ADSA Production Division: Meeting the Research and Educational Needs of the Dairy Industry During the Next 25 Years

506 Changing how we feed dairy cattle. J. R. Newbold*, *Provimi Research and Technology Centre*, *Brussels, Belgium*.

As global demand for milk continues to rise, the next 25 years will see further differentiation between two general models of dairy farming: that in which the cow is the first limiting resource (aim: to maximize yield per cow) and that in which feed, labor or some other resource is limiting (aim: to maximize return per unit of land or labor). Within each general model, cows will be fed as cheaply as possible to achieve those mixes of outputs required by specific customers: production of milk as a cheap commodity food, milk quality (safety and nutritional value), environmental stewardship, animal health and welfare (including longevity) and calf production. Advances in animal breeding should allow farmers to choose a genotype consistent with their specific environmental constraints and to reduce variability within the herd. The mix of feed resources available to the global industry may grow more diverse, while that used on individual farms may be simpler, partly in response to rising fuel costs. Nutritionists will need to predict a range of responses to diet (short-term productivity, cow health, fertility, environmental impact, etc). To achieve the necessary precision, required outputs from nutritional research include: continual improvement in feed characterization, expansion of the field of nutrition to incorporate a wider range of feed components (e.g. specific plant molecules) and, in particular, improved quantitative understanding of the molecular biology of key organ systems (e.g. mammary gland) and how these systems are integrated and regulated. Local empirical developments will remain important, but coordinated efforts to address these core issues in nutritional physiology are vital.

Key Words: Nutrition, Dairy

507 Advancements and future challenges in understanding mammary gland function. A. V. Capuco*[1], E. E. Connor[1], M. J. Meyer[2], R. W. Li[1], C. P. Van Tassell[1], T. S. Sonstegard[1], M. E. Van Amburgh[2], and Y. R. Boisclair[2], [1]*Bovine Functional Genomics Lab, USDA-ARS*, *Beltsville, MD*, [2]*Cornell University*, *Ithaca, NY*.

Examination of DHIA records demonstrates that the dairy industry has seen major increases in milk production due to improved management and genetic progress. Classical experiments discovered a great deal about hormonal regulation of mammary development and lactation. With the advent of molecular biology, greater detail has been learned about specific regulatory pathways and the multitude of interactions among them. The ability to produce quantities of bovine somatotropin through recombinant DNA technology led not only to greater elucidation of this hormone's biological effects and ultimately to its commercial application, but to a greater appreciation for the coordinated systemic regulation among tissues and organs that supports lactation and other critical physiological events such as pregnancy. Key studies in areas of photoperiodic regulation, immune function and milking management have led to further advances in production, efficiency and animal health. Beyond its impact on production, the effect of nutritional management on the myriad of physiological processes remains an active area of discovery. Transgenic approaches provide an additional means for studying mammary gland biology and, although controversial, provide a means for improving health of the mammary gland, altering milk composition, and utilizing the mammary gland as a bioreactor. Ever increasing sensitivity of methods to identify, isolate and interrogate cells will permit greater understanding of the function and interactions among mammary cells and will permit continued advances in mammary gland biology. Availability of sequence information for the bovine genome will further accelerate these advances. However, the integration of regulation at the tissue level with systemic physiology will remain a substantial challenge.

Key Words: Mammary, Lactation

508 Opportunities for improvement in dairy cattle genetics. C. Sattler*, J. M. DeJarnette, C. Marshall, and R. Nebel, *Select Sires, Inc.*, *Plain City, OH*.

Pressures to lower the cost of production have driven producers and industry to take advantage of new technologies and economies of scale. The trend toward fewer but larger herds is expected to continue. The trend toward consolidation and globalization among genetics companies is also expected to continue. To meet larger herds' needs, genetics companies will need to focus more on improving the genetics of fitness traits and to provide a higher level of service along with their products. These trends will have a huge impact on the industry's research and education needs. The most important products provided by research institutions are employable graduates. The industry's greatest employment needs in the future will be artificial insemination technicians, reproduction consultants and genetic consultants. Expansion of intern programs could be valuable to provide practical training for students. Land grant universities have an outstanding track record of delivering innovations in male and female reproduction as well as functional genomics. Universities are well positioned to continue this role. Consolidating research dollars into fewer and more specialized centers of excellence would help improve the cost-effectiveness of research. Emerging tools in this area will provide opportunities for genetics companies. To capitalize on these opportunities, genetics companies will need to accept a larger role in applied research and technology transfer. Also, much of the data that supports current genetics research has been gathered and supplied by industry. Genetic improvement in fitness traits will require a renewed commitment to identification and recordkeeping programs. Producers, industry and researchers will need to work together to accomplish this. Future industry growth will rely heavily on the people and technology resources generated by research institutions. Industry will need to play a larger role in providing the technical support for new technologies and everyone will need to work together to build effective data resources to support these efforts.

Key Words: Dairy, Genetic improvement, Industry trends

509 Transferring knowledge to students and the dairy industry. R. E. James*, *Virginia Polytechnic Institute and State University*, *Blacksburg*.

What will our students need to know for the dairy industry 25 years hence? Academics tend to focus on teaching new technologies, but this may not be the skill set needed. Surveys of industry leaders indicate that critical thinking, decision making, communication and management skills are essential and individuals should have a global perspective of pertinent issues. In contrast, universities seem to be moving on a track which emphasizes biotechnology and income generation from research grants to offset shrinking state and federal dollars. Multiple opportunities exist to achieve educational goals. One model involves teaching management skills through centers of dairy science and management that possess the critical mass of personnel and facilities. Programs are geared towards use of case studies and development of problem solving skills. The Academic Common Market Program in the southeast and the National Student Exchange programs enable students to study at universities with specialized programs and pay lower resident tuition fees. The down side of such centers is that it may weaken support for home state institutions. Fortunately high speed access to the internet has increased attractiveness of distance learning programs which permit live classroom participation at multiple sites. Distance learning programs may not be the panacea as they require considerable development time and resources for which funding can be limited. Combinations of distance learning experiences with intensive onsite programs may provide the best of both worlds. It is becoming increasingly evident that knowledge transfer may best be served from partnerships between academia and dairy industry firms using multiple educational technologies.

Key Words: Education, Dairy industry, Students

510 Design and analysis of pen studies in the animal sciences. N. R. St-Pierre*, *The Ohio State University*, *Columbus*.

Increasingly, research is being performed where animals subjected to a common treatment are also housed in a common pen. Issues have been raised regarding the proper planning of experiments and conduct of statistical analyses in these instances. This presentation reviews the problems associated with ignoring animal grouping during data analyses, and gives appropriate methods to use when animals are grouped in pens. Using animals as the error term when treatments are applied to pens can cause two types of biases. The first one is one of location, which biases point (parameter) estimates of the treatment effects. The pen effect includes unrecognized, systematic non-random effects other than that of the treatment, which is why pens must be replicated and randomized if treatment effects are to be estimated without biases. Pens also result in non-systematic random effects. These affect the variance of the sub-pen units (cows). That is, cows within a pen have more in common than cows across pens. In essence, pen studies have an implicit split-plot design where the main plots (pens) receive the treatments of interest, while the sub-plots (cows) receive all the same sub-plot treatment. Using the sub-plot error to test the effect of main plot treatment effects causes a second type of bias by creating artificial degrees of freedom, and hence biasing severely the test of significance for the treatment effects. Behind all statistical analyses is a mathematical model with its associated assumptions. The assumption with pen-based treatment is that pens have a random effect. Thus pens, or the interaction of pens with other model elements is/are the correct error term(s). The same statistical designs used with cows as experimental units can be used with pens. The number of experimental units to achieve a given power is considerably less with pens because the variance associated with pens is substantially less than the variance of cows within pens. Pens must be replicated, randomized, and included in the statistical model if treatment effects and their significances are to be estimated without biases.

Key Words: Pen studies, Statistical analysis

Animal Behavior and Well-Being

511 Behavioral time budget of dry cows: Photoperiod alters distribution of maintenance behaviors. K. E. Karvetski*, J. M. Velasco, E. D. Reid, J. L. Salak-Johnson, and G. E. Dahl, *University of Illinois*, *Urbana*.

In this study, we characterized the effect of photoperiod manipulation on the daily duration and distribution of maintenance and other behaviors during the dry period. Cows (n=22) were assigned to either short day photoperiod (SDPP, 8L:16D) or long day photoperiod (LDPP, 16L:8D) at dry-off, -42d prior to expected calving date. Cows were recorded for 24h at -41d and again at -20d using digital video recording. Using instantaneous scan sampling, individual behavior was classified at 10min intervals as drinking, feeding, lying, perching, standing, or walking. To obtain total daily time (h/d) spent engaged in a behavior, the total frequency of each behavior was calculated as a percentage of total observations and then multiplied by 24. To calculate average duration (in min) per hour of the day of each behavior, the frequency was summed hourly and multiplied by 10. During the dry period, cows spent an average of 14.1h lying, 5.3h standing, 2.2h feeding, 0.6h drinking, and 0.4h walking; there was no effect of photoperiod on total daily time for any behavior. However, LDPP increased total time spent perching from 1.6h at -41d to 2.3h at -20d ($p=0.1$), whereas SDPP decreased total time spent perching from 3.1h at -41d to 2.3h at -20d ($p=0.14$). There was a treatment by time of day interaction for feeding behavior ($p<0.0001$). Access to fresh feed at 1400h resulted in a peak in feeding times for both SDPP and LDPP cows (31.1 and 23.6min, respectively). SDPP cows had a smaller decline in feeding time afterwards; at 1600h, the SDPP feeding time of 12.1min was higher in SDPP cows than 3.6min for LDPP cows ($p<0.05$). For 2100 through 2300h, LDPP increased feeding behavior again, as the mean hourly feeding time of 11.8min for LDPP cows was higher than 3.1min for SDPP cows ($p<0.05$). In summary, photoperiod did not affect total duration of maintenance behaviors. However, the distribution of feeding behavior was affected by photoperiod. These results suggest that an understanding of maintenance behaviors requires consideration in order to improve dry cow management schemes.

Key Words: Behavior, Dry cow, Photoperiod

512 A retrospective video analysis of the behavior of periparturient dairy cattle. L. Misch, H. Putnam*, T. Duffield, S. Millman, K. Lissemore, and K. Leslie, *Ontario Veterinary College, University of Guelph*, *Guelph, Ontario, Canada*.

The impact of calving difficulty on the behavior of periparturient dairy cattle has not been reported. The objective of this study was to measure variables associated with difficulty of calving, and to identify the associations of parameters with periparturient behavior. Previously recorded videotapes of 23 cows on day –1, 0 and +1 relative to calving were analyzed. Data included frequency and duration of standing and lying behavior, calving difficulty score, duration of calving and calf body measurements. Calving difficulty was scored as: 0-unassisted,