

Abstracts and Presenters

Section 01: Large Herd Systems

01-01 Large confined dairy herd systems in hot climates.

Lance Whitlock*, Dennis Armstrong, and Joseph G. Martin.

Large dairy herd sizes are increasing, with the largest growth of dairies occurring in the Middle East and China. In the United States, most dairies are family owned, whereas in other parts of the world, most large dairies are investor owned. A lack of prior dairy experience often leads to many difficulties. Managers in the United States are often the owner or family members of the owner, and employees often come from Mexico, Central America, or South America. In other parts of the world, managers and employees often come from another country. Quality and availability of forages and other feeds is a challenge in many parts of the world. Large dairy operations require large amounts of water. It can be a challenge to get enough good quality water. In some instances, it is better to not locate a dairy in a projected area if the quantity and quality of water cannot be assured. The type of housing used in a dairy must match the environment. Commonly used housing types are dry-lot, desert barn, naturally ventilated freestall barn, low-profile cross-ventilated barn, and tunnel-ventilated freestall barn. Care and time must be spent in selecting the proper site for a dairy. It can be difficult to find a large enough tract of land for purchase that meets all the needs of a dairy. Factors to consider include soil type, prevailing wind speed and direction, site orientation and sun angles, access to utilities, access to major highways, minimum site elevation, availability of adequate cropland, earthquake zones, room for future expansion, and distance from neighbors. Construction costs can vary significantly but will often be quite a bit higher in countries outside the United States. Selection of a good dairy site should involve a commitment to environmental regulations that includes proper manure handling and removal.

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Lance Whitlock is a consulting dairy nutritionist with Progressive Dairy Solutions. He grew up in Kansas and completed his BS (animal science) and MS (ruminant nutrition) at Kansas State University. He completed his PhD (ruminant nutrition-dairy) at South Dakota State University in 2002. Whitlock primarily does consulting work for large dairy herds in the southern and southwestern United States, as well as in the Middle East. He resides in Arizona with his wife and two daughters.

01-02 Large dairy herd design in temperate and cold climates.

Gordie A. Jones*, David Combs, and David Kammel.

There are 4 types of dairies in the world: sunset dairies with fewer than 150 cows that when the current owner retires will no longer exist; niche dairies that produce a specialized product; lifestyle dairies that provide a second income; and large dairies, defined here as having more than 400 cows or the ability to sell a tanker load of milk or more in 1 or 2 d. These large dairies now make up more than two-thirds of the entire US milk supply. The majority of dairy production in the temperate and cold climates is in the northern hemisphere of North America, Europe, Russia, and China, with a small portion in the southern hemisphere in South America and Australia. Dairy facilities are tools that let the owner or manager implement their management plan. Good facilities allow farm managers not only to plan their daily chores, but to meet their overall management goals. Poorly designed facilities in temperate climates will often dictate how things are done rather than the dairy producer making the decisions. To design a large dairy operation in temperate climates, the owner/manager must first create a plan with the goals of optimizing cow performance and comfort, and minimizing the amount of labor required through facility design. The major tasks of dairy farming are material handling (feed, bedding, manure and milk), animal care, and the timing of each. It is the symphony of movement and timing of tasks that defines a great dairy farm. Facility designs should take into account daily activities such as delivering feed, breeding and manure removal, as well as weekly tasks such as pregnancy checks. Designs should allow all these things to happen efficiently. The dairy design should allow the “three circles of excellence” to be achieved: the circle of a cow’s 24-h day, the circle of the cow’s annual production cycle, and the heifer’s 2-year cycle from birth to entering the dairy herd as a productive animal. A cow should be doing 3 things: she should stand to be milked, stand to eat and drink, and the rest of the time, she should be lying down. No matter the size of the dairy farm, bottlenecks exist that keep it from performing at potential. When a bottleneck is released, performance can increase until the next bottleneck is reached. Although all farms may be different in the style and types of construction, the 4 major systems of cow housing, milking center, feed storage, and manure storage are integrated into an overall farmstead design that is the tool for implementing the dairy herd management plan for the farm.

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Gordon (Gordie) A. Jones currently lives in De Pere, Wisconsin. He attended Michigan State University and received his BS in dairy science and his DVM from Michigan State in 1977. He practiced dairy performance medicine in Wisconsin for 22 years and was a technical service specialist for Monsanto Dairy for 3 years. Jones is currently an independent dairy performance consultant and a partner of Central Sands Dairy LLC, a 4,000-cow dairy. Jones designed the Fair Oaks Dairy in Indiana, a dairy farm with more than 20,000 cows. He also started Central Sands Dairy, where he was the designer and has been managing partner for 5 years. Jones has consulted with dairy producers and veterinarians across the United States and internationally on dairy herd performance, nutrition, cow environments, dairy housing, expansion, dairy management, personnel SOPs, and cow comfort. He has placed considerable emphasis on housing design to keep cows clean, dry, and comfortable and has influenced the development of

several cow comfort features in barn construction through work with environmental consultants and contractors. Gordie and his wife, Mary, have been married 40 years and have 3 children.

01-03 Resilient pasture-based dairy production systems.

John Roche*, Donagh Berry, Danny Donaghy, Brendan Horan, and Steve Washburn.

Grazing production systems have increased in popularity because of the simplicity of establishment and increasing consumer concern around housed systems. Resilient grazing systems are designed to harvest a large amount of the pasture grown directly by the cow while minimizing the requirement for machinery and housing, and exposure to feed prices. This is primarily achieved by matching the feed demand of the herd with the annual pasture supply profile (i.e., seasonal milk production) and by designing the farm infrastructure of paddocks and cow tracks to facilitate easy access to pasture. Ideally, the entire herd calves 30 to 60 d before pasture growth equals herd demand; breeding and drying-off policies need to facilitate this. The type of cow is also important; she needs to be highly fertile and have good grazing behavior characteristics. Pasture species are chosen to best suit the predominant climate, and pasture management aims to maximize the production and utilization of chosen species. Pasture surplus to requirements in spring is conserved as silage or hay and offered to cows during periods of low pasture growth, particularly to nonlactating cows during winter. Purchased supplementary feeds can be successfully incorporated into grazing systems, as long as the stocking rate is increased to achieve high pasture utilization. Industry databases indicate, however, that, on average, profitability declines with increasing use of purchased supplementary feeds because of reduced pasture utilization and lower than expected milk production responses.

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Session B: Tuesday, 1:15 PM, Court E



John Roche is principal scientist for animal science at DairyNZ and an adjunct professor of animal science at Lincoln University in New Zealand. He is also managing director and principal consultant for Down to Earth Advice Ltd., a company providing strategic and operational advice to dairy farming businesses around the world. He has also held science appointments with the National Centre for Dairy Production Research at Moorepark in Ireland, the Department of Primary Industries in Australia, and the University of Tasmania. Roche leads a team of 14 scientists, developers, and postgraduate students and has published approximately 140 peer-reviewed science journal articles and book chapters. He is a regular contributor at international science and farming conferences and has been a section editor for *Journal of Dairy Science* since 2012. Roche is one of the most recognized authorities on the nutrition of grazing dairy cows, with a keen focus on profitability. His animal science program has focused primarily on

transition cow nutrition and the role of body condition score and energy balance on milk production, health, and reproduction. His review, *Body condition score and its association with dairy cow productivity, health, and welfare*, was the most cited article in the Physiology and Management section of *Journal of Dairy Science* in 2010–2011. Roche's research work in intake regulation identified diurnal patterns in the endocrine profiles of grazing dairy cows that explain observed behavioral responses to feeding. Roche has extensive publications in grazing management, with a particular focus on the responsiveness of temperate grasses to carbon depletion. He is also well known for his expertise in grazing farm systems, having published some of the seminal applied studies in stocking rate and farm system profitability.

01-04 Organic dairy production systems.

Cynthia Daley*, Keena Mullen, Kathy Soder, Brad Heins, Heather Darby, Andre Brito, and Ulrike Sorge.

Organic dairy production is a system of farming that relies upon specific management practices that enhance the chemical, biological, and physical properties of soil as the primary method for improving pasture and crop productivity. These soil-enhancing practices play a key role in suppressing weeds, pests, and disease. Several known farming practices are used by organic farmers that enhance soil quality, including crop rotation, no-till/reduced soil tillage, and perennial crops such as mixed pasture forages and leguminous hay, and grazing practices. According to the National Organic Program (NOP) of the USDA, organic is a production system that is managed to respond to site-specific conditions by integrating cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity. Organic milk production has been one of the fastest growing segments of production agriculture in the United States, created by consumer demand for organic dairy products. Among all nations involved in organic, the United States is the largest, with organic sales reaching \$29 billion in 2013. Organic dairy products are listed as the second leading food category (after fresh fruits and vegetables) for US sales of organic food. To meet this need, the organic dairy industry has grown to 6% of the national fluid milk sales. For some producers, organic dairy production can be a good fit. There are many factors to consider before making the transition, including current and future milk demand in your region, production standards, certification requirements, pasture availability, production costs, commitment, and lifestyle goals.

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Cynthia A. Daley completed her BS in animal science at the University of Illinois and her PhD at the University of California, Davis, in 1997. She is currently professor in the College of Agriculture at California State University, Chico. Aside from her duties in the classroom, committee work and advising, Daley created the Organic Dairy program at the Agriculture Teaching and Research Center for the purposes of research and education. Students are directly involved in an organic production paradigm including managed intensive grazing (MIG), organic pasture management, holistic herd health, milking hygiene, milk quality, organic calf management, and whole farm systems planning. Positions on the Student Dairy Management Team are competitive. Daley is also involved in a national consortium of researchers working to bring a variety of educational materials and research bulletins online (<http://eorganic.info/>) to benefit organic producers as well as the extension service, organic certification personnel, and agricultural educators. Active research

projects include reduced grain feeding and the use of soil amendments to improve forage quality and net profitability; the effect of pasture DMI on milk nutrient content and the use of fodder as a grain alternative in mid size dairy operations.

01-05 Dairy systems with automatic milking (robots).

Jack Rodenburg*, N. A. Lyons, and K. L. Kerrisk.

Large herds have been slower to adopt automatic milking systems (AMS) than smaller dairies because the lifestyle improvements that an AMS offers the family farm are not applicable to larger farms. Although <100 herds worldwide are using fully automated milking in herds >500 cows, more rapid adoption in the next decade is anticipated. Benefits include a reduction in total labor for the dairy; improved cow comfort and longevity; reduced feed costs; and improved production and system performance. New challenges with AMS include designing effective handling systems for voluntary milking and adapting feeding strategies so feed entices cows to visit the milking box. With free cow traffic, the feed in the milking box is the key and should be a high-quality pelleted concentrate. With guided traffic, the feed at the feed fence provides additional stimulus and reduces the number of cows that require fetching, but it reduces the number of meals and increases waiting time. One recent study reported higher production per cow with free traffic. In pasture-based AMS, a 3-way grazing system that allocates a fresh pasture area every 8 h brings cows to the AMS at regular time intervals. Barn layouts for AMS are typically modular sections of either 120 stalls and cows with 2 milking boxes with free traffic, or 60 stalls with 1 milking box with guided traffic. Grouping these sections so that AMS management is centralized and including separation areas behind the milking boxes for handling cows separated automatically after milking are keys to labor efficiency. Lameness prevention is critical to voluntary milking so a good foot bathing strategy is essential. Further automation of milking parlors with robotics such as stationary robotic teat sprayers beside rotary platforms and teat dipping in the milking cups is also being adopted. The latter has been shown to be more effective than manual dipping or spraying. The only commercial application of robotic milking on a rotary platform today is the DeLaval automatic rotary (DeLaval, Tumba, Sweden), used for voluntary milking on 3 large pasture dairies in Australia, and for timed milking in 9 freestall-housed herds in Europe. Benefits of further automation with batch milking reduces labor but will not contribute to improved cow welfare in the same way as AMS applications where cows are milked voluntarily close to their housing area. In future, labor costs will increase faster than technology costs; technology will continue to improve and the public will demand more cow-friendly management systems. Each of these factors will encourage widespread application of AMS on large dairies, suggesting this technology will play an important role in the future development of the dairy industry.

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Jack Rodenburg graduated in 1974 from the University of Guelph, Canada, with distinction and worked in dairy extension with the Ontario Ministry of Agriculture for 34 years. Since 1999, when the first robotic milking systems arrived in North America, Jack has advised robotic dairies and conducted numerous practical field studies. He chaired the First North American Conference on Robotic Milking in Toronto in 2002, and was program coordinator for the First North American Conference on Precision Dairy Management in 2010. Jack "retired" in 2008 and now consults on barn design and management for robotic systems as "DairyLogix."

Section 02: Building Sustainability and Capacity

02-06 Assessing carbon footprints of dairy production systems.

Al Rotz* and Greg Thoma.

The farm-gate carbon footprint of milk quantifies the net greenhouse gas emissions of a dairy production system. Published values vary widely depending upon farm management practices and the calculation method used. Standard procedures for calculating the carbon footprint of milk are now established, which is improving the accuracy and comparability of published values. The major greenhouse gas emission source on dairy farms is enteric methane from the animals, which makes up 30 to 60% of the farm-gate carbon footprint of milk. Other important sources are emissions from manure (10 to 30% of the footprint) and those associated with the production of resources used on the farm (10 to 25% of the footprint). Other smaller sources include emissions from cropland (1 to 10% of the footprint), the combustion of fossil fuels and decomposition of lime (3 to 5% of the footprint), and indirect emissions occurring beyond the farm from ammonia and nitrates leaving the farm (0.5 to 12% of the footprint). The carbon footprint of milk produced on well-managed farms normally ranges from 0.8 to 1.2 kg CO₂-equivalent/kg of fat- and protein-corrected milk produced, but lower and higher values are found. Methods for reducing the carbon footprint include increasing the milk production per cow, reducing the herd replacement rate, feeding less forage in the diet, and optimizing total protein intake. Manure emissions can be reduced by using a covered or enclosed manure storage or by using an anaerobic digester to produce gas and electricity used on the farm, thus reducing the need to purchase energy. With appropriate mitigation strategies employed, the farm-gate carbon footprint of milk may be reduced by 20 to 30%. Finding cost-effective strategies for reducing the carbon footprint of milk is both challenging and necessary as we work to improve the sustainability of our production systems.

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Al Rotz is an agricultural engineer with the USDA's Agricultural Research Service, where his work includes modeling and life cycle assessment of dairy and beef production systems. Al grew up on a dairy farm in Pennsylvania. His education includes a PhD from The Pennsylvania State University. He serves as the lead scientist of a project on integrated farming systems at the Pasture Systems and Watershed Management Research Unit in University Park, Pennsylvania. He is a registered Professional Engineer, Fellow of the American Society of Agricultural and Biological Engineers, and member of the American Dairy Science Association and American Forage and Grassland Council.

02-07 Impacts and mitigation of dairy feed on air quality.

Frank M. Mitloehner* and Mathew Cohen.

California leads the nation regarding the research and regulation of its anthropogenic air emission sources. Our previous work has shown that silages are a major source of volatile organic compounds (VOC) and oxides of nitrogen (NO_x) on dairies contributing to the California San Joaquin Valley's (SJV) ozone challenges. Most recent studies on emission of silage VOC and NO_x have sought to identify and quantify the major VOC and NO_x components of silage emissions through field or laboratory measurements, whereas 2 studies have looked at ozone formation through computer simulations. Literature on mitigation strategies for environmental pollutants from silages is extremely sparse and mainly related to minimizing dry matter (DM) losses and deterioration of feed quality. Most is known on the use of silage covers and additives to maintain high quality of silage and to reduce DM losses. In general, emission of VOC from silage can be mitigated by either (1) reducing VOC production in the liquid/solid phase of the silage pile, or (2) reducing relative emission from the face of the silage pile or the feedlane. Therefore, the focus of the present paper is on monitoring and modeling of VOC production from silages and emissions mitigation. The paper focuses on California, as it is the state with the first, and most stringent, rules around dairy air quality.

Session A: Monday, 9:15 AM, Kensington**Session B: Monday, 3:45 PM, Court E**



Frank Mitloehner is a professor and air quality specialist in Cooperative Extension in the Department of Animal Science at the University of California, Davis, where he has been since 2002. He received his MS degree in animal science and agricultural engineering from the University of Leipzig, Germany, and his PhD degree in animal science from Texas Technical University. Mitloehner is an expert in agricultural air quality, livestock housing, and husbandry. He has chaired a global United Nations Food and Agriculture Organization (FAO) partnership project to benchmark the environmental footprint of livestock production. He has recently served as workgroup member on the President's Council of Advisors on Science and Technology (PCAST) and has been a member on the National Academies of Science Institute of Medicine (IOM) committee, "A Framework for Assessing the Health, Environmental, and Social Effects of the Food System."

02-08 Water quality challenges in dairy production: Nitrogen and phosphorus.

Katharine F. Knowlton*.

Manure is a rich source of nutrients including nitrogen (N) and phosphorus (P) and it is used as fertilizer to enhance crop production. Despite this inherent value as fertilizer, spatial intensification of livestock production in recent decades has created problems as the amount of manure produced in a region overwhelms the assimilative capacity of cropland. Loss (runoff or leaching) of N and P impairs the quality and safety of both ground and surface water. Nonnutrient constituents of manure (e.g., steroidal hormones, residues of antibiotics or other pharmaceuticals) can also have negative environmental effects. If intensification of livestock and advancement of livestock production continues, continued impairment of water quality is expected. But continuous improvement in livestock production is required to maintain the global economy and to meet increasing demand of food supply. Global demand for animal protein is increasing, and this trend is expected to continue as global population is estimated to reach 9 billion by 2050. Intensification of livestock production is one of the options to maintain global food security but a sole focus on intensification threatens the sustainability of the livestock industry by widening the gap between industry practices and societal perceptions and expectations (von Keyserlingk et al., 2013). The threat posed to water resources by dairy farms is a major challenge to the sustainability of the industry and its ability to provide high-quality protein to meet the needs of a growing global population. Therefore, approaches are needed that increase efficiency of animal protein production while supporting the environmental and social pillars of sustainability.

Session A: Monday, 10:30 AM, Kensington

Session B: Monday, 4:30 PM, Court E



Katharine Knowlton grew up on a dairy farm in Connecticut and earned her BS in animal science from Cornell University, her MS from Michigan State University, and her PhD at the University of Maryland, with research on the nutritional physiology of lactating dairy cows. She is now the Colonel Horace Alphin Professor of Dairy Science at Virginia Tech, Blacksburg, with responsibilities focused on research and teaching on environmental and societal challenges associated with animal agriculture.

02-09 Feeding and breeding to improve feed efficiency and sustainability.

Mike VandeHaar*, L. E. Armentano, K. Weigel, D. M. Spurlock, R. J. Tempelman, and R. F. Veerkamp.

Feed efficiency has more than doubled for the US dairy industry in the past 100 years as the result of increased milk production per cow. With increased milk production per cow, more feed is consumed per cow but a greater portion of the feed energy is converted to milk instead of being used for maintenance. The impact of productivity on efficiency has been the driver of past increases in feed efficiency but the expected impact diminishes with each successive increment in milk yield relative to body size. To increase efficiency in the future, we must focus on directly enhancing feed efficiency. Cows vary in metabolic efficiency and in the future we will genetically select for this trait. One way to assess variation in efficiency is residual feed intake (RFI). Cows that convert feed gross energy to net energy more efficiently or have lower maintenance requirements than expected based on body weight use less feed than expected and thus have negative RFI. Cows with low RFI likely digest and metabolize nutrients more efficiently and should have overall greater efficiency and profitability if they are also healthy and fertile and produce at a high multiple of maintenance. Genomic technologies will help to identify these animals for selection programs. Nutrition and management will continue to play a major role in farm-level feed efficiency. We must reemphasize the importance of feeding cows according to stage within a lactation to increase milk yield, decrease nutrient excess, and thus enhance feed efficiency; nutritional grouping and computerized feeding systems will help. As the global human population continues to increase, competition for land and feeds will likely alter how we feed cows and demand greater efficiency. New approaches combining genetic, nutrition, and other management practices will help optimize feed efficiency, profitability, and environmental sustainability.

Session A: Monday, 11:15 AM, Kensington

Session B: Tuesday, 8:00 AM, Court E



Michael VandeHaar has been a professor of animal science at Michigan State University since 1988. He grew up on a dairy farm in Iowa and completed a BS at Dordt College and PhD at Iowa State University. His research has focused on heifer nutrition and feed efficiency. He developed the Spartan Dairy Ration software and has taught nutrition to more than 3,000 students. In 2013, he was awarded the ADSA American Feed Industry Association Award. He currently directs a multistate USDA project to improve dairy feed efficiency and serves on the National Research Council committee to revise nutrient requirements for dairy cattle.

02-10 Opportunities for growth and development of the dairy sector across the world.

Michel Wattiaux*.

Our first objective was to summarize world, regional, and national statistics related to milk and dairy production and consumption. Using databases of the Food and Agriculture Organization of the United Nations, we highlighted the continuum that exists and the extremes that lie at each end of the spectrum. The second objective was to discuss human protein needs and the contribution of animal protein to satisfy those needs in the future. The third objective was to address a few global issues of concern for the growth and development of dairy systems. For the last 50 yr, world milk supply has amounted to about 100 L per capita per year. In 2013, the human population was 7.1 billion and cow milk production was 635.6 t, yielding a per capita average of 0.242 kg/d, or little more than one large glass of milk. However, 22 countries (5% of world population) produced at a level lower than 1/32th of world average and 4 countries (0.05% of world population) produced at least 8 times above the world average. Countries that included 46% of the world's population produced 10% of the world's milk supply. Current protein intake recommendation for healthy adult is 0.80 g of good quality protein per kilogram of body weight per day for both women and men (56 g/d for a 70-kg individual) with no differentiation between protein sources (animal or plant). However, consuming moderate amounts of animal protein has been recognized as one of the means to minimize the likelihood of inadequacy in lysine from cereal-based diets. In 2010, worldwide per capita total and animal protein supply was 79 and 31 g/d, respectively, but the latter ranged from 12 to 60 g/d in low-income economies and developed countries, respectively. Growth in milk consumption is expected to be strong in parts of Latin America and Asia, where strong growth in the middle-class population will occur, but will languish below the world average for most of sub-Saharan Africa because of low income and persistent poverty. International markets will continue to expand as the demand for milk in developing countries will grow faster than production. Among other issues, dairy industry stakeholders should strive to reduce milk losses and waste throughout the supply chain (which varies from 10 to 25% of production), promote dairy farming systems that contribute to sustainable development and poverty alleviation, particularly in developing countries, and mitigate enteric methane emission, the main component of milk carbon footprint.

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Michel Wattiaux was raised on a dairy farm in Belgium and completed a PhD in ruminant nutrition at the University of Wisconsin-Madison. After 10 years of international dairy extension efforts with the Babcock Institute, Michel took a professorship position in the Department of Dairy Science at the University of Wisconsin-Madison. His disciplinary research focuses on efficiency of nitrogen and carbon utilization in dairy cattle and dairy systems sustainability around the world. Michel has gained an international reputation for his scholarship of teaching and learning. He has received teaching awards from the University of Wisconsin, ADSA, and USDA.

02-11 Sustainable dairy production subsystems for the future.

David Beede*.

Future dairy production subsystems (large herds and smaller) will be soil-centric and fully integrated into larger whole agro-ecosystems. In response to increasing societal demands, they will need to engage in extensive public discourse to develop, ensure, and improve market opportunities and secure the public's trust about production management practices, their consequences, and acceptability. Sustainability is defined here as a continuous process toward effective integration of social, environmental, and economic values, practices, and outcomes to bring valued contributions to mankind, while regenerating the resource base and the environment. If future dairy subsystems and their management are not socially acceptable and environmentally regenerative, they will not be economically profitable and sustainable. The trend in some developed countries will be for large dairy herds to produce an even greater proportion of that country's milk solids. However, large herds in more developed countries are projected to produce only about 6% of needed global milk solids by 2050. Management of large herd subsystems will deploy "sustainable intensification" with increased production and efficiency per unit land base, without irreversible use of resources and deleterious environmental consequences. The reality is that as much attention will be paid to environmental sustainability as to increasing productivity. Even with the tremendous technological advances to improve cow and subsystem productivity and efficiency in the last 100 years, it has not been regenerative. This must be reversed. Principles and practices associated with regenerative agriculture will dominate in both large and smaller dairy herds in developed and emerging countries. For example, recent research in other agro-ecosystems with cattle as an integral component shows that net greenhouse gas emissions can be 2- to 4-fold less with conservation grazing and cropping practices compared with simply removing one-half of the cattle from the system. As emerging countries develop dairy subsystems to supply the projected balance (94%) of needed global milk solids, many (more) smaller dairy herds will practice similar sustainable intensification and regenerative management to maintain viability. It will be for the "good of the commons" that the resource base and outputs will be in close spatial proximity to optimize soil organic matter regeneration, and water and nutrient recycling. Future dairy production has tremendous potential opportunities to innovate and be proactive in development of subsystems that are sustainable parts of whole agro-ecosystems, producing milk solids and ecosystem services.

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Session B: Tuesday, 9:30 AM, Court E



David K. Beede is professor and C. E. Meadows Chair of dairy management and nutrition at Michigan State University. He received a BS (Colorado State University, animal science), an MS (University of Nebraska, beef cattle nutrition), and a PhD (University of Kentucky, ruminant nutrition and metabolism). From 1980, at the University of Florida, and, since 1994, at Michigan State University, he has engaged in research, teaching, and extension/outreach efforts aimed to coalesce components of dairy nutrition and management and environmental issues with efficient use of resources for ecologically sustainable dairy systems.

Section 03: Facilities and Environment

03-12 A systems approach to dairy farmstead design.

David Kammel*, Joseph Zulovich, and Joseph P. Harner.

In a systems approach, each of the individual systems are designed to complement each other and are integrated to create an efficient and functional dairy farmstead design that supports a profitable dairy business. A farmstead designed with a systems approach enhances the opportunity to take advantage of excellent dairy herd management. “Facilities are the tools to implement a dairy herd management plan that allows the dairy cow herd to express its genetic potential to create a profitable business.” This key message has been discussed in various ways and presented in a variety of papers and presentations over the years by agricultural professionals in the dairy industry. It is the overriding principle in dairy farmstead design. The design and development of each system component is based on a management plan developed by the dairy design team with the combined knowledge of a group of people that have different perspectives. The dairy farmstead design is dependent on a biological system (the cow), which creates unique challenges in design and sometimes conflicting needs of the cow and the workers. Farms have different resources, including land, water, capital investment, and labor force. The available resources or the limitations of those resources will affect the specific design of the farmstead facilities and layout. The farmstead master plan identifies the location, site plan, and the space needed for each of the individual system components. There are 4 major sub-system components in a dairy farmstead: cow housing, milking center, feed storage, and manure storage. For site planning purposes, it is helpful to understand the amount of land required to develop the physical facilities of a dairy farmstead site for a certain number of cows. The overall land required for the physical facilities is approximately 915 ft²/lactating cow. Fifty-two percent of the overall land space is used by the physical facilities and the remainder (48%) is green space, area between buildings, along driveways, or separation between roads and neighboring property lines. The average number of cows that can be housed is 47 cows/acre of farmstead site with a range of 27 to 117 cows per acre.

Session A: Tuesday, 10:45 AM, Prince of Wales

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David W. Kammel is a professor and state extension livestock specialist in the Biological Systems Engineering Department at the University of Wisconsin. He received his PhD in 1985 and has worked in the area of dairy and livestock housing design with thousands of dairy farms in Wisconsin, the United States, and internationally. He is author of several chapters in the *Dairy Freestall Housing and Equipment Handbook*, which received an ASABE Blue Ribbon award in 2013, and he received the University of Wisconsin–Madison College of Agriculture 2014 Pound Extension Award for his extension activity.

03-13 Systems approach for design of milking centers and farmstead layouts.

Joseph Zulovich*.

The systems approach to dairy farmstead design has both breadth and depth aspects. This chapter focuses primarily on the breadth aspect of farmstead design and provides some additional design planning depth for several different system components. Additional planning and design information addresses milking center function and design, special needs and transition facility integration, and farm utility system development. The milking center often is a focal point of a dairy operation. The milking center not only generally provides for the actual milking function on a dairy but also other functions such as breeding activities, herd health management, and facilities for animals having special needs. The milking center often provides a focal point facility for workers' and managers' needs on a dairy. All these specific functions need to be provided and integrated into the entire facility system. Animals in transition management periods, such as early lactation cows, special needs facilities, such as maternity and close-up dry cow facilities, and general animal health management must be integrated between different facility systems. The management preferences and operational size will affect how and where these special needs are provided. The utility requirements of a dairy include a water supply capable of providing the needed water quantity and quality to support the operation. Key characteristics of the water supply system must be addressed for a successful dairy operation. The overall capability of a water supply system can limit the size and sustainability of a dairy operation. An adequate and dependable electricity supply must also be established. However, the existing availability of electricity should not be a primary factor affecting the location of a dairy farmstead. Generation of methane gas from manure can help offset on-farm electricity needs; however, the incorporation of methane gas production must be considered in the initial planning of a dairy operation. Methane gas production will not reduce the quantity of manure nutrients to be managed from a dairy operation.

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Joe Zulovich, PhD, is an assistant professor and agricultural engineer and provides educational leadership and develops technical materials for a number of program areas for University of Missouri Extension. The program areas include livestock facilities and systems for the swine, dairy, and beef industries; grain storage and handling system; and the small meat processing industry and on-farm milk processing in Missouri. Specific topic areas include functional facility planning, ventilation (environmental control) design and troubleshooting, structural design issues for various buildings, manure and waste handling systems, and development and layout of facility systems (farmstead planning and site selection). Joe is an active member of the University of Missouri Commercial Agriculture Program, which develops technical tools and educational materials and provides educational programs for both producers and allied industry personnel. His current applied research projects focus on development and implementation

of heat abatement systems for livestock facilities and livestock building system energy management. Joe also teaches classes for the Agricultural Systems Management program and other animal science and veterinary medicine classes at University of Missouri.

03-14 Whole-farm nutrient balance: A systems approach to dairy nutrient planning.

Richard K. Koelsch* and Quirine Ketterings.

Modern dairy farms are an increasingly complex assembly of sub-systems for milk production, replacement herd management, manure storage and management, feed production and storage, and ration preparation. With many farms specializing on individual sub-components such as milk production and relying on off-farm purchases of feed supplies, the challenges associated with managing nutrients are increasingly complex. Current public policy places the focus on managing nutrients within the cropping sub-system and farmstead's manure storage and runoff collection while ignoring other nutrient sources and flows within a dairy. In addition, farmers typically manage and monitor nutrients in the dairy cow's diet, but primarily for the purpose of optimizing milk production and income and typically not with the goal of minimizing environmental risk. The current focus of managing nutrients for these 2 sub-systems may not adequately address nutrient-related environmental risk associated with many dairies. Evaluation of the sustainability and environmental footprint of a dairy operation should include an assessment of the whole dairy system using nutrient tools such as whole-farm nutrient balance (WFNB). The WFNB offers several significant advantages over plan-based, field-level assessments, including identification of the "elephant in the room"—those sources of nutrients imported into farms that are driving the N and P environmental risks associated with dairies; estimation of the magnitude of the nutrient imbalance and of the reduction in nutrient imbalance necessary to achieve balances that in the "optimum operational zone"; evaluation of the performance of the whole dairy system as opposed to individual sub-components; and application of adaptive management strategies by the dairy farmer and advisor with WFNB measures serving as the gauge for judging progress. In this chapter, we pose several important questions to address nutrient management for the whole dairy farm or system. These questions can provide valuable insights to the underlying causes of nutrient risks associated with a dairy as well as alternative solutions beyond using manure nutrients in the cropping system of the dairy. A whole-farm nutrient review, especially when conducted on annually, can enhance the environmental sustainability of dairy production.

Session A: Tuesday, 1:15 PM, Prince of Wales

Session B: Wednesday, 8:00 AM, Court E



Richard (Rick) Koelsch is a professor at the University of Nebraska, Lincoln. He has BS and MS degrees in agricultural engineering from Kansas State University, and a PhD in agricultural and biological engineering from Cornell University. He has been teaching at the University of Nebraska since 1995. Rick recently completed his role as associate dean for extension programs at the University of Nebraska. He was responsible for extension programs in agriculture, natural resources, and community development. Rick returned in 2016 to the Departments of Biological Systems Engineering and Animal Science, where he had extension and research responsibilities for issues related to agricultural environment. He has provided national leadership for a Livestock and Poultry Environmental Learning Center that hosts a national extension website and a monthly webinar on animal manure issues. He has responsibility for programs targeting animal manure management and sustainability of agricultural systems.

03-15 Manure handling, treatment, and storage systems.

Dana M. Kirk*.

Over the past few years, agriculture has been the focus of significant attention related to the effect of manure and nutrient management on surface and ground water quality. To ensure the long-term success and growth of the dairy industry, these concerns should be addressed in a proactive manner and the sustainability efforts of dairy farms highlighted. Treating manure as a resource, not a liability, through improved manure handling, treatment, and storage is an important step toward more sustainable dairy farms. The science and knowledge for designing a functional, economic, and environmentally friendly manure management system has expanded rapidly over the past decade. To navigate the evolving world of manure management, dairy producers should be equipped with a basic understanding of design standards and principles, technical terminology, system performance, and cost so that they can work effectively with consultants and technology providers in an informed and meaningful way. A basic understanding of the capabilities and limitations of various manure management technologies will generate realistic expectations, investments that better address the needs of the farm, and more successful systems. In this chapter, the basic technologies and principles of manure handling from barn to storage will be reviewed. Manure management begins with collection and transfer systems, with 2 common approaches: scrape or flush. Treatment is the second step in manure management and drives how manure is stored on farm and eventually the land application and utilization of the nutrients. The capabilities and costs of individual nutrient recovery technologies and systems will be discussed in detail. Finally, a review of current manure storage design principles and national standards will be provided. Proper storage of manure is a critical component of regulatory compliance and the need for manure storage is expanding across the United States as more emphasis is placed in the 4 R's of nutrient management.

Session A: Tuesday, 2:00 PM, Prince of Wales

Session B: Wednesday, 8:45 AM, Court E



Dana Kirk, PhD, PE, is assistant professor in biosystems and agricultural engineering at Michigan State University and a licensed professional engineer in the State of Michigan. In addition, to his teaching and outreach responsibilities, he is the manager of the Anaerobic Digester Research and Education Center (ADREC). Applied research at ADREC includes bench-top, pilot-scale, and commercial anaerobic digestion systems used to evaluate feedstocks, optimize performance, and integrate technologies. Prior to joining Michigan State University, he worked as a consulting engineering for dairy and livestock farms around the Midwest.

03-16 Mature cow housing.

John T. Tyson*.

The goal of this chapter is to discuss the basic housing requirement needs of a modern dairy herd. The focus will be the theory behind the design of confinement dairy housing system. A good dairy facility must first be designed to meet the needs of the cow. The facility must provide “cow comfort”. Cow comfort can simply be defined as the removal of stress from the cow’s environment, allowing her to maximize for productive potential. Stress can come from many sources including nutrition, handling, health, milking, and housing. Reducing these stress factors improves milk production, milk quality, productive longevity, reproduction, animal health, and ultimately the profitability of the dairy operation. To minimize housing-related stress the dairy shelter must provide the following basics: good seasonally adjusted ventilation, a dry comfortable resting area, free access to feed, free access to water, and confident footing. Providing these basics well maximizes cow comfort and allows cows to reach their genetic milk production potential.

Session A: Tuesday, 2:45 PM, Prince of Wales

Session B: Wednesday, 9:30 AM, Court E



John Tyson, PE, is an agricultural engineer and extension educator with Penn State Cooperative Extension. In his current position, he has conducted educational programming in dairy housing, cow comfort, farmstead layout, feed storage design, manure handling, and agricultural ventilation. Programs have been conducted with producers, builders, agricultural suppliers, veterinarians, and financial lenders dealing with these agricultural engineering issues. His primary focus has been on individual assistance directly with the producer. During this time, he has been involved in the production of various extension publications involving dairy housing facilities. John has been a Licensed Professional Engineer in Pennsylvania since January 2003.

03-17 Replacement heifer facilities.

Dan McFarland*.

Well-designed facilities for dairy calves and heifers are a key element in ensuring healthy, well-grown heifers are ready to enter the milking herd by 24 mo of age. Along with a productive environment, facility choices need to reflect the farm's management plan, consider the changing needs of growing calves and heifers, provide safe working conditions for the caregivers, protect the environment, and be cost effective. This chapter will focus on design criteria for naturally ventilated facilities used to shelter calves and heifers in northern climates.

Session A: Tuesday, 4:00 PM, Prince of Wales

Session B: Wednesday, 10:45 AM, Court E



Dan F. McFarland is an agricultural engineering educator for Penn State Extension with program responsibilities. His program emphasis involves animal shelter and environmental systems design. Dan works closely with producers and agricultural professionals on issues related to new animal shelter design and existing facility improvement. Educational efforts include farmstead design and layout, ventilation system design and management, animal comfort and well-being, stall design, feeding area design, animal cooling, and watering systems. In addition to his regular duties, he has written articles for national dairy publications, prepared papers for ASABE conferences, and has been an invited speaker at industry-sponsored seminars on topics related to cow comfort and animal shelter design.

03-18 Feed center design.

Joseph P. Harner*.

Feed centers need to be designed to meet long-term goals but be flexible due to variation in ingredient particle size, bulk density, and moisture content. Total mixed rations (TMR) have become the major feeding system of the dairy industry. Mixing combines 2 or more ingredients so that each ingredient is uniformly diffused among the other ingredients. Due to multiple ingredients in the TMR, the feed center layout affects the ability to efficiently retrieve ingredients utilized in a given ration. Feed is a significant cost in milk production. Ingredients utilized are monitored through feed ingredient purchases, feed delivery records, and weighbacks of refused feed.

Session A: Tuesday, 4:45 PM, Prince of Wales

Session B: Wednesday, 11:30 AM, Court E



Joe Harner, PhD, PE, is professor and head of the Biological and Agricultural Engineering Department at Kansas State University. He is a graduate of the Agricultural Engineering Department at Virginia Tech. He has worked with dairies and beef facilities in North America, South America, Africa, Asia, and Europe, ranging in size from 18 to 90,000 cows. He has participated in numerous field studies and co-authored more than 300 publications. He received the 2003 ASABE Gunlogson Countryside Engineering Award and the 2009 ASABE Henry Giese Structures and Environment Award.

Section 04: Milk Markets and Marketing

04-19 International and domestic dairy market landscapes.

Mark W. Stephenson (presented by Cameron Thraen*).

The earliest evidence of man consuming milk from cows was from about 8,000 to 10,000 yr ago. A gene mutation provided lactase persistence into adulthood and rapidly spread across much of what is now Europe and West Africa. Thousands of years later, Europeans settling North America brought domesticated livestock with them. The global dairy markets of today can be traced back to these earliest associations of humans and animals. As the cow's genetic potential to produce more milk is pursued, we are finding the limits of heat stress on high-yielding animals. This is causing milk production to shift away from regions of the United States such as the southeastern and Gulf states. Farms are also finding increasing economies of scale, and the cooler northern tier of US states are seeing renewed growth in milk production. The yield potential of the modern dairy cow does not suggest that a limit on production will be found any time soon. This increased efficiency in production has outstripped the growth in domestic demand for milk and dairy products in the United States. Exports offer an option for additional sales. The US business model on dairy farms has evolved into a relatively intensive production strategy. This differs from other major dairy exporting countries, such as New Zealand, where pasture-based systems have similar total costs of production but the costs are partitioned quite differently. The United States has relatively high variable costs of production and lower fixed costs than New Zealand. The implication of the US system is the ability for rapid expansion when demand increases in countries like China. But it also means that US farms will be the first to contract when milk production is in excess and prices are low. This defines a balancing role for the US industry. Projections for long-term growth in world demand from the middle class in emerging economies bode well for future sales of exports. However, it is likely that the cyclical nature of an uncoordinated supply chain will mean low price years and contraction as well as years of growth.

Session A: Monday, 8:30 AM, Canterbury

Session B: Monday, 3:00 PM, Kensington



Mark Stephenson is the director of dairy policy analysis at the University of Wisconsin-Madison. In this position, he conducts and coordinates research and outreach activities related to the dairy industry. He is involved in applied research at the firm level, including milk assembly costs, processing costs, new processing technologies, farm costs, and price risk management. He is also active in sector-level performance, including dairy policy, spatial milk pricing, international trade and milk price forecasting. Stephenson received his BS and MS degrees in dairy science from Michigan State University and later, MS and PhD degrees in agricultural economics from Cornell University.

04-20 Changing global dairy markets: Comparison of dairy systems and economics.

Torsten Hemme*.

This article summarizes the research work of the International Farm Comparison Network (IFCN), which has been analyzing dairy farm economics since the year 2000. In the year 2015, 55 countries participated in the annual comparison of costs of production and 100 countries participated in the country profile analysis. There are 121.5 million dairy farms on this planet, keeping, on average, 2.9 cows per farm and with average milk yield of 2,145 kg of energy-corrected milk (ECM)/animal. Costs to produce milk in 2014 range from US\$4 to \$128 per 100 kg of ECM in the extensive farming system in Cameroon to \$118 for an average-sized farm in Switzerland. The simple average cost over all countries analyzed was \$46/100 kg of milk. From 2000 to 2014, cost of milk production increased in all countries, especially in Poland, China, and New Zealand, driven by currency strengthening and increase in input prices such as land, feed, and labor. Costs of milk production in China are still significantly higher than that in the EU and Germany, which is mainly driven by wage rate and currency appreciation. The IFCN developed an indicator “margin over compound feed costs,” which is a significant improvement compared with the often-used milk:feed price ratio. By using this margin, it becomes clear how much of a threat dairy farmers face in a situation when milk prices fall and feed prices increase to such an extent that 100 kg of feed is more expensive than 100 kg of ECM. The first estimation by IFCN for milk production costs in 2015 show stable costs for United States and significant cost reductions of \$5 to \$9/100 kg of ECM in the EU, New Zealand, Brazil, and Poland. The cost analysis results are based on 2014 data but changes expected for 2015 will be mainly driven by 2 factors: (1) changes in exchange rate, and (2) lower milk price, which drives changes in dairy farming systems. It is essential to understand the competitiveness and risk profiling of dairy systems and the means to improve their resilience and sustainability. Annual benchmarking by IFCN on dairy economics of typical farms is a part of strategic dairy development and milk sourcing. In times of significant change in dairy-related output prices, farm input prices, and exchange rates, it is extremely important to benchmark the competitiveness of the current dairy farming system annually. Competitiveness in this sense means competitive costs on the market for dairy products and competitive in the local market for production factors, especially land and labor. Such benchmarking exercises enable all dairy stakeholders to see and react faster to threats but also to anticipate opportunities that will arise.

Session A: Monday, 9:15 AM, Canterbury

Session B: Monday, 3:45 PM, Kensington



Torsten Hemme obtained his MSc in agricultural economics production from the University Göttingen (1993) and his PhD in agricultural economics (1999) in studies at Texas A&M University, Thünen Institute Braunschweig, Germany, and University Göttingen. With his PhD, he developed the TIPI-Cal model—the methodological basis for international cost comparison of dairy farming systems. After completing his PhD, Hemme started the International Farm Comparison Network (IFCN) with the mission to create a better understanding of milk production worldwide. In 2005, he founded the IFCN Dairy Research Center, which manages the network. The center employs 15 dairy economists in cooperation with University Kiel, Germany. Currently, Hemme acts as managing director of the IFCN.

04-21 Pricing farm milk in the United States.

Cameron Thraen*.

Dairy policy in the United States is multi-layered. Policy instruments range from programs with focused on environmental stewardship; programs aimed at limiting the importation of products from other countries; programs designed to limit the fall in milk price; and programs designed to boost revenue and limit destructive competition. Programs designated as safety-net programs are found in Title I In each Agricultural Act or farm bill. In the most recent 2014 Agricultural Act, the safety-net program is the margin protection program. Title XI of each farm bill includes programs aimed at providing subsidized insurance to the US farming sector. In Title XI, you will find the Livestock Gross Margin insurance program for dairy farmers. Working in tandem with these farm bill programs, the United States has the Federal Milk Marketing Order program, FMMO, a separate piece of dairy policy, dating back to 1935, predating the farm bill programs and policies. In this chapter, I will review in detail the FMMO programs of US dairy policy.

Session A: Monday, 10:00 AM, Canterbury

Session B: Monday, 4:30 PM, Kensington



Cameron Thraen received his MS degree from South Dakota State University (1974) and a PhD from The University of Minnesota (1981). During his tenure at The Ohio State University (OSU), Thraen held faculty positions in teaching, research, and university extension. Thraen served as OSU extension state specialist for dairy markets and policy. Thraen is co-recipient of the Award for Professional Excellence–Distinguished Extension Programs–Group, awarded in 2015, 2000, and 1987, presented by the Agricultural and Applied Economics Association. Cameron Thraen retired from The Ohio State University in 2015.

Section 05: Genetic Selection Programs and Breeding Strategies

05-22 Improving production efficiency through genetic selection.

John B. Cole* and Diane Spurlock.

Genetic selection has been a very effective tool for achieving lasting gains in animal production and efficiency. Prediction of the genetic merit of animals for a variety of traits occurs through the integration and analysis of multiple types of data, including genotypes that describe variation in DNA sequences among animals. These data are gathered, maintained, and analyzed through the efforts of multiple organizations working together in the dairy genetics industry. The success of this genetic evaluation program is evidenced by improvements in the genetic merit and actual performance of cows for milk, fat, and protein yields. Although these production traits will continue to be important to US dairies in the future, interest in the ability to select animals for improved efficiency of production has increased in recent years. Estimation of genetic merit for feed intake and efficiency traits will likely be added to US genetic evaluation programs in the future.

Session A: Monday, 2:30 PM, Court A-D

Session B: Tuesday, 10:00 AM, Canterbury



John B. Cole, PhD, is a research geneticist and acting research leader at the Animal Genomics and Improvement Laboratory, ARS, USDA, in Beltsville, Maryland. A graduate of Louisiana State University, he is an expert on genomics, calving traits, health data, and lactation persistency. Cole is also a special visiting scientist under the "Science Without Borders" program of Brazil's National Council for Scientific and Technological Development, and a member of the International Committee for Animal Recording's Working Group on Functional Traits. He resides in Bowie, Maryland, with his wife and two sons.

05-23 Improving health, fertility, and longevity through genetic selection.

Rebecca Cockrum*, Christian Maltecca, and Kristen Gaddis.

There has been a strong intensification of commercial livestock production throughout the last century. The need to feed a growing world population has also led to increased animal density. Combined with increased globalization of food production, animal health and welfare is increasing in importance. Improving health fertility and longevity is one of the largest challenges in dairy breeding for the next decade. In this quest, field data will provide valuable phenotypes. Combining knowledge available from farm records, field data, and epidemiological data will greatly increase our ability to select efficiently for these difficult traits. This will lead to improved health and welfare of dairy cattle, and will improve public perception of modern dairy farming. Within this chapter, we will review common health fertility and longevity selection opportunities on US dairy farms, combining genetic research with epidemiological knowledge.

Session A: Monday, 3:15 PM, Court A-D

Session B: Tuesday, 10:45 AM, Canterbury



Rebecca Cockrum began her graduate career at the University of Wyoming under the direction of Kristi Cammack. Her thesis research focused on identifying differentially expressed genes in ewes more or less tolerant of elevated dietary nitrate. After completing her MS in 2009, she continued her dissertation research with focus on identifying genotypes associated with residual feed intake (feed efficiency) in sheep. During her PhD research, Cockrum spent a few months in New Zealand collaborating with scientists at AgResearch Limited—an experience that provided a more global perspective of agriculture and science. After receiving her PhD in 2012, she began a postdoctoral program with Milton Thomas, who currently serves as the John E. Rouse Chair in the Beef Cattle Breeding and Genetics group at Colorado State University. Cockrum's research focused on identifying genotypes associated with tolerance to hypoxic-induced pulmonary hypertension (brisket disease) and bovine respiratory disease (BRD) in beef cattle.

Cockrum began her professional academic career with the Department of Dairy Science as the dairy geneticist in January 2014. She is currently conducting research that focuses on identifying markers and pathways associated with economically relevant traits in dairy cattle for marker-assisted selection.

05-24 Making effective sire selection and corrective mating decisions.

Kent Weigel* and Ted Halbach.

Genetic improvement programs for dairy cattle have resulted in remarkable changes in the production efficiency and physical appearance of dairy cows over the past half-century, and the rate of change is likely to accelerate due to widespread use of tools such as genomic testing and assisted reproductive technologies. The intensity of selection for key traits such as milk yield, length of productive life, and udder conformation is extremely high, and long-standing challenges such as low reproductive rates of females, long generation intervals for males, and poor accuracy of breeding values for females and young males have been addressed using the aforementioned technologies. Other challenges remain, such as maintenance of genetic diversity and selection for traits that are expensive or difficult to measure in routine data recording programs, such as feed efficiency and early postpartum health. Dairy farmers have a vast array of tools at their disposal to improve the genetic potential of their cattle, but careful and intense selection of service sires is still the primary method and the most cost-effective strategy. Identification of the key profit centers on a dairy farm, coupled with application of a selection index composed of the specific traits that contribute most heavily to farm profitability, can lead to rapid and permanent increases in the genetic potential of a dairy farm. Risk can be managed by proper use of reliability values, coupled with computerized mate allocation programs to reduce the risk of inherited defects, minimize the costs of inbreeding depression, and correct faults in physical conformation. Finally, gains in genetic potential must be accompanied by improvements in management and nutrition to fully realize the benefits of genetic or genomic selection.

Session A: Monday, 4:00 PM, Court A-D

Session B: Tuesday, 12:30 PM, Canterbury



Kent Weigel, PhD, is professor and chair of the Department of Dairy Science at the University of Wisconsin-Madison. He also serves as extension dairy genetics specialist and is a key technical consultant for the National Association of Animal Breeders and many other industry partners. His research focuses on methods and strategies for genomic selection of dairy cattle, as well as genetic improvement of productivity, health, and fertility traits using genomic testing, advanced reproductive technologies, crossbreeding, and on-farm sensor systems. Weigel has published more than 175 peer-reviewed journal articles on various aspects of genetic and genomic improvement of dairy cattle and has given lectures to academic, industry, and producer audiences in more than twenty-five countries.

05-25 Capitalizing on breed differences and heterosis.

Les Hansen and Chad Dechow*.

Dairy cattle genetic improvement programs have resulted in impressive gains in the yields of milk, fat, and protein over the last half-century. Crossbreeding has generally taken a back seat to within-breed selection programs, but erosion of fitness levels, unfavorable inbreeding trends, and better-than-expected yield in research trials have made crossbreeding an attractive option for commercial dairy producers. The 3 breed groups meriting strong consideration for crossing with Holstein in temperate regions are the Alpine breeds (Brown Swiss, Montbéliarde, and Fleckvieh), Red Dairy Cattle (derived primarily from Nordic countries), and Jersey. Although there are unknowns that prevent clear answers on some issues, research suggests that crosses of these breeds with Holstein will result in milk solids yields that are similar to those of pure Holstein with improvements in fertility, survival, and calving ability. We recommend a 3-breed rotation to capture the majority of benefits from hybrid vigor (or heterosis) without adding unnecessary complexity to the rotation. Crossbreeding provides dairy producers with a tool to more optimally match the genotype of their cows to their management system and to improve traits that have not been emphasized in their home country. A successful crossbreeding system requires that dairy producers select the top sires of each breed and does not diminish the need for robust purebred genetic improvement programs. The combined effects of crossbreeding with top sire selection have resulted in reproductively fit and healthy cattle with high yields of fat and protein, which will encourage more crossbreeding on commercial dairy farms.

Session A: Tuesday, 8:00 AM, Court A-D

Session B: Tuesday, 1:15 PM, Canterbury



Chad Dechow is an associate professor of dairy cattle genetics in the Pennsylvania State University's College of Agricultural Sciences. Dechow is a native of New York State and grew up on a small dairy farm that milked Holsteins and a few Brown Swiss. He has degrees from Morrisville State (AAS), Cornell University (BS), Penn State (MS), and the University of Tennessee (PhD). Chad's general research interest is the development of genetic selection strategies to improve productive efficiency while maintaining high levels of cow health and fertility. Dechow has teaching responsibilities in the areas of animal genetics, dairy cattle selection, dairy herd management, and the use of dairy management software. He also co-advises Penn State's Dairy Science Club and is the coach of Pennsylvania's 4-H Dairy Judging team. He and his wife Elizabeth have four sons and one daughter.

05-26 Genomic selection and reproductive technologies to produce elite breeding stock.

Heather Huson* and Jonathon Lamb.

The development of elite breeding stock for today's dairy industry requires a merger of contemporary genomic and reproductive technologies. Primary performance indices based on genomic markers have the greatest effect on animal value, providing a scientific means of identifying, managing, and marketing elite stock. Individualized mating programs are designed with specific dam–sire matings and appropriate reproductive technologies to optimize genetic progress. Reproductive management for elite stock capitalizes on the genetics of these animals by combining embryo transfer or ovum pick-up and in vitro fertilization for females and artificial insemination and sexed semen for males. These techniques are particularly aimed at reducing the generation interval by using younger animals and intensifying selection for overall merit as well as targeted traits. Proper marketing of elite stock both creates economic value for the producer and ensures propagation of elite stock, thereby incorporating advanced genetics into the industry. Utilizing both genomic and reproductive tools to intensify selection, improve accuracy of selection, and reduce generation interval are key in the development of elite animals.

Session A: Tuesday, 8:45 AM, Court A-D

Session B: Tuesday, 2:30 PM, Canterbury



Heather Jay Huson is the Robert and Anne Everett Endowed Assistant Professor of Dairy Cattle Genetics in the Department of Animal Science at Cornell University. Huson received her BS in animal science at Cornell University and PhD in molecular genetics at the University of Alaska, Fairbanks. She has a diverse background combining animal breeding, veterinary technician experience, and molecular genetics across livestock, companion animals, and wildlife species. Her research aims at improving animal health and performance by investigating the genetic regulation of economically important traits. In addition, she explores population structure and admixture to better understand selection, breed development, and conservation. Huson manages both graduate and undergraduate research within her lab and teaches courses on animal genetics and applied dairy cattle genetics. She resides in King Ferry, New York, with her husband, two children, and various pets.

05-27 Genomic selection and reproductive technologies to optimize herd replacements.

Francisco Peñagaricano*, Albert De Vries, and Don Bennink.

Genomic selection has transformed dairy cattle breeding worldwide. Hundreds of animals have been genotyped, including nearly every potentially elite young animal, and this genomic information is fully integrated into national genetic evaluations. Genomic selection is now extensively applied in 3 of the 4 paths of selection; namely, selection of sires and dams of bulls, and selection of sires of cows. The use of this technology for selecting dams of cows, typically performed on commercial farms, has been largely ignored. However, the potential use of genomic testing for selecting replacement heifers and selective mating decisions has recently attracted much attention. Several factors, including genotyping costs, herd replacement rate, and the proportion of heifers tested, affect the benefits of using this technology on commercial farms. Recent farm data have shown that early genomic predictions can be effectively used as predictors of future lactation performance, including production, health, and reproduction, reaffirming the potential benefits of using genomics for making accurate early-selection decisions. Simulation studies have shown that genomic testing is a cost-effective strategy when selecting replacement heifers in most situations. A case study shows that the application of routine genomic testing combined with the use of advanced reproductive technologies, such as embryo transfer or in vitro fertilization for rapid propagation of the best females, allow us to achieve remarkable annual genetic gains. This progress can be achieved without affecting the rate of inbreeding. Noticeably, genotyping heifers has additional benefits other than making accurate selection and mating decisions, including parentage verification, controlling inbreeding, or avoiding genetic disorders through planned matings. The massive use of routine genomic testing in commercial dairy farms will depend on the availability of friendly tools that can guide producers to make profitable decisions based on the results of the genomic test. These decision-support tools should help producers to, among other things, select which animals are best candidates for genotyping, visualize the results of the genomic test, and finally evaluate alternative strategies, including culling or breeding. The availability of these tools plus a potential decrease in genotyping costs will probably lead to the widespread use of genomic testing on commercial dairy farms in the near future.

Session A: Tuesday, 9:30 AM, Court A-D

Session B: Tuesday, 3:15 PM, Canterbury



Francisco Peñagaricano is assistant professor of statistical and quantitative genetics and genomics in the Department of Animal Sciences at the University of Florida. Francisco is originally from Uruguay, where he received two BS degrees, one in biology and the other in biochemistry, and an MS degree in animal quantitative genetics, all from Universidad de la República. He continued his graduate studies at the University of Wisconsin-Madison, where he gained an MS in statistics and a PhD in animal science in 2014. His research program focuses on the development and application of statistical and computational methods for the analysis of phenotypic and molecular data in livestock species. He also conducts an extension program focused on educating dairy and livestock producers and allied industries about practical and economically important aspects of genetic and genomic selection.

Section 06: Calves and Replacements

06-28 Management of the newborn calf.

Sandra Godden*.

Despite continuing advances in dairy herd health, many farms still have a significant opportunity to reduce losses due to stillbirth and calfhood illness during the period from birth to weaning. In national studies conducted in 2006 and 2014, 8.1 and 5.6% of all US dairy heifer calves, respectively, were reported stillborn (born dead or died within 48 h; USDA, 2007; USDA, 2016). Of all stillbirths, approximately 21% were born alive but died within 48 h. An additional 7.8% of liveborn heifer calves died before weaning (USDA, 2007), with the major illnesses affecting preweaned calves being scours (23.9%), pneumonia (12.4%), and navel ill (1.6%). In addition to the obvious welfare concerns and short-term losses caused by stillbirth and disease, calfhood illness results in impaired future productivity, health, fertility, and farm economics (Mee, 2008). Promoting excellent wellbeing of the neonatal calf will be achieved through the development of herd-level management strategies as well as simple protocols that describe how procedures will be correctly performed at the individual animal level, with particular focus on management of the pregnant dam during the last trimester (e.g., nutrition, vaccines, maternity pen environment), calving management, immediate care of the newborn calf, and management of the growing calf from 1 d of age to weaning (e.g., housing, sanitation, nutrition). This chapter will focus specifically on newborn care during the first 24 h after birth, discussing the following topics: (1) assessment of calf vigor, (2) resuscitation and critical care of newborn calves, (3) routine health management procedures, and (4) colostrum management. Appropriate care of the newborn during the first 24 h after birth will put the calf on the correct path to better assure both short- and long-term wellbeing and performance of the animal, as well as enhanced economic sustainability of the dairy farm.

Session A: Tuesday, 8:00 AM, Court G-J

Session B: Tuesday, 4:15 PM, Canterbury



Sandra Godden, DVM, is a 1993 graduate of the Ontario Veterinary College, University of Guelph, Canada. After working for two years as an associate veterinarian in mixed practice in eastern Ontario, she returned to Guelph to complete a Doctor of Veterinary Science degree specializing in dairy production medicine. Since 1998, she has been a professor in the Department of Population Medicine, College of Veterinary Medicine, University of Minnesota, where she is involved with professional student teaching, applied research, and outreach activities in dairy production medicine. Major academic interests include applied research in mastitis control, colostrum and calf health management, Johnes disease control, and transition cow management.

06-29 Nutrient requirements and feeding management of the preweaned calf.

Mike VanAmburgh*.

Consideration for the overall development of the calf has become a reality with the refinement of nutrient requirements and supply data for preweaned calves and the realization that the long-term productivity of the calf is enhanced by increasing nutrient intake above maintenance nutrient requirements. The energy and protein requirements of the calf should be considered in the first day of postnatal life, and a proactive growth objective should be established to ensure that proper nutrition and management are in place. The current growth objective for a preweaned calf is to double the birthweight by approximately 60 d. Colostrum is important not only for immunoglobulins, but also to stimulate the development of the gastrointestinal tract and enhance the uptake and utilization of energy from the diet. Thus, adequate colostrum intake is important not only for the immune system, but also to set the calf up for energy and protein utilization and this is part of the continuing process of the dam to reinforce anabolic behavior in the calf. Also, the nutrient content of colostrum should be recognized along with the immunoglobulins and other nonnutritive factors. Meeting and exceeding the maintenance requirement is the first step in ensuring adequate health and growth of the calf and adjusting the feeding and management to account for the effect of environment is necessary to achieve the growth objectives. The nutrient requirements for growth have been refined and new data are available that describe the energy and protein requirements for dairy calves. These data clearly point to the need for greater intakes of milk or milk replacer to achieve greater growth before weaning, and the nutrient profile needs to reflect the growth objective (e.g., greater protein intake for higher gain). The long-term productivity of calves has been strongly linked to preweaning nutrient intake and this has implications for the calf and the industry and provides opportunities and challenges for the nutritional and management strategies needed to ensure a proper transition to a functional and healthy ruminant.

Session A: Tuesday, 8:45 AM, Court G-J

Session B: Tuesday, 5:00 PM, Canterbury



Mike Van Amburgh is a professor in the Department of Animal Science at Cornell University, where he has a dual appointment in teaching and research. His undergraduate degree is from The Ohio State University and his PhD is from Cornell University. He teaches multiple courses, advises approximately 50 undergraduate students, and is the advisor for the Cornell University Dairy Science Club. For the last 17 years, a major focus of his research program has been to describe the nutrient requirements of dairy calves and heifers and aspects of endocrine control of developmental functions such as mammary development. This has evolved into describing and working to understand factors in neonatal life that establish lifetime productivity functions and outcomes. Mike currently leads the development of the Cornell Net Carbohydrate and Protein System, a nutrition evaluation and formulation model used worldwide. Mike has authored and co-authored over 70 journal articles and many conference proceedings

and is the recipient of several awards including the American Dairy Science Associate Foundation Scholar Award, the Land O'Lakes Teaching and Mentoring Award from ADSA, the AFIA Award for Research, the CALS Professor of Merit Award, and the CALS Distinguished Advisor Award.

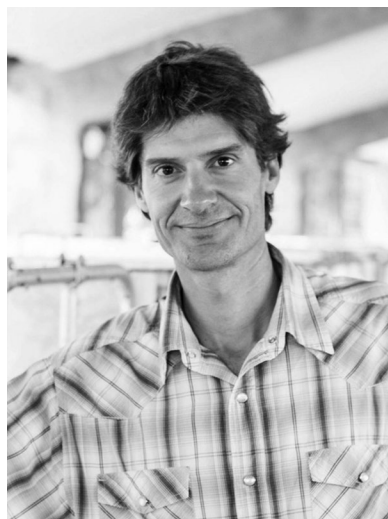
06-30 Managing and feeding the calf through weaning.

Alex Bach*, M. A. Khan, and E. K. Miller-Cushon.

In recent years, in an attempt to improve health status and foster the expression of full milk potential, the industry has progressively provided greater milk allowances to young calves. However, these feeding programs have challenged the ability of the calf to transition from a liquid to a solid diet. Increased supply of milk combined with a gradual weaning scheme can promote greater growth, reduce hunger distress, and improve feed efficiency in calves, but an adequate intake (~2 kg/d) of pelleted or texturized calf starter feed at weaning is necessary to support a daily gain above 1.2 kg/d after weaning, which should minimize health disorders and optimize rearing costs. The ideal feeding management of calves would consist of feeding either pelleted starter feeds along with some poor quality (in terms of nutrient content) chopped grass forage, or well-formulated texturized starter feeds that provide sufficient abrasive action in the rumen. A successful transition depends, among other factors, on adequate rumen development, which is affected not only by the amount and type of solid feed consumed but also by the nutrients supplied from liquid feed. To ensure that sufficient amounts of solid feed are consumed by calves at weaning time, milk allowance should be reduced before weaning. However, these weaning methods are cumbersome to implement in herds that do not have automatic milk feeders and, under those circumstances, a more practical approach consists of reducing the number of daily meal deliveries. In any case, when feeding large volumes of milk, producers may need to consider delaying weaning to facilitate transition to solid feed by giving more time to the calves to increase solid feed intakes.

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Session B: Wednesday, 8:00 AM, Canterbury



Alex Bach is an ICREA research professor and director of the Department of Ruminant Production of IRTA (a research institute in Catalonia devoted to study ruminant production systems). Alex conducts research in ruminant production systems. His research focuses on optimizing the growth curve of dairy replacement heifers, as well as their management and housing systems. He also uses mathematical models to simulate workflows of ruminant production systems with the aim of helping the decision-making process in dairy enterprises. In addition, Alex conducts basic research to understand the physiology and metabolism of ruminants with especial emphasis on the impact of nutrition and management during early development on future metabolic function. He has received several awards in recognition of his research activities, has spoken at more than 100 international congresses, is author or co-author of more than 100 peer-reviewed publications, more than 90 extension articles, and more than 10 books or book chapters. He has served as a scientific expert in several committees of the European Food Safety Authority. He is section editor and sits on the editorial boards of several scientific journals and is member of various scientific committees.

06-31 Feeding management of the dairy heifer from 4 months to calving.

Pat Hoffman*.

Traditionally, dairy heifer nutrition has been approached as an independent heifer management practice but new inferences embrace the reality that dairy heifer nutrition is co-dependent with other heifer management practices, such as reproductive efficiency and environment rearing conditions. Total growth of dairy heifers is a function of days on feed and genetic-body size at first calving. Controlling days on feed is critical to the success of any dairy heifer nutrition program. To rear a 40-kg Holstein calf to a 650-kg precalving body weight at 22 or 26 mo of age requires an average daily gain of 910 or 770 g/d, respectively. Attaining heifer growth of 910 or 770 g/d requires major differences in diet formulation, thus days on feed has a direct effect on heifer nutrition. However, days on feed is also controlled by heifer reproductive efficiency and, as such, reproductive efficiency, days on feed, average daily gain, and heifer nutrition are inherently codependent and heifer nutrition programs need to account for these codependences. Dairy heifers are also raised in diverse environmental conditions. Dietary energy and protein are primary nutrients that influence heifer growth but maintenance energy demand can be highly variable. Environmental factors such as ambient temperature, resting surface, wind, hair coat conditions, and radiant energy gain or loss can affect maintenance energy demands. New information regarding the role dietary neutral detergent fiber (NDF) plays in heifer dry matter and energy intake is now being used proactively to control energy supply and heifer growth rates. These new data suggest that heifer dry matter intake is partially controlled by NDF fill at a static 1.0% of body weight and, as such, heifer diets can be formulated to control energy intake in heifers by regulating both dry matter intake and dietary energy density. Alternative nutritional strategies have also been explored that precisely allocate energy, protein, and other nutrients to dairy heifers to improve feed efficiency and nutrient utilization. Feeding strategies such as limit feeding, avoidance of excess protein supplementation, and careful inclusion of dietary phosphorus in heifer diets are becoming focused elements of dairy heifer nutrition programs. Finally, there are new areas of heifer nutrition exploring feeding behavior and its implications on heifer, growth, health, and lactation performance.

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Patrick Hoffman is professor emeritus at the University of Wisconsin-Madison. Within the Department of Dairy Science, his research focused on dairy heifer management and feed chemistry. In collaboration with students and colleagues, he authored or co-authored over 500 peer-reviewed publications and presented 10 invited papers at American Dairy Science Association (ADSA) conferences. He served on the editorial board for multiple scientific journals, was president of the Midwest Branch of the ADSA, and is a featured speaker at national and international dairy conferences. Patrick is currently a dairy technical specialist for Vita Plus Corp. in Madison, Wisconsin.

06-32 Disease prevention and control for the dairy heifer.

Geof Smith*.

Heifer calves represent the future of the dairy and therefore management of these animals from birth through weaning should be a high priority on farms. Despite this, calf mortality remains high and many farms are not able to generate an adequate supply of replacement heifers. The major causes of morbidity and mortality in dairy calves continues to be diarrhea, pneumonia, and septicemia. These are largely management diseases that can be prevented by having a good colostrum program in place and maintaining good cleanliness and hygiene on the farm. Risk factors for disease include dirty calving pens, inadequate colostrum ingestion, nursing dirty teats, unsanitary feeding utensils (nipples, bottles), overcrowding, poor housing design, contamination of milk with bacteria, poor ventilation, and failure to isolate sick calves. The primary purpose of this chapter is to discuss the risk factors that cause disease in calves, along with keys to prevention and control of disease. These keys to prevention focus on 4 primary goals: (1) removing the source of infection from the calf's environment; (2) removing the calf from a contaminated environment; (3) increasing the immunity of the calf; and (4) reducing stress on the calf. Despite our best efforts at preventing disease, it still occurs even in well-managed herds. Therefore, it is also critical to learn to identify sick calves early in the course of disease and institute proper treatment programs. Working with a veterinarian to develop treatment protocols for common diseases such as diarrhea and pneumonia is important to ensure that sick calves receive appropriate therapy and respond to treatment.

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Geof Smith received a BS in animal and dairy science from Clemson University in 1994, followed by an MS in toxicology in 1996 and a DVM in 1998, both from the University of Illinois. Following graduation, Geof remained at the University of Illinois for another 4 years while he completed an internship and residency in ruminant internal medicine along with a PhD in physiology. Smith joined the faculty at North Carolina State University in 2002 and is currently a professor of ruminant medicine in the Department of Population Health and Pathobiology. He is a Diplomate of the American College of Veterinary Internal Medicine (ACVIM) and his primary clinical and research interests revolve around clinical medicine of ruminants with a specific focus on calf health.

06-33 Economic considerations regarding the rearing of dairy replacement heifers.

Mike Overton*.

One of the largest contributors to the cost of production for commercial dairies is replacement animals, and their costs are influenced by many factors including morbidity and mortality risks, rates of weight gain across the entire rearing period, nutritional management, housing approach, labor efficiencies, and reproductive performance. In the past decade, many heifer-rearing operations have moved from a conventional feeding and management approach that places an emphasis on low-input costs, especially in the young calf, to a more intensive management system that provides more nutrient-dense rations. The intensive approach is more expensive on a per-day basis, but the allure of healthier, well-grown calves with reduced morbidity and mortality has encouraged people to adopt this system. However, many question whether this approach is truly economical. A spreadsheet model was developed to answer this question. Based upon the assumptions used, intensive rearing results in savings of \$4 per heifer calving. When also considering the potential extra marginal milk associated with higher growth rates, the advantage for intensive feeding increases to \$89.

Session A: Tuesday, 1:15 PM, Court G-J

Session B: Wednesday, 10:45 AM, Canterbury



Michael Overton received his DVM from North Carolina State University and practiced veterinary medicine for 8 years in North Carolina. After a move to California to complete a dairy production medicine residency and his masters of preventive veterinary medicine degree, he worked as a dairy production medicine specialist at UC Davis–Veterinary Medicine Teaching and Research Center in Tulare, California, for 6 years. Then, he joined the University of Georgia College of Veterinary Medicine where he served as professor of dairy production medicine and chief of service for the food animal program for about 7 years. In May 2012, Overton left the University of Georgia to assume a dairy analytics position with Elanco Knowledge Solutions. In this role, Overton is responsible for developing economic models and tools for internal and external customers, providing consultative services to dairies and their consultants, and building analytical capabilities for the global Elanco team. Throughout his professional career, Overton has

worked extensively in the areas of reproductive management, transition management, analysis of on-farm records, and economic decision making. He has been active in service to the dairy industry and travels frequently to speak and consult in the U.S. and internationally. He has authored or co-authored over 100 peer-reviewed, proceedings, or industry publications on various topics regarding dairy production medicine. Overton lives in Athens, Georgia, with his wife Carol, who works as a middle school math teacher. They have two children.

06-34 Facility systems for the young dairy calf: Implications for animal welfare and labor management.

Marcia Endres* and Bob James.

Preweaned calves can be housed individually or in groups. Individual calf housing reduces transmission of infectious diseases because of limited physical contact between calves. In addition, individually housed calves are easier to observe, which can result in more effective disease treatment. However, some animal welfare disadvantages of individual calf housing are the lack of social contact among calves and the limitation of movement because of the physical space provided. In addition to this concern, dairy producers are housing calves in groups to facilitate improved labor efficiency and working conditions and to permit successful adoption of higher liquid feeding rates for calves. Three major types of feeding systems can be used in group housing: mob feeders, ad libitum acidified milk feeders, and automated calf feeders. Feeding calves in groups allows calves to express some natural behaviors that cannot be expressed when housed individually but offers some challenges in relation to maintaining good health, another important aspect of good animal welfare. Good health is achievable when group housing preweaned calves as long as appropriate management and maintenance of equipment are emphasized and implemented.

Session A: Tuesday, 2:00 PM, Court G-J

Session B: Wednesday, 11:30 AM, Canterbury



Marcia Endres is a professor in the Department of Animal Science at the University of Minnesota with an extension/research appointment. Her research interests include dairy management, welfare, and behavior. She has studied how various housing and management systems can influence health, welfare, and performance of dairy cattle. In recent years, she has also conducted research and outreach on precision dairy technologies, including automated calf feeders, robotic milking systems, and individual cow behavior. She has published over 280 popular press articles, 90 scientific abstracts, 90 conference proceedings, and 40 peer-reviewed scientific manuscripts. She is a director for PAACO (Professional Animal Auditor Certification Organization) and served on their Dairy Welfare Guidelines Review Committee during her previous term on the board. She represents the University of Minnesota on the National NC-1029 Applied Animal Behavior and Welfare and the NC-2042 Dairy Management committees

and has been a member and chair of the Animal Behavior and Well Being and the Production, Management and Environment Joint Program committees for the American Dairy Science Association Annual Meetings. She is a member of the National Dairy Animal Care Review Panel for the Center for Food Integrity. Endres received her PhD from the University of Minnesota, MSc from Iowa State University, and a veterinary medicine degree from University Federal of Parana, Brazil.

Section 07: Reproduction and Reproductive Management

07-35 The estrous cycle of heifers and lactating dairy cows: Ovarian and hormonal dynamics and estrous cycle abnormalities.

Roberto Sartori*, Milo Wiltbank, and J. R. Pursley.

Use of ultrasonography and development of more accurate hormonal assays have allowed great progress in understanding the physiology of the estrous cycle in cattle, particularly as it relates to ovarian function. As early as 5 d after parturition, ovarian transrectal ultrasonography can be performed, and development and regression of ovarian follicles and corpora lutea (CL) can be assessed. Moreover, knowledge of hormone-based programs for manipulation of the estrous cycle and artificial insemination (AI) has improved substantially during the past 25 yr. This manuscript reviews some of the recent progress on 2 topics. First, the estrous cycle is examined from 3 different perspectives: (1) changes in the ovarian structures, (2) changes in circulating reproductive hormones, and (3) alterations in these dynamics due to high milk production. Second, cows that do not ovulate normally (termed anovular cows in this review) will be discussed from 4 perspectives: (1) return to cyclicity after calving, (2) estrous cycle irregularities after first ovulation, (3) classification of anovulation based on physiology of the anovular cow, and (4) treatments for anovular cows.

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Roberto Sartori received his DVM and MS degrees from School of Veterinary Medicine and Animal Science, São Paulo State University (1992 and 1997, respectively). His PhD degree in dairy science was from University of Wisconsin-Madison (2002) in the area of reproductive physiology of dairy cattle. From 2004 to 2009, Sartori worked as a researcher at Embrapa Genetic Resources and Biotechnology in Brazil. Currently, Sartori is an associate professor at the Department of Animal Science of the University of São Paulo, Piracicaba, SP, Brazil. His main research interests are reproductive efficiency in cattle and the influence of nutrition on reproduction.

07-36 Integration of reproductive programs and technology to maximize fertility.

Paul Fricke*, Julio Giordano, and Paulo Carvalho.

Aggressive reproductive management programs for lactating dairy cows that maximize 21-d pregnancy rates integrate technologies for submission of cows for artificial insemination (AI) and for nonpregnancy diagnosis. Two factors that determine the 21-d pregnancy rate in a dairy herd are the AI service rate and the resulting fertility of inseminated cows. Development of the Ovsynch protocol and timed AI over 20 yr ago provided dairy managers with a tool to dramatically increase the AI service rate and yielded fertility similar to that of cows submitted for AI after a detected estrus. Modifications of the original Ovsynch protocol can now yield high fertility to timed AI in high-producing dairy cows. The key factor affecting fertility to an Ovsynch protocol is the response to each of the 3 sequential hormonal treatments that we have defined using progesterone profiles. Cows with the greatest fertility to timed AI have mid-level progesterone concentrations at the first gonadotropin-releasing hormone (GnRH) treatment, high progesterone concentrations at the prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) treatment, and low progesterone concentrations at the last GnRH treatment of the Ovsynch protocol. Presynchronization strategies that combine GnRH and $PGF_{2\alpha}$ to tightly control ovarian function optimize progesterone concentrations at the first GnRH and $PGF_{2\alpha}$ treatments of the Ovsynch protocol, thereby increasing fertility to timed AI. Cows that initiate an Ovsynch protocol in a low-progesterone environment ovulate to the first GnRH treatment at a high rate but fail to undergo complete luteal regression after $PGF_{2\alpha}$ treatment 7 d later, resulting in low levels of progesterone at the second GnRH treatment that are associated with incomplete luteal regression and decreased fertility to timed AI. Addition of a second $PGF_{2\alpha}$ treatment 24 h after the first within an Ovsynch protocol decreases progesterone concentrations at the last GnRH treatment, thereby increasing fertility, particularly for cows that initiate Ovsynch in a low-progesterone environment. Early identification of nonpregnant cows after AI, coupled with a strategy to resynchronize nonpregnant cows for second and greater timed AI, further increases the 21-d pregnancy rate by decreasing the interval between AI services, thereby increasing the AI service rate. Aggressive reproductive management strategies that incorporate these concepts can now yield AI service rates, fertility, and 21-d pregnancy rates that are unprecedented for high-producing Holstein dairy herds.

Session A: Monday, 12:00 PM, Canterbury

Session B: Tuesday, 4:00 PM, Court G-J



Paul Fricke completed a BS in animal science (1988) at the University of Nebraska and went on to complete an MS (1992) and a PhD (1996) in reproductive physiology at North Dakota State University. Paul worked as a postdoctoral research associate in the Department of Dairy Science at the University of Wisconsin-Madison from 1995 to 1998 and then joined the faculty on July 1, 1998. Fricke was promoted to associate professor with tenure in 2004 and to full professor in 2009. His current position includes 70% extension and 30% research appointments in dairy cattle reproduction.

07-37 Reproductive management of seasonally calving herds.

Scott McDougall*.

Seasonal or block calving systems involve calving cows in 1 or 2 defined periods in a year. These calving patterns align the cow's nutrient requirements with availability of pasture, to maximize production at periods of maximum pasture quality and quantity. Pasture-based systems may be relatively low cost as pasture is harvested in situ, reducing the requirement for machinery and housing. However, to optimize pasture quality, individual cow intakes are generally less than maximal and therefore milk yield is constrained. Seasonal-calving systems require a high level of reproductive performance to maintain a 365-d inter-calving interval. Factors associated with reproductive performance in seasonal calving herds include heifer rearing, calving distribution, body condition score (BCS) and nutrition, incidence of disease, management of noncycling cows, estrus detection efficiency, and artificial insemination (AI) and natural breeding management. The management cycle approach to optimizing performance involves setting targets and intervention points, assessment of current performance, identification of areas for improvement, assessment of potential intervention options, implementation of selected interventions and monitoring of outcomes. Key performance indicators (KPI) used in seasonal-calving systems differ from those of a year-round calving system and include the proportion of cows pregnant in the first 6 wk of the breeding program and final not in-calf rate. Secondary indicators include submission rate and conception rate. The management cycle approach has been demonstrated to improve fertility in seasonal-calving herds. Although herds vary in which risk factors contribute to poor performance, common risk areas include poor growth of replacement heifers, suboptimal BCS, high prevalence of anestrous cows, and poor conception rates. Specific cow-level interventions such as diagnosis and treatment of uterine disease and diagnosis and treatment of anestrus have been proven via controlled randomized studies to result in improvements in 6-wk in-calf rate. Future challenges include maintaining estrus detection efficiency with increasing farm size and fewer trained staff, managing fertility with increased societal focus on antimicrobial and hormonal use, and improving decision making with increasing availability of data including outputs from accelerometers (pedometers), in-line milk yield monitoring, and walk over weighing systems.

Session A: Monday, 1:45 PM, Canterbury

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Scott McDougall is a veterinarian with postgraduate training in production medicine and with a PhD from Massey University and Dairying Research Corporation Ruakura (now DairyNZ). He is a registered specialist in bovine reproduction and holds an adjunct associate professorship in the Institute of Veterinary, Animal and Biomedical Sciences at Massey University. Scott currently leads a research group at Cognosco, AnexaFVC, which undertakes applied research and extension work in reproduction, mastitis, and antibiotic usage. Scott is also involved in undergraduate and postgraduate teaching in New Zealand and internationally as well as policy work for the dairy industry.

07-38 Understanding and managing postpartum uterine disease.

Stephen LeBlanc*, Rodrigo Bicalho, and Vinicius Machado.

Metritis, purulent vaginal discharge, and endometritis are infectious and inflammatory disease of the reproductive tract that impair well-being and reproductive performance. One-third of cows are affected by one or more of these conditions in the month after calving. Essentially all cows have bacterial contamination of the uterus after calving, but cows in worse metabolic health, with worse immune function, or with poorly regulated inflammation are at risk of disease. Pathological inflammation is characterized by early bacterial infection with pathogenic strains of *Escherichia coli*, followed by infection with anaerobic bacteria, and later, *Trueperella pyogenes*. Each of these bacteria have virulence factors that contribute to uterine disease. Metritis is characterized by fetid discharge, fever, and systemic illness. There are approved treatments for metritis but more research is needed to refine criteria and methods of diagnosis to target therapy to cows that will benefit from intervention. Purulent vaginal discharge (PVD) and endometritis (chronic uterine inflammation based on cytology) after 4 wk postpartum each affect 15 to 20% of cows and are consistently associated with reduced reproductive performance. There is an effective treatment for PVD (not presently approved in the United States) but inconsistent data on therapy for endometritis. Presently, prevention of reproductive disease relies on nonspecific good hygiene at calving and good management in the transition period. Future developments of vaccines and genetic selection tools will likely help to reduce the incidence of these diseases.

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Session B: Wednesday, 8:00 AM, Court G-J



Stephen LeBlanc is a professor in the department of Population Medicine at the Ontario Veterinary College, and research program director of Animal Production Systems at the University of Guelph, Canada. He received a BSc(Agr) in animal science from McGill University in 1992, and a DVM (1997) and DVSc (2001) from the University of Guelph. After five years of private dairy veterinary practice, he joined the faculty at the University of Guelph, where he teaches veterinary and agriculture students and provides clinical farm service. His research focuses on transition dairy cow metabolic and reproductive health and management. With graduate students and collaborators, this work has resulted in over 90 peer-reviewed papers.

07-39 Monitoring and quantifying value of change in reproductive performance.

Mike Overton* and Victor Cabrera.

Reproductive performance significantly affects dairy herd profitability in a variety of ways. When cows fail to become pregnant in a timely manner, herd-level milk production decreases; cows spend a greater proportion of lactation in a less productive portion of the lactation curve, fewer calves are produced, opportunities for selective culling diminish, and the rate of genetic progress is reduced. Often, the cost per pregnancy rises because of the inefficiencies. Accurate and reliable on-farm records coupled with the timely and appropriate interpretation of these data can help guide producers, veterinarians, and consultants in making better management decisions regarding reproductive management and to detect changes in performance sooner rather than later. Careful review and evaluation of accurate records including the 21-d pregnancy rate (or risk) can help to answer questions such as (1) how has the dairy performed historically? (2) Where is the dairy currently in terms of performance? (3) What opportunities exist to improve reproductive performance? (4) Where is the herd heading in the future regarding reproductive performance? Inappropriate metrics can delay the identification of changes in performance or otherwise mislead management. Focusing on the efficient delivery of first service, the timely and accurate evaluation of pregnancy outcomes, and efficiently reinseminating nonpregnant cows generally leads to improved reproductive performance. The economic value of reproductive change can be measured as the profit difference between 2 reproductive management strategies but it is critical to include costs and benefits of all reproductive events and their performance. Recent research suggests that simulation modeling is the state-of-the-art approach to assess the value of reproductive management. The correct and optimal reproductive management approach is both herd- and cow-specific and therefore, any economic evaluation should be performed using accurate farm-level inputs, current program parameters, and expected market-specific parameters. Adjustable and adaptable decision support tools are critical for evaluating the potential economic impact of changes in reproductive management.

Session A: Monday, 3:45 PM, Canterbury

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Michael Overton received his DVM from North Carolina State University and practiced veterinary medicine for 8 years in North Carolina. After a move to California to complete a dairy production medicine residency and his masters of preventive veterinary medicine degree, he worked as a dairy production medicine specialist at UC Davis–Veterinary Medicine Teaching and Research Center in Tulare, California, for 6 years. Then, he joined the University of Georgia College of Veterinary Medicine where he served as professor of dairy production medicine and chief of service for the food animal program. In May 2012, Overton left the University of Georgia to assume a dairy analytics position with Elanco Knowledge Solutions. In this role, Overton is responsible for developing economic models and tools for internal and external customers, providing consultative services to dairies and their consultants, and building analytical capabilities for the global Elanco team. Throughout his professional career, Overton has worked

extensively in the areas of reproductive management, transition management, analysis of on-farm records, and economic decision making. Overton lives in Athens, Georgia, with his wife Carol, who works as a middle school math teacher. They have two children.

07-40 The male component of dairy herd fertility.

Joe Dalton*, Mel DeJarnette, R. G. Saacke, and R. P. Amann.

The objective of this chapter is to elucidate the role of the artificial insemination (AI) center and dairy producer regarding the male component of herd fertility. Topics include (1) semen quality, (2) semen quality control and quality assurance, (3) basis for numbers of sperm per AI dose, (4) estimates of AI sire fertility, (5) effect of genomics, and (6) farm management of semen. Through stringent collection, processing, and quality control procedures, commercial AI centers provide AI straws containing sufficient numbers of quality sperm to maximize fertility in most herds. Quality control addresses bull fertility as affected by compensable semen deficiencies, which can often be overcome by increasing sperm number per straw to a threshold level, and uncompensable deficiencies, which depress fertility independent of sperm dosage and can only be removed by culling. Sire fertility is expressed as an estimated deviation from an overall average for the sampled population. An underappreciated factor affecting sire fertility evaluations is binomial variation. The confidence interval around each deviation allows for a meaningful interpretation of the precision of the sire fertility estimate. Importantly, as number of services increase, the effect of binomial variation decreases, and the confidence interval narrows. Approximately 12% of AI sires have fertility deviations greater than 3% of population average. Thus, the majority (~88%) of AI sires have comparable fertility potential, providing evidence of the success of the quality control programs. After purchase, the maintenance of semen quality and fertility potential is in the hands of the producer, farm employees, and AI technicians. To optimize on-farm conception rates, appropriate care of the liquid nitrogen storage tank coupled with (1) accurate timing of insemination as associated with identification of estrus or appropriate treatment of animals for synchronization, (2) appropriate thawing of semen, (3) appropriate hygienic procedures and thermal protection of straws during AI gun assembly and transport, (4) deposition of semen in the uterus within 15 min after thawing, is critical. Natural service sires remain popular on some dairies, despite the risks of disease transmission, unknown genetic merit, and questionable fertility. Bulls in AI centers, in contrast, are under continual disease surveillance by veterinarians, and every semen collection is scrutinized for quality before sale.

Session A: Monday, 4:30 PM, Canterbury

Session B: Wednesday, 9:30 AM, Court G-J



Joseph C. Dalton is a professor and extension dairy specialist in animal and veterinary science at the University of Idaho. He received a PhD in animal science (reproductive physiology) from Virginia Tech, MS degree from Utah State University, and BS degree from Cal Poly, San Luis Obispo. Dalton's research in applied male and female reproductive physiology focuses on factors important to increasing the efficiency of artificial insemination (AI) in cattle. His extension program emphasizes the enhancement of reproductive efficiency in cattle. Dalton serves as the past president of the Dairy Cattle Reproduction Council.

07-41 Physiological approaches to improving fertility during heat stress.

Peter Hansen*.

Heat stress is a major limitation to optimal reproductive function of the lactating cow and, to a much lesser extent, the nonlactating heifer. Exposure to heat stress can reduce estrous behavior, alter follicular development, damage the oocyte and early embryo, lower pregnancy rates, and compromise fetal development. Cooling cows is an important tool in preventing effects of heat stress but by itself does not usually prevent summer infertility in warm areas of the world. Additional approaches to reduce effects of heat stress involve manipulating the physiology of the cow to bypass or reverse the effects of heat stress on reproductive physiology. Timed AI can bypass consequences of reduced estrous behavior during heat stress but does not increase pregnancy per AI. The only proven method to prevent reduced fertility caused by heat stress is embryo transfer. In this procedure, the embryo is placed in the uterus at a stage in development at which the embryo has acquired resistance to elevated temperature. Other possible approaches to improving pregnancy/AI during heat stress include provision of antioxidants, treatment with melatonin, and hormonal treatments that increase circulating concentrations of progesterone after insemination. A long-term solution that is only now being examined is to produce dairy cattle that have genetic potential to both produce large amounts of milk and have superior ability to regulate body temperature during heat stress.

Session A: Tuesday, 8:00 AM, Canterbury**Session B: Wednesday, 10:45 AM, Court G-J**



Peter J. Hansen is a Distinguished Professor and L. E. "Red" Larson Professor of Animal Sciences in the Department of Animal Sciences at the University of Florida. His research interests center around the basic mechanisms controlling the establishment and maintenance of pregnancy and development of methods to improve fertility. Particular emphasis is placed on elucidating effects of elevated temperature on early embryonic development, identifying genes controlling embryonic survival, and characterizing interactions between the immune system, the reproductive tract, and the embryo. Another focus is on development of methods to increase profitable uses of embryo transfer.

07-42 Impact of environmental, nutritional, and management factors during late gestation on future performance of the cow and her calf.

Geoffrey E. Dahl*.

The importance of dry-cow nutritional, health, and housing management is becoming increasingly evident. The focus of this chapter is on examples of management interventions, particularly those related to heat stress abatement, that result in significant improvements in cow and calf performance following parturition. Heat stress during the dry period programs the mature cow to produce less milk in the subsequent lactation and reduces immune status in the transition period. In addition, in utero heat stress in late gestation produces a smaller calf with greater immune challenges that ultimately cannot achieve its full genetic potential at maturity. These negative outcomes reduce the efficiency of production and economic returns to the producer.

Session A: Tuesday, 8:45 AM, Canterbury

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Geoffrey E. Dahl is professor and chair in the Department of Animal Sciences at the University of Florida, Gainesville. He grew up on a dairy farm in Massachusetts and received his BS in animal science (with a minor in food and resource economics) from the University of Massachusetts in 1985. Dahl completed his MS in dairy science at Virginia Tech in 1987, and earned his PhD in Animal Science from Michigan State University in 1991. He then spent 3 years as a postdoctoral fellow in the Reproductive Sciences Program at the University of Michigan, before joining the faculty at the University of Maryland in 1994. At Maryland, he served as associate professor and undergraduate program coordinator in the Department of Animal and Avian Sciences. Before his current appointment, Dahl served as professor and extension dairy specialist in the Department of Animal Sciences at the University of Illinois, Urbana-Champaign (2000–2006). Dahl has authored more than 95 peer-reviewed papers and numerous

symposium and popular press articles. He has trained 22 graduate students and postdoctoral fellows. Dahl received the Agway Inc. Young Scientist Award (1999), the Merial Dairy Management Research Award (2004), the Pfizer Animal Health Physiology Award (2008), and the West-Agro Award (2014) from ADSA.

Section 08: Nutrition and Nutritional Management

08-43 Drinking water for dairy cattle.

Paul Kononoff*, Daniel Snow, and David Christensen.

Water is considered second only to oxygen as the most important element necessary for life. Consequently, it is generally recommended that clean drinking water be accessible and available to all animals throughout the day. In general, good quality drinking water is clear and colorless, has low total solids, and does not contain pesticides or disease-causing organisms. Furthermore, this water should not have an undesirable flavor or odor nor contain any objectionable gases. Dairy cattle fed in confinement are usually offered ground water to drink. The quality of this water depends upon on the residence time in the ground and the nature of the soil or geological deposit where it is stored or has passed through. Minerals in water may contribute to the requirements for some minerals but, in most cases, this supply is minimal. Most reports on water analysis provide data that focus on the total concentration of a mineral in a given water sample and usually do not report data related to speciation; however, the form(s) of some elements can greatly influence their bioavailability and toxicity. Sulfur, sodium, iron, magnesium, selenium, and fluoride are among the minerals most likely to reach toxic concentrations in drinking water. Minerals such as copper zinc, bromine, bismuth, and some rare earth minerals may be added to feed and water, resulting in a potential for toxicity. Very few surface water supplies contain a toxic level of minerals. Perhaps one exception is nitrate, which is often the result of specific point of pollution. The nature and effects of saline waters can vary greatly depending on the specific salts they contain. Sulfate may be one of the most common undesirable components of drinking water. Drinking water offered to dairy cattle may also contain waterborne pathogens. Unfortunately, identifying the specific pathogens may be challenging because any virus, algae, bacterium, fungi, or protozoa could be present. Surface waters may also contain cyanobacteria (blue-green algae) capable of producing deadly toxins. To date, a great deal of research has been conducted on the use of water for dairy production, and the effect of this production on the quality of ground and surface waters has also been well studied. Surprisingly, there is substantially less research that has sought to understand the effect of water quality in cattle.

Session A: Monday, 8:30 AM, Court F

Session B: Tuesday, 1:15 PM, Court F



Paul Kononoff is a native of Saskatoon, Saskatchewan, Canada. Paul holds BSA and MSc degrees in animal science from the University of Saskatchewan and a PhD in dairy nutrition from The Pennsylvania State University (University Park, PA). Paul is currently an associate professor of dairy nutrition and dairy nutrition extension specialist at the University of Nebraska Lincoln. Paul's research to date has focused on feed characterization and understanding the relationships between forage quality and ruminal fermentation in lactating dairy cattle. More recently, Paul has investigated ration formulation methods that seek to maximize the inclusion of corn milling co products while sustaining normal milk production. Paul currently serves as section editor for the *Journal of Dairy Science* and is on the Committee on *Nutrient Requirements of Dairy Cattle*, 8th edition. He is a co-inventor of the Penn State Forage and TMR Particle Size Separator.

08-44 Protein and amino acid nutrition.

Geoffrey Zanton*.

Dairy cattle protein and amino acid nutrition are important factors in the economic and environmental management of the farm. The essential requirements for the dairy cow are for amino acids, which are provided by both the digestion of microbial protein produced in the rumen and feed protein sources escaping the rumen. Because of the microbial population in the rumen, the ruminant is capable of extracting energy from structural carbohydrates and transforming poor quality protein or nonprotein nitrogen sources into high quality microbial protein. However, because the rumen microbes have the first opportunity to digest the true dietary protein, this complicates our ability to understand the amino acid supply and requirement to the cow for her metabolic purposes. Protein nutrition of the rumen and the cow are intricately linked to carbohydrate nutrition, and jointly optimizing carbohydrate and protein nutrition can improve the efficiency of capturing feed nitrogen into milk protein. Optimizing the flow of microbial protein and rumen undegradable protein and the amino acid composition of these protein sources can increase the economic and nitrogen efficiency of the farm. Achieving this optimization in practice is complicated, and realizing these benefits requires a commitment to the use of nutritional models and amino acid balancing.

Session A: Monday, 9:15 AM, Court F

Session B: Tuesday, 2:00 PM, Court F



Geoffrey Zanton was raised on a dairy farm in southern Wisconsin and earned a BS degree in animal science from the University of Wisconsin–Madison. He received his PhD in dairy and animal science, with a minor in statistics, from the Pennsylvania State University. He has worked in the feed industry managing ruminant research and development in amino acid and trace mineral nutrition. He is a research animal scientist with the US Dairy Forage Research Center (USDA-ARS) based in Madison, Wisconsin, where his research focus is on increasing the nutritional efficiency of amino acids and protein utilization in dairy cattle.

08-45 Carbohydrate nutrition.

David Casper*.

Carbohydrates represent 60 to 70% or more of the ration fed to dairy cattle. These carbohydrate fractions can include neutral detergent fiber (NDF), acid detergent fiber (ADF), lignin, hemicellulose, cellulose, nonfiber carbohydrates (NFC), starch, sugars, and even volatile fatty acids (VFA) from ensiled feeds. The ruminal and total-tract digestibility of these carbohydrate fractions can range from very low to essentially 100%, which has a huge effect on the nutrient availability to the animal for the major metabolic functions of maintenance, growth, milk production, and reproduction. Not only are they a major source of energy to the cow, but carbohydrates also provide the precursors for 3 important milk components: lactose, fat, and protein. Carbohydrate nutrition has been a very active area of research and development for improvements in feeding dairy cattle in recent years. Considerable interest and knowledge has been developed and applied in the areas of NDF concentrations, structure, and digestibility, starch structure and digestibility, and sugars. Improving the nutrient supply, digestibility, and absorption provides the dairy producer the opportunity to enhance production and performance while lowering costs to improve economic viability and sustainability, as well as compete in the world market. The objectives of this chapter are to describe the major types of carbohydrates, indicate their importance for milk synthesis and provide some practical recommendations for feeding dairy cattle.

Session A: Monday, 10:30 AM, Court F

Session B: Tuesday, 2:45 PM, Court F



David P. Casper is an assistant professor at South Dakota State University and he has extensive research and industry experience. He grew up on a dairy farm in Wisconsin, and obtained a bachelor's degree from the University of Wisconsin-Platteville. Both his MS and PhD degrees are from South Dakota State University. He was actively involved in research at the USDA Agricultural Research Service, Cargill, and Agri-King before joining South Dakota State. Major impacts of his research are in the areas of forage digestibility, feed additives to improve forage utilization, and feed efficiency. Dave Casper is active in ADSA, the American Society of Animal Science, American Registry of Professional Animal Scientists, European Association of Animal Production, and Agricultural Institute of Canada. He has served as Midwest ADSA president and overall program chair of the Joint Annual ADSA-ASAS Meeting (2011). He has published more than 35 refereed journal articles, 60 abstracts, and numerous popular press articles. He

was awarded ADSA's Richard M. Hoyt Award for his practical applications of research in the dairy industry.

08-46 Lipid and fat nutrition.

Kevin Harvatine*.

Fat supplementation increases the energy density of the diet without increasing diet fermentability or decreasing forage fiber. However, unsaturated fatty acids (FA) can have a negative effect on ruminal fermentation, which may lead to decreased fiber digestion and milk fat depression. Almost all dietary ingredients contribute some fat to the diet, and ingredients with a low fat concentration that are fed at high rates are commonly overlooked but contribute greatly to fat intake. Oilseeds, liquid fats, and rumen-inert fats rapidly increase dietary fat and differ in their fatty acid profile, rumen activity, and effect on the cow. More recently, high-fat byproducts such as distillers grains and the development of varieties selected for a specific FA profile have provided opportunities and challenges. Unsaturated FA are biohydrogenated in the rumen, resulting in absorption of predominantly *trans* intermediates and saturated FA. The cow efficiently absorbs these FA with the assistance of lysolecithin, a potent emulsifier. After absorption, lipids are used for energy, milk fat synthesis, body weight gain, and as a substrate for membrane and signaling factor synthesis. Linoleic and linolenic acid are essential FA as the body cannot synthesize them, but determining requirements for lipids is complicated due to rumen biohydrogenation and the diverse roles of lipids. Fatty acids are also well known as bioactive nutrients that modify metabolism and physiology. Milk fat depression commonly occurs when feeding highly fermentable and high unsaturated FA diets and is one example of a potent bioactive FA made in the rumen that has major effect on physiology. Many risk factors interact, making prediction and management of milk fat depression difficult. When selecting diet ingredients and balancing FA, it is important to consider the effect on the rumen, intake, and digestibility. Fat supplements are also sometimes fed to improve milk and milk fat yield, reduce heat stress, and increase reproduction and immune function. Inexpensive rumen-available fat sources should be utilized first. Rumen-inert fats should then be selected based on the goals for feeding the supplement, and cow response should be monitored over the short and long term.

Session A: Monday, 11:15 AM, Court F

Session B: Tuesday, 4:00 PM, Court F



Kevin Harvatine is an associate professor of nutritional physiology in the Department of Animal Science at Penn State University. His research includes dairy nutrition and lactation research and he teaches a junior level course on the principles of animal nutrition. He was raised on his family's dairy farm in Pennsylvania and received his undergraduate degree from Penn State. His master's work was completed under the supervision of Mike Allen at Michigan State University and his PhD and postdoctoral work were completed at Cornell University under the supervision of Dale Bauman and Yves Boisclair. Kevin's field of expertise is nutritional regulation of lactation. His lab conducts experiments that range from applied dairy nutrition to mechanistic molecular biology experiments.

08-47 Minerals.

Jesse Goff*

Minerals are minor constituents of most diets but their absence can have major implications on the health and productivity of animals. A description of the physiologic function of each mineral is discussed, as well as symptoms that might be seen during deficiency or toxicity. The National Research Council (2001) developed a model that took a factorial approach to determining requirements for each mineral for each of the various stages of the cow's life. Since 2001, newer studies suggest that some improvements to that model could be made. Minerals can interact with each other to affect acid-base balance, which can affect cow performance. Minerals, especially those that are classified as transition elements (copper, iron, zinc, manganese), can function as antioxidants and, when overfed, they can act as pro-oxidants and damage various tissues. In many cases, ruminants absorb minerals less efficiently than do monogastric species. Factors that are commonly thought to interfere with mineral absorption are examined. This will allow the nutritionist to make informed decisions about mineral sources that may circumvent some of these factors to ensure mineral requirements of the cow are met.

Session A: Monday, 12:00 PM, Court F

Session B: Tuesday, 4:45 PM, Court F



Jesse Goff, DVM, PhD, is a professor of biomedical sciences in the College of Veterinary Medicine, Iowa State University. He holds a 70% research, 25% teaching, 5% extension service appointment and teaches first-year students clinical veterinary nutrition, focused on general aspects and the dog, cat, and horse. He teaches digestive physiology to veterinary students, helps team-teach dairy nutrition and production medicine to fourth-year veterinary students, and teaches portions of the graduate physiology courses. Goff's research has focused on the metabolic diseases that occur in the transition dairy cow. His group has have focused on the role of hypocalcemia on immune function and predisposition to other metabolic disease. He also has some interest and experience with mastitis and metritis research in cows, again focused mostly on immunology of the cow. Goff's work has helped demonstrate that metabolic alkalosis is the major cause of milk fever in cows and he has developed practical methods to acidify cows utilizing anion supplements. Goff's

research has demonstrated that cows developing retained placenta and metritis are immune-suppressed more than normal herdmates before development of these diseases.

08-48 Vitamins.

Gonzalo Ferreira* and Bill Weiss.

Vitamins are organic compounds required by animals and are involved in all facets of metabolism, physiology, and health. Historically, vitamin requirements were set at the level needed to prevent clinical deficiency signs. Despite this, supplementation strategies for vitamins need to be based on broader measures of cow health, and supplementation rates should be modified (increased or decreased) based on factors that are known to influence vitamin status and the likelihood of a response. Vitamins A, D, E, and K comprise the fat-soluble vitamins. Vitamins A and E (or their provitamin forms) must be consumed or injected. β -Carotene and other carotenoids were long considered only as compounds that could be converted to vitamin A within the cow; however, they likely have functions independent of their provitamin A role and will be discussed in this section. Vitamin D can be synthesized from cholesterol when cows are exposed to direct sunlight; however, because of management systems and geography, sun exposure is rarely adequate for cows to synthesize enough vitamin D. Ruminal bacteria can synthesize Vitamin K, so its deficiency is rarely an issue in dairy cows. The group of B-vitamins, vitamin C (which is not required by cows because they can synthesize it), and choline comprise the water-soluble vitamins. Clinical deficiencies are unlikely in functional ruminants, as B-vitamins are synthesized in the gastrointestinal tract. On the contrary, vitamin degradation can also occur within the gastrointestinal tract, therefore limiting vitamin availability for absorption. Overall, several studies showed that supplementation of certain B-vitamins can enhance animal production, animal health, or both. Biotin, choline, and niacin are the only water-soluble vitamins commonly supplemented to dairy cows.

Session A: Monday, 1:45 PM, Court F

Session B: Wednesday, 8:00 AM, Court F



Gonzalo Ferreira obtained his BS in agricultural production from Universidad Católica Argentina (1998), his MS in dairy nutrition from University of Wisconsin–Madison (2002), and his PhD in dairy nutrition from The Ohio State University (2006). After graduation, from 2006 to 2008, Ferreira worked as technical manager for ruminants at DSM Nutritional Products Argentina. From 2008 to 2013, he worked as a dairy consultant in Argentina. Currently, Ferreira is an assistant professor in dairy management at Virginia Tech. His research is focused in forage quality and management, and vitamin nutrition and metabolism.

08-49 Transition cow nutrition.

Heather Dann*.

Feeding and management practices for transition cows can have a substantial impact on a cow's productivity and health and ultimately affect a herd's profitability. Those transition cow practices have been focus areas of dairy research for more than 30 years. Despite the abundance of research and its application on-farm, transition cows remain an opportunity area on many farms. The best-formulated diets cannot overcome suboptimal management practices. Therefore, attention should be given to implementing management practices that allow access to good quality feed while minimizing social and environmental stressors and promoting cow comfort. The nutritional strategy used on-farm will be determined in part by grouping strategy that is dictated often by facility design and by management ability. When feeding transition cows, emphasis should not only be on optimizing milk production, but also on managing body condition score, improving immune function, and restoring fertility. Therefore, an integrated nutritional approach that addresses energy metabolism, protein metabolism, mineral metabolism, rumen function, and immune function is needed. In general, nutritional strategies that control energy intake while meeting the requirements of other nutrients during the dry period and promote a rapid increase in dry matter intake after calving will be beneficial. In addition, avoiding excessive body condition or protein mobilization during either the dry or fresh periods can help reduce the risk of metabolic problems and immune dysfunction. Health problems during the transition period result in less milk production, delayed reproduction, and represent an economic loss to the farm.

Session A: Monday, 2:30 PM, Court F

Session B: Wednesday, 8:45 AM, Court F



Heather M. Dann grew up on a dairy farm in New York, where she developed a passion for dairy and an appreciation for research. She received a BS degree from Cornell University, an MS degree from the Pennsylvania State University, and a PhD degree from the University of Illinois. Currently, she is a research scientist at the William H. Miner Agricultural Research Institute in Chazy, New York. Her research focuses on dairy cow nutrition and management with an emphasis on transition cows.

08-50 Variability in feed sampling and analyses.

Normand St. Pierre* and Bill Weiss.

Variation in the nutritional content of feed ingredients is receiving increased attention because of its possible effects on animal performance and profitability. Apparent variation comes from many sources, some of which represent true compositional variance, whereas others are caused by the observer, such as laboratory, sampling, and assay variances. In this chapter, we first explain and quantify the predominant components of variance for some of the major nutrients across the main feedstuffs used in North America. We then review the economics of variation and how a sampling schedule that minimizes total quality costs can be identified. We also present summaries of recent research that attempt to quantify the effect of nutritional variation on dairy cow performance. The chapter closes with our recommendations on how nutritional variation can best be managed in dairy operations.

Session A: Monday, 3:45 PM, Court F

Session B: Wednesday, 10:00 AM, Court F



Normand St-Pierre is professor emeritus of animal sciences at The Ohio State University. He grew up in Québec, Canada, where he received his BS degree in animal science and MS degree in animal nutrition. He received his PhD degree in dairy science in 1985 from The Ohio State University and became a Buckeye at heart for the rest of his life. Following graduation, he spent a year in New Zealand as a postdoctoral fellow, working on various issues of farm production economics and stochastic systems analysis. After working for 10 years in the private sector, he joined the Department of Animal Sciences at The Ohio State University in 1997, where he conducted research and extension programs in the areas of dairy farm management, nutrition, and biometrics. He also taught 3 courses in nutrition and dairy management to undergraduate students and 1 graduate course in biometry at Ohio State. St-Pierre has published over 400 articles in various publications, including *Journal of Dairy Science*, *Hoard's*

Dairyman, and *Progressive Dairyman*, and has received numerous awards for his research and extension work. When not around cows, he can be found riding or fixing one of his 12 bicycles or sailing his sailboat *Branch Office* anywhere with plenty of water and as few people as possible.

08-51 Forage harvesting, storage, and feeding.

Limin Kung Jr. and Richard Muck*.

Forages usually represent more than 50% of the total dry matter consumed daily by lactating dairy cows. Ensiling forages provides the opportunity for long-term storage of feed but presents many challenges that can reduce the feeding value of the originally harvested crop. This chapter will discuss ways to optimize conditions in the silo to maximize the recovery of dry matter and nutritive value during ensiling. Forages should be harvested at an optimal stage of maturity to achieve the best compromise between nutritive value and total yield of dry matter. Fast wilting is desirable for crops requiring a reduction in moisture before ensiling because it reduces the chance for exposure to rain and minimizes oxidation of fermentable sugars used for fermentation. The dry matter content at ensiling can have major effects on the ensuing fermentation. Excessive moisture can increase the chances of a clostridial fermentation, whereas lack of adequate moisture slows and curtails the ensiling process. Optimum forage particle length is needed to ensure good silo packing, reduce potential sorting in total mixed rations, and provide effective fiber to the dairy cow. For corn silage, optimal kernel processing is needed to ensure adequate surface area digestion. Filling silos quickly, packing tightly to remove excessive air trap in the forage mass, covering and sealing silos, and using appropriate additives can assist in preventing undesirable fermentations and aerobic spoilage. Ensiled corn crops should be stored for several months before feeding to take advantage of natural proteolytic processes that increase starch digestibility. Removal of silage from silos during feed-out should also be optimized to minimize exposure of silage to air, which initiates the spoilage process.

Session A: Monday, 4:30 PM, Court F

Session B: Wednesday, 10:45 AM, Court F



Richard Muck received his PhD from Cornell University in agricultural waste management and immediately started as a research agricultural engineer for the USDA Agricultural Research Service in Ithaca, studying nitrogen transformations and losses in dairy cattle waste management systems. In 1983, he was transferred to the US Dairy Forage Research Center, Madison, Wisconsin, and his research shifted to the front end of the cow until his retirement in 2014. His research has spanned a range of silage issues: documenting silo losses, improving silage density, comparing silo covers, enhancing protein preservation during ensiling, and studying the effects of silage additives.

08-52 Utilization of by-product and co-product feeds.

Barry Bradford* and Gail Carpenter.

Many food, fuel, and fiber industries produce large quantities of nutrient-rich by-products and co-products that are nevertheless unsuitable for consumption by humans. Furthermore, the ability of ruminants to digest fiber and detoxify some antinutritional factors make them particularly good at utilizing these feedstuffs that might otherwise go to waste. A very wide variety of by-products and co-products have been fed to dairy cattle, and they can provide valuable nutrients of every nutrient class. Formulating with these ingredients requires careful consideration of particle size, ruminal and intestinal digestibility, product stability, handling characteristics, and potential toxicities. Furthermore, comparative pricing or valuation of these feedstuffs should, as much as possible, account for the breadth of nutrients provided and any additional costs incurred with the use and handling of the product. Despite the complexity of incorporating by-products and co-products in dairy rations in novel ways, the potential benefits for the sustainability of the food system and the profitability of dairies make it a worthwhile effort.

Session A: Tuesday, 8:00 AM, Court F

Session B: Wednesday, 11:30 AM, Court F



Barry Bradford grew up on a seedstock beef operation in Iowa and received dual BS degrees in animal science and agricultural biochemistry at Iowa State University. He then completed his PhD in animal nutrition at Michigan State University. In 2006, he joined the faculty Kansas State University as an assistant professor, and was promoted to associate professor in 2011. Bradford oversees an active research program focused on novel approaches to formulation of dairy cattle rations, interactions of inflammation and metabolism, and transition cow physiology. He has given more than 60 invited presentations on these topics around the world. In addition, he teaches over 170 students per year in several undergraduate and graduate courses in animal nutrition and physiology. Through his research and education efforts, Bradford seeks to improve the sustainability of animal-derived foods by improving the health and productivity of dairy cattle.

08-53 Total mixed rations and feed delivery systems.

Tom Oelberg* and Bill Stone.

A total mixed ration (TMR) is a combination of all of the feed ingredients that make up the diet and supply all of the nutrition for dairy cattle. The ingredients are blended together in a homogeneous mixture with a TMR mixer. TMRs are formulated to contain a combination of feedstuffs that provide the right balance of nutrients in every bite taken by the animal. The goal is to make sure the TMR is consistent within a group or pen so that nutrition is the same for every bite for every animal every day. Poorly mixed TMR negatively affect animal performance and health. There are many factors in the TMR mixing and loading process that can create variation in the TMR. Facing silage from bunkers and piles, and then lifting and pushing the faced silage into a pile makes the silage more consistent in moisture and nutrients and is a key to making consistent TMR. Mixing feedstuffs into a uniform TMR requires a lifting and dropping action created by augers, reels, paddles, or a combination of these elements in mixers. TMR consistency or mix quality can be determined by performing Penn State Particle Separator analysis on 10 equally spaced samples taken from freshly delivered TMR along the feed bunk. Time-lapse cameras can be placed above feed bunks to monitor feed access continuously for 24 h a day and for up to 1 to 2 weeks. Video captured from these cameras can be used to properly train employees how to deliver and to push up TMR so that all animals have constant access to feed 24 h per day.

Session A: Tuesday, 8:45 AM, Court F

Session B: Wednesday, 8:45 AM, Kensington



Tom Oelberg has worked in the Upper Midwest dairy industry for 32 years in several roles. He has BS and MS degrees from South Dakota State University and a PhD from The Ohio State University. He spent 10 years as manager of animal research for a regional feed company. He led research efforts in the development of many animal nutrition products for dairy, beef, swine and poultry that affected US and overseas operations for the feed company. Oelberg spent 13 years with Monsanto Dairy Business, leveraging his expertise in cow cooling, stall comfort, feed bunk, and silage management. For the past 8 years, he has been working with Diamond V. In 2008, Tom introduced the TMR audit on large dairies in the United States. Since then, he has conducted many training sessions, written many articles, and given presentations on TMR audits at numerous nutrition conferences. Recently, he co-authored a chapter on TMR audits in the 2014 *Veterinary Clinics of North America Food Animal Practice*. Tom will share the key learnings obtained

from the TMR Audits and from time-lapse photography of feed bunks. Tom lives in New Ulm, Minnesota, with his wife Kristy and daughter Sydney. His son, Wyatt, is a freshman in medical engineering at University Minnesota, Twin Cities.

08-54 Nutritional diagnostic troubleshooting.

Bill Stone* and Sam Mosley.

Many common dairy diseases linked to nutrition can be prevented, and production can be enhanced, by implementing some basic management standard operating protocols (SOP). Dairies should have SOPs in place that provide them with accurate analyses of all stored forage available to the dairy, employees trained on the proper way to collect forages for sampling and for preparing loads of feed, dry matter monitoring and adjustment guidelines, a zero tolerance for spoiled feed to be fed to lactating cows, proper processing and particle size monitoring for chopped hay and straw, minimal sorting of the total mixed ration, open communication between herd and feed managers, and appropriate routines to keep feed pushed up and distributed along the feed bunk. Cows will also perform better on their nutrition program when dairy managers work to ensure that the dairy staff recognizes the importance of a cow's time budget and adjust their work routines accordingly. They should monitor and project the stocking density of all pens, and then make adjustments to prevent or alleviate overcrowding. Herd- and cow-based systems linked to the nutrition program that should be monitored include those that increase the risk of disease, such as days spent in close-up group, prefresh urine pH, body condition score, rumination, dry matter intake, and stall usage indexes, and those that are early indicators of disease, such as periparturient β -hydroxybutyrate, nonesterified fatty acids, and blood macromineral levels, and early lactation milk production. Dairy personnel and consultants should also have an understanding of new fiber terminology and its use, and the way nutrition can influence subacute ruminal acidosis, laminitis, and milk components.

Session A: Tuesday, 10:00 AM, Court F

Session B: Wednesday, 9:30 AM, Kensington



Bill Stone grew up on a beef and hog farm in southeastern Wisconsin. He attended the University of Wisconsin-Madison, where he received his veterinary degree. He practiced veterinary medicine as a bovine practitioner for three years before returning to school to obtain his PhD in dairy cattle nutrition from Cornell University. Stone operated his own dairy nutrition and management consulting business for several years in central New York State. He joined Cornell's PRO-DAIRY program when the opportunity arose. This state-wide extension position allowed him to work actively in a continuing education role with producers, nutritional consultants, and veterinarians in the areas of dairy herd management and nutrition. His main areas of focus and research have included forage management, rumen acidosis, and approaches to reduce variation in dairy feeding programs. Bill joined Diamond V in 2007, where he serves as director of the ruminant technical services team.

08-55 Ensuring access to feed to optimize health and production of dairy cows.

Trevor DeVries*.

Despite many advances in the nutritional management of dairy cows, we know that dry matter intake is not always maximized nor is the way feed consumed always ideal for the cow. The goal of this chapter is to describe the role that feeding behavior, including how, when, and what cows eat of the feed provided to them, has on ensuring dairy cow health and productivity, and then describe how we use that knowledge to evaluate feeding systems, including the management of feed and the feeding area. Strategies may then be implemented that allow cattle to have good access to the feed provided to them and consume it in manner that is conducive to good health, productivity, and welfare. An example of this includes the frequent delivery of fresh feed, which has positive effects of meal patterning and reducing the variability in composition of feed consumed. This, in turn, not only helps maintain high levels of feed intake, but may also have a positive effect on milk fat production and the efficiency of production. Frequent push-up of feed in the bunk is just as critical, as is ensuring that feed is provided in sufficient amounts across the day, so that feed is available when cows go to the bunk and we prevent inconsistent feed intake patterns from developing. Finally, reducing competition for feed access by increasing the amount of space provided to cows at the feed bunk, along with proper design of the feed bunk barrier and feeding surface, may all have significant effects on ensuring cows can get to feed when they want to and, thus, on promoting healthy feed consumption patterns, which result in high levels of intake, good health, efficiency, and production.

Session A: Tuesday, 10:45 AM, Court F

Session B: Wednesday, 10:45 AM, Kensington



Trevor DeVries is a Canada Research Chair in Dairy Cattle Behavior and Welfare and an associate professor in the Department of Animal Biosciences at the University of Guelph, Canada. Trevor received his BSc in agriculture from The University of British Columbia (UBC) in 2001. Immediately following, he began graduate studies at UBC, focusing his research on dairy cow feeding behavior. After receiving his PhD in 2006, he worked for a year as a postdoctoral researcher at Agriculture and Agri-Food Canada, focusing his research on ruminant nutrition. In 2007, he was appointed as faculty with the University of Guelph. In his current position, Trevor is involved in research and teaching in the areas of dairy cattle nutrition, management, behavior, and welfare.

08-56 Feeding the herd for maximum fertility.

José Santos* and Charles Staples.

During early postpartum, high-producing dairy cows undergo a period of extensive tissue catabolism because of negative nutrient balance. Selection for milk yield has ensured that homeorhetic controls partition nutrients to favor lactation at the same time that homeostasis secures survival. However, unrestrained metabolic disturbances often lead to diseases that, in turn, dramatically decrease reproductive performance. Negative nutrient balance in early lactation is associated with compromised immune and reproductive functions in dairy cows, mediated by a multitude of mechanisms, including changes in the pattern of ovarian follicle growth, which can affect oocyte quality. Some of this disruption seems to be the result of endocrine and biochemical changes that alter the microenvironment of the growing and maturing oocyte. In addition, cows experiencing negative nutrient balance have extended periods of anovulation. Therefore, dairy cows are managed and fed diets to minimize the extent and duration of negative nutrient balance in early lactation. Because of negative nutrient balance, dairy cows might experience excessive loss of body condition, which can magnify postpartum anovulation and infertility. The underlying mechanism for resumption of ovulatory cycles seems to be associated with metabolic signals and regulatory hormones, primarily insulin and insulin-like growth factor 1. Feeding diets that promote increases in plasma glucose and insulin may improve the metabolic and endocrine status of cows in early lactation. However, diets with excessive starch or fat content can depress appetite and defeat the purpose of improving caloric intake. Furthermore, fertility in postpartum cows is determined by peripartum health. Reductions in circulating concentrations of calcium and antioxidant minerals vitamins around parturition are also linked to impaired immune competence and result in increased risk of uterine and other diseases that impair reproduction. Therefore, formulating diets that minimize the risk of mineral-related disorders and minimize the depression in antioxidants during late gestation and early lactation are expected to improve health and reproduction. Specific nutrients and dietary ingredients have been implicated to affect reproduction in cattle. Specifically, feeding moderate amounts of unsaturated fatty acids improves fertilization rate and embryo quality in dairy cows. In contrast, some dietary ingredients such as gossypol, decrease fertility of dairy cows because of negative effects on embryo quality and pregnancy maintenance.

Session A: Tuesday, 11:30 AM, Court F

Session B: Wednesday, 11:30 AM, Kensington



José Eduardo P. Santos, associate professor in the Department of Animal Sciences at the University of Florida. He grew up in Brazil and obtained his DVM degree from São Paulo State University in 1992. He received his MS and PhD degrees in ruminant nutrition from the Department of Animal Sciences at the University of Arizona in 1995 and 1997, respectively. After his graduate program, he completed a clinical residency in dairy production medicine in the School of Veterinary Medicine at the University of California at Davis in 2000. He spent eight years on the faculty of the School of Veterinary Medicine at the University of California at Davis and, in 2008, moved to the University of Florida. He is noted for his applied and basic research on reproductive physiology and nutritional management to enhance reproduction, health, and lactation performance of dairy cattle. His extension activities at the University of Florida focus on dairy cattle nutrition and reproduction.

Section 09: Lactation and Milking Systems

09-57 Mammary development in calves and heifers.

Mike Akers*.

Very basic studies utilizing rodent models, cell culture, and cancer evaluations have provided detailed understanding of many aspects of the molecular, biochemical, and endocrine regulation of mammary tissue growth and development generally. However, the significance of the dairy cow and other dairy ruminants to the dairy industry justifies the need for continuing scientific study to confirm or refute if responses in these model systems adequately mimic the lactation cycle of dairy animals. Simply put, cows, goats, and sheep are not rodents or truly modeled by mammary cells growing in a culture dish. If the dairy industry is to continue to build on past success, there must be a cadre of dairy-interested scientists that can secure the necessary support to deliver the discoveries, insights, and breakthroughs that will serve producers in the future. This chapter highlights the relevance of mammary development of calves and heifers to support future lactation.

Session A: Tuesday, 10:45 AM, Court A-D

Session B: Wednesday, 8:00 AM, Amphitheater



Mike Akers is the Horace E. and Elizabeth F. Alphin Professor and department head of Dairy Science at Virginia Tech. He completed his BS (biology) and MS (dairy science) at Virginia Tech and PhD at Michigan State University in 1980. His research interests focus on endocrine regulation of mammary development and function. He has received several awards in recognition for his research and scholarship including the Young Scientist, Upjohn Physiology, and Borden awards from ADSA, and Animal Growth and Development Award from ASAS. He was elected an ADSA Fellow in 2006. He has authored or co-authored around 200 refereed papers, 250 abstracts, and 3 books.

09-58 Regulation of the lactating mammary gland.

Laura Hernandez*, Robert Collier, and Geoffrey E. Dahl.

Dairy cows are unique mammals that produce substantial amounts of milk during their lactation cycles. Genetic selection for milk production traits has vastly increased the amount of milk a dairy cow can produce. During lactation, the mammary gland is able to regulate its capacity to synthesize and secrete milk by producing signals that interact with the maternal tissues. The various signals secreted by the mammary gland drive maternal metabolism to preferentially support milk synthesis by the mammary gland. Several management strategies based on the dairy cow's physiology have been adopted to further maximize the amount of milk being produced during a lactation. These strategies are based on endocrine, autocrine, and paracrine mechanisms that act on the mammary gland to increase milk supply based on the demand. Specifically, in this chapter, we highlight the following methods for improving milk production during lactation: the use of hormones, such as recombinant bovine somatotropin and prolactin; the manipulation of day length during the dry period and lactation; management of dry period length; and management of negative regulators of milk synthesis by milking frequency.

Session A: Tuesday, 11:30 AM, Court A-D

Session B: Wednesday, 8:45 AM, Amphitheater



Laura L. Hernandez completed her PhD at the University of Arizona, where the focus of her research was mammary gland physiology and the role of serotonin. She then completed a postdoctoral fellowship at the University of Cincinnati in molecular and cellular physiology. She is currently assistant professor in the Department of Dairy Science, University of Wisconsin–Madison. Hernandez's main research focus is on regulation of mammary gland function and maternal homeostasis during lactation, specifically on the role of serotonin on coordinating calcium dynamics in the mammary gland. She is also interested in other physiological functions serotonin regulates within the mammary gland and how that pertains to maternal physiology during lactation as well as milk formation.

09-59 Oxytocin and the regulation of milk ejection during machine milking of dairy cows.

Rupert Bruckmaier*.

Only up to 20% of the milk stored in the udder is immediately available for milk removal (cisternal milk). The major portion of milk is fixed by capillary forces in the alveoli and small milk ducts and therefore requires active milk ejection into the cisternal compartment to be available for the milking machine. Milk ejection is caused by oxytocin, which is released from the posterior pituitary in response to tactile stimulation of teats. Requirements for the type and intensity of tactile stimulation do not exist as long as the stimulus is not painful for the cow. Oxytocin is usually released within 30 s after the first touch of the teat. However, the lag time of response to the released oxytocin to shift alveolar milking into the cisternal compartment depends of the degree of udder filling, and takes 40 to 50 s in well-filled udders compared with up to 3 min in udders containing only small amounts of milk. To avoid milking on empty teats before milk ejection, a pre-stimulation (i.e., stimulation without simultaneous milk removal) is recommended. Pre-stimulation is not necessarily continuous; it can be as short as 15 s through teat cleaning and pre-stripping, followed by a short latency period to allow milk ejection to occur before the teat cups are attached. Teat stimulation (performed by the cyclic liner movement) and oxytocin release are important throughout milking to maintain continuous refill of the cisternal compartment with alveolar milk until the udder is emptied. Disturbed milk ejection occurs occasionally in individual cows if the release of oxytocin in response to teat stimulation is lacking. Vaginal stimulation may be an alternative way to induce milk ejection if this method suits the present milking system. Mostly, disturbed milk ejection is treated by injection of artificial oxytocin. In practice, the dosage of oxytocin used is far beyond the physiological level. Therefore, cows get addicted to the treatment, and the injections cannot be stopped before the next dry period even if the release of oxytocin from the pituitary is normalized. Caution with dosage and duration of oxytocin treatments is therefore recommended.

Session A: Tuesday, 1:15 PM, Court A-D

Session B: Wednesday, 9:30 AM, Amphitheater



Rupert Bruckmaier is professor and head of veterinary physiology, Vetsuisse Faculty University of Bern, Switzerland. He received his PhD from the Technical University of Munich, Germany, in 1988. He has been working on various topics related to the physiology, immunophysiology, and endocrinology of dairy animal species. An important focus of his work for more than 30 years is the neuroendocrine regulation of milk ejection through oxytocin as well as related hormonal mechanisms, and the interaction between the physiological regulation and the biotechnology of milking systems including robotic milking.

09-60 Milking machine management.

Doug Reinemann*.

The basic design of the teatcup has not changed over the last 100 yr. The dairy cow and the dairy farm have, however, evolved considerably. This chapter will provide a review of the fundamental biomechanics of milk removal and how this understanding can be applied to managing machine milking on the 21st century dairy farm. The main goals of machine milking are to remove the available milk from each quarter quickly and completely, without slipping or falling, with minimum discomfort to the cow and minimum damage to her teats. Balancing these goals requires compromise because (1) maximizing milking speed often results in less complete and/or less gentle milking; (2) maximizing gentleness results in slower milking and may result in less complete milking; and (3) maximizing completeness of milking generally results in slower and less gentle milking.

Session A: Tuesday, 2:00 PM, Court A-D

Session B: Wednesday, 10:45 AM, Amphitheater



Douglas J. Reinemann is professor and chair of the Biological Systems Engineering Department at the University of Wisconsin-Madison. He has BS and MS degrees in agricultural engineering from University of Wisconsin-Madison, and PhD in agricultural engineering from Cornell University. He joined the faculty at the University of Wisconsin in 1990. In his role as milking machine extension specialist, he developed the UW Milking Research and Instruction Lab (MRIL) with Dr. Graeme Mein. Doug was named chair of the Biological Systems Engineering Department at the University of Wisconsin in 2014. As a long-time member and frequent chair of the National Mastitis Council, International Dairy Federation, International Organization for Standardization, and American Society of Agricultural and Biological Engineers milking machine committees, his work with international experts has focused on the development and interpretation methods for machine milking performance indicators and the development and

adoption of automatic milking systems. Doug's research interests also include rural energy issues, renewable energy systems, sustainable biofuel production, integral ecology, and stray voltage. He attempts to bring a practical perspective to his research and extension work.

09-61 Milking systems for large dairy herds.

Olaf Pichler (presented by Bengt Göran Martensson*).

Milking systems start with the milking machine, which operates in several complex ways. It removes milk from cows as completely and gently as possible and reduces congestion of the teat by closing a liner against the teat with an adequate pulsation and the correct vacuum level. The liner is the most important part and it has to be designed to avoid liner slip and fall-offs. In low line installations, an operating vacuum level from 42 to 46 kPa is accepted, and in high line installations from 47 to 51 kPa. There are various clusters on the market from standard to light weight, which all claim to optimize milking efficiency, to milk faster and more completely, to be ergonomic, and to help the milker to be more efficient. Milking systems for medium to large herds can be designed as parlors, rotaries, or automatic milking systems (AMS). Data from 2,612 dairy farms in Europe showed 48% herringbone parlors, 19% parallel parlors, 18% rotaries, and 10% AMS. For herds larger than 1,000 dairy cows, there were 42% installed static parlors and 58% rotaries. Nevertheless, there is a clear trend in large dairy herds for AMS to reduce labor costs. As labor is relatively expensive, dairy farmers in the segments of static parlors and rotaries look for highest throughput in cows/milker and hour to reduce labor costs. Most common is the steady-state throughput, which is calculated without start up, shut down, and group change. Herringbone parlors vary in size from double-4 to double-24 with acceptable throughput; parallel parlors vary in size from double-8 to double-60 with a higher throughput. Herringbone rotaries are available with from 20 to 44 bails with a throughput of 5 cycles per hour, and parallel rotaries can have 30 to 110 bails with a throughput of 7 cycles per hour. To reduce the number of milkers, a teat spray robot can be installed for parallel rotary systems. Automatic milking systems can be of single- or multi-stall type. The single box system, where one robot serves one milking box, is dominating the market. Practical experiences from dairy farms with automatic milking systems show that it is possible to produce 1 kg of milk for €0.04 up to €0.07 based on labor hours of 6 to 8 h per cow and year. Automatic milking rotaries today are available from 2 manufacturers with different concepts: The 24-bail herringbone rotary (available in one size only so far) and the parallel automatic rotary (available in various sizes). For both concepts, one person is needed in or at the rotary to monitor and control the complete system and to assist cow flow and cow traffic. Through the end of 2015, 19 automatic milking rotaries had been installed in Germany. These farms report that it is possible to produce 1 kg of milk for approximately €0.05.

Session A: Tuesday, 2:45 PM, Court A-D

Session B: Wednesday, 11:30 AM, Amphitheater



Olaf Pichler has an MS degree from the Agricultural University of Hohenheim, Germany, and a PhD in milk production and animal health from the Institute of Animal Production and Milk Production.

Section 10: Mastitis and Milk Quality

10-62 Contagious mastitis: *Staphylococcus aureus*, *Streptococcus agalactiae*, and *Mycoplasma* spp.

John Middleton* and Lawrence K. Fox.

Contagious mastitis refers to mastitis caused by pathogens that are usually harbored in the cow's mammary gland and spread from cow to cow during the milking process. The major bacteria causing contagious mastitis are *Staphylococcus aureus*, *Streptococcus agalactiae*, and *Mycoplasma* spp. This chapter reviews the sources of infection and disease transmission, clinical signs, detection and diagnosis, treatment, and prevention and control measures used in the management of these 3 pathogen types.

Session A: Monday, 8:30 AM, Court E

Session B: Monday, 3:00 PM, Amphitheater



John Middleton holds a DVM and a PhD from Washington State University and is a Diplomate of the American College of Veterinary Internal Medicine. He is also an associate member of the European College of Bovine Health Management. He is professor of food animal medicine and surgery and assistant director of the Agricultural Experiment Station at the University of Missouri. He has clinical, research, administrative, and service responsibilities in the Department of Veterinary Medicine and Surgery. His research is focused on mastitis and milk quality, particularly staphylococcal mastitis. He is a past president of the National Mastitis Council. He is the recipient of the American Dairy Science Association West Agro Award for milk quality research (2009), the Northeast Regional Association of State Agricultural Experiment Station Directors, Award for Excellence in Multistate Research (2009 and 2013), National Mastitis Council Distinguished Service Award (2015), and the Zoetis Award for

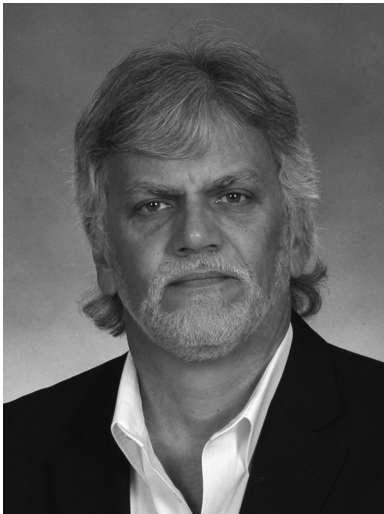
Veterinary Research Excellence (2015), and was recognized as a Top Faculty Achiever by the Chancellor of the University of Missouri in 2014.

10-63 Practical approaches to environmental mastitis control.

Joe Hogan*.

Successful control programs for environmental mastitis account for interactions between the environment and physiology of dairy cows to positively affect mammary health and milk quality. The primary reservoir for environmental mastitis pathogens is the surroundings in which the cow lives. Managing the primary sources of environmental mastitis involves understanding the ecological niche these bacteria occupy and altering these environments to reduce their exposure to teats of dairy cows. A significant source of mastitis pathogens in total confinement systems is the material used for bedding cows either in stalls or loose housing. Populations of the bacteria in bedding are related to the number of bacteria on teat ends and rates of clinical mastitis. Therefore, reducing the number of bacteria in bedding generally results in a decrease in environmental mastitis. Rates of new intramammary infections caused by coliforms and environmental streptococci are generally greater during the dry period than during lactation. Therefore, the thrust of herd management strategies for reducing environmental exposure should focus on the dry period and early lactation. Enhanced host defenses against environmental mastitis during the dry period and early lactation have been achieved by supplementation of diets with antioxidant vitamins and minerals and vaccinating cows with core antigen gram-negative vaccines.

Session A: Monday, 9:15 AM, Court E**Session B: Monday, 3:45 PM, Amphitheater**



Joe Hogan is a professor and associate chair in the Department of Animal Sciences, The Ohio State University, located at the Ohio Agricultural Research and Development Center in Wooster. His degrees include a BS from Louisiana State University, MS from University of Kentucky, and PhD from University of Vermont. His research activities focus on studies to characterize bovine mammary gland host defense against intramammary infections, characterize virulence factors of mastitis causing bacteria, and develop means to modulate mammary defenses. He is past president of the National Mastitis Council, former chair of National Mastitis Research Foundation, and currently the United States representative to the International Dairy Federation Standing Committee on Animal Health and Welfare.

10-64 Modulation of the bovine mammary gland.

Steve Nickerson* and L. M. Sordillo.

The goal of this chapter is to provide an overview of how bovine mammary gland immunity can be modulated to resist or eliminate intramammary infections (IMI). Although the mammary gland of the cow evolved to nourish and support the diet of the newborn calf during its first year of life, dairy cattle genetics and nutrition have been dramatically manipulated to allow production of copious amounts of milk for human consumption. The stresses associated with the high-producing Holstein, however, have rendered her more susceptible to diseases such as mastitis. Nature has provided her with innate anatomical defenses to repel mastitis-causing bacteria, and once bacteria enter the mammary gland, various cellular and molecular defenses play a role in removing the invading pathogens. In addition, the cow adapts to specific bacteria by eliciting antibodies and immune cells that function to destroy these pathogens. Research has demonstrated that these innate and adaptive immune mechanisms can be modulated to various degrees. Vaccination, dietary supplementation, and immune stimulation have been used experimentally as well as commercially to enhance the composition, magnitude, and efficiency of the bovine immune system with varying degrees of success to prevent the establish of IMI.

Session A: Monday, 10:30 AM, Court E

Session B: Tuesday, 8:00 AM, Amphitheater



Steve Nickerson did his undergraduate work at the University of Maine, his graduate training at Virginia Tech University, and his postdoctoral studies at Purdue University. He subsequently joined the faculty at Louisiana State University as director of the Mastitis Research Laboratory in 1980, where his research focused on mastitis control and milk quality in dairy cattle. He moved to Virginia Tech in 2000, where he served as head of the Dairy Science department and director of the Ag Tech Program. He is currently a professor of dairy science at the University of Georgia, and conducts research on boosting the bovine immune system to intramammary infection.

10-65 Mastitis control in pasture and seasonal systems.

Eric Hillerton*.

This chapter considers how mastitis management differs in a pastured dairy system. No substantial effort is made to repeat the detail of mastitis control, common to all dairy systems, except that particular emphasis is placed on the 2 fundamental principles of preventing new infections and shortening the duration of any infections that do occur. The chapter considers how pastured systems differ and how that drives management of hazards and risks and our knowledge of mastitis. The principles are described according to the disease process of exposure, invasion, establishment, and elimination of pathogens in the context of first the highly synchronized year on a pastured dairy farm, and then the daily routine applying to grazing cows. Targets and successful achievement are part of the mastitis management planning required. Control points specific to the hazards, risks, unique features applying, and activities required are the skeleton of managing mastitis on a large pastured dairy farm; these are provided throughout and gathered in an appendix.

Session A: Monday, 12:15 PM, Court E

Session B: Tuesday, 8:45 AM, Amphitheater



Eric Hillerton is a semi-retired consultant on animal health and milking. He retired from the role of chief scientist at DairyNZ Ltd., where he managed a research team of 100 staff. He was previously a principal scientist at the Institute for Animal Health in the United Kingdom, where he led several teams conducting contract research for the animal health industry. He graduated from the University of Edinburgh with BSc and PhD degrees. He is an adjunct professor in dairy systems at Massey University and a Fellow of the Royal Entomological Society. For more than 40 years, Hillerton has researched the epidemiology and control of mastitis and other diseases of dairy cattle, including bovine spongiform encephalopathy and foot and mouth disease; developments in milking technology including automated systems and milk quality; and veterinary entomology. He has more than 330 publications. His representative roles have included New Zealand member of the International Dairy Federation Standing Committees on

Animal Health and Welfare, and Farm Management, and past-president of the United States National Mastitis Council.

10-66 Practical approaches to mastitis therapy on large dairy herds.

Pamela Ruegg*.

Mastitis is a frequent disease of dairy cows that occurs in both a clinical and subclinical state. Subclinical mastitis is typically treated at dry-off using long-lasting intramammary antibiotics but most clinical mastitis is treated with antibiotics during lactation. The purpose of this paper is to describe practical mastitis treatment protocols for large dairy farms that are effective and economical, and that minimize nonessential usage of antibiotics. Managers of large dairy farms should develop protocols that allow milking technicians to accurately detect clinical mastitis but treatments should not be administered during routine milking times. Assignment of treatments should be performed by animal health managers who work closely with local veterinarians. Cows with severe mastitis (symptoms that extend beyond the udder) should be treated immediately using supportive therapies and parenterally administered antibiotics. Before administration of antibiotics to cows affected with nonsevere mastitis, the medical history should be reviewed to determine if antibiotic therapy is likely to be beneficial. When antibiotic use is not justifiable, other case-management options (including watchful waiting or culling) should be considered. All regulations for drug usage should be followed, and the local veterinarian must supervise all extra-label usage. The purpose of inflammation is to kill pathogens, and occurrence of abnormal milk does not always indicate the presence of an intramammary infection. To ensure that antibiotics are used to treat active bacterial infections, managers of large dairy farms should use culture-based treatment protocols. If culture-based treatment is not used, narrow spectrum intramammary antibiotics should be used on-label for as short a duration as possible. Unless there is an alternative use for discarded milk, treatment of subclinical mastitis is rarely advised during the lactation period. Although use of comprehensive antibiotic dry-cow therapy is recommended for most farms, some farms may be able to use selective dry-cow programs that combine the use of internal teat sealants (for prevention of new intramammary infections) with targeted use of antibiotics for treatment of existing infections.

Session A: Monday, 1:00 PM, Court E

Session B: Tuesday, 9:30 AM, Amphitheater



Pamela Ruegg is a professor and extension milk quality specialist in the Department of Dairy Science at the University of Wisconsin, Madison. She received her undergraduate degree and DVM from Michigan State University and completed a residency in food animal herd health and reproductive management and MS in preventive veterinary medicine from the University of California–Davis. Before joining UW Madison, she had a varied professional career, including private veterinary practice, academic practice, and corporate technical service. Ruegg's research interests are focused on using epidemiologic techniques to solve critical issues related to animal health and milk quality, and she enjoys bridging the gap between research and practical applications on dairy farms. She is a frequent speaker at veterinary and farm conferences throughout the world.

10-67 Milk quality and safety.

Stephen P. Oliver*.

Milk is regarded as a “perfect food” and a variety of highly nutritious and delicious dairy products are used to feed infants, children, adults, and the elderly. Consequently, several regulations are in place to ensure access to a safe, wholesome, nutritious, and readily available milk supply for human consumption. Several different methods are used to assess milk quality. Some methods such as the somatic cell count, standard plate count, and antibiotic residue testing are mandated by the grade A Pasteurized Milk Ordinance, which is a document that specifies safety standards of grade A milk. Other methods, although not mandated, are useful to monitor milk quality and to help diagnose potential on-farm problems or deficiencies associated with abnormally high counts and poor quality milk. The focus of this chapter is on milk quality and safety and the following topics will be discussed: (1) assessing milk quality; (2) issues associated with antibiotic use including antibiotic residues in milk and antimicrobial resistance of veterinary and foodborne pathogens; and (3) hazards associated with consumption of raw milk. Mastitis, milk quality, and dairy food safety are all interrelated. Poor milk quality affects all segments of the dairy industry, ultimately resulting in milk with decreased manufacturing properties and dairy products with reduced shelf life. The safety and quality of dairy products starts at the farm and continues throughout the processing continuum. One thing is certain—it is impossible to transform a low-quality raw milk product into a high-quality finished dairy product. To meet increased raw milk quality standards, producers must adopt production practices that reduce both mastitis and bacterial contamination of bulk tank milk. A safe, wholesome, abundant, and nutritious milk supply should be the goal of every dairy producer in the world. Use of effective management strategies to minimize contamination of raw milk and proven mastitis control strategies including prudent use of antibiotics will enable dairy producers achieve these important goals.

Session A: Monday, 1:45 PM, Court E

Session B: Tuesday, 10:45 AM, Amphitheater



Stephen Oliver received his BS degree from North Carolina State University, and MS and PhD degrees from The Ohio State University. He is professor of animal science and assistant dean and assistant director of University of Tennessee AgResearch. Prior to this, Oliver was a faculty member for 26 years at The University of Tennessee Institute of Agriculture, where he was a professor in the Department of Animal Science and co-director of the Food Safety Center of Excellence. Oliver continues to have an extensive research program on lactation biology, mastitis in dairy cows, and pre-harvest dairy food safety. He has authored or co-authored 215 peer-reviewed scientific papers and has given over 330 presentations at local, state, regional, national, and international meetings. He is a Fellow of the American Society of Microbiology, editor-in-chief of *Foodborne Pathogens and Disease*, a former member of the National Mastitis Council (NMC) Board of Directors, and former chair of the NMC Research Committee. Oliver's

research accomplishments have been recognized nationally and internationally. His research focuses extensively on discovery of non-antibiotic approaches for the prevention and control of environmental mastitis in dairy cows. Oliver's expertise in mastitis and milk quality has also led to a research and outreach initiative in dairy food safety that has received significant federal and institutional funding. His ultimate research goal is to better enable dairy producers in Tennessee, the United States, and the world to enhance the quantity and quality of milk, and thus reduce the economic impact of mastitis.

Section 11: Animal and Herd Welfare

11-68 Assuring and verifying dairy cattle welfare.

David Fraser and Katie Koralesky*.

Programs designed to provide assurance of farm animal welfare vary in 3 main dimensions: requirements, formats, and animal welfare objectives. The requirements used in such programs include animal-based measures (such as body condition), environment-based measures (such as space allowance), and procedure-based measures (such as pain management). Formats include nonmandatory welfare codes, government regulations, product-differentiation (labeling) programs, and corporate specifications. The main animal welfare objectives pursued by assurance programs include promoting basic health, managing affective states such as pain and comfort, accommodating natural behavior, and including natural elements in the environment. Science plays diverse roles in setting requirements. These roles include identifying critical thresholds for measures such as space, identifying achievable targets for measures such as incidence of lameness, assessing and mitigating the effects of procedures such as disbudding, and identifying the animals' own preferences. Because of the prominent role of science, many animal welfare standards are described as "science-based." However, the creation of standards inherently involves political or value-based decisions about which animal welfare objectives to prioritize, followed by the use of science to identify requirements needed to meet those objectives. Because different stakeholders (producers, veterinarians, animal protectionists) tend to emphasize different animal welfare objectives, inclusive processes are needed to develop standards that will capture different priorities so that standards will be widely seen as valid. Recent research has shown that basic animal welfare outcomes vary widely among farms using similar environments, likely because of differences in the quality of animal care. This has led to increasing reliance on animal-based rather than environment-based measures. It has also sparked increasing emphasis on human factors including selection and training of stockpersons, producer engagement, attention to the "culture" of care on farms, and encouraging a "professional" model of animal production.

Session A: Monday, 8:30 AM, Court G-J

Session B: Tuesday, 8:00 AM, Kensington



Katherine (Katie) Koralesky graduated from the University of Wisconsin, Madison. She has worked on farms in the United States and abroad, including three years in Togo, where she served as an agricultural extension agent in the United States Peace Corps. As a graduate student in the Animal Welfare Program at the University of British Columbia, her research interests include investigating different approaches to dairy cattle welfare assurance programs, understanding the factors that can affect the outcomes of such programs, and identifying on-farm producer self-assessment tools that have the potential to improve dairy cattle welfare.

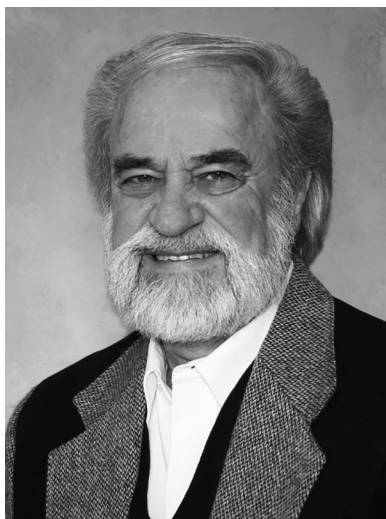
11-69 Standard operating procedures for compromised cattle.

Jan Shearer*.

Farm and Food Care Ontario defines a compromised animal as “an animal with reduced capacity to withstand the stress of living or transportation due to injury, fatigue, infirmity, poor health, distress, very young or old age, impending birth or any other cause” (Ontario Farm Animal Council, 2010). Despite our best efforts to elude those circumstances that may result in physical disability, it is not possible to fully avoid disease and accidental injury that could have devastating consequences for the health and well-being of animals. Therefore, protocols for dealing with compromised cattle are necessary for all operations. Standard operating procedures (SOPs) are usually in the form of written documents that provide specific instruction on how farm duties should be conducted. Basic information would include names of the owner and the farm and in the case of SOPs related to health issues, the name of the herd’s veterinarian. The SOP must outline a plan of action that clearly defines “who” is responsible to implement the plan, “when” or under what conditions it should be executed, “what” needs to be accomplished, along with specific details of “how” it is to be done. Facilities and management schemes vary significantly from farm to farm; therefore, SOPs for compromised cattle must be tailored to meet the needs of individual farms. In operations with multi-cultural employees, whether information is presented as part of a training program or as written information, it must be in the native language of employees. If some employees are unable to comprehend SOPs in written form, personal one-on-one instruction will be necessary. Other options might be to consider putting the information on audiotapes, videos, or other forms of educational media. Finally, to be relevant and effective, SOPs should be reviewed and updated in consultation with the herd’s veterinarian at least annually.

Session A: Monday, 9:15 AM, Court G-J

Session B: Tuesday, 8:45 AM, Kensington



Jan Shearer is professor and extension veterinarian at Iowa State University’s College of Veterinary Medicine in Ames, Iowa. He received his DVM degree from The Ohio State University and entered veterinary practice in Orrville, Ohio. He served 4 years as associate veterinarian at the Orrville Veterinary Clinic before returning to The Ohio State University to pursue graduate study in animal nutrition and immunology, earning him an MS in 1981. He was appointed assistant professor in the Department of Veterinary Preventive Medicine the same year, just before relocating to the University of Florida to become a dairy extension veterinarian in 1982, a position he held until June of 2009. He is a Diplomate of the American College of Animal Welfare and serves as a board member and scientific advisor to multiple organizations and dairy operations. He is currently chair of the Food Animal Working Group (FAWG) of the American Veterinary Medical Association’s (AVMA) Panel on Euthanasia and member of the AVMA’s

Panel on Humane Slaughter and Mass Depopulation. At Iowa State University, he is responsible for the development and delivery of veterinary extension programs designed to meet the needs of dairy farmers, veterinarians, and the allied agri-business industry. His primary areas of research interest are lameness and welfare issues of beef and dairy cattle.

11-70 Proper handling techniques for dairy cattle.

Ulrike Sorge*.

Cattle handling has a tremendous effect on the daily operations and production of dairy farms. The quality of cattle handling influences not only the health and wellbeing of cattle, but has also been shown to affect production and reproductive success. Therefore, proper training of employees in cow behavior and good cattle handling practices need to be an integral part of good care practices on every dairy farm.

Session A: Monday, 10:30 AM, Court G-J

Session B: Tuesday, 10:00 AM, Kensington



Ulrike Sorge is an assistant professor of dairy production medicine at the College of Veterinary Medicine at the University of Minnesota. She received her veterinary and a doctorate degree from the Free University of Berlin, Germany, and completed an MSc and PhD in veterinary epidemiology at the Ontario Veterinary College, Canada. She is board certified in veterinary preventive medicine. Sorge has always been interested in animal care practices that improve animal wellbeing and health and are practical and economically feasible for dairy producers at the same time. Besides investigating risk factors for disease on farms as a veterinary epidemiologist, she spends a lot of time on the development of effective preventive and curative management solutions for organic and conventional dairy farms. Human–animal interactions are a large part of animal care and they have a profound impact on the wellbeing and productivity of cattle and humans. Sorge continues to study the impact of stockmanship on production and worker health on large dairy farms and on testing

novel approaches of how it can be improved. She is frequently invited to speak about stockmanship techniques for dairy farms and to provide hands-on cattle handling training on dairy farms.

11-71 Elective procedures in dairy cattle.

Hans Coetzee* and Jennifer Walker*.

Several elective procedures may be done on calves and cows, all of which cause pain, some of which are necessary and others which are of questionable value or simply not acceptable. If the procedure in question is one in which there is scientific evidence to support the procedure to promote the health and welfare of the individual animal or herd, the “3 S” approach proposed by researchers in the European Union aims to help caretakers assess possible solutions to painful procedures, considering their feasibility, acceptability and availability. This approach takes into account opportunities to (1) Suppress—consider other options that make the procedure unnecessary either by eliminating the need for it or through genetic selection; (2) Substitute—look for better ways to perform the procedure that may be less painful, using different methods or performing the procedure at an earlier age/stage; and (3) Soothe—consider ways to minimize the pain associated with the procedure by using analgesics and anesthetics. In this chapter, we will examine elective procedures including tail docking, dehorning, castration, branding, extra teat removal, teat amputation, and invasive surgeries in the context of the 3 S approach to identify strategies to avoid the need for painful procedures all together, minimize their occurrence, or when absolutely necessary, provide proper procedural and post-procedural pain relief.

Session A: Monday, 11:15 AM, Court G-J

Session B: Tuesday, 10:45 AM, Kensington



Hans Coetzee is a professor in the Department of Veterinary Diagnostic and Production Animal Medicine at Iowa State University. He obtained his Bachelor of Veterinary Science degree from the University of Pretoria, South Africa, in 1996. He received a specialist certificate in cattle health and production from the Royal College of Veterinary Surgeons (London) in 2000, and a doctorate in veterinary microbiology from Iowa State University in 2005. He holds board certifications in veterinary clinical pharmacology and animal welfare and his professional interests include the development of analgesic drug regimens for use in food animals and therapy of bovine anaplasmosis. He has published over 100 peer-reviewed papers and received over \$6 million in research funding. In his free time, he enjoys spending time with his wife and twin daughters.



A California native, Jennifer Walker earned her BS in animal science (1994) and DVM (2000) from the University of California at Davis. As an associate veterinarian in a California practice specializing in dairy herd health, she developed her interests in on-farm education, udder health, and animal welfare. In 2010, she completed her PhD in veterinary preventive medicine at The Ohio State University, where she also minored in university education. Jennifer joined Dean Foods as their director of dairy stewardship in July 2010. In this role, she has been putting to use her expertise in on farm milk quality and passion for animal welfare by working with customers, suppliers, and dairy farmers to develop an industry-wide standard that promotes the good welfare of dairy cattle.

Section 12: Herd Health

12-72 Behavior of transition cows and relationship with health.

Katy Proudfoot* and Julie Huzzey.

Transition dairy cows cope with physiological and environmental challenges that threaten their health and welfare. Many cows have difficulty making a healthy transition from pregnancy to lactation, as evidenced by the high incidence of disease that occurs during the weeks following calving. Behavioral changes around parturition not only identify sick cows but may also identify those that are likely to become sick. In this chapter, we first review normal changes in behavior that occur gradually over the transition period, and those that change dramatically when a cow goes into labor. We then review research identifying changes in behavior that occur when a cow becomes clinically ill (“sickness behaviors”), including reduced overall activity, feed intake, and social interactions. These behaviors may be useful for improving disease diagnosis, allowing for an assessment of treatment efficacy, and providing insights into designing appropriate housing to optimize disease recovery. In addition to being a consequence of disease, behaviors have also been noted to change far in advance of disease diagnosis. Researchers have identified behavioral changes in cows that become ill sometimes weeks before clinical diagnosis, and in many cases before the cow has given birth. Similar to sickness behaviors, these include a reduction in feed intake, changes in standing time, and a reluctance to compete for access to feed during peak-feeding periods when competition is high. The causes of these early changes in behavior remain unclear; for example, cows may be feeling ill before being diagnosed with a clinical illness, or may be experiencing a secondary, undiagnosed illness, both of which could cause the change in behavior. An alternative theory is that cows change their behavior for other reasons (e.g., individual animal factors or management practices) that then predispose them to become ill. Regardless of the cause of these early behavioral changes, they can be useful for detecting at-risk animals or those in early stages of disease, allowing for early intervention. Future research should focus on developing a better understanding of individual differences in behavior and disease risk, precision technologies that can measure behavioral changes and signal disease, and the development of housing and management practices that accommodate both normal and sickness behaviors of transition cows.

Session A: Monday, 8:30 AM, Amphitheater

Session B: Tuesday, 4:00 PM, Court A-D



Katy Proudfoot is an animal welfare extension specialist at The Ohio State University's College of Veterinary Medicine in the Department of Veterinary Preventive Medicine. A native Californian, Katy attended the University of California, Los Angeles (UCLA), where she received a BSc in psychology and neuroscience. Her love of animal welfare research started when she completed her MSc at the University of British Columbia (UBC) Animal Welfare Program. Her MSc research identified the impact of stocking density on the behavior of dairy cows in the few weeks before calving. Katy also pursued her PhD at UBC, where she focused her research on behavioral indicators of illness, and maternal behavior during the calving period. Katy currently teaches animal behavior and welfare to veterinary students, and focuses her research and extension efforts on improving the quality of life of dairy cattle and veal calves.

12-73 Management of transition cows to optimize health and production.

Daryl Nydam*, Tom Overton, Sabine Mann, Maris McCarthy, Jessica McArt, and Brigid Sweeney.

The transition from late gestation to lactation is a period of many physiological changes and a critical time to ensure cows are well prepared for a profitable lactation. There are many opportunity areas to implement management practices mitigating the risk of early-lactation catabolic Armageddon. Although comparison to external benchmarks is inherently dangerous to sound decision-making, we aim to provide a framework such that a dairy can begin to internally calibrate its management metrics. Monitoring performance metrics that have little momentum, bias, and lag will help dairy farms reach their goals. Systematic recording of clinical diseases with consistent case definitions is one of the best groups of metrics to monitor. We suggest lactational incidences of displaced abomasum of <3%, clinical milk fever <2%, and retained fetal membranes of <8%. Subclinical disease has also been shown to be very costly to dairy performance. We advise hyperketonemia (defined as BHB concentration >1.2 mmol/L) prevalence <15–20% and fresh cow mastitis prevalence (defined as first test-day linear score >4) to be <10% for multiparous cows and <7% for first-parity heifers. For nutritional management of far-off cows, we suggest examining diet formulation and aiming for 110 to 120% of metabolizable energy (ME) requirements and >1 000 g/d of metabolizable protein (MP). The diets of close-up cows should be formulated to provide 110 to 130% of ME, but not more, and >1,200 g/d of MP. Routine inspection of dietary cation-anion difference (DCAD) should be performed to ensure herd goals are being met. If aiming for a negative DCAD by feeding anionic salts, monitoring urine pH weekly and ensuring it is adequately acidified is good practice. Delivery of this diet is equally important to formulating it. Given the bulkiness and potential palatability challenges of these recommended diets, it is prudent to monitor the particle size and use the Penn State Particle Separator weekly. We recommend 10 to 20% on the top screen, 50 to 60% in the middle, and <40% in the bottom pan, with the long straw or hay particles not more than 4 cm. Further, it is important to continuously measure the dry matter and keep the total mixed ration wet enough to be 46 to 48%. Our field observations corroborate that stocking transition cows at 80% of headlocks or 0.8 m of bunk space per cow is beneficial, and these metrics should be evaluated often. Consistent and accurate recording of actionable metrics can allow for timely interventions to ensure the dairy is proactively addressing transition cow opportunities.

Session A: Monday, 9:15 AM, Amphitheater

Session B: Tuesday, 4:45 PM, Court A-D



Daryl Nydam grew up in central New York State, where his grandparents owned a small, mostly dairy, farm and his father was a practicing dairy veterinarian for 40 years. He earned a BS in biochemistry at the University of New York–Geneseo and a DVM at the College of Veterinary Medicine at Cornell University. Following a stint in private clinical practice, Nydam returned to Cornell and earned a PhD in epidemiology. He is currently employed in the Department of Population Medicine and Diagnostic Science, Cornell University, as associate professor of dairy health and production. Daryl is the director of Quality Milk Production Services. In these roles, he is active in disease control programs and on-farm dairy production medicine programs for efficient production, and he provides regular clinical service. He publishes scientific articles in these fields, speaks with various audiences, and teaches veterinary students. He has a wife (Gillian Perkins, DVM, DACVIM), daughter (Heidi), and son (Peter).

12-74 Minimizing postcalving metabolic disorders.

Garrett Oetzel*.

Dairy cattle are vulnerable to metabolic disorders after calving due primarily to the sudden outflow of calcium and energy that accompanies the onset of lactation. Calcium homeostasis is the first metabolic challenge the cow faces after calving. Preventive measures for hypocalcemia include low calcium diets, acidogenic diets, and oral calcium supplementation. Some cows have persistent hypophosphatemia after their hypocalcemia resolves; this may be a poor prognostic sign. The key to preventing hypophosphatemia is preventing the original hypocalcemia. Hypomagnesemia occurs sporadically in dairy cows after calving. It can be managed by controlling dietary potassium and supplementing the diet with highly bioavailable sources of magnesium. Ketosis is probably the most common metabolic disorder after calving and is the result of inadequate adaptation to high energy outflow early in lactation. Early detection and treatment of ketosis can be very effective in managing this disorder. Prevention of ketosis includes controlling excessive body condition at calving, providing properly formulated diets, allowing adequate eating space during the transition period, identifying and prophylactically treating high-risk cows, and eliminating silages that contain butyric acid. Hypokalemia is a complication of prolonged inappetance in early lactation cows that may be exacerbated by certain ketosis treatments. It is entirely preventable by supplementing early lactation cows with oral potassium if they are off feed 3 or more days. Displaced abomasum is most likely to occur in cows that have experienced hypocalcemia, ketosis, or other disorders very early in lactation. Prevention of displaced abomasum is primarily through preventing these other disorders.

Session A: Monday, 10:30 AM, Amphitheater

Session B: Wednesday, 8:00 AM, Court A-D



Garrett R. (Gary) Oetzel is a professor and section chief in the Food Animal Production Section, Department of Medical Sciences, School of Veterinary Medicine, at the University of Wisconsin-Madison. Oetzel grew up on a beef cow-calf farm in southwestern Ohio. He completed his undergraduate and veterinary medical training at The Ohio State University, receiving his BS in 1978 and DVM in 1981. From Ohio, he went to the University of Illinois where he completed an internship, residency, and graduate program. He received his MS degree in veterinary clinical medicine in 1985. Oetzel then spent three years as an assistant professor at Colorado State University, where he refined his interests in dairy nutrition and dairy production medicine. After one year in private dairy practice in Reedsville, Wisconsin, Oetzel joined the Food Animal Production Medicine Section at the University of Wisconsin-Madison School of Veterinary Medicine in September 1989. Oetzel's research interests are in applied dairy nutrition and metabolic

diseases such as milk fever, ketosis, displaced abomasum, and ruminal acidosis. He teaches veterinary clinical nutrition to first-year veterinary medical students, food animal medicine to third-year students, and transition cow troubleshooting and applied dairy nutrition to fourth-year veterinary medical students. His clinical interests include troubleshooting techniques and the application of herd-based tests for metabolic disease problems in dairy herds. Oetzel is the faculty advisor for the student Christian Veterinary Mission group at UW-Madison and leads student mission trips to Ecuador.

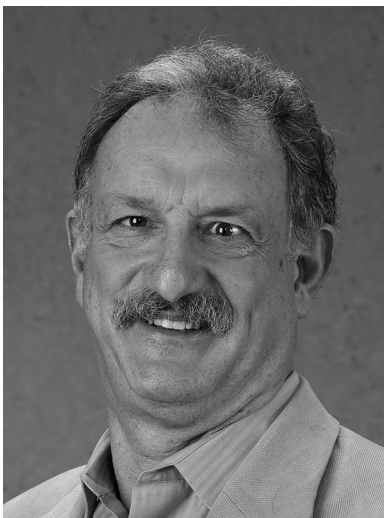
12-75 Immunology and vaccination of dairy cattle.

Victor Cortese*.

It is necessary to consider many variables in order to scientifically choose a vaccine or design a particular vaccination program for today's dairies. The increased movement and purchasing of cattle seen with today's larger herds puts additional stress on the vaccine program as disease risk rises. Thus, vaccine programs need to be based on more science than ever before. An in-depth understanding of the immune system is important for managing all aspects of the dairy and in designing proper disease prevention programs. Improper handling of the immune system precalving can lead to increased problems postcalving and decreased milk production and increased reproductive failures. Improper knowledge of the immune system can lead to increased calf problems that will lead to lifelong decreases in milk production and increased health problems and culling rates. This chapter will cover current information on the immune system of the dairy animal and discuss possible interventions that can improve immunologic function and health.

Session A: Monday, 11:15 AM, Amphitheater

Session B: Wednesday, 8:45 AM, Court A-D



Victor S. Cortese graduated from Michigan State University with BS and PhD degrees. He received his DVM in 1980. He then entered a predominantly dairy practice in Wisconsin, where he also held a nontenured adjunct professor position with the University of Wisconsin-Madison, College of Veterinary Medicine. In 1989, he joined Diamond Scientific in their technical services department, where he was promoted to director of veterinary operations. In June 1990, he moved to SmithKlineBeecham Animal Health (now Pfizer Animal Health) as a senior technical services veterinarian, with his main emphasis on dairy and its allied sectors. He currently holds the title of director technical services in cattle immunology. His responsibility is 75% North American and 25% international. He has many publications on viral infections, immunology, neonatal immunology, and young dairy calf management, several textbook chapters, and guest lectures at many veterinary and university meetings, including the American

Association of Bovine Practitioners/World Buiatrics Congress and the AVMA. He received his diplomate status to the American Board of Veterinary Practitioners (Dairy Practice Specialty) in 1995. In September 1997, at the American Association of Bovine Practitioners Conference in Montreal, he received the AABP's Award for Excellence. In 1999, he successfully completed his PhD in microbiology from the Western College of Veterinary Medicine, University of Saskatchewan. In 2013, *Bovine Veterinarian* magazine selected Vic Cortese as one of the twenty most influential cattle veterinarians in the United States.

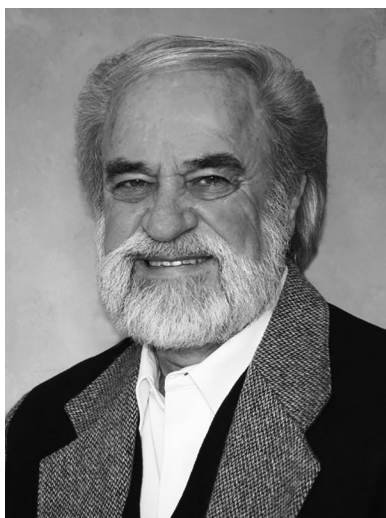
12-76 Managing the herd to minimize lameness.

Jan Shearer*, M. F. Hutjens, and Marcia Endres.

To minimize investment and improve profitability there has been a gradual change in the US dairy industry toward increasing herd size and management intensity. Coincident with this are several technological advancements in feeding, housing, and disease control that have raised the level of milk production per cow, permitting greater total milk yield from fewer cows. Meeting the nutritional demands of high-producing dairy cows requires properly formulated rations with high-quality feeds and forages and 24 hour per day access. However, feeding for healthy feet and leg health goes well beyond the challenges of feeding for maximum performance. Feeding cows to maintain body condition throughout lactation and the dry period is essential to assuring healthy feet and legs. Housing systems provide shade and supplemental cooling during periods of intense heat and humidity. During the winter months, housing offers a wind block and shelter for animals, keeping feed and resting areas dry. Confinement housing can also result in reduced cow comfort and lameness from increased exposure to hard flooring surfaces. It also increases the exposure of feet and legs to moisture and manure contamination, which is believed to increase the potential for infectious disorders of the foot skin such as digital dermatitis and foot rot. An understanding of lameness conditions in terms of what they are, how or why they occur, and what to do about them is essential to minimize production losses as well as the loss of cows from these and related problems.

Session A: Monday, 1:00 PM, Amphitheater

Session B: Wednesday, 10:00 AM, Court A-D



Jan Shearer is professor and extension veterinarian at Iowa State University's College of Veterinary Medicine in Ames, Iowa. He received his DVM degree from The Ohio State University and entered veterinary practice in Orrville, Ohio. He served 4 years as associate veterinarian at the Orrville Veterinary Clinic before returning to The Ohio State University to pursue graduate study in animal nutrition and immunology, earning him an MS in 1981. He was appointed assistant professor in the Department of Veterinary Preventive Medicine the same year, just before relocating to the University of Florida to become a dairy extension veterinarian in 1982, a position he held until June of 2009. He is a Diplomate of the American College of Animal Welfare and serves as a board member and scientific advisor to multiple organizations and dairy operations. He is currently chair of the Food Animal Working Group (FAWG) of the American Veterinary Medical Association's (AVMA) Panel on Euthanasia and member of the AVMA's

Panel on Humane Slaughter and Mass Depopulation. At Iowa State University, he is responsible for the development and delivery of veterinary extension programs designed to meet the needs of dairy farmers, veterinarians, and the allied agri-business industry. His primary areas of research interest are lameness and welfare issues of beef and dairy cattle.

12-78 An overview of paratuberculosis infection: From mycobacteria to dairy populations.

Owen Rae and Pablo Pinedo*.

Paratuberculosis or Johne's disease (JD) is a chronic infectious disease affecting primarily ruminants, caused by *Mycobacterium avium* ssp. *paratuberculosis* (MAP) and characterized by granulomatous enteritis that results in profuse diarrhea and progressive weight loss (Chiodini et al., 1984). The progressive form of clinical paratuberculosis is characterized by production losses and severe emaciation, leading to death, because no effective treatment is available (Koets et al., 2015). Most cattle with JD are infected as calves by fecal-oral transmission, and in utero infection has been reported (Whitlock and Buergelt, 1996). Notably, most infected young animals manifest no clinical signs and the incubation period ranges from 2 to 10 yr (Whitlock et al., 2000). The lesions are confined to the intestine and the mesenteric and ileocecal lymph nodes (Buergelt et al., 1978) and the disease is characterized by granulomatous enteritis, which leads to chronic, unresponsive diarrhea. Paratuberculosis has a worldwide distribution and is categorized by the Office International des Epizooties as a list B disease, which is a serious economic or public health concern (OIE, 2004). Although paratuberculosis primarily affects cattle, goat, and sheep, the infection also occurs in other ruminants and wildlife (Eglund, 2002). Despite the availability of different tests, antemortem diagnosis of paratuberculosis has been characterized by inaccuracy due to the limitations in sensitivity (in most of the cases) or specificity of the current diagnostic tools (Stabel and Bannantine, 2005). In addition to animal health and welfare implications and significant economic losses caused by JD to the cattle industry, a suggested role for MAP in the etiology of Crohn's disease in humans represents an extra concern. Although an association between MAP and Crohn's disease has been documented (Sechi et al., 2005; Scanu et al., 2007), a causal link has not been shown (Feller et al., 2007; Waddell et al., 2015). Current gaps in knowledge include the mechanisms involved in differential age susceptibility and variable patterns of shedding, the genetic basis for host resistance to MAP infection, and potential diagnostic tools for early detection of infection.

Session A: Monday, 1:45 PM, Amphitheater

Session B: Wednesday, 10:45 AM, Court A-D



Pablo Pinedo is an assistant professor in dairy systems management in the Department of Animal Sciences at Colorado State University. He obtained his DVM from the University of Chile and his PhD from the University of Florida. His doctoral work was centered on Johne's disease diagnosis and the association between genetic variation and susceptibility to infection. Subsequently, he completed the residency program in the Food Animal and Reproduction Medicine Service of the University of Florida and joined Texas A&M University for 4 years as assistant professor in ruminant health. His main research goal is to improve health, well-being, and productivity of dairy cattle by use of epidemiology and emerging tools, such as genomic analysis and precision dairy technologies.

Section 13: Business, Economic Analysis, and Decision-Making

13-79 Benchmarking dairy farm financial performance.

Christopher Wolf* and Nicole Olynk-Widmar.

Farm financial benchmarking helps managers to identify areas for improvement, set targets for performance, and focus on planning and managing finances. The objective of this chapter is to explain and consider how benchmarking dairy farm financial performance can inform and facilitate informed decision-making. Key financial statements that are particularly relevant for farm financial benchmarking are the balance sheet and income statement. The balance sheet summarizes the value of all farm-owned assets and all of the debts or liabilities held by the farm business. An income statement reports the profit the business generated over a specific period. Because farms vary in size and scope and the economic landscape changes over time depending on price levels and other conditions, financial ratios are useful to standardize and facilitate comparison across farms and over time. There are multiple dimensions to the financial condition of a farm business that relate to the ability to generate sufficient returns, pay bills as they come due, and maintain sufficient assets to adequately account for liabilities against the farm business. Liquidity is the ability of a business to meet its cash financial obligations as they come due. Working capital is a dollar measure of liquidity defined as total current farm assets minus total current farm liabilities. Profit is a dollar value defined as revenues minus the cost of production. Profit is a flow concept, meaning that it measures what is occurring in the business over a period of time, usually a year. Profitability is the extent to which income is generated to adequately cover costs, including a fair return to management and capital invested. To measure profitability, we use rate of return on assets, defined as operating profit divided by total farm asset value, which controls for farm asset size. Farm size, usually measured by milking herd size on dairy farms, is an important aspect to consider when choosing relevant benchmarks. Larger herd size is often associated with more specialization in the milking herd (i.e., less allocation issues). The average benchmark provides a reference point for recognizing better than average performance. Benchmarks from high-profit farms can be useful goals if current farm performance is falling short. When benchmarking, it is also important to consider reasons why your farm may be unique and have some measures outside recommended levels.

Session A: Monday, 3:45 PM, Prince of Wales

Session B: Wednesday, 8:00 AM, Prince of Wales



Christopher (Chris) A. Wolf joined the Agriculture, Food, and Resource Economics Department at Michigan State University in 1997 and currently a professor in the department. He also works as an extension dairy specialist. Wolf has a BS from the University of Wisconsin and a PhD from the University of California–Davis. His research and outreach interests include farm management, dairy markets and policy, risk management, economics of livestock disease, structural changes in agriculture, technology adoption, and farm size distribution.

13-80 Economic consequences of production diseases in dairy farming.

Henk Hogeveen and Mariska van der Voort*.

To support decisions in the field of animal health on dairy farms, knowledge of the impact of diseases on farm profitability is important. Production diseases on dairy farms decrease the efficiency of milk production, requiring a higher level of input to produce the same amount of milk. The optimal production with and without disease will differ for a specific farm. To estimate the economic effects of a production disease, preventive costs and failure costs can be distinguished. Failure costs are associated with production losses (including milk production decrease, mortality, and culling), treatment costs (including veterinarian, drugs, labor, and discarded milk), and the risk of new cases of disease. Preventive costs are associated with preventive measures (including costs of diagnostics, labor costs, and veterinary service). The total costs of disease can be large, and there is a large variation in costs of disease between farms. Economic calculations to support decision making therefore need a farm-specific approach, where a reduction in failure costs due to implementation of a preventive measure will be compared with the additional costs of that preventive measure.

Session A: Monday, 4:30 PM, Prince of Wales

Session B: Wednesday, 8:45 AM, Prince of Wales



Mariska van der Voort completed an MS in animal sciences at Wageningen University, the Netherlands, and then began working toward a PhD at Ghent University, Belgium. Her research focused on the economic impact of gastrointestinal nematode infection in dairy cattle using production economic theories. After successfully defending her PhD in January 2015, van der Voort started working at the Institute for Agricultural and Fisheries Research, Belgium, on animal health economics and decision support systems. Since December 2015, she has been working as a post-doc at the Business Economics Group, Wageningen University, focusing on the economics of production diseases in dairy cattle and operational and strategic decision making.

13-81 Using herd somatic cell counts and clinical mastitis reporting to monitor herd performance and effect change.

Mark Kirkpatrick* and Jerry Olson.

Milk quality is a critical control point with several ramifications in a dairy operation. It is closely related to production, cow health, reproduction, and overall profitability of the dairy. Even without the presence of milk quality bonuses, it remains in the financial best interest of the producer and veterinarian to actively monitor this area and exert control. The DairyComp 305 database was used to document the performance of a dairy herd with respect to udder health and milk quality. Monitoring is best accomplished through using a set of defined commands to produce routine and repeatable somatic cell determinations and evaluation of on-farm clinical mastitis treatments. This develops a more complete picture of the farm's situation. There is a trend in dairy operations to devalue routine component and somatic cell count determinations on a herd level in an effort to save expenses. These tests are a valuable resource; unfortunately, the utility and value of these determinations have not been adequately demonstrated to dairy owners by their advisors. With a repeatable and methodical framework to access this information, the value can be clearly demonstrated.

Session A: Tuesday, 8:00 AM, Prince of Wales

Session B: Wednesday, 10:00 AM, Prince of Wales



Mark Kirkpatrick is a graduate of Iowa State University Department of Dairy Science, with BS (1985), DVM (1989), and MS (2000) degrees in veterinary clinical sciences. He practiced 9 years in mixed practice in northeast Iowa with an emphasis on swine and dairy work, and he returned to Iowa State University as food animal ambulatory clinician and veterinarian for the Animal Care and Use Committee at the College of Veterinary Medicine. In addition to providing veterinary services for the university's herds, he was active in dairy extension, field investigations, and student teaching in dairy production medicine. Based on an Iowa State field investigation, he published a case report on jejunal hemorrhage syndrome of dairy cattle. His MS work focused on cell-mediated Johne's disease testing. Kirkpatrick is a collaborator with the Iowa State College of Veterinary Medicine and is actively involved in VDPAM 484 (Senior Veterinary Student Dairy Rotation).

Currently he is a manager in the dairy technical services group and is the information management specialist for the dairy production specialist team. His area of emphasis includes records evaluations, fresh cow performance, and calf operations. He is located in Kuna, Idaho.

13-82 Dairy decision making in a financial context.

John Fetrow and Steve Eicker (presented by Albert De Vries*).

Dairies operate in a changing environment. There are opportunities for increasing profit both through better management of the existing system and by changing the system itself. Financial evaluation can help inform decision makers as they consider making changes, and useful techniques exist to make those financial evaluations, most starting from simple partial budgets. The concept of marginality and marginal decision making is key to making the right decisions on dairies. Dairy farmers and their advisors can be led astray, however, when they begin to base the next marginal economic decision on the overall historic average performance in the herd or the industry. Marginal milk (added revenue minus the cost of the feed to support the added production) is very profitable on any dairy and is not related to the dairy's average feed cost or its overall profitability. Getting cows to eat more feed, thus getting them to produce more milk will essentially always produce more profit. Dairy producers and their advisors have a responsibility to think freshly (and marginally) about the parameters and techniques used for decision making on dairies. For example, income over feed cost is the proper parameter to monitor and calculate when considering the financial value of a proposed feeding change. Cost control is a key factor in dairy profitability, but there are circumstances where a broader understanding of the dynamics that lead to profit can help dairy farmers focus their thinking and make informed decisions.

Session A: Tuesday, 8:45 AM, Prince of Wales

Session B: Wednesday, 10:45 AM, Prince of Wales



John Fetrow is professor of dairy production medicine, College of Veterinary Medicine at the University of Minnesota. Fetrow has served on the faculty at colleges of veterinary medicine at the University of Minnesota (since 1991), North Carolina State University, and the University of Pennsylvania. He has nearly four decades of on-farm dairy experience and academic work in dairy production medicine and field large animal practice. He was the co-author of the textbook "Herd Health: Food Animal Production Medicine" and has co-authored numerous articles in professional journals and for dairy production specialists. Fetrow's current academic focus is in dairy production management, the economics of operating decisions made on dairy farms, disease control, and drug use management on dairies. John Fetrow is a Diplomate of the American Board of Veterinary Practitioners, Dairy.

13-83 Dairy risk management.

John Van Sickle*.

Risk management is a challenge for all agricultural producers, but several alternatives exist that can be used by dairy producers. Risk is defined by the uncertainty and volatility in expected returns to production of an economic good. Agriculture poses many risks that include production risk, price risk, financial risk, institutional risk, and human risk. Many agricultural producers focus on production risk management and the challenges that affect productivity and quality. Production risk can be managed with human capital and crop insurance for those products where it is available. Financial risk management starts with understanding your financial health and your ability to access the necessary resources to achieve the objectives in the organization. Institutional risk management begins with understanding the current public policies that affect your operation and the means you have to manage their effect on your operation. Title I Farm Bill programs are the first and most visible of those institutional policies that have a direct effect on your returns. Conservation programs can also have significant impacts on your operations and should be monitored for potential changes and their effects on your operation. Human resource risk management centers on the people who work with your operation. Risk management in this area should focus on training and insurance. Price risk management focuses on the prices of inputs you need to purchase and the prices of products you sell. One of the primary inputs associated with dairy production is feed. Nationally, feed represents 76.9% of total operating costs and purchased feed represents 50.9%. These parameters imply that milk producers should be paying close attention to the prices they receive for milk and the prices they pay for feed purchased. Hedging with futures and options can also be done for milk by trading class III milk on the Chicago Mercantile Exchange (CME). Livestock Gross Margin Dairy (LGM Dairy) insurance is another tool that can be used to manage price risk associated with milk and feed cost. This insurance product allows you to purchase margin insurance for the difference between feed cost and milk value, as determined by prices from the CME for corn and soybean meal and the CME for milk. The Margin Protection Program for Dairy (MPP-Dairy) is the newest tool to be made available to dairy producers; it replaces the Milk Income Loss Contract (MILC) program administered by the USDA FSA. MPP-Dairy gives producers the opportunity to protect the margin between the all milk price and average feed cost. Risk management is a critical management practice that all producers should take an active interest in.

Session A: Tuesday, 9:30 AM, Prince of Wales

Session B: Wednesday, 11:30 AM, Prince of Wales



John J. Van Sickle is professor of food and resource economics and director of the International Agricultural Trade and Policy Center (IATPC) at the University of Florida. He earned a BS in agricultural business (1974) and a PhD in agricultural economics (1980) from Iowa State University. His current research focuses on risk management, international trade and competitiveness. A major effort has been placed on evaluating the competitiveness of products in global markets. He has developed a risk management simulation tool for futures and options to teach students and others the mechanics of trading futures and options and how they can be used for risk management. John is a member of the Agricultural and Applied Economics Association, the Southern Agricultural Economics Association, the Food Distribution Research Society, and the Florida State Horticultural Society.

Section 14: Effectively Managing Farm Employees

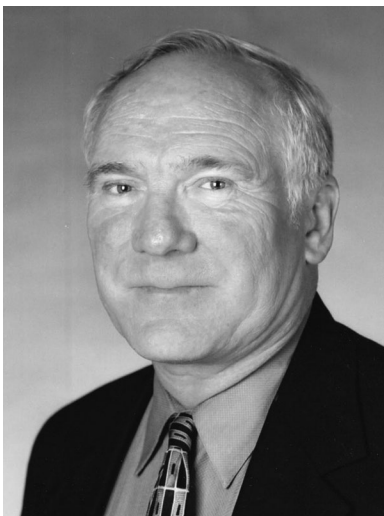
14-84 Leadership for the farm business.

Robert Milligan*.

Continued success in owning a dairy farm business today requires that owners are hard workers, great managers, and now exceptional leaders. Leadership is distinct from management—having a greater focus on followers and the world external to the farm. A descriptive comparison is “managers decide” versus “leaders rally.” Dairy farm business owners have individual leadership responsibilities to those they lead and, in multiple-owner businesses, have a team responsibility to lead the dairy farm business. The most important leadership responsibility is articulating and communicating the farm vision and core values and then embedding them in the farm business culture. Family farms have always had a vision for the farm business. The challenge today is to articulate the vision so it can become an integral part of the farm culture and provide the meaning that every member of the workforce requires to become engaged and passionate about the farm. Research in psychology and neuropsychology provides a greater understanding of the importance of the farm vision and core values. To be an effective leader of the dairy farm business, the owners must also facilitate the development of individuals and teams; be proactive, decisive decision-makers; and recognize the importance of representing the business both internally and externally. Because leadership skills are learned skills, leaders must plan for their own leadership development. Today, most farms have multiple owners; thus, leading the dairy farm business is a team function. The strategic leadership team, composed of all owners, must develop a structured approach to executing its responsibilities for the farm vision and core values, the farm strategy, and the farm business culture. Strategy development has evolved from an annual activity to a daily responsibility. At least one leader should view strategy as their most important priority. Leading thinkers in business culture now recognize that business success, including farm success, has 2 components. The first, referred to as smart, includes our traditional measures of profitability, productivity, and so on. The second, the new frontier with greatly increasing importance, is referred to as “healthy.” Healthy is represented by a culture an engaged, passionate workforce that has exceedingly high productivity while receiving great satisfaction from their personal and team accomplishments.

Session A: Monday, 8:30 AM, Prince of Wales

Session B: Tuesday, 12:30 PM, Kensington



Robert A. Milligan is senior consultant with Dairy Strategies LLC, a business, leadership, and human resource consulting business focused on the ag sector. Bob is also professor emeritus in the Charles H. Dyson School of Applied Economics and Management at Cornell University. At Cornell, he was an award-winning instructor in the tenth-ranked undergraduate business program (2015 US News). Bob is best known in extension for developing and leading the PRO-DAIRY Program, a program that developed and taught leadership and management principles and concepts.

14-85 Building the team: Continuous recruitment, selection, and on-boarding.

Melissa O'Rourke*.

Human resource management and labor expenditures are one of the highest cost categories in the dairy operation and are significantly affected by high employee turnover. Careful attention to continuous team building via well-planned recruitment, selection, and on-boarding of new employees yields substantial benefits to the dairy operation. Essential human resource management tasks include labor needs analysis and crafting of position descriptions; continuous recruitment of potential team members; thoughtful implementation of selection processes; and effective on-boarding and orientation of new dairy workers. In particular, judiciously constructed position descriptions are tools that reap multiple benefits for dairy team-building in recruitment, selection, training, development, evaluation, and overall team communication, leading to increased worker satisfaction and productivity. In regard to continuous recruitment, the dairy human resource manager will exercise creativity to identify potential team members, with special focus on word-of-mouth referrals and social media contacts. Dairy managers report that a continuous internal employee referral process can be the top source for dairy team candidates. Whether or not a current vacancy exists, successful dairy team building includes maintaining a continuous file of potential candidates from multiple sources along with regular screening interviews. Additionally, when a strong candidate is identified, the skillful dairy human resource manager explores avenues to connect the individual to the dairy on a part-time or temporary basis until a permanent position opens on the farm. Meticulous preparation for the critical pre-employment interview is an essential aspect of the dairy team building process. The effective dairy human resource manager makes wise use of precious time with the job applicant, both in terms of information shared with and solicited from the candidate. Careful formulation of interview questions aids in evaluation and comparison of candidates as similar inquiries are posed to each applicant. Dairy managers who have taken the time to develop thoughtful position descriptions have a document that provides significant guidance in planning interview questions. Following selection, new employee on-boarding and early orientation must be given high priority, as the ability to get a new employee off to a strong start sets the stage for a satisfying, long-term employment relationship on the dairy farm.

Session A: Monday, 9:15 AM, Prince of Wales

Session B: Tuesday, 1:15 PM, Kensington



Melissa O'Rourke is an attorney and farm and agribusiness management specialist and extension dairy team member for Iowa State University Extension and Outreach. She holds a BS from Illinois State University, an MA from the University of Minnesota, and a JD from the University of South Dakota School of Law, and she is admitted to the bar in Iowa, South Dakota, and Nebraska. Melissa has practiced in the fields of business and estate planning, employment legal issues, and agricultural commercial litigation. She has worked with numerous farm and ranch families to facilitate planning for management of their farm businesses. Melissa's work with Iowa State University combines her background in education, agriculture, and law as she informs and advises members of the farm and agribusiness community on an expansive array of business planning and legal topics.

14-86 Compensation, bonuses, and benefits: Key start to building a committed, productive workforce.

Felix Soriano*.

A good compensation program that is clearly communicated can be a great start to building a committed and highly productive workforce. It can also be a powerful management tool to help recruit better quality employees and achieve high employee tenure. Having a well-defined and clearly communicated compensation strategy will also reduce employers' and managers' headaches due to constant requests for raises from employees. A good, comprehensive, compensation package should include a clear, well-defined, wage structure (direct compensation or base pay), a bonus or incentive program (variable pay), and a well-defined benefits package (indirect compensation) for each employee at the dairy. But, before developing the compensation package, the employer needs to define what his or her compensation philosophy is. The compensation philosophy should be in line with the values, vision, and mission of the operation. Finally, a compensation package must be clearly communicated to all employees

Session A: Monday, 10:30 AM, Prince of Wales

Session B: Tuesday, 2:00 PM, Kensington



Felix Soriano, president and founder of APN Consulting and apndairy.com, has more than 18 years of experience working with dairy producers and he has dedicated his career to developing tools, services, and programs to improve dairy farm performance and profitability. Felix has a BS in animal science from Universidad Católica Argentina (1994), and an MS degree in dairy nutrition from Virginia Tech (1998), and he received an Agricultural Labor Management Certificate from the University of California (2008). Felix worked for a feed company (Central Connecticut Cooperative) after finishing his MS degree. He then worked as a manager for a feed additive company (Alltech Inc.), where he had the opportunity to build his own team, which helped him develop his leadership and supervisory skills. For the last 9 years, Felix has been sharing his labor management experience with many dairy producers in the United States through his consulting company, APN Consulting LLC.

14-87 Building a culture of learning and contribution by employees.

Phil Durst* and Stan Moore*.

Through interviews with 174 dairy farm employees from 13 farms in 4 US states, we found that employees have a desire to learn and a commitment to the success of the farm operation. It is the responsibility of the dairy management team to recognize that desire and commitment, to build on the desire to learn, and to nurture the commitment to success for the greatest benefit to the business. Effective training programs build on this foundation of learning and commitment and ultimately improve farm productivity and profitability. Successful programs include training that is frequent, progressive, and protocol driven, and that teaches the “why” of farm protocols. Effective training programs also continue to be reviewed and revised as employees help us build upon previous successes and address shortcomings. A culture of learning and contribution by employees requires that dairy owners and managers believe in the value and worth of each individual who works for them and build relationships with employees based on mutual trust.

Session A: Monday, 11:15 AM, Prince of Wales

Session B: Tuesday, 3:15 PM, Kensington



Phil Durst, MS, PAS, is a field-based Michigan State University (MSU) Extension dairy educator with an emphasis on cattle health. He works extensively with MSU veterinarians and is an extension affiliate of the MSU College of Veterinary Medicine. Durst initiated and led a project to improve employee management on dairy farms and has presented findings at academic conferences and producer meetings. He is involved in a major project to reduce mastitis and antibiotic use, as well as several projects on bovine leukemia virus. Durst also works to help young dairy people develop their skills and abilities as farm managers through a peer group that meets monthly, a Facebook page for young people in dairy (“Young, Savvy & into Dairy”) and “Dairy Moosings” podcasts with Stan Moore. He was recognized in 2016 with the Distinguished Academic Staff Award by Michigan State University.



Stan Moore is an MSU Extension senior dairy educator in the northwest area of the lower peninsula of Michigan. Moore has served with MSU Extension for 25 years in various roles, including agricultural educator and county extension director. He has led successful statewide educational efforts in calf care and agricultural labor management. Stan received both his BS and MS degrees from MSU in animal science with an emphasis in dairy nutrition. Moore has authored and co-authored several agricultural labor resources (bulletins, factsheets, and templates). Moore is also involved in a multi-state project on employing employee feedback for improved employee management on dairy farms with Phil Durst. He is a co-investigator on a multi-state USDA project to reduce mastitis and improve antibiotic use on dairy farms. He lives in Central Lake, Michigan, with his wife Gayle; they have one daughter and two sons.

14-88 Setting goals and using performance feedback effectively.

Jorge Estrada*.

The focus of this chapter is to provide dairy managers and supervisors worldwide with a practical framework and hands-on tools to execute their work swiftly and effectively and to have an effect on everyday results. A systemic approach to performance management is given so that users can gain perspective and understand the processes fully and how to apply the skills. The objectives of the chapter are (1) to present a framework for performance management, (2) provide a process for setting goals, and (3) build skills in using feedback effectively in a step-by-step manner. Setting goals and using performance feedback effectively are 2 key responsibilities of dairy managers to accomplish sustainable results on their enterprises. The framework for managing performance effectively includes (1) setting behavioral standards and performance expectations; (2) SMART goal alignment, identification and prioritization; (3) performance coaching, using performance feedback effectively; (4) performance evaluations; (5) change in responsibilities, pay increases and promotions. As managers measure and quantify the performance of their employees in their teams and individuals, they integrate 3 types of performance feedback: recognition, redirection, and reprimand. Each type of feedback gives managers situation-based skills and approaches. Then, we provide managers a practical guide for a performance feedback conversation, following a 5-step process: (a) stating your intentions and expectation; (b) describing your observations; (c) explaining the impact; (d) asking the employee to respond; (e) focusing on empowered action to solution (action plan). It is important for managers to understand and be able to lead employees to outstanding results. To achieve outstanding results, employees need empowered and focused actions. To take empowered action, employees need clear agreements and clear understanding. To achieve clear agreements, employees and managers need to have powerful conversations. The practical processes in this chapter aid in bringing powerful conversations to setting goals and providing performance feedback, which encourage the strengthening of the employee-supervisor direct relationship, affecting employee engagement, productivity, and bottom-line results.

Session A: Monday, 1:00 PM, Prince of Wales

Session B: Tuesday, 4:00 PM, Kensington



Jorge Estrada is the founder and CEO of Leadership Coaching International Inc. (LCI Inc.) and co-founder and director of Centro Liderato, both of which are committed to integrating the transformation of persons, teams, and organizations. He considers himself a biologist of organizational systems. Jorge received his biologist degree from El Zamorano, the Pan-American School of Agriculture in Honduras, his BS and MS degrees in business management from Kansas State University, and his leadership coaching certification from the Hudson Institute of Santa Barbara, California. Before launching LCI Inc. in 2000, he worked in the feed and pharmaceutical industries in the United States and abroad, serving management roles in growing organizations. Jorge is originally from Guatemala and he coaches, trains, facilitates, and consults globally, including organizations in the United States, Mexico, Guatemala, Canada, Costa Rica, Honduras, El Salvador, Nicaragua, Argentina, Finland, Puerto Rico, Dominican Republic, Chile, Thailand, Spain, Bolivia, and Great Britain. Jorge consults, trains, and coaches for English- and Spanish-speaking clients.

14-89 Overcoming challenges and building team cohesion.

Barbara Dartt*.

A cohesive team is a group of interdependent people who rely on each other to accomplish the desired outcome. Cohesive teams have repeatedly been found to be more productive than work groups. In fact, cohesive teams are greater than the sum of their parts. Cohesive teams feature commitment of their members—commitment to both a clear common purpose and to the way the work will be completed. Teamwork on dairies is clearly required to effectively and humanely produce milk. Interdependent teams exist in many areas with a dairy business, including cow health and the parlor, crop and dairy teams, heifer and dairy teams, and shift-to-shift in the parlor, to name just a few. Building these cohesive and highly productive teams requires a set of skills that have not traditionally been valued in the dairy business. These skills focus more on business culture and relationships than on deep technical knowledge. Many challenges exist to the formation and maintenance of cohesive teams. Most can be traced back to the management and leadership ability that exists within the business. Leaders either do not have the skills they need to build a culture that supports teams or they lack the coaching ability to help their team members grow and develop into strong team members. The challenges include dilemmas that are unique to family-owned businesses, leaving team members out of the communication loop or overstepping the lines of authority. In addition, the unwillingness or inability to provide constructive feedback and the tendency to micromanage get in the way of cohesive teams. Ways to tackle each of these challenges are outlined within the chapter.

Session A: Monday, 1:45 PM, Prince of Wales

Session B: Tuesday, 4:45 PM, Kensington



Barbara Dartt, DVM, MS, is a consultant for The Family Business Consulting Group (FBCG), assisting businesses with succession strategies, long-term planning, management transitions, and family governance implementation, as well as other opportunities and challenges unique to family-owned businesses. Barb's path into family business consulting is based in very traditional roots. Growing up, she watched her grandfather and father provide educational extension services to family-owned farms. Her interest in serving farm families led her to study veterinary medicine, earning her doctoral degree from Michigan State University (MSU) in 1996. In 1998, Barb earned an MS in agricultural economics at MSU where she worked as a graduate research assistant, and then as a farm business management specialist. She continued her family legacy as a third-generation extension agent, working closely with family farms to enhance their business practices, develop management skills, and identify growth opportunities. In 2014,

Barb joined FBCG to leverage her extensive advising experience to work with family enterprises across industries. Barb earned an advanced certificate in family business advising from the Family Firm Institute in 2014. She recently wrapped up six years as director and past-president of the Michigan FFA Foundation. Barb lives in Olivet, Michigan, with her husband and three children; she enjoys cooking, reading, and cheering on her favorite basketball teams.

14-90 Effective and efficient operations management for farm staff.

Kay Carson*.

Manufacturing industries, from auto to aerospace to pharmaceuticals, have long used a management system known as lean to improve production efficiency. Lean management achieves this through employee engagement in pursuing excellence in production performance. In very simple terms, staff activity and costs are focused exclusively on activities that add value to the business. As companies have done so, they have reaped the rewards of sustained profitability. Can the principles of lean management be applied to dairy farm operations; and can their application increase profitability and employee engagement in the business? Can industrial production management work for the management of cows, which are not machines, and employees, who can be seen as a cost and not as value-adding agents on farm. Based on research carried out on commercial dairy farms in Cheshire, England, we believe that the answer to all these questions is “yes” but that it requires a new management culture in both farm managers and employees. This chapter describes how the implementation of lean principles in dairy farm management can achieve effectiveness and efficiency in dairy operations. Dairy operations are effective when they achieve their targets, and they are efficient when they do so at minimum unit cost. Six years after the start of the research project on which this chapter’s conclusions are based, the first 6 participating farms are still achieving a 10% return on dairy assets before depreciation and tax. The success of dairy lean management is founded on 2 pillars: (1) technical knowledge of all dairy production processes, and (2) staff engagement with the goals of the dairy business. A thorough quantitative understanding of the best achievable technical performance of any given dairy system and the alignment of business targets with that performance is essential to the production of realistic production targets. Once these are set, they become the focus of daily staff activity. Lean staff teams are responsible for the delivery of these targets and they do so by operating in a culture of daily accountability. Staff members know the targets to be achieved and how to achieve them, and they can be confident that their performance will deliver business goals. As a result, staff stress levels and turnover are low. Finally, lean staff teams are trained and coached by the business’s leadership team to be intelligent, inasmuch as they can learn from their mistakes and apply new knowledge as their part in a continuously improving business.

Session A: Monday, 2:30 PM, Prince of Wales

Session B: Wednesday, 8:00 AM, Kensington



Kay Carson is an agricultural economist specialising in the economics of milk production. She works as an independent consultant in Cheshire, United Kingdom. Since 2010, Kay has been working on bringing the principles, tools, and techniques of lean management and modern management to British dairy farms. Kay moved to the UK in 1982 from Uruguay, where she was born and raised.

Section 15: Precision Management Technologies

15-91 Precision dairy monitoring technology implementation opportunities and challenges.

Jeffrey M. Bewley*, Matthew Borchers, Amanda Stone, Carissa Truman, Amanda Lee, and Karmella Dolecheck.

Technologies are changing the shape of the dairy industry across the globe. In fact, many of the technologies applied to the dairy industry are variations of base technologies used in larger industries such as the automobile or personal electronic industries. Undoubtedly, these technologies will continue to change the way that dairy animals are managed. This technological shift provides reasons for optimism for improvements in both cow and farmer well-being moving forward. Many industry changes are setting the stage for the rapid introduction of new technologies in the dairy industry. Dairy operations today are characterized by narrower profit margins than in the past, largely because of reduced governmental involvement in regulating agricultural commodity prices. The resulting competition and growth has intensified the drive for efficiency, resulting in increased emphasis on business and financial management. Furthermore, the decision-making landscape for a dairy manager has changed dramatically with increased emphasis on consumer protection, continuous quality assurance, natural foods, pathogen-free food, zoonotic disease transmission, reduction of the use of medical treatments, and increased concern for the care of animals. Last, powers of human observation limit dairy producers' ability to identify sick or lame cows or cows in heat. Precision dairy monitoring may help remedy some of these problems. Precision dairy monitoring is the use of technologies to measure physiological, behavioral, and production indicators on individual animals to improve management strategies and farm performance. Precision dairy monitoring technologies provide tremendous opportunities for improvements in individual animal management on dairy farms. Although the technological "gadgets" may drive innovation, social and economic factors dictate the success of technology adoption. Excitement about technical capabilities must be balanced with consideration of implementation challenges.

Session A: Monday, 8:30 AM, Court A-D

Session B: Tuesday, 12:30 PM, Amphitheater



Jeffrey Bewley is from Rineyville, Kentucky, where he grew up working on his grandfather's (Hilary Skees) dairy farm. He received a BS in animal sciences from the University of Kentucky in 1998. In 2000, he completed his MS in dairy science at the University of Wisconsin-Madison under the direction of Roger Palmer. His PhD work under Mike Schutz at Purdue University focused on the application and economics of precision dairy farming technologies. Jeffrey's program focuses on precision dairy technology implementation, mastitis prevention, cow comfort, lameness prevention, and decision economics.

15-92 Automated detection and prediction of estrus as a complementary technology for reproductive management.

Julio Giordano* and Paul Fricke.

Achieving and maintaining high estrus detection (ED) efficiency and accuracy is critical for dairy farms, in which insemination of cows in estrus is an integral part of the reproductive management program. Because traditional methods of ED have multiple limitations, many dairy farms fail to implement a successful ED program. Therefore, automated ED systems have been developed to help dairy managers identify and inseminate cows in estrus. Most systems use sensors attached to the cow to monitor physical activity (PA) and generate estrus alerts based on the increase in PA associated with estrus in cattle. Research studies and observations from commercial dairy farms that incorporated automated activity monitoring systems (AAMS) confirmed that most the cows that display estrus can be detected. Nonetheless, a combination of physiological, management, and environmental factors that contribute to reduce estrus expression in lactating dairy cows coupled with technical limitations of AAMS limit the success of reproductive management programs designed to submit all cows for insemination based on PA. Thus, dairy farms that incorporate AAMS for ED should implement a program that combines insemination of cows based on PA and synchronization of ovulation protocols for timed AI. Multiple reproductive management strategies combining these 2 methods can be designed to meet the needs and demands of dairy farms and achieve optimal reproductive performance. In the future, technological advancements and improvements will help refine existing and develop novel methods and devices for automated ED thereby favoring adoption by dairy farms.

Session A: Monday, 9:15 AM, Court A-D

Session B: Tuesday, 1:15 PM, Amphitheater



Julio Giordano obtained his DVM degree at the Universidad Católica de Córdoba, Argentina (2005), an MSc in animal science at the University of Tennessee-Knoxville (2007), and completed his PhD in dairy science at the University of Wisconsin-Madison (2011). After working as a postdoctoral research associate in the Department of Dairy Science at the University of Wisconsin-Madison (2012), he joined the faculty in the Department of Animal Science at Cornell University (2012) as assistant professor of dairy cattle biology and management. His current position includes 50% research and 50% teaching appointments in dairy cattle reproduction, health, and economics of dairy farms.

15-93 Opportunities for managing health and well-being using precision technologies.

Christina Petersson-Wolfe*, Turner Schwarz, Brian Dela Rue, and Nicole Steele.

Disease prevention and treatment is a constant focus in the management of a dairy herd. Historically, dairy producers have focused much of their health management efforts on the treatment of disease. However, more recently, dairy producers have adopted a more proactive health management strategy and in response, advanced technology tools for monitoring herd health have been developed. Developments in on-farm monitoring technologies have allowed producers to enter the realm of “precision dairy farming,” which is defined as a collection of technological advances that can measure physiological, behavioral, and production indicators on individual animals. These advancements provide management tools to identify problem areas related to reproduction, nutrition, dairy calf management and feeding, dairy cattle health, mastitis, and milk quality. The opportunities for managing health and well-being using precision technologies is advancing at a rapid rate and is limited only by the speed at which researchers can evaluate and discern the masses of data that are collected from these advancements. The objective of this chapter is to discuss the current state of knowledge regarding disease identification as it relates to the dairy industry, from the standpoint of lactation and nonlactating animals, as well as young stock.

Session A: Monday, 10:30 AM, Court A-D

Session B: Tuesday, 2:00 PM, Amphitheater



Christina Petersson-Wolfe is an associate professor of dairy science at Virginia Tech. She completed her BS (dairy and animal science) at Penn State University, MSc (epidemiology) at the University of Guelph, and PhD (animal science) at Ohio State University in 2006. Her research interests are focused around mastitis prevention, disease detection, and animal well-being. Currently, she has a heavy extension appointment, where she works directly with stakeholders in the field, while also maintaining an active research program.

15-94 Principles to determine the economic value of sensor technologies used on dairy farms.

Mariska van der Voort*, Henk Hogeveen, and Claudia Kamphuis.

Precision dairy farming (PDF) technologies are tools that automate the process of monitoring behavioral and physiological parameters that are related to health or fertility of individual cows. Dairy farmers can use information retrieved from these technologies to take appropriate management actions, such as inseminating a cow or starting an antibiotic treatment. Despite advantages that PDF technologies can offer, adoption is still limited. This is explained by the lack of information on added economic value when these technologies are used on-farm. Without this information, farmers cannot make well-informed investment decisions. To determine the economic value of PDF technologies, the straightforward partial budget can be used. This economic tool allows an estimation of extra costs and benefits that result from using a PDF technology. Because PDF technologies concern long-term investments, an investment analysis can be used to retrieve a more precise estimation of the economic value. An investment analysis takes into account the different periods between costs made and benefits retrieved by converting current and future extra costs and benefits into present values. Uncertainties or risks that are inherent to dairy farming are not captured in an investment analysis. To account for these, simulation modeling is helpful to make results easier to interpret. Simulation modeling, however, is only of interest to farmers when the model is combined with an interface that allows farmers to complete only required farm data, and where the actual simulation takes place in the background. For any of these 3 economic tools, the lack of clear cost benefit information is the most limiting factor in their application. Although many PDF technologies aim at improving animal health and disease costs are known for many production diseases, the parameters monitored by PDF technologies cannot always be associated with an animal health disorder or with a clear management action. Moreover, there is no evidence that implementing PDF technologies actually improves key performance indicators of animal health and production in dairy herds. Even though the economic value is unknown for many PDF technologies, farmers do invest in them. The driver of farmers investing in PDF technologies may not be the economic value, but farmers' preferences and social impact may be as important or even more important than the potential economic benefits.

Session A: Monday, 12:30 PM, Court A-D

Session B: Tuesday, 3:15 PM, Amphitheater



Mariska van der Voort completed an MS in animal sciences at Wageningen University, the Netherlands, and then began working toward a PhD at Ghent University, Belgium. Her research focused on the economic impact of gastrointestinal nematode infection in dairy cattle using production economic theories. After successfully defending her PhD in January 2015, van der Voort started working at the Institute for Agricultural and Fisheries Research, Belgium, on animal health economics and decision support systems. Since December 2015, she has been working as a post-doc at the Business Economics Group, Wageningen University, focusing on the economics of production diseases in dairy cattle and operational and strategic decision making.

15-96 Automated on-farm milk component testing analyses for precision management of feeding, reproduction, and health.

David Barbano*.

An automated milk component analysis system to measure fat, protein, and lactose using near-infrared (NIR) analysis technology integrated into a milking system is commercially available. The milk weight plus the milk composition data can be used to monitor component production and detect when a ration change may be negatively affecting milk composition. The ratio of milk fat to milk protein concentration may be used as a predictor of transition cows that have a higher probability of subclinical or clinical ketosis. This is the beginning of milk analysis for individual cow precision management. The evolution of farm structure to much larger scale milk producing units using intensive management approaches offers the opportunity for cost-effective use of milk component analysis. We need to start thinking of milk component analysis as more than fat, protein, and lactose. In the broader sense, this opens up a path to extract more information from milk mid-infrared (MIR) spectra for use in management of feed efficiency, health, and reproduction of individual dairy cows. Recent work that demonstrated the relationship between milk fatty acid composition and bulk tank milk fat and protein test has opened up a new perspective in milk component analysis. Application of higher frequency MIR fatty acid testing to milk from individual cows, coupled with the fat, protein, lactose and milk urea nitrogen and milk weight adds value to the milk technology that can support precision management decision making. Recent success in estimating blood nonesterified fatty acids level by extracting more information from the same milk MIR spectra will continue to build the value returned by the investment in real-time milk testing technology while reducing stress on cows. Additional farm management metrics extracted from a MIR milk spectra will foster further development of milking systems with integrated milk component analysis for managing nutrition, health, and reproduction of individual cows.

Session A: Monday, 1:15 PM, Court A-D

Session B: Tuesday, 4:00 PM, Amphitheater



David Barbano is a professor of food science at Cornell University and director of the Northeast Dairy Foods Research Center program that is funded jointly by national and regional milk promotion units, suppliers, and dairy product manufacturers. He is also adjunct professor of animal science at the University of Vermont in Burlington. He has a BS in biology and food science from Cornell University and MS and PhD degrees in food science, also from Cornell. He has been on faculty at Cornell since 1980. Barbano conducts an applied and basic research program on natural cheeses and whey products; improvement of methods of analysis of dairy foods; raw milk and dairy food quality; and membrane filtration of milk and whey for protein separation and microbial removal. Recently, Dave has focused on developing new milk analysis measures of cow metabolic health for dairy herd management. Dave also delivers a technology transfer program to communicate research results to the dairy industry and teaches a dairy chemistry

course. He has been very active in the analytical groups of International Dairy Federation and AOAC International for the past 30 years. Barbano likes working with people who are interested in learning new things and working together with students to create new knowledge, technology, and science-based solutions to problems in the dairy industry.