feeding situations, and comparing possible changes to the dairy industry. Table 1 compares data obtained from the Hoard's Dairyman Magazine Market Surveys in 1976 and 2010. Each year, Hoard's Dairyman market researchers select 2000 random readers who subscribe to their magazine weighed for percent of readers in each state. In 2010, Wisconsin was represented by 14.9%, Ohio was 6.8%, and 34.3% for the East North Central region (OH, IN, IL, MI, and WI). Topics and dairy Extension activities in the 1970's are listed below with comments on the impact on future direction and decisions.

- High moisture ear corn was an active area of interest and focus. Because combines were becoming a harvesting method compared to corn pickers, researchers compared both forms of the high moisture corn. The fiber in the cob was found to be beneficial in some studies, suggesting high moisture corn was equal to shelled corn on a DM basis. The impact of these studies initiated interest in fiber levels in grain mixtures, high moisture cob fiber compared to crib dried cob fiber, and rumen digestion based on starch levels due to the level of cob included. Snaplage was also being studied, but separation in vertical silos was a problem; leading to moldy areas and inconsistent feed.

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- Haylage was a term applied to forage stored in oxygen limiting structures compared to wetter grass silage. The continuous feeding of fermented silage was appealing to dairy managers. Sealed unit manufacturers educated dairy managers on forage production, fertilizing strategies, hybrid selection, and harvesting guidelines, leading to high quality forage which improved milk production. This approach focused on going beyond selling a product. Alfalfa continued to be the queen of forages, with corn silage fed in limited amounts (considered a steer fed).

- Cafeteria mineral feeders were appearing as a way to supplement dairy cattle, allowing cows to select each day from 8 to 15 different mineral products. Studies indicated that cows consumed salt, sodium bicarbonate, sodium bentonite, and limited amounts of phosphorous.

- Magnetic grain feeders were used on freestall dairy farms to provide extra grain to higher producing cows. Cows identified with a chain had free choice access to grain mixtures. "Boss cows" took on a new meaning. Electronic grain feeders were the next generation of grain feeding technology which interfaced with milk recording in parlors and cow identification for management purposes.

- Computer based ration formulation was the Michigan State dial-up program using a telephone. Four to six nutrients were calculated and recorded by hand. Busy signals were the "kiss of death" at meetings. Texas Instrument **(TI)** units allowed ration formulation on site. A hard copy tape print was generated with more data.

Extension programs were tied to DHI with one or two Extension specialists responsible for the day-to-day management of the program and labs. The educational focus was county based meetings with specialists in Minnesota limiting the number to 80 meetings annually with four dairy specialists (over 320 meetings) plus forage, farm management, dairy engineers, and milk quality specialists available in most states. Overhead projects were delivery systems with slides becoming more common. Funding was excellent, with opportunities to launch new programs and efforts. The Four State Dairy Extension group (WI, MN, IA, and IL) had been formed in the 1960's, which become the model for other regional groups.

Looking at 2011

Table 2 lists feeding decisions and strategies for U.S. dairy managers in 2010. Dairy nutrition continues to have key economic impacts for Midwest dairy managers, with competitive advantages compared to western states dairy managers. As forage and corn grain were produced on the farms, forage quality was controlled and production costs of forages and grains were lower than current market prices. Illinois workers calculated the cost to raise alfalfa hay was $107 a ton, while the market price is over $160 a ton in 2011. A similar financial competitive advantage pattern exists for corn silage, shelled corn, and soybeans.

Evaluating feeding economics

- <u>Herd feed efficiency **(FE)**</u> from 1.4 to 1.6 lb of 3.5% milk per pound of DM with each change in 0.1 FE point worth $0.30 to 0.38/cow/day. Factors impacting FE include forage quality, fiber digestibility, ration formulation, DM intake, milk quality, somatic cell count status, rumen health, reproductive efficiency, and environmental impact. Milk protein efficiency will become another FE measure as dairy cows recover 25 to 30% of dietary protein as milk protein. This value will need to increase to 35 to 40% by genetic selection, feeding programs, and feed ingredients which will be a win-win-

win-win for dairy cows, dairy managers, the environment, and consumers.

- Feed cost per pound of DM at $0.11 to 0.12/lb of DM reflects the cost of feed ingredients selected when building and balancing the ration. Feed ingredient selection, forage quality, and feed additives are key factors.

- Feed cost per 100 lb of milk ($7 to 8/cwt) reflects the cost per pound of DM, amount of DM offered, weigh backs, shrink, and milk yield. Milk yield is the key factor.

- Income over feed costs ($7 to 13) represents margin (dollars available) for fixed, variable, and labor costs, and return to management. Milk price is a key factor in this value.

Feed related factors

Corn hybrids offer flexibility with low lignin corn silage, corn silage specific hybrids, higher starch levels, and improved FE. Forages high in neutral detergent fiber digestibility **(NDFD)** provide sources of rumen fermentable carbohydrates, reducing concentration corn grain needed.

Use of computer modeling programs allows for fine-tuning rations. Lower levels of protein based on amino acid balancing and rumen microbial estimation can reduce feed costs while optimizing production. Milk protein yield continues to be important in the Midwest based on milk pricing systems.

With corn grain over $7/bu, starch level and utilization must be optimal. Lower levels of starch (20 to 22%) can maintain milk production with high quality forage, rumen fermentable fiber, adding sugar, and/or feeding an ionophore. Plant or kernel processing of corn silage and processing corn grain can increase starch availability in the rumen and reduce fecal losses of starch. If fecal starch is over 5 to 6%, examine the cause of higher fecal starch values.

By-product feeds can be an economical nutrient source. Corn by-products continue to be economical sources of nutrients. Distillers grain and wet brewers grain can reduce protein costs, while corn gluten feed, soy hulls, and wheat midds can maintain energy levels while reducing feed costs. Dairy managers and nutritionists must monitor corn by-products as ethanol producers continue to market corn nutrients in by-products (corn oil for bio-fuel, corn protein for monogastic animals, and corn bran for ruminants) to capture value-added feed markets.

Review shrink losses. Managing and monitoring weigh backs can increase profitability. One guideline is to target 1 to 2% weigh back per cow per day. Bunk management may allow feeding to an empty bunk, reducing feed refusals and saving 1 to 3 lb/cow/day of DM ($0.11 to 0.30/day). Other areas to reduce feed shrink include mixing errors monitored by computer based software on weigh scales, mixing inside the building, minimizing weather and wind losses, and controlling waste.

Forage storage systems continue to shift to bunkers, baleage, bags, and drive over piles. Herd size and local availability of forages impact these forage storage systems. Oxygen barrier covers reduced DM loss and shrink.

Snaplage (a high moisture grain consisting of corn grain, cob, husk, and some plant material) is returning as high moisture corn (35 to 40% moisture), using large forage harvesters with snapper head attachments. The ability to harvest large acreages in a short time period and process the high moisture corn prior to storage in the field is appealing to dairy managers and custom harvesters, along with higher DM recovery per acre. The added fiber can improve rumen fermentation and health and reduces starch levels.

Future Feeding Strategies

Precision feeding can be defined as delivery of the same ration and form every day to every cow. Blending rations with consistent feed processing can result in the same physical form and nutrient content ration in each batch of feed every day will be needed. Feed ingredients will be added with an exact mixing time (minutes of mixing time and revolutions of the TMR mixer) and feed order. The NRC standard nutrient composition tables may not be used in ration formulation. Fuzzy cottonseed does not contain the same nutrient level due to new genetic selection of the crop and growing conditions. Measuring forage quality when harvesting forages using near infrared **(NIR)** sensors on the chopper will capture real time forage yield, DM changes, and nutrient level of the forage before it is stored. The field harvesting chopper will automatically adjust chopper theoretical length of chop **(TLC)** and roller clearance of the kernel processor as DM content changes in the field to process uniform and desired corn silage forage for ensiling and feeding. Measuring and managing variation in forage quality will be available to nutritionists and dairy managers to correct nutrient content based on standard deviation of feed based on multiple test summarization. Ration balancing and protection of ration nutrient changes, such as adequate protein or a shortage of fiber, can be programmed into a computer software program. Commercial forage testing labs provide summaries of specific forages from the dairy farm over several samples and time periods.

High forage-based rations (over 65 to 70% of the ration DM) will become economically attractive. As competition for corn and soybeans continues between human food uses and bio-fuel production, the dairy cow may not compete economically for these high quality food resources as feed. Dairy cattle have a rumen-based digestive tract that allows ruminants to consume feed ingredients that humans cannot utilize (such as grasses, pasture, distillers grains, wheat midds, urea, and other by-product feeds). Cornell researchers have measured herds producing over 80 lb of milk fed rations containing 65 to 70% of the total ration DM as forage (Chase, 2010). Nutritionists and dairy managers will need to be skillful when managing these rations (inventory control, rumen models to predict results, and harvesting high quality forage). As a hungry and growing populations continues to expand, the future may dictate that dairy managers cannot afford corn or soybean-based feed ingredients as dairy feed.

Designer dairy products will become more than food that we consume for providing high quality protein, calcium, potassium, B-vitamins, and other key nutrients. Cows will produce fatty acids (type of milk fat) in milk that will improve health and avoid diseases [an example is conjugated linoleic acids **(CLA)**]. Specific dairy proteins could also be a valuable food resource to reduce or slow memory loss and aging. Improved weight loss may be achieved with whey proteins. Calcium and vitamin D may have future human health benefits.

Genomic cell engineering (gene sequencing) has been identified for dairy cattle, allowing researchers to find "the combination of genes" that could reduce mastitis, decrease transition cow health risks, and/or reduce milk fat synthesis. By selecting these genetic markers and turning on or off these genes, cows could produce milk containing 2% milk fat instead of 4% fat, which may reflect consumer demand and lower energy needs of high producing cows. Illinois researchers have identified genes that are up regulated (turned on) or down regulated (turned off) based on the diet the dry cow consumes, which may impact metabolic risks in transition cows. This biotechnology tool has tremendous potential in the dairy industry.

New rumen-based feed additives continue to emerge from research labs and companies which may enhance rumen function and efficiency. Enzymes may increase digestibility, providing more nutrients for the cow or microbes resulting in less manure - another win-win situation. Enzymes could be added to forage when ensiling, treating feed prior to consumption, or fed to function in the rumen or lower digestive tract (protected from microbial destruction). Encapsulation technology is available to allow companies to "protect" key nutrients from rumen microbial destruction (such as rumen protected amino acids, fatty acids, niacin, and choline). Direct-fed microbes will be identified through selection and DNA finger printing that can enhance rumen fermentation, reduce lactic acid build up, and improve cell and cow immunity. Essential oils are a class of feed additives that offer alternatives and opportunities, depending on the future role of feeding antibiotics.

Computer technology and software programs allow for continual improvement in rations, with the ability to predict rumen microbial yields, amino acid flows, rumen pH, milk urea nitrogen values, fatty acid levels, and the environmental impact of nitrogen and phosphorous excreted in dairy cow manure. Balancing long chain fatty acid levels and types to predict desired milk fatty acid composition is possible. In the future, we may not balance for NDF, but balance each fiber fraction to predict performance (lignin, hemicelluloses, and cellulose). Computers will "see" and adjust for feed particle size, heat stress impact on the rumen environment and pH, impact of cow comfort on feed intake and digestion, refine dietary cation-anion difference calculations, adjust mineral levels based on bioavailability, and predict nutrient efficiencies (DM, protein, energy, and minerals) delivered by the ration feed ingredients monitored by feed models.

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Table 1. Comparing dairy data from 1976 and 2010 data reflecting changes in the dairy industry (Kerschensteiner, M. H., 1976; Vorpahl, G.L. 2010)

	1976	2010
Dairy Enterprise:		
Herd size (number of cows)	64.5	167.5
Milk yield per cow (lb/lactation)	12,694	20,044
Heifer herd size (number)	38.1	117.1
Steers (number)	13.8	31.9
Milk price ($/cwt)	9.98	12.82
Gross income per farm ($)	95,000	447,337
Grade A producers (%)	78.8	95.7
Breeds (% of farms reporting)		
Holstein	80.2	89.3
Jersey	7.6	28.2
Crossbreds	NA[1]	27.6
Feeding Aspects:		
Commercial feed purchases ($)	16,796	127,298
Milk replacer use (%)	68.6	63.8
Complete dairy grain concentrate (%)	48.5	46.0
Green chop forage (%)	2.3	NA
Baleage use (%)	NA	24.1
Bunker silos (% using)	8.1	26.8
High moisture corn use (%)	16.0	49.9
High moisture shelled corn (% wet corn)	43.5	75.3
Silage inoculants use (%)	17.4	40.1
Metabolic disorders (% reporting):		
Milk fever	80.0	79.7
Ketosis	47.0	63.7
Displaced abomasum	24.0	59.3

[1]NA = not available.

Table 2. Benchmarking for 2010 feeding practices (% using) for future consideration (Vorpahl, G.L. 2010).

Use of TMR Tracking systems	16.8
Considering buying TMR tracking system	29.0
Feeding fat in lactating ration	43.8
Oilseed sources	43.6
Fat products	26.2
Inert fat sources	46.6
Organic trace minerals use	28.3
Silage additives use	40.1
Corn silage	83.9
Hay silage	73.5
High moisture corn	32.2
Baled hay	20.4
Fresh cow products—calcium or propylene glycol	81.1
Feed additive use	
Buffers	41.4
Yeast/yeast culture	31.8
Mycotoxin flow agents	23.1
Ionophore for lactating cows	21.4
Niacin	14.0
Probiotics	13.2
Anionic salts	4.4
Do not use any	8.1
TMR feeding system	61.9
Vertical mixer	35.8
Reel type mixer	27.9
Auger type mixer	24.0
Drum mixer	4.8
Kernel/plant processor use	26.3
Balancing rations	
Feed company	42
Private nutritionist	35
Dairy manager-self	19
Veterinarian	2