Symposium: Ruminant Nutrition, and Production, Management & Environment Joint Symposium: Designing Field Studies to Evaluate Nutrition Effects on Production, Reproduction and Health of Dairy Cows

222 Utilizing appropriate statistical designs and techniques for data collected from commercial dairies. R. J. Tempelman*, *Michigan State University*, *East Lansing*.

Due to increasing constraints placed on conducting large studies at universities, more research is being conducted on commercial dairies thereby raising some implications for experimental designs and data analysis. For example, experimental units are often specified to be pens of animals in on-farm studies, thereby requiring that at least two pens be used per treatment group in a single dairy study. Even when treatments are compared within pens, the precision of inference on treatment differences is still primarily limited by the number of pens in the study, rather than the number of cows per treatment in each pen. Other challenges with on-farm studies include proper blocking and randomization of cows or pens to treatments. On the other hand, multiple farm studies are attractive as they facilitate a broader scope of inference on treatment effects across a wider range of management and/or climatic conditions and genetic backgrounds compared to single-site university studies. Furthermore, studies based on multiple farms or multiple pens within a single large farm can facilitate greater power for treatment comparisons on binary reproduction or health responses than can be achieved at a smaller research herd. Since quantitative geneticists have been analyzing commercial dairy data for decades, they have developed useful data analysis techniques that should be harnessed to facilitate even greater statistical scope and power for on-farm studies, such as accounting for genetic effects, stage of lactation, differences in variability across farms or management groups, and farm-specific covariates such as ambient temperature. Finally, multivariate ANOVA should be used to facilitate greater information recovery on treatment effects when analyzing several different but correlated response variables of interest.

Key Words: Experimental Design, Experimental Unit, Scope of Inference

223 Examples of experimental designs to study production responses. N. R. St-Pierre*, *The Ohio State University*, *Columbus*.

There are increasing opportunities to conduct field research in commercial herds where cows are invariably grouped in pens. Dedicated research facilities are best suited for determining mechanisms of treatment effects. Field studies on commercial farms are better suited for quantifying the magnitude of the response to dietary treatments over a broader range of environments. In nutrition field experiments, the experimental unit is generally the pen, while cows serve as sampling units. Among the many types of designs available for field studies, the best one depends on many factors, including what production trait is of primary importance. Generally, cows require 6 to 10 weeks to fully express a milk yield response to dietary treatments. This often forces the use of longitudinal designs where pens remain on their assigned treatments throughout the trial. Milk fat and protein contents and yields generally show much quicker responses, typically 2 to 4 wk. When these are the traits of importance, a vast array of rotation designs can be used with considerably more power. With longitudinal designs the use of an appropriate covariate on the sampling units (cows) generally doubles the efficiency of the experiment. Rotation designs such as the cross-over, Latin square, switchback, and double cross-over estimate treatment effects within the experimental units (pens). This generally results in considerably more power than longitudinal designs of similar size. The optimum pen size is dependent on the variation between pens (V_p) and the variation between cows (V_s). As long as all cows in a pen are participating in the experiment, the variance due to competition is not a factor in determining the optimal pen size. In this instance, $V(Y) = V_p + (V_s/k)$, where k is the number of cows per pen. Estimates of these variances in combination with the cost per cow and the cost per pen can then be used to calculate an optimal pen size. A uniformity trial can be conducted to estimate the variance components. Numerous examples with the appropriate SAS code will be presented.

Key Words: Field Trials, Statistics, Experimental Designs

224 Field studies to study reproduction in dairy cows. J. D. Ferguson*, *University of Pennsylvania*, *Kennett Square*.

Due to limited power to detect differences within university herds, it is attractive to do reproductive trials on dairy farms. Benefits include the potential to examine effects across multiple locations and diverse management systems. Field trials may examine treatment effects on cattle health which may impact on fertility, management interventions to control reproductive efficiency, and specific therapies to alter reproductive function in cows. Outcomes may comprise effects on uterine involution and endometritis, days to first ovulation, conception rate(s), pregnancy rate and overall reproductive performance, estrus expression, and pregnancy wastage. Categorical data analysis and event time models would be most appropriate to analyze reproductive data. An advantage of field studies is the ability to enroll large numbers of cows in trials; a disadvantage is the loss of control of experimental conditions. Therefore study designs need to control for extraneous variables by collecting data on potential confounders, which may have limitations based on the herd management and cost to collect it. Study designs may include split herd, random assignment of cows to treatment groups, blocked by age and season of calving. A challenge with split herd designs is ensuring similar management of each treatment group and blinding management to treatment. Alternatively, cows may be matched within herd and followed in a prospective, longitudinal trial. Herds may be matched and treatment assigned to one herd and the alternative herd untreated to act as a control. This would be an attractive approach to examine management interventions to alter reproductive performance. Challenges in field trials include ensuring herd compliance with treatment assignments, control of selective management of treatment groups, and loss of meticulousness in control of extraneous variables through study design. Studies need to be larger and more information collected on each cow to control for confounding variables.

Key Words: Field Studies, Dairy Cows, Reproduction

225 Examples of designs to study health responses and the role of meta-analysis. I. J. Lean*[1], A. R. Rabiee[1], and T. F. Duffield[2], [1]*Bovine Research Australasia*, *Camden, NSW, Australia*, [2]*University of Guelph*, *Guelph, Ontario, Canada*.

Many diseases are infrequent, rare, or sporadic in incidence, are often poorly defined and pose particular challenges in study design. The best forms of evidence are randomized controlled trials which need many cattle to study effects of interventions on infrequent health disorders. Studies conducted across several farms are more robust and have greater external validity. Other study designs that have been effective in increasing knowledge of disease include prospective cohort and case-control studies. Studies need to account for effects of time in assessing causality. Studies that evaluate surrogate measures of health such as serum chemistry and rumen parameters are helpful in understanding an intervention. These are easier to conduct but cannot be used solely to predict impacts on health.

A powerful tool for evaluating disease is meta-analysis; a formal study design used to provide a synthesis of previous studies. Typically, but not necessarily, randomised clinical trials are used to provide data. Outcomes include a more precise estimate of the effect of a treatment or risk factor on disease. Identifying sources of heterogeneity and determining the generalizability of responses can lead to more effective treatment or modification of management to prevent disease. The pooling of numerous studies allows sample size to be increased and potentially allows the effects of environment, including nutrition, on treatment responses to be evaluated. Recent examples include milk fever risk, disease and monensin treatment and impact of reproductive treatments. Despite a relatively low number of cattle used per trial, publication of disease information from physiological studies will help to evaluate the impact of interventions on health in future meta-analyses.

Key Words: Study Design, Health, Meta-Analysis

226 Collecting research data with dairy management software. L. Jones*, *FARME Institute, Inc*, *Homer, NY*.

Central to managing a modern dairy farm is an on-farm dairy management database system (on-farm system). Data relating to animal identification and performance are recorded and integrated to provide management information for the dairy farm manager. Data may include real-time milk production, milk quality, reproduction, health information, and general descriptive statistics. These on-farm systems are designed first and foremost to support managerial decisions and not as research data collection tools. Nonetheless, under certain circumstances, they can be used to collect research data. Paramount to collecting research data with on-farm systems is an appropriate experimental design. For a small scale trial, there are three prerequisites to a valid data collection project. First, the trial must be blind. Producer actions and decisions are inherently biased, and knowledge of treatments may result in biased management and biased results. Second, all data required from the producer should be entered through the on-farm system as part of the general course of herd management. Relying on the producer for supplemental data is problematic and unreliable. Third, the researcher must understand generally how data are handled by the specific on-farm system and how the individual producer defines variables on their farm. Variables with the same name can have completely different definitions between farms. The major on-farm systems have the ability to export data in a format that can be utilized by statistical analysis systems. A common feature of on-farm systems is the practical limitation of the number of events that can be recorded for each animal. Some systems have an audit feature which records variables changes, but this is not a common requirement for herd management. Prior to initiating a research trial, the historical records from the on-farm system should be exported and analyzed to ensure they support the experimental design employed. Large scale trials can be performed when the only data of interest are predefined by the on-farm system and the interpretation is unambiguous (e.g., sire identification).

Key Words: On-Farm Systems, On-Farm Research