

## Dairy Nutrition: Looking Back 100 Years with an Eye to the Future

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The relics of the past century of American agriculture can be seen parked along fence-rows and under slowly decaying barns. Old farm implements, the abandoned milking parlor and other equipment remind us of the changes that have occurred in how farmers have done the work that fed a nation during a period of unbelievable change. We have seen first flight occur on the Outer Banks of North Carolina and manned space travel with the space shuttle returning to earth to be launch on a future mission. Communication has evolved from correspondence taking several days or weeks (depending on the distance between the addresses) to several seconds. Communication is made even more remarkable through Internet connections as we are able to communicate messages across the globe in seconds. Medical advances make what were once considered medical miracles today's expected outcomes of medical treatment. The entertainment industry has grown from pictures without sound to movies ordered on demand from the comfort of your own home. Among these remarkable changes we often overlook the advances made possible by rural electricity, indoor plumbing, telephones, and refrigeration. Fast food, microwaves, and cellular phones developed in response to a mobile and harried society. Indeed, the last century was marked with discoveries, change, and accomplishments hard to comprehend.

The dairy industry mirrored the century of technological change. Dairy producers have successfully adapted to change as the industry has evolved to the "high-tech" industry that continues to produce a high quality and nutritious food. Farm size and management structure has changed on U.S. dairy farms. The dairy cow, initially a source of milk and dairy products for the family, became a provider for a growing community. The family's herd of a few cows expanded for the export of milk to meet local demand. Now, milk is shipped long distances to supply large processing centers adequate volumes of fluid milk to keep plants operating at peak efficiency.

Biotechnology such as recombinant DNA and genetically modified organisms are quickly becoming part of the landscape of US agriculture. Of course the advent of artificial insemination and other reproductive management tools greatly impacted the change as well as the rate of change of the dairy cow's genetic potential. The increased ability of the dairy cow for higher milk production potential had a great impact on how the industry fed and housed the dairy cow. Current agricultural "biotechnology" has the potential to dramatically accelerate the rate of change in the dairy animal's genetic make-up and again the industry will change in response to this change in order to increase efficiency and maintain

a competitive advantage in the global marketplace.

In short, the history of the dairy industry represents a heritage of change including production practices, milk processing and distribution, and regulatory policies that govern the marketing of dairy products. Dairy cattle nutrition has been an integral part of this change within the context of learning how to better feed the better dairy cow within a more complex dairy industry of larger farms and intricate production management systems.

The many editions of Henry and Morrison's **Feeds and Feeding** books provide an invaluable historical record of the evolution, progress and change in our understanding of ruminant nutrition and the changes in the feeding of dairy cattle. In some ways the authors observations and comments published a century ago apply to successful operation of modern dairy farms at the start of the new century. The changes in dairy cattle nutrition have corresponded with changes in the farming system. For example, the metabolic diseases reported in animal husbandry and veterinary texts at the turn of the century describe rumen impaction, the result of poor quality forage, as a nutritional challenge for cattle farmers. In contrast, today's dairy cattle are fed diets contain smaller amounts of forages that are of higher quality, that are more highly processed forages, that are then combined with large quantities of rapidly fermented carbohydrates from processed grains. This highly fermentable diet can contribute to and is associated with a higher incidence of ruminal acidosis, lower milk fat, and laminitis. With the expansion of our understanding of basic

nutritional principles, diet formulation programs have been developed to allow for a more comprehensive analysis of the diets and are structured to provide diets with the proper balance of dietary carbohydrates including source, rate of fermentation and predicted physical parameters. Furthermore, feed additives such as yeast and sodium bicarbonate have been developed to help moderate the fluctuations in rumen pH that can occur due to high starch diets.

A century ago, milk fever was considered one of the most fatal diseases affecting dairy cattle. One text reported the exact cause of milk fever as unknown. Hogins and Haskett (1907; The Veterinary Science) reported an alternative treatment for milk fever to involve injecting air into the quarters of a cow suffering from this disorder. Today, we enter the new century understanding the role of calcium and other cations play in milk fever. Furthermore, scientists have developed preventative strategies that include the use of anionic salts.

Mammary gland disorders were thought to be the result of a number of different causes including consumption of irritating weeds and the drinking of stagnant water. Today, we associate mastitis with the dirty environment the stagnant water represented. Furthermore, dairy cattle farmers have available safe and effective intra-mammary antibiotic therapy. We have also developed a better understanding the role of nutrition has on mammary gland health. Vitamin E, biotin, selenium and zinc all function as part of the immune system of the cow and her mammary glands.

Nutrition of the dairy cattle has evolved with our continued growth in understanding of Carbohydrate digestion and metabolism, protein and amino acid digestion and metabolism, lipid digestion and metabolism.

Macrominerals, microminerals, and vitamins have all become better understood and therefore more efficiently utilized in dairy cattle diets. In 1930, Ragsdale concluded that vitamin supplements were not needed as the forages in the diet provided sufficient amounts of these nutrients to meet the animals' needs. With the level of production and given the use of highly processed feeds, we understand the need to provide adequate amounts of the small inclusion nutrients such as the macrominerals, microminerals, and the vitamins. Even in the last few years, we are realizing that B-vitamins can be economically added to the diets.

The December 1999 (Volume 50, number 10) issue of Feed Management included a time line illustration of advances in animal nutrition. The anonymous author outlined the significant events in livestock feed industry. As outlined below, the last half of the 20<sup>th</sup> century held for exciting and important changes in our feeding knowledge. Least Cost Dairy Feed Formulation was developed. Commercial milk replacers were introduced to the U.S. The decade of the sixties included the isolation of aflatoxin and the development of analytical methods to measure this potent mycotoxin. The Net Energy System was developed. Selenium supplementation was allowed in the 1970s and sodium bicarbonate was discovered to affect rumen pH. The degradable/undegradable protein system

was also described during this decade. In the 1980's selenium allowances were increased from .1 ppm to .3 ppm. The commercial production of rumen inert fat was also initiated.

The 1990s marked a shift in the animal nutrition and feed industry. Methionine was found to be a limiting amino acid for milk production. And while we continue to grow our knowledge and understanding of animal nutrition, consumer issues affected the feed industry. Following the BSE scare in Europe, mammalian protein was banned from ruminant diets. High profile personalities seem to have a greater influence on public opinion. With the growing distance between production of food and the consumers of food, consumer perceptions could become an issue that affects change and the direction of change. The changes during the last decade likely foreshadow the issues that will face animal agriculture and with many of these issues needing more scientific study before conclusions can be reached. While some sectors would see this as a challenge, it should be evaluated as an opportunity to grow a better understanding and a more loyal customer base. This shift could also lead to more niche markets and opportunities for smaller scale production systems of specialty foods unique to a geographically limited demand.

There are challenges that will carry forward from the last century. Transportation, medical advances, and availability of energy resources will grow to be major concerns and controlling factors for continued success of agriculture. Will the availability of natural resources limit farming and how specific will this be to location.

Consumers will continue to inquire about the quality and safety of their food. In fact, the role of milk as a possible nutraceutical has grown given the ability to alter the fatty acid content of milk fat by changing feeds involving supplemental fat. What steps can be taken to create a sustainable system? How will the industry respond to challenges and where will the industry look for new opportunities?

In some ways, the most important question involves new opportunities. If we recall past successes in dairy cattle nutrition, we are reminded that many advances were made through our

responses to challenges the industry faced. Collectively, the industry worked to answer the hard questions. The answers gave us new advantages. The answers also led the industry to new questions. For example, nitrogen digestion and metabolism led the dairy nutrition industry from crude protein to degradable protein system to an amino acid system. As an industry, we must focus on opportunities to solve challenges while also identifying new opportunities for future growth and continued success in providing a high quality, nutritious food for a growing global neighborhood.