Dairy Cattle:

Principles, Practices, Problems, Profits

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DR. RICHARD C. FOLEY *passed away on February 23, 1972, just as the first edition of this text was being readied for printing. He has been sorely missed by his former students, co-workers and friends. He conceived and was senior author of the first edition of this text, which occupied most of his work time for several years prior to his death. It is perhaps appropriate that he died while attending a meeting of dairymen—to the very last moment he dedicated his professional career to the dairymen and the great American dairy industry.*

Preface

The third edition of this text contains major updating as well as new material. The sections on breeding, feeding, reproduction, lactation, herd management, milk marketing, and herd health contain major revisions based on the latest research findings and changing conditions in the dairy industry.

This book is written for use as a text in senior dairy herd management courses at both the Associate degree (2-year) and Bachelor's degree (4-year) level. By stressing both the fundamental principles that determine why certain programs are more desirable than others and the detailed practices about how to breed, feed, and manage dairy cattle, we hope that this third edition will serve all segments of the dairy industry. It has been our intention also to produce a text that would be useful in all 50 states, in the major dairy areas of the world, and in those developing nations that are striving to improve their animal agriculture and to increase their supply of animal products.

Success in dairy farming, as in any other business, requires planned programs, based upon realistic standards of performance directed toward reasonable goals and executed with energy and enthusiasm. An effective dairy farm manager or operator must possess an understanding of the fundamental principles of economics, genetics, nutrition, physiology, and veterinary medicine, and a knowledge of desirable animal husbandry practices. The profitableness of the enterprise depends in large measure upon his ability through experience to solve the problems that are common to dairy farming everywhere and upon the soundness of his judgment in making decisions relative to all phases of breeding, feeding, and managing dairy cattle, and marketing dairy products.

Recognizing that the innumerable problems involved in managing dairy cattle and producing and marketing quality milk vary widely from place to place, some of the major problems have been presented as examples but no attempt has been made to discuss all of them or to present solutions that will apply universally.

In addition to planning this book as a text, we wanted a book that would be valuable to dairy farmers everywhere, to those individuals who sell to farmers or buy from farmers, as well as those who give them counsel at all levels. Finally in this era of intensive specialization this text may provide animal geneticists, nutritionists, physiologists, and veterinarians with a readily available source of information about those aspects of dairy herd management that are outside their respective fields of expertise. It may serve also as a useful reference for agricultural economists, agricultural engineers, dairy technologists, plant and soil scientists, and other individuals or groups who require current information about dairy cattle.

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PART ONE

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CHAPTER 1

Dairy Farming—U.S.A.

1.1 Introduction

Milk is defined as the "physiological secretion from the mammary gland of mammals." Since the dairy cow is the most commonly and extensively used source of milk in the United States, the term milk shall be understood to mean milk of the dairy cow unless otherwise specified.

Dairy cattle require more labor per animal and are influenced to a greater degree by the level of management they receive than any other class of farm animals. Tremendous advances have been made in recent years in the production, marketing, and processing of milk and dairy products. This progress, combined with the dairy cow's greater efficiency over other farm animals in converting feedstuffs into edible, nutritious human food, means that mankind should respect the cow's role in feeding the hungry world. Further, cattle utilize much more readily available feed (forages and by-product feeds) that cannot be directly consumed by humans.

This chapter briefly discusses why the United States has dairy cattle and a dairy industry. The discussion touches on the industry's development and current practices and projects of the near future. Included is a comparative analysis of dairy farming in the different regions of the United States and American producers versus producers in other parts of the world.

1.2 Why Dairy Cattle?

Most world food authorities believe that livestock production will retain its importance in the future. Phillips lists 5 factors that favor continuation of animal agriculture:

1. Food requirements of a rapidly expanding human population.
2. Nutritional merit or special qualities of animal food products.
3. Special ability of animals to transfer feedstuffs into edible food for humans.
4. Role of animals in maintaining soil fertility and in soil and water conservation.
5. Need for animals as a source of power.[1]

The authors feel that all of these except the last will continue to play an important role in U.S. agriculture.

Some people believe that animals no longer have a place in the world. They insist that only 10 to 30% of the energy fed is returned as food for humans. However, this figure holds true only if the entire diet of the animal is composed of food eaten by people.[2]

Ruminants, especially the dairy cow, play a significant role in maintaining a strong agricultural economy. The sale of dairy products ranks No. 1 in agricultural cash receipts in 7 states and is in the top four in 35 states. In 14 states, milk sales account

for more than 20% of all farm cash receipts. Furthermore, dairy cows generate many times their farm value as income to allied businesses and industries concerned with manufacturing, processing, and distributing both the inputs (feed, equipment, and supplies) sold to dairymen and the outputs (milk and cattle) they market.

The ruminant does not compete for food essential to humans.[3,4] Ruminants utilize cellulose and non-protein sources of nitrogen, which humans cannot use directly. Furthermore, ruminants are scavengers; they consume crop residues and industrial by-products. More than 9 million tons of by-product feeds, left over after processing food grains for human products, are consumed annually.

Finally, food products from ruminant animals are in great demand. Combined, the dairy and beef industries supply two-thirds of the protein, 80% of the calcium, 62% of the phosphorus, and one-third of the energy the American people consume.

In addition to food, ruminants provide a wide array of other useful products, for example, leather, hair, essential enzymes (such as rennin) needed in manufacturing cheese, and pharmaceuticals such as insulin. Cash receipts for ruminants and their products account for 43% of the receipts from all U.S. agricultural commodities.

Dairy Cow Efficiency

Dairy cows are very efficient in converting feedstuffs into edible human food (Table 1.1). Another fact often overlooked is that dairy cattle, when offered an economical urea or ammonia supplement, can manufacture protein with an efficiency of conversion exceeding 100% if we consider only those quantities of plant products that cows consume and can also digest.[4]

In recent years, the dairy farmer has been more concerned with yield of milk per cow than with pounds of milk produced per pound of feed fed. Even though the efficiency with which dairy cows convert feed to milk decreases with high levels of feeding, it has been economically rewarding to breed and feed for high production. This is because proportionately less feed goes toward maintenance of the high producing cow, and most non-feed cash costs (for example, milking, housing, and waste handling) are essentially on a per head basis.[5]

TABLE 1.1 *Efficiency of Various Classes of Livestock in Converting Feed Nutrients to Edible Products*

	Efficiency of conversion of indicated nutrient, in %	
	Protein	*Energy*
Ruminants		
Dairy cattle	25	17
Beef cattle (edible cuts only)	4	3
Lambs (edible cuts only)	4	—(not reported)
Non-ruminants		
Hens (eggs)	26	18
Broilers	23	11
Turkeys	22	9
Swine	14	14

Source: Wedin, W. F., Hodgson, H. J., and Jacobson, N. L.: Utilizing plant and animal resources in producing human food. J. Animal Sci. *41*:667, 1975.

The feeding of concentrates to cows in DHIA herds increased from 3,000 lb per cow per year in 1950 to 6,000 lb in 1983, because (1) grain production increased significantly, (2) the U.S. population (human and livestock) could not consume all of the grain produced, and (3) price-depressing surpluses of grain accumulated.

In spite of the great amount of labor involved in producing milk, the cow is an efficient producer of energy and protein. Thus, the U.S. consumer can purchase protein and food solids at a lower cost per unit when they come from milk and dairy products rather than from meat and eggs (Table 1.2).

1.3 What is a Dairy Farmer?

Traditional dairy farmers in past years depended on the use of dairy cattle, land, and labor as major resources. The thrust in modern day dairying is the increased use of capital and management. The successful dairy farm operator must combine all of these resources into a productive and profitable unit.

Absolute rules that will assure a dairy farmer success cannot be written. This book does provide guidelines and important considerations, but in the final analy-

TABLE 1.2 *Retail Costs of Protein and Food Solids in Dairy Products, Red Meat, and Eggs*

Food	*Price per pound $(U.S.)*	*Grams protein per pound*	*Cost of protein per pound $(U.S.)*	*Grams food solids per pound*	*Cost of food solids per pound $(U.S.)*
Milk (instant dry nonfat)	.85	162.8	2.37	427.2	.90
Cottage cheese (creamed)	.50	61.7	3.68	96.4	2.35
Cheese (American)	1.20	113.4	4.80	278.1	1.96
Ice cream	.35	20.4	7.79	165.1	.96
Red meat (ground beef, lean)	1.10	93.9	5.32	140.3	3.56
Chicken (fryer, ready to cook)	.50	57.4	3.95	73.1	3.11
Eggs	.50	52.1	4.79	104.1	2.40

Source: Protein and food solids compositions. *Composition of Foods,* USDA Handbook No. 8, 1963.

sis, it is the expertise, judgment, and experience of the manager that determines his success or failure.

Most dairy farms consist of at least two enterprises, the dairy herd and the crop farm. Except in those areas of the United States where specialization has developed to the point that producers purchase all feedstuffs, the successful dairy farm operator must be both a good *crop farmer* and an outstanding *milk producer* (manager or herdsman).

The crop farmer produces feedstuffs that have a market value. Although this enter-

TABLE 1.3 *Rank of Major Competency Areas and Competencies Within Areas Necessary for Dairy Farm Herdsmen to Succeed*

Rank	*Major area*	*Competencies*
1	Record-keeping	A. Maintains breeding records
		B. Keeps animal identification up-to-date
		C. Analyzes and uses production records
		D. Keeps enterprise records and analyzes them at least annually
2	Milking	A. Insists on and uses correct milking procedures
		B. Maintains milking system in good condition
		C. Keeps mastitis losses at a minimum
3	Herd health	A. Minimizes calf losses
		B. Recognizes animal health problems and knows when to treat and/or seek assistance
4	Feeding	A. Utilizes basic principles of nutrition
		B. Uses technology needed to formulate the most profitable rations
		C. Provides an adequate and balanced ration to all groups of animals
5	Breeding	A. Detects cows in heat and determines best time for breeding
		B. Plans and follows constructive breeding programs
		C. Correctly inseminates cows if direct herd service is used
		D. Selects cows based on production and physical traits of economic importance, culling those not meeting standards
6	Business management	A. Maintains adequate and accurate farm records
		B. Obtains and uses credit wisely
7	Housing	A. Understands housing requirements, including ventilation needs
		B. Minimizes materials handling and labor requirements, especially manure and bulky feeds
8	Labor	A. Plans labor needs, including anticipation and preparation for peak work loads
		B. Uses labor efficiently, and recognizes circumstances requiring immediate attention

Source: Orth, R., Iowa State Univ., Ames.

prise, like the dairy industry, involves its own set of principles, practices, problems, and profits, it is not the purpose of this book to include a detailed discussion of this topic.

Dairy farmers, on the other hand, market these feedstuffs through their dairy cattle, with the expectation of profiting from more fully utilizing their available labor, capital, and management capabilities. Therefore, the producer makes daily decisions regarding the selection, breeding, feeding, managing, housing, and care of his dairy herd.

Many recent 4-year college and 2-year technical school graduates are seeking employment as herdsmen on dairy farms. A recent study identified and ranked the major areas in management that herdowners believe herdsmen must master to achieve success.[6] These areas of herdsmanship, and the more important competency items within each area (also ranked), are listed in Table 1.3.

These results, obtained from a survey of producers nationwide, suggest areas of study that students of dairying should definitely include in their curricula. It implies that students of dairying should make certain they become proficient in the competencies listed. It does not necessarily mean, for example, that milking procedures (No. 2A) are more important in achieving success on the dairy farm than, for instance, providing an adequate ration (No. 4C).

1.4 Composition and Nutritional Value of Milk

Chemically, milk is a complex mixture of fats, proteins, carbohydrates, minerals, vitamins, and other miscellaneous constituents dispersed in water. Table 1.4 lists these constituents along with the normal variation present.

TABLE 1.4 *Gross Composition of Mixed Herd Milk*

Constituent	*Average content*	*Normal variation*
	%	
Water	87.2	82.4–90.7
Fat (milk fat)	3.7	2.5–6.0
Solids—not fat	9.1	6.8–11.6
Protein	3.5	2.7–4.8
Casein	2.8	2.3–4.0
Lactalbumins and lactoglobulins	0.7	0.4–0.8
Lactose (milk sugar)	4.9	3.5–6.0
Minerals	0.7	0.6–0.8
Total solids	12.8	9.3–17.6

Source: Compiled from various sources.[7–10]

Milk Fat

The most important milk constituent in determining the price received for milk is milk fat. Essentially all dairy products, except skim milk and those items made from skim milk, contain varying amounts of fat. Butter contains 80% or more fat, natural cheddar or American cheese 30 to 40%, and ice cream varies from 10 to 18% milk fat. The desirable qualities of smooth body and texture and rich mellow flavor of many dairy products are attributed to fat.

In milk, fat is dispersed in the form of small globules of a true oil-in-water type emulsion. The globules range in size from about 0.5 to 20 microns (1 micron = $\frac{1}{25,000}$ in.) with an average size of approximately 3 microns. Milk from the breeds of cattle that secrete a higher fat content generally contains globules of the larger size. The larger sized fat globules contribute to the easier formation of cream layers and are also more susceptible to partial churning during handling and transportation of milk. Milk fat aids in calcium absorption, and since milk contains abundant calcium, the complementary effect of fat in milk is especially important to the nutrition and health of humans.

Protein

Among the most complex of all organic compounds, proteins are essential to all forms of life. They are composed of a series of "building blocks" known as amino acids. Animals are able to synthesize proteins only from the proteins or amino acids they consume in their foods, although they can sometimes convert one amino acid to another. Those proteins that cannot be formed in the animal body and, therefore, must be present in the foods consumed are called *essential amino acids.* Thus, the nutritional or "biological value" of a given source of protein is measured in terms of