An Overview of Animal Welfare in the U.S. Dairy Industry

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Abstract

Dairy production systems in the United States (US) have changed considerably over the last several decades due to forces that promote economic efficiency of production and to scientific and technological advances that afford opportunities for change. Societal values and concerns about animal well-being, and specifically about livestock production systems and their impact on animal well-being, have also changed throughout that time. It would be worthwhile for dairy producers and veterinarians to critically evaluate production practices for their impact on the animals. Optimizing animal well-being is not only a moral imperative, but should also assure optimal animal productivity. This manuscript attempts to summarize industry changes that impact dairy animal management, and to highlight areas of real or perceived concern about dairy animal welfare that warrant careful attention by producers and veterinarians. This material was originally published as a chapter in the book *The Well-Being of Farm Animals: Challenges and Solutions*, GJ Benson and BE Rollin (eds), Iowa State University Press, 2004. Some readers may wish to see that book for thoughts on animal welfare in other livestock production industries.

Résumé

Les systèmes de production laitière des États-Unis ont bien changé dans les dernières décennies en raison de la pression pour accroître l'efficacité économique et des percées scientifiques et technologiques qui permettent de faire des changements. Les valeurs de la société et les préoccupations concernant le bien-être animal ont elles aussi changé surtout en ce qui concerne les systèmes de production animale et leur impact sur le bien-être des animaux. Il serait intéressant que les producteurs laitiers et les vétérinaires évaluent de façon critique les pratiques de production pour en déterminer l'impact sur les animaux. L'optimisation du bien-être animal n'est pas seulement un impératif moral, mais il devrait aussi assurer une productivité animale optimale. Cette présentation tente un survol des changements de l'industrie qui ont un impact sur la gestion des animaux laitiers et met en évidence les domaines de préoccupations aussi bien tangibles que perçues au niveau du bien-être des animaux laitiers qui mériteraient une attention plus particulière de la part des producteurs et des vétérinaires. Ce matériel a été publié préalablement dans un chapitre du livre intitulé « The Well-Being of Farm Animals : Challenges and Solutions » (édité par G. J. Benson et B. E. Rollin, Iowa State University Press, 2004). Certains lecteurs pourraient désirer voir le livre pour de plus amples informations sur le bien-être animal dans d'autres secteurs de la production de bétail.

Introduction

A reasonable discussion of the well-being of dairy animals relies heavily on an understanding of the structure and function of dairy production systems. The dairy industry in the United States has undergone dramatic changes over the last 40 to 50 years, and these changes are ongoing. The impetus for change is mostly provided by economic factors, plus the availability of new technology. As with other livestock production areas, changes are reflected in increased production per animal, increased total production, and decreased input of human labor per animal or per pound of production. Many features of these changing production systems have the potential to positively or negatively impact animal welfare, such as housing, nutrition and feeding systems, animal handling and disease control programs.

Some discussions of animal welfare in livestock production environments focus on a few specific practices or details of animal management that some people have considered abhorrent (e.g. debeaking of poultry, use of gestation crates for sows, downer cow management in the slaughter industry). These isolated aspects of livestock production become the lightning rods for those trying to change industry practices. Unlike the pork and poultry industries, the dairy industry has received little such attention and very few practices have achieved widespread notoriety for being indicative of dairy animal suffering. This is a very good time for the

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dairy industry to take stock of some of the impacts that production practices can have on animal welfare with an eye towards continual improvement of animal well-being. It is reasonable to presume that future dairy industry changes, predicated primarily on the improvement of animal welfare rather than primarily on the improvement of economic efficiency, could profoundly benefit both the animals and the industry.

Changing Features of US Dairy Production

A common vision of dairy farming for much of the public would be the image of a small herd of dairy cows grazing in a pasture and periodically being called to the barn for milking. This image is accurate as a snapshot of dairying on a nice summer day on some dairies in the traditional dairy regions of the country. However, it provides only a glimpse of the full picture, which would include details of how the cows are housed in bad (winter) weather, how they are fed when pasture forage is not available, what other activities the dairy producer is doing besides milking cows, and what kind of housing and management is provided for youngstock. Furthermore, that common image is in sharp contrast to that of a dairy with a thousand or more cows, housed in large open dirt lots in western US arid lands and fed mixed and processed silage and grain exclusively from a feedbunk. Dairy animal management is continuing to undergo dramatic change, and both of these snapshot views are accurate for some settings, illustrating that animals in the industry experience a diverse range of environments and management practices.

Some statistics can help to demonstrate the magnitude of change that has occurred in the US dairy industry over the last 50 years. In 1950 there were approximately 22 million dairy cows, producing 5,300 lb (2409 kg) of milk per year, for a total of 117 billion lb (53 billion kg) of total US milk. By the year 2000, there were only 9.2 million cows, averaging 18,200 lb (8273 kg) of milk, for a total of 167 billion total lb (76 billion kg). That is, fewer than half as many cows, producing 3.4 times as much milk per cow, and 50% more total production. In 1950 the US Census of Agriculture reported that there were approximately 5.4 million farms in the US, of which 3.7 million had milk cows, thus 68.3% of farms had some milk cows. In 1997 these numbers had changed to 1.9 million farms with 116,874 milk cows, so that only 6.1% of farms had milk cows. Thus we have reduced the number of farms with milk cows to 0.3% of the numbers 50 years earlier. Average number of milk cows per farm in 1950 was six head, and 98.3% of operations had less than 30 cows. In the year 2000, cows per operation had increased to 88 head, and 29.6% of operations had fewer than 30 head, while 20% had greater than 100 head. Although there were still numerous small farms in the year 2000, only 1.8% of all milk cows were on farms with less than 30 head, and 36% of all US milk cows were on farms with more than 500 head. Thus the dairy farms are, on average, very much larger, and the trend is clearly for the disappearance of small farms.

The geographic location of milk production in the US has also changed. While milk is produced in all 50 states, the magnitude of production is very different between various states and regions. The top 10 dairy producing states provide 70% of all milk production, and the top five states account for 53% of the total. The top five milk producing states in 2000 were the same as those in 1975: California, Wisconsin, New York, Pennsylvania and Minnesota, though the order of ranking was different. The traditional dairy states have been northeast, Great Lakes, and cornbelt states, plus Texas and California. Since 1975, however, there has been a profound shift in the location of dairy production. California is now the leading dairy state, and from 1975 to 2000 has increased total production by nearly three-fold (10.8 billion to 32.2 billion lb; 4.9 to 14.6 billion kg), now producing almost 50% more milk than the next highest state, Wisconsin (23.2 billion lb; 10.5 billion kg). In the same time frame Idaho increased production from 1.6 to 7.2 billion lb (727 million to 3.3 billion kg), and New Mexico from 366 million to 5.2 billion lb (166 million to 2.4 billion kg), and now both states are in the top 10 for total production. Arizona increased from 840 million to 3.0 billion lb (382 million to 1.36 billion kg), and Colorado increased from 845 million to 1.9 billion lb (384 to 864 million kg) of total milk during the years from 1975 to 2000.

These statistics demonstrate very profound trends in the changing dairy industry. Consistently there has been increased production from fewer total cows, more production per cow, many more cows per herd, with many fewer herds, and dramatically increased milk production in some non-traditional dairy states in the western US with arid climate. More detail concerning these features of the dairy industry can be found in a recent USDA report from which these numbers were obtained[4]. It seems important to emphasize that while these trends have radically changed the face of the dairy industry, the industry is not adequately characterized by focusing only on the large operations. That the average herd size is still 88 cows per herd is an illustration of the fact that there are still many small traditional dairy farms. It is more accurate to view US dairies as being tremendously diverse, with small farms at one end of a spectrum, and very large farms at the other.

These statistics do not, in themselves, tell us anything about dairy animal well-being. For this magnitude of change to occur in such a short time period, however, requires that powerful and persistent forces

are at work. These forces, and their consequences, can profoundly affect animal well-being, both directly and indirectly. This paper will not analyze all of the complexities of the dairy industry, but it is worth considering the nature of some of these forces, and how they ultimately affect animals.

Forces That Change the US Dairy Industry

Like most livestock products, milk sold by a producer is primarily marketed as a raw commodity. Other entities besides the producer then process the product and eventually reap the benefits of retail sale. There are exceptions to this, in the form of 'producer-processors' who take milk from production through to retail sale, sometimes including home delivery, but these are a relatively small number of producers. Generally the producer, like the producer of other commodities, has very little control of the price paid for the raw product. However, milk is a very perishable commodity that must be kept highly sanitary and processed and sold promptly. In the early 1930s, when milk prices dropped dramatically due to poor ability of consumers to pay, there was little coordination of milk marketing systems and danger that major disruptions of milk supply would develop. The federal government intervened in the name of public interest, fair marketing, and provision of a stable supply of this highly perishable product. The result, over many years of modification, is an extremely complex milk marketing system that attempts to maintain consistent pricing of milk across regions of the country based on complex formulas regarding milk composition, supply, demand, transportation, and end use. More details on milk marketing and pricing can be found in a recent book.[2]

Very significant results of the way milk is priced for producers are that they cannot control their price, and that milk prices tend to hover near the actual cost of producing the milk. For example, the actual sale price of milk to producers in 2000 approximated what it was in 1980, about $10 per hundred pounds. Facing this situation, it is clear to most producers that the way to profit from their business is to continually seek means to keep their cost of production as low as possible. It is a common mantra for commodity livestock producers that if you can't control the price you receive then you need to control the cost you invest. This is the mindset of most successful dairy producers, and several consistent trends result. It is increasingly the case that the most important skills a producer needs in order to continue dairying are business skills, rather than animal handling and husbandry skills.

Referring back to the statistics above, it is apparent that in times gone by, many dairies were a component of a diversified farming operation. Dairy producers have traditionally looked at dairy farming as a way of life, an avocation that provides a good environment for the family, where cows and cow care are central elements of family activity. There appears to be a progressive shift towards dairy production as a highly specialized business, designed and operated to generate income more than a shared family activity. Producers who fail to adjust to this economically driven change will eventually go out of business if they fail to generate sufficient income. Increasing numbers of dairies are solely dedicated to milking many dairy cows on a relatively small piece of property, where all other aspects of the entire process are hired out, such as feed production. It is appropriate to say that dairying is becoming increasingly 'industrialized'. In order to operate as a successful business there is great pressure to minimize human labor input, make decisions based on economic efficiency, find ways to decrease overhead costs, and maximize production at any given cost level. These are examples of the thought process that drives producers to increase herd size as a means to take advantage of the economies of scale and move dairying as a business to regions in the country where overhead costs, such as housing structures and feed costs, are lowest. These factors are not inherently good or bad, and they do not automatically produce poor animal welfare. Rather, they supercede animal welfare concerns in terms of their importance in decision-making. Fortunately for the animals, many management changes that improve productivity also are beneficial to the animals in some way, but this is not always the case.

Another factor in the changing face of dairy production is the ongoing development of new technology. This factor facilitates the 'industrialization' of production methods. New technologies have radically improved forage and grain production, harvest, storage, and feeding methods. Similarly milk harvest, cooling, storage, and transportation methods have been dramatically altered over the last half-century. Computerization is under continual improvement for monitoring and measuring techniques, animal tracking and identification, animal production and management procedures. Some results of these technological advances are revolutionary changes in animal nutrition, animal breeding and selection processes, housing and waste management systems. These promote and facilitate the trend toward larger and more industrialized farms and a move away from pasture-based grazing systems toward confinement feeding systems. The effects on animals can be seen as highly beneficial in some cases, for example, the fact that nutritional deficiency is unusual in modern dairy cattle, but again, the total effect on animal welfare is more complex. The developments in technology may improve industrial efficiency, and may enhance a producer's opportunity to make money in the business, but could be neutral or even detrimental to animal well-

being. In such cases the technology will still be adopted for the sake of improving profitability, and negative consequences for the animals then become items that need to be 'managed'.

Dairying has traditionally been a family-based, rather than corporate enterprise. Despite the changes highlighted to this point, the industry has retained this characteristic. Although there are several different business organizations that are used, such as partnerships and family corporations, less than one percent of all dairies are run by nonfamily corporations. Thus, on dairies of all sizes the overwhelming majority of decisions are made by individuals or families, not by corporate boards. This is extremely important, because the industry is steeped in a tradition of caring for animals, and today's dairy owners/operators generally come from a dairy background that emphasizes good animal husbandry. Many dairies maintain purebred animals, even when their primary income is from commercial sale of milk, reflecting that even commercial producers still see cattle as individually important members of the farm operation. There are longstanding principles regarding animal well-being that are held as ideals by many, and perhaps most, dairy producers. These include the notion that you have to care for the animals if you expect them to care for you, and that animals should be properly handled, fed and housed, etc.

Although some dairy producers would argue that their industry is not 'subsidized', in fact there are very substantial public policies that directly or indirectly influence dairy production, even when these policies are not overt subsidies. In fact, the US dairy industry is considered one of the most heavily subsidized agricultural enterprises in the country [19]. Some of the public interventions include dairy price supports and government purchase of surplus dairy products, which influence milk prices and are a part of the effort to maintain fairly stable dairy product supply. There are also import quotas and tariffs that modify competition from other world dairy sources. As mentioned above, milk pricing is a very complex phenomenon, and could not be properly analyzed in this paper. It could be argued that the system works to the public benefit by supplying an abundant and relatively constant supply of dairy products, but it is also appropriate to note that an effect of the milk pricing and supply/demand/market system is a relatively low milk price paid to producers compared to the cost of production, and a modest oversupply of dairy products. This continues to hold producers in a position where economic efficiency of production is a driving force in producer decision-making. Beyond the price of milk, other government policy influences are also prominent in dairying. Grain prices are dramatically affected by government policy, and inexpensive feed grains for cattle are the norm. Federal development of water resources has had a profound impact on agriculture in the western states. Despite its relative scarcity, water is available at low cost for agricultural use. This has stimulated the growing of forages on western lands at low cost and with extremely high cattle feed value. This plus the further availability of water for intensive livestock production accounts for much of the development of the dairy industry on arid lands in the western US. The western climate allows animals to be maintained without extensive housing costs, as are found in the wetter and colder traditional dairy states, and this combination of factors decreases the cost of dairy production in a region where it would be impossible without the historic government program intervention.

Overview of Dairy Animal Well-Being

From the description of the dairy industry above, it should be clear that dairy production in the US has changed dramatically over the last several decades. These changes impact dairy animals in profound ways, with mixed effects on their well-being. It is relatively easy to identify one or another specific aspect of dairy animal care that can be taken out of context and used to demonstrate either improvement or deterioration of animal well-being. Such approaches are often used by industry antagonists, or industry supporters, when two sides take issue in an argument. The following discussion attempts to examine a number of issues with an eye towards identifying areas where a focus on animal management and well-being could benefit animals and the dairy industry together.

In general, dairies have not experienced the type of extreme criticism that has been focused on the swine or poultry industries. This is probably attributable to multiple factors that work in favor of animal welfare even during a process of industrialization. Dairy producers have traditionally had a strong animal welfare ethic and, as mentioned above, most dairies are still operated by individuals or families who maintain this approach. It is characteristic of producers to hold both the herd, and individuals within the herd, in high esteem, to take pride in their animals and to pride themselves on the care of their animals. Furthermore, each individual animal typically has a substantial monetary value. These factors mitigate any tendency to view animals as 'cogs in the production cycle' or as 'production machines', as may more easily occur with low individual animal value, corporate ownership, and where the decision-makers are remote from the animals. In general it is fair to say that dairy animals are well cared for in the modern dairy industry. Typical dairy husbandry provides good nutrition, circumstances that promote animal interaction and normal expression of individual and herd behavior, space and opportunity to get exercise, and

protection against adverse weather conditions. There are exceptions to these generalizations. Numerous animal welfare concerns exist in the industry, but they tend to be complexities of the balance between an excessive focus on economics and production efficiency rather than an expression of disregard for, or diminution of the importance of, the animals themselves.

There is clearly pressure on producers to increase production efficiency and total production as the means to improve their business and maintain their livelihood. In such an environment animal welfare may be important to the producer, but it is not the motivation for change. Rather, economics and growth drive change, while animal welfare is an important, but secondary, consideration. Additionally, as the enterprise grows it may no longer be the producer or the family members who provide primary animal care. Without an appropriate training process for employees, a system that has specific guidelines for animal handling and welfare, a monitoring system for assessing these features, and a decision making system that adjusts to specific individual animal needs, then it is very easy for the producer to believe that animals are faring better than is truly the case. Very few dairies, as they get very large, make the time investment to specifically focus on animal welfare and the employee training and monitoring required for enhancement of animal welfare. In this situation individual animals can fall outside the average for the herd and go unnoticed. For example, an animal with a debilitating disease may suffer for a considerable time before being euthanized, even though the producer would not conceive of letting the animal suffer if it had been noticed earlier. In other words, when production systems get very large, it is easier to 'say' that each individual is valued than it is to take action based on that principle.

New feed preparation technologies, advances in measurement of feed characteristics, better understanding of animal nutritional needs, and computer-based management systems have provided the ability to revolutionize dairy nutrition programs. Similarly, technologies that measure and monitor animal production performance provide opportunities to fine-tune animal health and management programs. Although many people like to idealize 'life on a small farm in times gone by', the management of such systems is often haphazard and based on poor information. Animal welfare in such production systems can be highly variable, and is less dependent on the size of the operation than the skills and focus of the manager. Cattle in those systems may be pampered and exquisitely managed, or alternatively may suffer from poor nutritional and health management. Producers on small, diversified farming operations may pay attention to animal needs only when they are not attending to the other farm problems. By contrast, large specialized dairies that purchase feed and only run a dairy business that harvests milk from cows can afford the time to focus specifically on things that influence the cows. Most modern large dairies can capitalize on economies of scale to afford the new technologies that promote tremendous improvements in animal production. This would seem to be great groundwork for improving overall animal well-being, and indeed some would claim that this feature characterizes the modern, intensively managed large dairy. Unfortunately, the push to increase production brings other liabilities, such as diseases of nutritional excess, metabolic and digestive disorders associated with feeding errors, and disorders in some individuals who do not tolerate well those management factors that promote extremely high production in the majority of their herdmates. These problems are known as 'production diseases' because they rarely occur in animals that are not managed to perform at extremely high production levels.

To be realistic, it seems foolish to look at old-style and small-scale dairy production systems and suggest that they provided ideal animal welfare. Clearly, some managers and some settings provided good animal welfare, with grazing systems and exercise and low stress. Other circumstances in similar time, style and place could provide squalor, starvation, poor housing and exposure to the elements, due to monetary constraints, lack of information, or lack of resources. In similar fashion the modern, large-scale, intensified dairy systems have the potential to provide for excellent animal welfare, but may produce new disease problems, inadequate attention to individual animal problems, and improper training for employees to recognize and manage animal problems.

Does High Productivity Equate with Good Animal Welfare?

A common contention among defenders of industrializing animal management systems is that increased animal productivity is synonymous with improved animal well-being. This argument holds that the animals in a highly productive system must be faring well or they would not be producing so well. There is logic to this suggestion. It is true, for example, that a healthy, well-fed dairy animal will grow and produce better than her counterpart afflicted with disease and poor nutrition. Proponents of a particular animal management system or of a particular performance-enhancing technique, when challenged about the effects of that technique on the animals, will commonly point to herd productivity as proof that the effects must be positive, and that animal welfare is good. Taken to its logical conclusion, we should then believe that animals in the modern dairy industry must be vastly better off than they

were 50 years ago, because production averages during that time have more than tripled.

Unfortunately this is a flawed argument. Herd productivity is not an ideal surrogate measure for good animal welfare. There are several reasons that cows today produce more milk than cows did in previous years, and they do not necessarily equate with animal well-being. The two most important causes of increased production are genetic changes due to selection of breeding stock for high productivity, and improvements in animal nutrition and feeding systems. Neither of these changes can be assumed to unfailingly result in animal welfare improvement. In fact, these changes put the animals at increased risk of health problems under certain circumstances. For example, cows with genetic potential for extremely high milk production are prone to metabolic diseases that can be very debilitating, and even life-threatening, if feeding programs do not meet their high nutritional needs. For another example, which will be explored further below, cows on diets that promote extremely high production are at increased risk to suffer from gastrointestinal ailments induced by the ration. Under optimal conditions the genetically selected and well-fed cow may indeed experience good health, high productivity, and optimal well-being. But a modern dairy cow can also produce more milk than her counterpart of 20 years ago and suffer numerous insults to her overall well-being that were far less common on dairies two or three decades ago.

Another flaw in the argument that high productivity equals good welfare is that herd productivity is calculated as an average. Similar to any other numerical average, herd productivity numbers do not tell the story of each individual in the herd. For virtually all populations, only a certain number of animals are close to the average, while others can deviate quite far from the average and are not adequately characterized by the number. In typical populations, the average animal may be producing quite well but a percentage of animals are producing quite poorly. To follow the logic of the concept that productivity equals welfare, then these animals are suffering. Alternatively, if they are not suffering, then productivity alone is not a good measure of welfare.

On the other hand, having argued that high productivity is not equivalent with animal well-being, the two are associated and productivity is a relevant evaluation that can help assess animal welfare. Physiological responses to stress and adverse circumstances can indeed limit production performance. One of the primary indicators that something has gone wrong in any livestock operation, including dairies, is a reduction in animal performance. It is worth noting that some of the improvements in animal nutrition that result in increased production have indeed reduced the types of animal suffering that occur with poor nutrition and nutritional deficiencies. Animal scientists, nutritionists, veterinarians and dairy producers have substantially improved nutritional programs for post-weaned youngstock, for example. Overt nutritional deficiency disorders are uncommon on modern dairies, and can often be promptly diagnosed and corrected when they do occur. An improved understanding of the nutritional needs of these growing animals has resulted in remarkable improvements in growth rates and decreased disease rates. Not all well-fed animals are by default also experiencing optimal well-being, but it seems fair to say that all other management features being equal, a healthy, growing, well nourished young animal, as typified in many modern dairies, is better off than its less well-fed counterpart in management systems of the past.

Interestingly, there is a contrary and common belief that increased dairy animal productivity makes the animals more likely to suffer from a variety of health problems. This issue has been thoughtfully discussed in a recent article by Fetrow and Eicker [7]. Their analysis suggests that this concern is largely a matter of perception rather than reality, and that increased production *per se* does not increase risk of disease in an individual cow. Some disease risks have increased across the industry as a whole, and these issues will be discussed further below because they are central to a discussion of modern dairy animal welfare. The point to be made here is that some people would like to believe that high production equates with good welfare, while others are swayed to believe exactly the opposite. It seems most realistic to conclude that productivity alone is not an adequate measure of animal welfare, and that management features that promote high production can sometimes benefit the animals, but sometimes increase risk of animal problems.

It is also worth commenting here on the common notion that 'old style dairies' were somehow far superior, from an animal welfare point of view, to the modern 'industrialized' dairy. Although I have argued above that high productivity does not equate with optimal welfare, the trend towards industrialization in the dairy industry, which is closely linked with increased productivity, often provides benefits to the animals that accrue from the push to increase production. It is a pleasant thought that cows on pasture, maintained as part of a diversified family farm, were animals in an optimal environment. The reality is, however, that diversified farms that produce milk as only one of several components of the operation, have the liability that they cannot afford to attend to the animals as their only priority. For example, a farm that produces multiple species of animals and harvests its own feedstuffs has greater needs for different housing and storage facilities, plus an array of machinery, than does a dairy that

raises and feeds only dairy animals and purchases all feeds. An aspect of the management changes that increase milk production is an increased focus on the management of the cattle as the highest priority, i.e. specialization within the industry. As anyone who has worked with small diversified farms can attest, management time and money can get spread very thin, and some things will receive attention due to urgency while other things suffer from lack of attention. Only a limited amount of operating money and effort is spent on the animals in such a setting because many other demands, such as planting crops, harvesting, facility maintenance and machinery repair, also require investment of time and money. It is common on such operations that animals occasionally, or even routinely, suffer from neglect of basic essentials such as appropriate feed, suitable housing, removal of manure, etc. The trend to specialize farms for milk production, and to industrialize the process, can reduce the likelihood of such neglect as part of the means to increase animal productivity, or at least provide the opportunity to do so. While a blanket statement that high productivity equals good welfare is not accurate, it is reasonable to argue that many of the features of management systems that promote high productivity do improve some aspects of animal care. The subjects to be discussed below provide specific areas of concern that contravene this argument and that need to be addressed by the dairy industry.

Environmental Stress

Stressful events are not unique to domesticated production animals, and over the course of evolution all species have developed adaptive responses to stressors. Stresses become problematic when they are excessive in duration or magnitude, such that they overwhelm these protective mechanisms. There are numerous stressors that dairy cattle encounter in the course of life in any production setting. Some stressors may be considered somewhat of a fact of life, such as adverse animal interactions in a population setting, or the physiological stresses of late pregnancy. While it is unrealistic to view almost any particular stressor as completely avoidable, it is quite realistic to manage most stressors so that they are not frequent, prolonged, or grossly detrimental to the animals. Several of the subsequent topics focus on particular stresses that dairy animals frequently or consistently encounter in certain management settings. This topic of environmental stress includes the physical stresses associated with climate and housing conditions of dairy cows.

The predominant dairy breed in the US is the Holstein Friesian. These animals originate from northern Europe, and are well adapted to temperate climate. The other common dairy breeds originate from the British Isles and Western Europe and are also adapted to cooler temperate conditions. In the US these animals tend to fare well in the northern states with cold winters and moderate summer temperatures. The traditional housing management system for such cattle includes access to pasture during the warm seasons when grass is available and confinement in barns during the winter. Winter confinement serves both to centralize the animals for feeding when pasture is unavailable, and to protect the cattle from the most adverse weather conditions. Even without such protection, however, dairy cattle are fairly resistant to cold conditions. Adult cattle generate very substantial heat both by metabolism and from rumen fermentation. For adult animals the lower critical temperature (the point at which additional metabolic activity is needed to maintain body temperature) is estimated between -5 to -35 F (-20 and -35 C). For baby calves the tolerance to cold is much less, and lower critical temperatures are estimated as 50 F (+10 C) for newborns, to 30 F (0 C) for one-month old calves. These estimates are based on assumptions of no wind, moderate humidity, a dry hair coat, and moderate body condition. In wet or windy weather, or for lean animals or a wet hair coat, the effects of cold will be much more profound. With modest measures to ensure protection from adverse conditions, dairy cattle are quite tolerant of cold, and winter weather has not typically been seen as a major problem. There are exceptions to this generalization, the most common of which are young calves without adequate feed supply to meet metabolic demands in the cold, or growing heifers that are not afforded the expense of enclosed housing during extreme bouts of weather.[5]

The preceding comments might be taken to suggest that old-style dairies in northern US regions do not present environmental stress problems for the cattle. Indeed, this is the dairy management setting that seems to be idealized by many in the public at large as the 'way dairies ought to be'. A more balanced view of this issue suggests that winter housing in barns may not be as idyllic as it seems. Because buildings are a major expense, most confined dairy barns provide limited space and close quarters for the cattle. Adequate ventilation is difficult to achieve in such buildings. The result in many cases can be significant animal congestion, limited exercise for prolonged periods of time, injuries caused by confinement in small stalls, and air quality problems that predispose to infectious respiratory disease. One of the housing design changes over the last several decades is the development of free-stall barns. In free-stall barns cows are not restrained, allowing them to move where they wish and rest in any stall they wish. These structures are relatively efficient in use of space, but provide shelter against the elements, excel-

lent freedom of animal movement, and usually very good ventilation. Since they are a major expense, these structures typically accompany significant herd expansion and are associated with the trend to industrialize dairy production. Additionally, herds housed in free-stall barns are often restricted from grazing because it can be more efficient to raise and harvest forage to feed in the barn than to harvest pasture by grazing. Some may argue that this housing and feeding change negatively affects the cows since grazing is a normal activity that is curtailed or eliminated. One could alternatively argue that free-stall housing can represent a major improvement in animal care since the cows are well fed, well sheltered from adverse weather, and provided with a well-ventilated environment and freedom of movement.

Dairy industry growth in the arid West has proceeded with remarkable vigor, such that numerous states have more than tripled their dairy production over the last 25 years. The multiple reasons for this growth include favorable land prices, mild winters that allow minimal investment in animal housing costs, availability of forages with high feeding value due to extensive irrigation, and resultant low costs of production. Average herd sizes in the western states are very large compared to those in the central and northeastern US. Along with the movement of dairy animals to these regions have come very significant problems with heat stress. The effects of heat stress are profound on these animals that are well adapted to cold conditions. High relative humidity exacerbates the impact of ambient temperature, and therefore the potential for heat stress is more closely related to a temperature-humidity index than to environmental temperature alone. Heat stress may be the single biggest animal welfare challenge facing these Western dairies. Similar or greater heat stress problems occur in the humid southern and central states. Affected cows show increased core body temperature, altered respiration, abnormal gastrointestinal function, increased water loss, reduced feed intake, reduced and altered milk production, delivery of low-birth weight calves, reduced reproductive performance, and other negative effects. In severe cases animals can die of heat stress. The problem can also occur in northern areas of the country, but generally is less common and less profound. In the western and southern states, heat stress conditions can persist unabated for months at a time.[23]

It is not news to dairy producers that heat has profound negative effects on their cattle. Virtually all of the dairy trade periodicals contain frequent articles about the problem and new ideas on how to manage it. There are several striking and sobering aspects of the response the dairy industry has had to this problem. The movement of the industry to areas where heat stress is common is not being made for the benefit of the animals, but for purely economic/cost of production reasons. The overwhelming majority of literature that focuses on heat stress details the effects of the phenomenon on production parameters, with scarcely a mention of the fundamental animal suffering that takes place while production is declining. Thus, heat stress is seen almost exclusively as an economic/production problem, rather than as the animal welfare issue that it really is. These trends in the response of producers to the well-being of their animals are very different from the traditional ethics of animal care that have been standard in the industry. There are means to reduce the impact of heat on the cattle, including modified shelters, fans that move large volumes of air around the cattle, water spraying misters, and alterations in diet. These mitigations are broadly applied, and it would be inaccurate to imply that the problem is not taken seriously. Heat stress is the common focus of considerable research and management effort. This problem and the discussions of its magnitude and management stand out as the type of issues that arise in dairy animal welfare, resulting directly from the economic forces that drive change in the industry. Heat stress is seen as an issue that has to be managed, with minimal thought given to geographic location as a means to minimize the problem, i.e. manage cows in a friendlier environment.

Cow Comfort, Exercise and Housing Design

Housing and handling facilities have a profound impact on animal well-being. There are numerous dimensions to the cow's physical environment beyond weather conditions. At a minimum, these would include good air and water quality, space to move and express normal behaviors, surfaces that provide good footing and areas to lie and rest, adequate eating areas to promote good feed access, restraint and holding facilities that minimize the likelihood of injury. One of the reasons for the appeal of the scenario of small herds on pasture is that it appears to provide all of these environmental benefits. As mentioned previously, the pasture-based management setting can also have significant compromises in its provisions for animal welfare, given that winter housing may be far less idyllic. Furthermore, weather and specific geographic features of the local landscape may also compromise welfare of pastured animals. The trends towards specialization and industrialization of dairy activities, and the growth of larger herds with novel housing needs, have focused attention on some of the specific details of dairy cow housing requirements. The very substantial capital investments that are made in dairy housing and handling facilities have forced these changes and promoted the science of understanding cow comfort. This is an ongoing process, and facility design is not a perfected area of agricultural engineering, but tremendous progress has been made.

Producers, veterinarians and design consultants have learned to ask some of the relevant questions about cow environment and behavior that have been ignored out of ignorance in the past. How much slope and what texture should footing surfaces have to promote drainage, provide good traction for cow locomotion, maintain normal hoof health and avoid injury? What bedding materials and what bedding maintenance are optimal to keep cows comfortable? What stall and stall divider designs and dimensions provide the optimal environment for cows to lie down and rise again comfortably with minimal risk of injury, minimal manure contamination and optimum udder health? What amount of time should cows spend lying down and ruminating versus eating or exercising? What restraint chutes and alleyway designs promote the best access to the cows for treatment and the least likelihood of cow injury? What handling techniques should be taught and promoted to farm workers and animal handlers? Recent publications are beginning to more definitively address the facility design features that improve the cow's environment.[18] Other publications use the term 'cow comfort' to define this area of animal welfare concern and link it closely with cow productivity.[3,9] Two recent publications provide excellent guidance on evaluating cow interactions with their environment and a system for evaluating freestall housing features that affect dairy cow welfare.[1,17] Lay journals written for dairy producers frequently present ideas and suggestions to assist in evaluation and promotion of cow comfort as a critical issue in dairy management. Increasingly, facilities have been designed and/or remodeled with the best interests of the cows as the top priority.

Because knowledge in the area of dairy facility design is still not ideally developed, different consultants and contractors provide different and often divergent recommendations. Thus many facilities are inadequately designed or built. Many operators are still in need of education about cow comfort assessment and the maintenance of appropriate housing and facilities.[1,17] Many cows in dairy production systems live in environments that are far from ideal and suffer discomfort, injuries or ill health as a result. The issue of cow comfort may be the single most compelling example of a scenario where focus on animal welfare is the best approach to improving dairy production. It has been repeatedly shown, both in anecdotal reports and in scientific evaluations, that cows maintained in an environment that promotes animal well-being are more productive, and the farms are more profitable. This particular area of concern supports the rationale that placing animal-care priorities on par with economic efficiency priorities is beneficial to both the animals and the production system. Because most dairy producers are predisposed to favor ideas and investments that benefit their animals, as long as they do not conflict with economic priorities, the notion of building facilities that improve cow welfare is generally met with enthusiasm. As new knowledge and means to attain this goal are developed, they will almost certainly be widely adopted.

Production Diseases

The term 'production disease' refers to conditions that occur infrequently or not at all in animals that are not pushed to achieve high performance, but that increase in frequency in high production settings. There are several production diseases of dairy cattle that will be discussed here, each representing a significant negative impact to animal welfare. Further information about these diseases can be sought from a recent text.[22] Some problems, such as mastitis and other infectious diseases, appear to have higher prevalence in the modern dairy industry than 40 or 50 years ago. The increased occurrence rates of such infectious problems may be influenced by the promotion of production, but are substantially affected by housing and environment and so they are not categorized here as production disease and are considered separately. A thoughtful consideration of how some of these problems relate to high production has been cited above.[7]

Subacute Rumen Acidosis and Laminitis

Cows that produce the vast quantities of milk that typify modern dairy production (many herds produce an average of 70 to 90 lb (32 to 41 kg) of milk per cow per day) require intense nutritional support. Methods to provide these nutrients to dairy cattle have been developed over the last several decades, revolutionizing the field of dairy nutrition. Processed feeds with high energy density are commonly used and these promote very high rates of rumen fermentation. When the feeding program is well tuned to the needs and physiological limits of the cow and her rumen, she can derive the necessary nutrients and maintain optimal health. Unfortunately the balance between sufficient energy supply and excessive generation of rumen acids can be fairly tenuous, and subacute ruminal acidosis (SARA) is common in cows on most dairies with high average production. Typically this is a subclinical problem, so the cow does not manifest overt illness, although that too can occur. Cows with mild or moderate reduction of feed intake due to this form of indigestion can develop chronic and recurrent metabolic problems. Many cows with SARA show minimal disease signs at the time of the rumen problem, but alterations in blood flow to the feet and alterations in hoof growth occur as a result. This related problem is known as subclinical laminitis, although clinical and severely painful acute laminitis oc-

curs in some cattle. Weeks to months after the onset of laminitis, affected cows frequently develop severe lameness associated with one or more sole or hoof wall diseases that are sequellae to the hoof horn insult. These non-infectious foot diseases represent approximately half of all foot lameness in dairy cows. A recent national survey of the US dairy industry estimated that lameness occurred in 17% of all dairy cattle during the 12 months preceding the study. Lameness is one of the top two or three animal health concerns in dairy cattle, and it clearly represents a very substantial animal welfare concern.[12]

Other features of animal management also contribute to the occurrence of laminitis. Foot trauma contributes to the problem, often associated with excessive time spent standing on concrete or reduced time spent lying down. These factors can be managed with appropriate housing and stall design. Inappropriate designs of feedbunks, crowding of pens, and animal interactions that prevent feedbunk access also contribute by promoting infrequent feeding and over-consumption of feed when feed access does occur. Again, these problems can be managed to minimize laminitis, if they are monitored and observed. The two most important management techniques used to control laminitis and its severe clinical effects are nutritional modification to minimize SARA, and foot trimming to minimize the effects of abnormal hoof growth. Virtually all high producing dairies have cows affected with this problem. It appears the problem can be managed to decrease its impact, but it has become accepted as a feature of dairy production that cannot be completely prevented. The bottom line is that laminitis is a disease that presents a major dairy animal welfare concern, and that clearly results from the drive to increase milk production.[8]

Metabolic Disease

Cattle can develop several metabolic problems that are relatively unique to ruminant species, but uncommon in other animals, and that become increasingly problematic in animals bred and managed for very high production. The most characteristic of these are hypocalcemia (milk fever), ketosis, fat cow disease, and fatty liver disease. Hypocalcemia occurs when the demand for calcium in milk exceeds the ability of the cow to supply it from bone reserves or from dietary intake. Ketosis and abnormal fat metabolism problems are sequellae of the unique fat metabolism of ruminants.

Milk fever has historically been a major metabolic problem of dairy animals. In clinical cases, the problem manifests as profound weakness and recumbency. Unfortunately, cows can also suffer severe muscle damage when they are involuntarily recumbent, and downer cows are a major potential complication of the disease. For many years this disease has occurred at a fairly consistent frequency (5% to 10% of dairy cows) across the dairy industry, i.e. it does not appear that the disease frequency has increased as milk production has increased. It may be that increased understanding of the physiologic basis of the problem and improved detection and treatment have been offset by increased milk production levels and increased cow susceptibility. However, recent developments of preventive measures that entail modification of dietary mineral intake can dramatically reduce the occurrence of this disease in well managed herds. This particular problem, though included as a production disease with some very debilitating effects, can actually provide a good success story for the dairy industry.

Ketosis is a disease condition characterized by abnormally high circulating levels of ketones, which are partially oxidized fatty acids. Affected animals show poor appetite, general malaise and weight loss. Ruminants rely on fat metabolism to supply the majority of their energy needs, and a low level of ketone production and utilization is normal. However, when dietary energy intake is lower than energy demand, a circumstance called 'negative energy balance', cattle utilize stored fats very extensively, and may produce ketones in excess of utilization, resulting in disease. Dairy cattle commonly experience negative energy balance, and ketosis can be a very common disease in dairy cows. The problem may occur in 3 to 20% of cows in a herd at a given point in time, with outbreaks occurring when feeding errors or other problems limit cows' ability to consume sufficient feed. Like the other production diseases, this problem can be managed, and is the focus of considerable management effort. But also characteristic is that it cannot be eliminated in high producing herds and remains a significant cause of animal suffering in many herds. Two related diseases are fatty liver disease and fat cow syndrome. Fatty liver disease is a condition characterized by chronic, persistent ketosis that does not respond well to common treatment methods. Essentially fatty liver disease occurs with the same predispositions as ketosis, but with additional complications. Fat cow syndrome is a yet more extreme disease related to abnormal fat metabolism. This occurs in obese cattle near the time of parturition. It can occur in outbreaks, affecting multiple animals, in herds that have mismanaged feeding regimens such that cows consume excessive energy during late lactation when energy demand is low. The negative energy balance in these obese animals can be extreme because they cannot consume sufficient feed, and additionally they have extensive fat deposition in multiple organ tissues. Their metabolic crisis is very severe, and affected cows typically become recumbent and die. Fortunately, the occurrence of this problem is now unusual in well managed herds that manage energy delivery and cow body condition.

Abomasal Displacement

Prior to the 1970s, disease of the abomasum was extremely infrequent. As feeding systems were altered to promote increased energy delivery and increased milk production, abomasal displacement was increasingly recognized. Abomasal displacement is not compatible with normal function and affected animals develop decreased appetite, malaise, metabolic problems, body fluid disturbances and further disruption of gastrointestinal function. The cause is multifactorial, including several physiological or feed-related factors that result in increased gas production and/or decreased abomasal motility. Under some management conditions the problem can occur as outbreaks, or can be endemic, such that it affects 10% to 20% of cows in a herd over a year's time. This problem is so characteristic of feeding problems that can occur when feeding is targeted toward high milk production, that some dairies use the disease as an indicator to fine-tune their management. Thus, some producers will monitor this disease and accept that their strategy and implementation are sound if abomasal displacement occurrence rates are below a certain percentage (e.g. 3%) per year. Some people have come to accept that this problem is a 'cost' of high production, and do not envision complete prevention.

Numerous other problems might be considered as 'production diseases', but those discussed here are notable both for their frequency of occurrence and their clear association with genetic selection and dairy management that emphasize very high milk production. Although all of these problems can occur occasionally in cattle managed for lower production levels, or can result by accident or gross mismanagement, they are so closely tied to production performance that they are almost accepted as part of normal dairying by many in the industry. These production diseases represent an example where management focused to maximize animal well-being, rather than to maximize production, could provide benefit to animals and producer alike. Cows affected by these problems not only suffer, but also represent a real financial and production liability. It is not realistic to expect zero occurrences under any management strategy, since these are biological problems that cannot be absolutely controlled. However, it is realistic to manage with a target of no endemic or routine occurrence, given that maximal production is not the only indicator of success. Unfortunately, the economic forces affecting the dairy industry and described above make this option a very difficult choice for a modern producer who expects the operation to succeed. It is plausible that managing towards eliminating these production diseases could be economically rewarding, since the costs of disease treatment, reduced performance of sick cows, and increased loss or culling of cows could offset some revenue loss due to decreased total milk production. For many producers the choice is to balance between the risks of too little production and too high disease occurrence, and accept that a certain proportion of animals will suffer with these diseases.

Downer Cow Problems

The term 'downer cow' refers to animals that are recumbent and unable to rise. The circumstances that predispose to these problems include inadequately balanced diets that induce metabolic disease, or housing and flooring conditions that promote poor footing and promote injury. Once a cow becomes involuntarily recumbent, a vicious cycle of additional problems can occur as a result of ongoing muscle injury. Mature dairy cattle typically weigh between 1200 and 1600 lb (545-727 kg). If they are recumbent and unable to move their body mass, the limbs and tissues on which they are lying are rapidly injured by bruising and decreased blood flow to the tissues, complicating the original problem that made them recumbent. As a result it is common for an animal to be 'down' due to one specific problem, but then fail to rise even if that problem is addressed. For example, hypocalcemia will produce muscle weakness and recumbence, but the cow may develop hind limb injuries during the problem and fail to rise even after the hypocalcemia is corrected with appropriate therapy.

Downer cow problems have achieved considerable notoriety in some settings, particularly when they occur in animals penned prior to slaughter or at sale barns. In many such cases the cause of the problem in the individual animal was weakness or debility, which was the reason the animal was sent to sale or slaughter and was also the cause of the final 'downer' event. In other words, many of these cases represent very poor judgment by the original owner, who has chosen to defer an animal health problem to another buyer or to eliminate the problem by slaughter. Most such cases clearly should have been dealt with on the original farm, either with treatment or euthanasia.

On dairies these downer cow cases cannot be completely avoided. Some are due to unforeseeable or unpreventable circumstances. Sooner or later, all cattle owners have animals that become downers. Except on a case-by-case basis, it is difficult to generalize what the most appropriate disposition of such animals may be. Clearly these situations warrant a thorough examination of the animal to determine the cause of the problem. In many cases, appropriate care, with the right housing, will allow affected animals to regain normal health and return to productivity. Alternatively, euthanasia is often an appropriate choice when it is clear that the prognosis for recovery is poor, and prolonged recumbence represents needless suffering. On most dair-

ies downers do not represent a significant animal welfare dilemma. It is so clear to any producer that the condition has occurred, and that this condition represents a major problem for the individual animal in addition to a major economic loss, that such occurrences are typically dealt with very expediently. While it could be argued that bad decisions may be made concerning the care and/or disposition of some affected animals, I believe this is infrequent. Furthermore, if there are specific predisposing circumstances that lead to frequent occurrence of downers, these are typically dealt with effectively, because any other course is a plan for financial ruin.

Infectious Disease Problems

There are numerous infectious diseases of concern to dairy operations that represent challenges to animal well-being. Information from the National Animal Health Monitoring System Dairy '96 Study[11] demonstrates that infectious diseases represent a tremendous area of concern in dairy animals. Clinical mastitis occurs in 13.4% of all dairy cows, respiratory problems in 2.5%, and diarrhea in 3.4%. Approximately 50% of the dairy cow lameness reported in the Dairy '96 survey was apparently infectious in nature.[12] In dairy calves, scours, diarrhea and respiratory problems are responsible for 85% of all calf deaths from birth to weaning, and death rates of calves through that age range averaged 10 to 13% in the NAHMS survey. It is common for 35 to 50% of dairy calves to become ill and require medical attention between birth and weaning (approximately eight weeks of age). These estimates of average disease incidence provide only one side of the infectious disease picture. Even more troublesome than ongoing disease losses is the development of explosive new infectious problems. Despite the lower profile infectious diseases may have assumed in some discussions of herd health and productivity, infectious agents are still as important as ever and perhaps even more problematic as animal density and herd size increase.

Increased dairy size and concentration of many animals in a single location are factors that promote the transfer of contagious infections. For herds to rapidly grow in size requires considerable trade and traffic of animals between herds and areas of the country, facilitating spread of pathogens. A look at the findings from the NAHMS Dairy '96 Study puts in perspective the opportunities for disease spread with animal movement. Between 45 and 80% of dairies of different herd sizes brought cattle onto their operation within the year preceding the study. Of the purchased and introduced animals, fewer than 25% were quarantined and even fewer were adequately tested for infectious diseases. These statistics alone emphasize the high risk of infectious disease introduction in most dairies. Between 20 and 50% of dairies fail to require common vaccinations before introducing new cattle into their herd. Thirty to 80% of dairies fail to require milk somatic cell counts (an indicator of udder infection) and 60 to 90% of dairies fail to request milk culture before introducing new animals into the herd. Although the circumstances that occur with herd expansion can promote spread of infectious disease, this does not explain all of the infectious disease challenge faced by the modern dairy industry. Small farms included in the NAHMS survey had similar or higher rates of infectious disease occurrence as the larger farms. It appears that some diseases such as salmonellosis may be more common in large herds, while other problems such as contagious mastitis are more common in the smaller herds. It is inaccurate to say that large herd size promotes disease in general. It is more accurate to say that as herds consolidate we are missing opportunities to minimize and limit disease occurrence and spread.

Unfortunately the trend toward increased herd size, animal density, and animal trade are not paralleled by increased awareness of effective disease control measures. It seems that confidence in technological advances as the means to solve problems extends to the area of infectious disease control. Vaccination has apparently become the most widely used tool for prevention of infectious disease. It is promoted and incorporated into almost all disease prevention programs for individuals and herds. Progress in vaccine production technology is the focus of major corporate ventures and is widely publicized in lay and professional publications. The emphasis on vaccination is so pervasive that many have come to rely on it as the primary means of infectious disease control. Unfortunately, the protection against infection or disease afforded by most vaccines is not nearly as thorough as most producers or their veterinarians would like to believe. The interaction between disease agent and host is extremely complex and different from disease to disease. Thus, it is textbook knowledge that vaccines are more commonly useful in modifying disease manifestations than in actually preventing infection or disease. The development of new antimicrobial agents has also been useful for controlling infectious disease problems when they do occur. Remarkable new drugs have been periodically developed over the course of the last several decades. Producers and veterinarians have been lulled into a false sense of security that antibiotics can effectively cure infected animals. But again that faith is typically extended beyond what is realistic. Antibiotics have essentially no benefit in combating viral diseases, and very limited efficacy in treating many bacterial diseases, for example those where the pathogen is resistant to the drug or located in a body region that the drug does not penetrate.

There are numerous management procedures that can be implemented to decrease animal exposure to infectious agents, but that have not been widely adopted in modern dairy management. These procedures may be called biosecurity or biocontainment practices, and include separation of different animal groups, prevention of contact between healthy and sick animals, cleaning and hygiene procedures, minimizing manure contamination of premises or feed, and so on. Looking more specifically at calf management, for example, some infectious diseases are spread from dams to newborns and the time of separation of the calf from the cow can have an impact on the transmission of these diseases. In the NAHMS survey only 13% of operations separated newborn calves from the dams within one hour of birth. Twenty-five percent of operations separated the calves beyond 12 hours after birth. Fifteen percent of operations allowed calves to stay with their dams more than 24 hours. Thirty percent of operations failed to wash teats and udders before colostrum was collected for administration to the calves. Approximately 55% of operations used the calving area as a hospital area for sick cows. Fecal contamination is a common means for spread of many enteric infections. Developing more fully integrated approaches to infectious disease control could have a profound impact on dairy animal welfare.

Calf Management Practices

Calf rearing practices in the modern dairy industry present some very real problems regarding animal welfare. As described above, an excessive number of dairy calves die from infectious diseases (estimated 10 to 13% between birth and weaning), but this figure does not reflect the entire story. In a later section we will discuss some issues regarding calf delivery (birthing) and associated disease and death losses. In this section we will focus on some other calf care issues.

Orphan Rearing and Early Weaning

Some people have voiced concerns about the fact that dairy calves are orphaned at birth or soon after, that is, the cow and calf are separated after birth and the calf is raised separately while the dam enters the milking herd. It is true that this separation is not natural, and the idea of the cow/calf pair bonding and remaining together is appealing as a closer reflection of natural maternity. Indeed, that model is the mainstay of beef herd production where the principal product is the growing calf. In the dairy industry, where the product is milk, there are obvious problems with such an approach. The economic argument, of course, is that it is preferable to sell the milk and to rear calves using less valuable commodities, such as non-saleable milk or milk replacer. There are multiple features to the process of rearing dairy calves as orphans. One is the decision to wean earlier than normal, i.e. at six to eight weeks rather than six to eight months. This is both economical and also conducive to good growth. Calves left to their own dietary preferences would continue to suckle milk for many months, and in natural settings this could extend to approximately a year, until the dam produces the next offspring. The calf's preference does not represent a physiologic necessity, however, and with proper feed availability calves can adequately digest solid feeds by six to eight weeks of age such that they will grow as well or better if weaned to a completely solid diet at that time. While it is certainly true that beef calves are not typically weaned until well beyond two months of age, they also are not typically provided the additional nutrition that dairy calves receive in the weaning process. It is interesting that such management decisions are viewed negatively by some of the public, when similar decisions regarding human child weaning and nutrition are commonplace and unquestioned by most, i.e. human babies are rarely allowed to nurse until the mother ceases lactation or the child voluntarily declines nursing.

There is more than the economics of milk disposition at the heart of this dairy management decision. In addition to the reasons to wean calves early, there are also reasons to separate the pair shortly after birth. Dairy cattle are handled directly by humans on a daily basis, and orphan-rearing a calf bonds it to humans from the beginning of its life, facilitating subsequent animal management. It also seems apparent that early separation of the pair is less stressful than separation after significant bonding has taken place. As with other species, the neonate appears to bond with whoever supplies its needs, even if the individual is a different species, and if humans intervene before the calf has bonded to the dam there is little evidence of stress or concern on the part of the baby calf. Likewise, it seems much more stressful to the dam to remove a calf after the pair has closely bonded over time than to circumvent considerable interaction by removing the calf shortly after delivery. While beef cattle have been selected over time for good mothering traits, which include attention to the calf that enhances calf survival, dairy cattle have been selected with virtually no concern for these traits. Many dairy cattle show very poor instinct for mothering, and in such cases it is difficult to perceive much concern on the part of the dam when the calf is removed.

Under modern dairy management conditions where cows do not calve in an extensive pasture setting and rather newborn calves are delivered in relatively congested or trafficked maternity pens, there are compelling animal health reasons to separate calves

from dams. In the section above concerning infectious disease, the need to reconsider hygiene as a means to minimize spread of infectious agents was emphasized. One of the major areas of concern is the spread of pathogens to newborn calves. As highlighted earlier, baby calf infection rates, and subsequent death losses are considerable. Spread of infection to newborn calves is most likely during the hours and days immediately following birth. There are several studies that verify what common sense suggests, that the longer the calf is exposed to contaminated environments and adult cows that shed pathogens, the greater the likelihood of calf disease. Current recommendations from various animal health professionals to dairy producers that manage cows in large herds, are to separate the calf from the cow immediately after birth or as soon as possible thereafter, both for the health of the individual calf and to minimize the endemic spread of diseases throughout the herd.

With all of the preceding discussion of why it makes sense to separate newborn calves from dams right after delivery, it remains a liability of modern dairy management methods that this process must induce at least some degree of animal distress. There are reasons to believe that this distress is not as great as it might be for animals with well-established maternal/neonatal bonding, or for animals that are bred and selected for strong maternal characteristics. Nevertheless, it would be foolish to suggest that this is not a viable animal welfare concern. It seems more realistic to say that there are reasons for the practice that have to be balanced against the potential of animal suffering. On smaller dairies some producers do find ways to allow much more extensive contact between dams and offspring than are afforded in large-scale, more confined dairy settings. Producer advocates of more 'natural' calf housing and rearing practices can also boast very good animal health when some of the other predisposing causes of infectious disease are well managed. Specifically this requires that producers assure that the dam mothers the calf, that the calf suckles adequately from the dam to get the benefit of colostrum ingestion, that the calf is born in a clean and relatively open environment, and that cows in the herd have low rates of infectious disease occurrence. These types of prerequisites are extremely difficult to achieve except on small dairies with considerable investment of personnel effort.

Newborn Calf Care

Even if one accepts that early separation of calves and orphan rearing is a reasonable practice, there is another side of the calf rearing issue that is routinely overlooked, and that seems a much bigger animal welfare problem that the orphaning process *per se*. The implicit assumption in current calf rearing systems is that humans assume the role of the dam and properly care for the newborn. In my mind this is a much bigger question than that discussed above. It seems fair to say that modern calf raisers very commonly fail to meet the standards of any reasonable natural cow mother. The ideal is for newborn calves to receive good mothering, which at a minimum includes drying the haircoat after delivery to ensure a thermal protective barrier, stimulating the calf to rise and move, encouraging suckling and colostrum consumption, and seeking or providing a sheltered environment. These simple aspects of calf care are routinely ignored in many dairy settings. Many calves are retrieved from the calving pen and placed into other holding or housing facilities to be looked at or fed at a later time. In fact many people leave the calves with the cows to avoid having to do these chores, assuming the cow will show good maternal instincts. Since dairy cows are not selected for maternal traits, this default mode is inappropriate, because leaving the calf to be cared for by a dam that may or may not provide good mothering is effectively a plan for inadequate care. The responsibility for calf care clearly falls to the producer and dairy management personnel, either by assuring that cows provide such care, intervening if they don't, or simply adopting a routine policy of having the care provided by humans as surrogate mothers. Having shouldered the responsibility of rearing baby calves, it is imperative that the task be done properly.

A critical feature of newborn calf care is colostrum feeding within hours after birth. This first milk of the dam provides fluid, extremely high quality nutrition including many micronutrient elements, and components that support the calf's naïve immune system to enhance infectious disease resistance. A large dairy survey that focused on dairy calves provided solid evidence that calves left with cows to nurse their colostrum frequently failed to achieve adequate supply and experienced higher death rates than calves fed colostrum by humans.[10,26] This could be explained by a failure of dams to adequately mother the newborn calf, by large udders with teats that are difficult for calves to find and suckle, or by the production of voluminous colostrum with inadequate immunoglobulin concentration that makes it difficult for calves to consume sufficient immunoglobulin mass. All of these circumstances occur in modern dairy cows selected for high milk production. The study findings reinforce the notion that modern dairy cows do not always serve as good mothers and that dairy personnel should take the responsibility of providing appropriate calf care to enhance neonatal survival. Producer education efforts over the last decade have focused on the positive impact of colostral management on calf health and survival. A subsequent survey sug-

gests that colostrum provision is more carefully managed than it was half a decade earlier, mainly due to these educational efforts.[14] This is encouraging, because it suggests that educating producers about the benefits of management practices that increase calf health and well-being will improve calf care.

During episodes of cold or inclement weather, calf care practices become even more important because these young animals are more susceptible to environmental challenges than their more mature counterparts. Strategies to provide protection from the elements should be especially targeted towards smaller calves, calves that experience dystocia, calves that aren't doing well or any calf in extremely cold weather. Whether a calf can maintain body heat depends on a combination of factors, including sufficient feed energy to withstand the cold, sufficient thermal insulation, dry hair, wind speed and humidity, good nutrition and physiological soundness. Extremely important is appropriate housing, and the hutch structures must be windproof, watertight, well ventilated and properly positioned so the elements are coming from the back or sides. It is very important that they are well bedded. This kind of environment retains the heat more, retains the dryness and blocks the wind so the calf can maintain itself in the cold. In some circumstances calf jackets or blankets may be warranted. Simply placing a calf in a hutch without concern for these other details may not be enough to protect it from extremes of weather conditions.

Calves exposed to prolonged cold need additional energy to maintain body heat production. Some dairy calf feeding programs fail to meet these needs during bouts of cold weather. In these circumstances calves utilize their meager body fat reserves quickly for heat production, and then may die from starvation rather than the cold itself. This "starving calf" problem is common and happens when young calves, typically between two and four weeks of age, are not yet eating much solid feed. Such calves are still reliant upon fluid feeding for energy, and if only provided a fixed amount of milk replacer, instead of proportional to body weight, they are in danger of undernourishment. The likelihood of this problem increases in situations where the producer elects to feed low quality replacer to save cost. A producer might feed a lower quality/lower fat content replacer to a 70 lb (32 kg) calf sufficient for survival, but when that same amount is continually fed to a 100 lb (45 kg) calf, in cold weather the calf can suddenly die at the critical two-to-four weeks of age. This scenario is particularly tragic because the reasons for curtailing milk feeding in such cases are economically based. The lower fat replacers are more economically priced, and it is also more costly to feed three or more times a day to increase the volume fed.

Calf Feeding and Nutrition

As discussed above, calves can be, and typically are, weaned from fluid feed by four to eight weeks of age, but only if they are consuming sufficient solid feed for their survival and growth. The most compelling reason to wean calves to solid feed is that fluid diets are quite costly, both due to the cost of the feed ingredients (milk or milk replacer) and due to the labor cost. Conversely, solid feed diets are fairly economical. Therefore the primary reason to convert calves to a solid diet is an economical one, although it is also apparent that calves grow faster and have fewer health problems once they have been weaned to solid diets. This last statement, and the feeding practices used to wean calves early, warrant closer scrutiny.

Calves at birth are unable to digest solid feeds, and require milk for nutrition like other mammals. The development of the rumen from a non-functional stomach compartment in the neonate into the preeminent digestive organ of adult cattle requires consumption of small amounts of solid feed, which deposit in the undeveloped rumen and initiate the process of microbial fermentation in this stomach compartment. As the rumen grows in size and its bacterial fermentation processes become more robust, the calf can consume increasing amounts of feed and derive increasing nutritional support from the feed. The industry standard for calf age at weaning is currently about eight weeks of age because most calves are consuming sufficient solid feed for their maintenance and growth by that time. It is appealing to think that current calf nutrition programs are providing an optimal fluid diet for the first eight weeks, while calves gradually increase solid feed consumption during that time. Unfortunately, this is not what actually occurs, and it is fair to say that baby calves on milk diets are substantially underfed.

For several reasons the diet calves receive prior to weaning is very restricted. Feeding calves milk or milk replacer by bucket or nipple feeder has been common practice on most dairies for over 50 years. Such feeding is time and labor intensive and the fluid diet is relatively expensive. Under natural conditions a baby calf left with its dam would typically nurse 6 to 8 times per day and consume 16 to 24% of body weight in fluid milk. To bucket feed dairy calves similarly would be a very time consuming and costly process. Thus, most calves are fed only two times a day. The maximum amount most calves are provided at a feeding approximates 4 to 5% of body weight, because higher volumes can be associated with digestive disturbances. This means that most calves receive a maximum of 8 to 10% of body weight as fluid feed per day. Given the normal nutrient density of fluid milk, this provides only enough energy for body maintenance plus a small amount of growth. Calves fed

in this manner may be expected to gain approximately 0.45 lb (200g) per day, compared with approximately 2.2 lb (1kg) per day for calves fed *ad libitum*. The problem of poor growth is particularly true for calves fed milk replacer compared to their milk-fed counterparts, because the energy density in most milk replacers is less than that in whole milk. In other words, the most common calf feeding practices do not provide optimal nutrition, and in fact are so close to being true starvation that in some circumstances calves may indeed die from lack of energy in colder weather, as discussed above. There is a method to this madness however, part of which is playing the game of rearing calves for the least cost, but another aspect is that maintaining the calves in a fairly hungry state induces them to begin solid feed consumption more quickly. This in turn means the calves can be weaned at the earliest time.

The observation that calves grow better after weaning is probably less a tribute to the benefits of solid feed than the fact that before weaning the calves are relatively starved. This method of calf rearing has evolved over such a prolonged time that most producers actually believe that 8 to10% body weight feeding of milk is optimal for the calf, despite the evidence that the calves remain very lean and are at high risk of disease. In fact this system did not evolve with the best interests of the calf in mind; rather it evolved as the least cost, lowest labor input solution. Recent research, directed at the question of how to feed calves for optimum growth and health, has begun to demonstrate to producers that the extra cost of a higher plane of nutrition for baby calves may be well worthwhile as a wise investment in the health, growth and future productivity of calves. Furthermore, there are feeding strategies that have been demonstrated to meaningfully benefit the calf and still allow weaning at a desirable early age, such as feeding the calf more energy during the first weeks of life and then decreasing fluid feeding to encourage solid feed intake later. Hopefully in the near future, the methods of calf feeding will be directed towards the best interest of the animal, rather than the lowest cost for time and feed investment.[6]

Bull Calf Management

The last topic I'd like to address under the heading of calf management practices is the management of newborn bull calves. Calf management has tended to receive less attention by dairy producers than some other management concerns. This is probably due to the fact that calf problems are further removed from revenue generation than some other issues, such as cow health and milk quality. Bull calves and their management are often yet lower on the priority list. Since the development and widespread use of artificial insemination as a means of breeding milk cows, plus the adoption of selective breeding strategies to improve genetics for milk production, most bulls are not destined to be used as breeding animals. Yet approximately 50% of calves are males, and therefore producers have a large number of animals born each year that will not play a role in milk production. Some producers raise bull calves to be sold or slaughtered, but the majority of dairy producers prefer to sell bull calves early in life to decrease the feed, housing and management costs that rearing these animals would require. Bull calf economic value has tended to be very low. In some times the market for these calves has been poor enough that it costs more to sell the calf at auction than the selling price received. It is difficult to marshal appropriate management attention to bull calves that will not become production animals on the dairy, and frequently bull calves receive very little attention. Unfortunately, this can lead to significant morbidity and mortality that can go unnoticed except to the buyer (veal operations and dairy beef rearing units). Clearly it is appropriate to treat bull calves like heifers in attending to their needs as newborn animals, that is, provision of colostrum, warmth and nursing care, as described above. Unfortunately, many producers are guilty of overlooking these needs because the effects of poor bull calf management are not a major economic liability, and subsequent poor bull calf health and survival are likely to be someone else's problem. It is important for dairy producers to realize that it is an ethical obligation to care for newborn bull calves with the same attention afforded to heifer calves, even when the economic reward is limited or nonexistent.

Birthing/Calf Delivery Problems

Probably because newborn calves are not the major direct source of revenue for dairy producers, it appears that calf delivery and newborn calf management are undervalued as areas of concern. The problem of dystocia has been almost ignored. Few dairy producers incorporate breeding strategies to decrease dystocia occurrence, or have delivery management and newborn calf management protocols that specifically address the problem. The effects of dystocia are highly variable, depending on the severity of the problem. In affected calves, dystocia produces trauma and asphyxia that decrease calf vitality, predispose to infectious or non-infectious disease, and may result in stillbirth or neonatal mortality. Affected dams may develop reproductive tract problems that impair reproductive function, and in severe cases trauma and paralysis can result in euthanasia or culling.

Despite, or perhaps as a result of, the inattention the dairy industry has paid to calving difficulty, the rate of dystocia in dairy animals is substantially higher than

in beef cattle. National surveys show that approximately 3% of beef cows and 17 % of primiparous beef heifers, with a total of 4% of cattle across all age groups, need calving assistance.[13] In sharp contrast, the average for all dairy cattle is 18.4% assisted deliveries, and dairy first-calf heifers require assistance for almost 32% of calvings [10]. As described above, infectious disease is typically considered the main cause of dairy calf morbidity and mortality, and national surveys estimate that on average 35 to 50 % of all dairy calves will be treated for illness and 10 to 13% will die prior to eight weeks at time of weaning. However, most producers do not monitor calf death losses that occur before calves are identified in official records. Stillbirth incidence is typically not included in evaluation of dairy calf mortality, and calves that die prior to 24 hours of age are grouped with stillbirths. Since most calf loss estimates exclude stillbirth losses, they underestimate the magnitude of newborn dairy calf health problems. Estimates from some studies, including unpublished work we have conducted at CSU, suggest that loss of calves less than one day of age, attributable to calving difficulty, approximately equals the death loss of calves beyond a day of age. This would equate to approximately 50% of all calf deaths, very similar to estimates of the distribution of beef calf losses. Such an estimate also reflects the trend seen in neonates of other species. This means that the current estimates of dairy calf losses, although very high, only represent half of the story, since this other proportion of losses is typically not tallied.

Calving area management, delivery management and newborn calf management should be extremely important areas of dairy management focus. Events that occur here can affect calf morbidity and mortality, treatment costs, transmission of herd disease agents (including zoonotic pathogens), dam health and reproductive performance, and ultimately the cost/benefit of replacement heifer rearing. The combined effects of all of these on dairy health and productivity should be profound. Furthermore, dairy replacement heifer raising is the second leading expense for dairy operations, behind feed costs for the lactating herd [25]. Yet attention to this area of management has been lax. It appears that the short and long-term benefits of newborn calf health or the costs of calving management problems have not been clearly identified and conveyed to producers. Thus, dairy producers have failed to see economically compelling reasons to direct valuable time and management to changes in these areas. Because calving occurs year-round in dairy operations, it is easy to overlook insidious, ongoing losses unless they are measured and monitored. Looking at his situation from an animal welfare perspective presents a sobering picture. Here is a welfare concern that seems to be all but ignored, and yet, if addressed in a meaningful way that decreased animal losses, could derive substantial benefit to the animals plus improve economic returns for the producer.

In the cow/calf segment of the beef cattle industry, where calf production is the primary source of revenue, dystocia has been surveyed and monitored, concluding that it is the single most important factor predisposing to disease and death in calves. Although the more severe dystocia deliveries account for the greatest losses, even mild dystocia has been shown to impact calf health and survival. Producer management includes considerable focus on calving management and strategies to decrease dystocia occurrence and impact. Simple methods for increasing calf viability include straightforward nursing care techniques applied promptly to all calves suffering dystocia birth, such as warming, drying, extra provision of colostrum, shelter, stimulation, oxygen delivery, and extra mothering attention. In contrast, dairy animals are not rigorously selected for calving ease or calf vigor, and management is not directed at reducing dystocia risk or effects on baby calves. Despite the fact that dairy AI sires are evaluated for calving ease, most producers preferentially select bulls based on transmission of increased production traits. Except for the dairies involved in AI bull evaluations, most dairies do not even report dystocia occurrence as part of their record keeping. Few dairies have adequate protocols in place for employees to manage the delivery of calves properly, and these dairies often provide little or no supplemental care to calves born with difficulty. This set of management steps could be used to reduce the incidence of dystocia and to decrease the impact of dystocia on newborn dairy calves when it does occur. An increased focus on calf welfare as the reason to institute improved animal management strategies could greatly improve dairy animal well-being.

Culling and Death Loss

Evaluation of the reasons that cows leave a herd, the condition of the cows that leave, and the causes of cow death loss provides insight into animal welfare. In an idealized setting, cows might only leave a herd because they die or cease production from old age. In reality, this is unusual and there are many other potential reasons for cows to be sold out of a herd. In situations where a maximum number of animals have been achieved on an operation, some animals may be sold to another operation for milk production. As described above, the number of dairy operations in the US is decreasing, while the remaining farms are typically increasing in size, and in this scenario many herds are selling some or all of their animals, while other operations are acquiring animals and trying to decrease the number of animals that leave the farm. In a production setting, cows could be electively culled and sold for

slaughter if their level of milk production is low, in order to make room for more productive cattle. Injury and disease are major reasons for removal of animals from a herd, even when the herd is expanding and when it is undesirable to lose herd members.

The recent national survey of dairies in the US [14] showed that approximately 25.5% of dairy cows left herds permanently during 2001, and that approximately 6% of these cows were sold to other dairies, while 94% were culled (i.e. sold and not returned to milk production, sent for slaughter). The reasons cows were culled included mastitis and udder problems (27% of culled cows), lameness or injury (16%), other disease (6%), reproductive failure (27%), and poor milk production not related to these other problems (19%), while other miscellaneous reasons accounted for about 5% of culling. Therefore, on average, the overwhelming majority of dairy cows leaving farms are not fit for sale as dairy production animals, and approximately 50% of these cows are leaving because of disease or injury problems, rather than being selectively removed because of low fertility or milk productivity.

A partial view of the welfare of culled dairy cows can be obtained from recent audits of cows at slaughter.[15,16] These audits showed high rates of significant problems in dairy cull cows that affected their health ante mortem, and decreased their value as slaughter animals. Visible abscesses were identified in 13% of cull dairy cows, while 80% had bruised tissues identified at slaughter. Approximately 12% of dairy cattle went to slaughter with intact horns, which has been shown to increase the risk of injury to non-horned cattle. Approximately 1% of cows were considered disabled, which may have occurred during transit to the slaughterhouse, or because of health and/or dystocia-related reasons. Almost 5% of dairy cows had very poor body condition at the time of slaughter (extreme lack of weight/flesh). All of these findings were identified in the study as relevant concerns about the slaughter value of the cows. More importantly, however, they represent potentially avoidable problems that speak clearly to the issue of animal welfare. Most of these problems must occur in any population at some level, and it would be unrealistic to think that injuries and other health problems could be completely avoided. Furthermore, the population of animals studied was that group selected for removal from the herd precisely because they had problems that made their retention in the herd undesirable. However, the frequency of occurrence of these problems suggests that there are substantial improvements to be made in animal health monitoring, handling and transportation of dairy cattle, and prompt removal from the herd before the animals are severely emaciated. Improved injection methods, improved handling facilities, improved recognition and assessment of disease, uniform dehorning practices, removal of animal injury risks, and improved decision processes that provide for humane euthanasia to prevent animal suffering from incurable disease problems are all achievable goals. Such improvements would not only enhance the quality of slaughter animals, but substantially decrease animal welfare problems. The fact that the majority of cows that leave a herd do so because of problems, rather than because of undesirable production, and further, that a high percentage of these cows have significant slaughter defects speaks poorly for the welfare of dairy animals. Most of these problems can be improved with attention to a variety of management changes.

Besides being culled for slaughter, or sold for dairy production on another farm, the other major reason a cow drops out of the production population is on-farm death. The NAHMS 2002 survey shows that approximately 5% of cows die on the farm each year. This is a very high death rate compared with that of beef cows or feedlot animals, where death rates are estimated between 1% and 1.5%. Unknown reasons accounted for the largest percentage (20%) of dairy cow deaths, followed by calving difficulty problems (17%), mastitis (17%), and lameness or injury (14%). Information was not collected in the survey to suggest what percentage of these deaths were sudden occurrences, without warning, versus what percentage represented animals with more prolonged illness. However, it seems clear that there is room for improvement in detection and diagnosis of disease and need for prompt and appropriate treatment decisions to avoid suffering in animals. Furthermore, this high death rate suggests that there are significant risks for life-threatening illness on dairy farms. The reasons for these risks and the methods for identifying and treating or humanely euthanizing affected animals should be closely scrutinized. There is a high likelihood that these statistics demonstrate some substantial problems in overall animal health monitoring and maintenance. The need for improved methods to avoid dystocia, and for training in methods to alleviate dystocia have been discussed above. There are many other health management and training procedures that would be very beneficial in avoiding animal mortalities.

Bovine Growth Hormone (bST, Recombinant Bovine Somatotropin)

Bovine growth hormone, or bST, can substantially increase milk production when administered to dairy cows. Advances in biotechnological methods allowed the large-scale production of bST. Its ability to induce higher production in dairy cattle was the focus of considerable research throughout the 1980s. During the process of drug approval for use of bST in commercial milk producing animals, there was considerable controversy sur-

rounding questions about its potential to produce ill effects in the treated animals and in humans that consumed their milk. Furthermore, there was debate about the ultimate benefit the product would derive, since national milk supply has been adequate or above for many years, and milk prices to producers are negatively affected by increased supply. Despite these controversies, the corporation seeking to market the drug won approval and bST is currently administered to approximately 22% of US milk cows.[14]

During the approval process, numerous concerns were voiced about the possibility that cows receiving bST would suffer from increased occurrence of metabolic problems associated with the extra demand for energy for increased milk production. There were also concerns about increased occurrence of mastitis. Indeed, such problems were reported to occur, both in clinical trials conducted before approval and in some herds after the drug was approved and marketed. The corporation successfully argued against the importance of these concerns to win approval of the product, and subsequently employed numerous dairy consultants to help implement use of the drug on farms and to combat the occurrence of these problems. Since that time no trials have shown definitive evidence of animal health problems associated with bST use. It was argued that metabolic problems occurring in treated animals were the result of poor nutritional management, and that these problems could be circumvented. The corporate-sponsored consultants have helped implement management improvements on farms utilizing the drug, and these changes may be responsible for minimizing expected problems, and perhaps for improving production more than the drug effects *per se*.

At present there is little reason to believe that the use of bST, when administered to cows under the appropriate management, provides a significant animal welfare concern. It could still be argued whether it is in the long-term best interests of the dairy industry in the US to use bST to provide increased milk production. Some producers have certainly benefited financially from its use in the short term. However, this is a product without a problem to solve, because milk production nationally has been at or above demand levels, which depresses the price of milk at the producer level. If milk price remains at or near, and sometimes below, the cost of production, the economic forces described above will continue to drive changes in the dairy industry that can have some negative effects on dairy animal welfare. Whether there are any negative human health impacts will be difficult to discern, and no long-term studies were conducted to answer this question because the corporation was successful in arguing that there shouldn't be any. If public concern about the use of production-enhancing drugs in dairy cattle intensifies, the dairy industry will be the long term loser. The only long-term beneficiary of the use of bST appears to be the corporation that produces and markets it, because there are no apparent benefits to the cows, the dairy industry, or the consuming public. In my opinion, morally relevant concerns exist about the use of bST, but they are not based on overt animal welfare issues.

Dehorning and Tail Docking

These are two specific management practices that attract attention from an animal welfare perspective. These practices are similar in that they represent procedures that alter the anatomy of dairy animals, but they are very different in the type of challenge they pose to animals and the dairy industry.

Horned animals pose a very real threat to animal and human health because of the relatively close contact dairy cattle have with their herdmates and their human handlers. Although dairy animals are neither extremely aggressive, nor extremely territorial, they normally express both types of behavior in many routinely encountered situations. It is well documented that injuries from horned animals can be avoided by dehorning, and the practice is widely accepted and seems well justified. Therefore the relevant welfare issue that relates to dehorning is not so much whether it is practiced, but how it is performed, and how pain and subsequent morbidity are avoided. Simply stated, any surgical dehorning procedure (where the skin is cut and the horn bud removed) is clearly an invasive and painful procedure. Furthermore, the open wound that remains after surgical dehorning is not only prone to infection, but also is a source of residual pain for days after the procedure. For these reasons, performing a surgical dehorning without appropriate anesthesia is a major problem for the baby calf. The longer the dehorning is delayed, and thus the older the calf at the time of surgical dehorning, the more profound the associated problems become. If the procedure is performed after calves are more than three months old, then a bony projection has begun to grow into the base of the horn and typically the frontal sinus is opened during the dehorning, dramatically increasing the risk of infection and calf morbidity and suffering.

There are straightforward, and widely accepted means to minimize dehorning problems. These include dehorning with a bloodless procedure (chemical or cauterizing) to avoid subsequent wound infection, dehorning at a very early age (within several weeks after birth) to avoid substantial horn development and innervation, and appropriate anesthesia and analgesia to avoid/minimize pain. It is worth noting that the bloodless methods of dehorning avoid or minimize pain and discomfort. Even hot-iron dehorning (commonly performed with an

electric hot iron device), which clearly produces pain at the time of application, appears to leave little residual pain, perhaps because the nerves are destroyed. Shortly after electric/hot iron dehorning calves will again seek out human attention, while calves clearly avoid humans after surgical dehorning. Thus, while local anesthesia is still clearly desirable for hot iron dehorning, the pain seems to be more transient and subsequent analgesic use seems less important. The use of bloodless methods, applied early in life, decreases calf morbidity associated with the procedure, and these methods have become increasingly well accepted within the industry. A recent dairy survey [11] estimates that approximately 50% of producers now use the bloodless procedures. This leaves the more problematic procedures still in wide use, but it is my impression that welfare issues associated with dehorning are becoming less important as producers are made aware of the value of the more desirable methods and adopt them. This shift should be enhanced by education and encouraged by veterinarians and other consultants, because it is clearly in the best interests of the animals and the operation to use the best and least-harmful procedures.

Tail docking of dairy cattle has been fairly widely used in New Zealand and Australia, but has only been adopted by some US dairies over the last decade or so. The procedure removes the lower third to two-thirds of the cow's tail, and this can be accomplished by applying a strangulating elastic band, by applying a cauterizing cutting implement ('hot-knife') or by surgical means. Tail docking can be performed during calfhood or later in life. Several studies have evaluated different tail docking methods and demonstrated minimal discomfort when the procedure is properly performed, but the most innocuous method appears to be banding. Tail docking is practiced to improve cow cleanliness and worker comfort by eliminating the possibility of a cow swinging a manure-covered and urine-soaked tail. Some proponents have maintained that the procedure improves udder health and milk quality by improving cow cleanliness. Some milking parlor arrangements put the milkers directly behind the cow as they work with the udder and the milking equipment, and it is easy to see that tail docking does eliminate tail contact in that situation. Numerous concerns about tail docking have made the procedure controversial. Even if the procedure itself does not produce overt animal suffering, it does deprive the animal of a normal anatomical component that is useful for fly avoidance, temperature regulation, and visual communication with other cows. Furthermore, there are alternative practices that can accomplish the same goals this procedure is designed to achieve, specifically, housing management to avoid manure accumulation on tails, tail switch trimming to shorten the tail without amputation, and milking parlor design that helps keep the tails out of contact with workers. Recent reviews of published studies report no significant benefit to cows or workers that can be attributed to the procedure.[3,20,21,24] That is, there is currently no evidence that supports the claims made by proponents of the procedure. This presents an interesting problem for the dairy industry, or at least for those in the industry who practice or endorse tail docking. Although there appears to be no gross animal suffering associated with the practice, there is also no clear justification for it.[21] As one recent article title states, "Tail docking makes little sense".[20] In this situation, dairy producers seem to have little to gain and much to lose in terms of public appraisal of their care for their animals. The current research does not identify clear problems with the procedure, but public opinion can be greatly influenced by perception, and it is difficult to envision that the perception of the benefits of tail amputation can be favorable, particularly without compelling evidence of a benefit for the affected animals.

Dairy Veterinarians and Animal Welfare

Animal health issues figure prominently in any discussion of dairy animal welfare, because health and welfare are intimately associated. This being true, it seems obvious that dairy veterinarians are well positioned to positively impact dairy cattle welfare via their role as health care providers and consultants. Veterinarians have opportunities to monitor health events, to help evaluate the impact of nutrition and housing management on animal well-being, to establish treatment and culling protocols, to train workers in animal handling and treatment procedures, and to provide producers and managers with objective assessments of current welfare status plus goals and methods for improvement. Unfortunately, it appears that only a small minority of dairy veterinarians actively pursue animal welfare improvement as an objective of their work. Many more seem content to fill the role of service providers rather than welfare consultants and advocates. It is my strong impression that many veterinarians find it very convenient to assume the attitude that economic efficiency and maximum milk production are the overriding goals of the dairy industry. In turn, this makes it easy to further assume that certain levels of animal disease and discomfort that can follow from particular attitudes and management practices are acceptable trade-offs. In particular, some practitioners may fear that voicing strong concern for animal welfare may alienate or antagonize their clients. It is rewarding to see that certain issues, such as facility design that enhances cow comfort, are being recognized as key links between animal well-being and herd productivity. Hopefully veterinarians will increasingly see the opportunities available to promote

dairy animal welfare as strong components of the service they provide.

Dairy Producers and Worker Training

One of the common attributes of dairy producers emphasized in the first part of this paper is their well-established ethic of caring for their animals. I can honestly say that virtually every dairy producer I know sincerely cares about the well-being of their animals, and works to assure that their animals are well cared for. Unfortunately this does not mean that in fact dairy animals always fare well, nor that they really receive optimal care. The numerous concerns presented in the preceding discussion highlight areas where dairy animal welfare is frequently compromised. Some of the reasons are lack of knowledge or tools to deal with the problems, lack of recognition that a problem exists, and possible conflicts between economic constraints and ideal management practices. However, I believe that an equally or more important challenge to improving animal welfare in modern dairy operations relates to the problem of dealing with individual animal welfare on operations of increasing size. In many cases it is not the owner who identifies and manages individual animal problems. Increasingly, dairy animals are handled and managed by employees, and in turn these employees frequently do not have the same background, training or perceptions of the owner. In such circumstances it is easy for producers to believe that observations are made, and actions are taken as they would personally do them, while in reality it is not the case. Few dairies have active worker training programs that meaningfully educate workers about key principles of livestock care, and that then follow up with evaluations of performance at periodic intervals. In many cases, the owner and the worker may not communicate well because of language and cultural barriers. I believe that one of the most important means of improving dairy animal welfare is the development and implementation of effective worker training programs. Many of the issues discussed above highlight this need, such as calf care and management, calf delivery management, disease recognition and treatment procedures.

Summary and Conclusions

The dairy industry has undergone steady and remarkable change over the last several decades. Numerous factors have stimulated and shaped these changes, but an overwhelmingly important feature has been the demand for increased economic and business efficiency. This tends to force dairy producers to prioritize economic considerations above animal welfare concerns as they make management decisions. Currently dairy operations in the US vary widely in size, geographic location, facility design and management, with a trend toward larger size and migration to the western arid states, though there are still many dairies in traditional dairy regions that follow more traditional management practices. With these changes have come new challenges to animal well-being, in addition to some of the older ones. The dairy industry has not had to face some of the extreme criticism that has been focused on other, more industrialized animal production systems. Nevertheless there are areas of concern that should be addressed, and most of these can be improved via education, research, and appropriate management changes. Dairy producers would benefit the welfare of their animals by increasingly making animal welfare a top priority, on par with the priority awarded to economic efficiency in the production system. There are numerous examples of management improvements that would positively impact animal well-being and also improve dairy productivity. Dairy veterinarians can play an important role in helping to educate and advise their clients, monitoring for animal welfare problems, and guiding implementation of improved management strategies. There is a very real need for improved training of dairy farm workers, because it is more commonly the workers than the owner/operators who directly implement animal care and welfare procedures.

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