603 How many pigs? Statistical power considerations in swine nutrition experiments. D. K. Aaron* and V. W. Hays, *University of Kentucky, Lexington*.

Replication refers to the assignment of more than one experimental unit (EU) to the same treatment. Each replication of a treatment is an independent observation; thus, each replication involves a different EU. In swine nutrition research, the EU may be an individual animal, as in sow reproduction experiments, or a group of animals, as in growing-finishing pig experiments. In either case, calculation of the number of replicates needed to give an accurate and reliable outcome is an important step in a pre-experiment protocol. Although investigators often appear to choose replication arbitrarily on the basis of cost or availability of animals, convenience, or tradition, the question of "how many pigs" (i.e., how much replication is necessary) is a statistical one that has a statistical answer. A power analysis, performed while in the process of designing an experiment, will provide an investigator with the number of replicates needed for an experiment of known power and sensitivity. This *a priori* power analysis ensures that an investigator does not waste time and resources carrying out an experiment that has little chance of finding a significant effect, if one exists. It also makes sure resources are not wasted by including more EU than are necessary to detect an effect. A second type of power analysis may also be useful. If no significant effects are found in an experiment, the investigator can assess *post-hoc* the actual power of the experiment, or may determine the size of treatment effect that could have been detected using the standard deviation and number of replicates in the experiment. This *a posteriori* or retrospective power analysis can be very useful in explaining results. If the actual power to detect an effect of the size found in the experiment is high, it can be safely concluded the treatment has no effect. If the actual power is low, results will not be sufficient to say there is no effect. The objective of this paper is to discuss *a priori* and *a posteriori* power analyses as they relate to the kinds of experiments typically conducted in swine nutrition research.

Key Words: Power, Replication, Swine Nutrition

604 Experimental design in companion animal and equine nutrition: issues and insights. C. M. Grieshop* and E. A. Flickinger, *University of Illinois*.

Numerous challenges exist in designing experiments for companion animals and horses including the small number of animals available, subjective response criteria, and high variability in most responses of interest. One of the greatest challenges in companion animal research is the inability to use large numbers of animals due to lack of availability or prohibitive costs. Experimental designs such as the Latin square and crossover design can be used to maximize power for detecting differences while minimizing the number of animals required. These designs allow animals to serve as their own baseline or controls, thus reducing variation among treatments. Another challenge that exists in designing experiments for companion animals is the subjectivity for many response criteria. Responses such as longevity, quality of life, and palatability are difficult to assess in a quantifiable and objective manner. Various defined experimental protocols have been designed in an attempt to decrease subjective variability in these measurements, but often it remains difficult to detect and interpret statistical differences. A high level of variation exists naturally for most of the responses of interest. Sources of this variation can be both within and between herds or colonies. Significant differences in genetic backgrounds and in management practices exist that can result in large differences in many different response criteria. Due to the challenges outlined, designing experiments for companion animals is a complex task. Specialized statistical designs and defined experimental protocols are necessary to minimize variability and maximize the ability to detect statistical differences in biologically significant responses in companion animal and equine experiments.

Key Words: Experimental design, Equine, Companion animals

605 Design of experiments for bioequivalence testing of biotechnology derived crops as feeds for dairy cattle. R. J. Tempelman*[1] and M. A. Faust[2], [1]*Michigan State University*, [2]*Iowa State University*.

Experiments for dairy feed product testing have been primarily designed for the purpose of providing sufficient power of test to detect economically important differences in various performance measures, e.g. milk production. The emerging importance of biotechnology derived feed crops have led to their recent comparisons with conventional feedstuffs for their effects on dairy cattle performance. A current or future goal of these studies may be to assess bioequivalence of hybrids or feedstuffs. However, experimental designs that are appropriate for testing bioequivalence may be subtly different from designs for detecting mean differences. We discuss experimental designs that may be more suitable for the purpose of bioequivalence testing in dairy cattle nutrition studies, noting that the crossover design has been already widely advocated for bioequivalence testing in clinical research studies. We further discuss the design issues pertinent to dairy nutrition studies such as group-fed versus individually fed animals and multiple testing and data reduction concerns surrounding the collection of many different performance measures. Literature estimates of mean differences and variability are used to derive representative sample size requirements for dairy bioequivalence studies.

Key Words: Dairy nutrition, Bioequivalence testing, Biotechnology crops

680 Power of the test considerations for beef cattle experiments. C. R. Richardson*[1], G. A. Nunnery[1], D. B. Wester[1], N. A. Cole[2], and M. L. Galyean[1], [1]*Texas Tech University, Lubbock, TX*, [2]*USDA-ARS-CPRL, Bushland, TX*.

The inherent value of evaluating the power of a test procedure in beef cattle experiments is similar to that for other species; however, because of major differences in the methods and conditions involved compared with other species, considerations for the use of power test procedures are distinct and specific for beef cattle experiments. Some of these major differences include: 1) lack of similar research facilities, which leads to wide fluctuations in the number of animals used per experimental unit (pen) by researchers; 2) variation in types of pens (totally or partially enclosed indoor pens, open outdoor pens, enclosed fields, or open ranges); 3) use of individual animal data from Pinpointers, Calan gates, and metabolism studies; 4) seasonal effects by region on animals housed outside; and 5) variation in the performance of control groups among locations because of differences in diet composition and animal genetics. When power tests are used in the planning and experimental design phase of a research study, they provide critical information on sample sizes necessary to detect a treatment effect at a predetermined α level. In using power tests across different experimental designs, attention should be given to the consequences of both Type I and Type II errors. Lowering the Type I error rate increases the Type II error rate and vice versa. For several common statistical procedures and experimental designs, power tables are available; however, none specifically addresses beef research, and software is not readily available. Data will be reviewed from published beef cattle research in which comparisons can be made to determine the effects that experimental design, numbers of animals within the experimental unit, number of replications, type of housing, regional effects, feed composition, and genetics have on power tests. Estimation of power in beef cattle experiments is important.

Key Words: Beef cattle, Statistics, Power test

Lactation Biology Symposium: Altering the lactation cycle in dairy cows

606 Why re-evaluate length of dry period? R. R. Grummer* and R. R. Rastani, *University of Wisconsin, Madison*.

Possible advantages of reducing length of dry period include increased income from milk production, simplified dry cow management, and alleviation of over-crowded dry cow facilities. The traditional recommendation is a 60-d dry period. Physiologists describe the dry period as consisting of three phases: active involution, steady state involution or rest phase, and redevelopment of secretory tissue. The importance of a rest phase has never been established. There are abundant data in the literature to support a 6 to 8 week dry period. However, interpretation of the data is difficult. The great majority of data is from studies using farm records (e.g., DHI data). In these data sets, cows with less than 6 to 8 wk dry periods probably were not intended to have short dry periods and consequently were not managed for short dry periods.

Additionally, recommendations from observational data may be biased due to interactions between parameters such as milk yield or calving interval and length of dry period. Some experiments specifically designed to compare 30 and 60-d dry periods indicate that shorter dry periods are possible without sacrificing milk production the next lactation. Additional studies are needed to confirm these findings and determine the effects of shortened dry periods on body condition, incidence of health disorders, and reproductive performance. If 30-d dry periods can be achieved without negative effects the next lactation, the next logical question becomes: can the dry period be reduced further? To study the effects of no dry period, twins or quarters within a cow have been assigned to continuous milking or a traditional 60-d dry period. These results have indicated a 25 to 40% drop in milk yield the following lactation due to continuous milking. However, these and other studies have utilized low cow numbers and cows with extremely low milk production. As milk yield and persistency of lactation increases, either through genetic selection or administration of exogenous agents such as bST, the likelihood of successfully shortening or eliminating the dry period should increase.

Key Words: Dry period length, Continuous milking, Lactation

607 Effect of POSILAC® (bST) and dry period management strategy on milk yield. E. L. Annen*[1], M. A. McGuire[2], J. L. Vicini[3], and R. J. Collier[1], [1]*Univ. of Arizona, Tucson,* [2]*Univ. of Idaho, Moscow,* [3]*Monsanto Co., St. Louis, MO.*

A dry period of 40-60 d has been a routine practice in the dairy industry and was intended to provide a balance of maximum lifetime milk and profitability. A dry period less than 40 d reduces yield in the subsequent lactation by 5 to 15%. Omitting the dry period completely results in production losses of 20 to 40% in the subsequent lactation due to reduced functionality of mammary parenchyma rather than nutritional status or endocrine regulation. This study evaluated milk production effects of shortened or omitted dry periods on today's high-producing cows treated with bST (500 mg every 14 d). The study utilized 3 commercial dairy herds and included four treatment groups. Initially, five multiparous and five primiparous cows from each farm were assigned to each group. Treatments included: 1) control: 60-d dry period, bST per label (bST started at 57-70 DIM to end of lactation), 2) 30-d dry period, bST per label, 3) continuous milking, bST per label and 4) continuous milking with continuous bST. Average milk yield was reduced in primiparous cows during the first 17 wk postpartum for treatments 2, 3 and 4, compared with controls (40.1, 32.2, 34.6, vs. 43.1 kg/d; P<0.01, N=57). Milk production in multiparous cows was not affected by treatment (45.6, 42.0, 45.5 vs. 47.3 kg/d; N=38). We hypothesize that a shortened or omitted dry period impedes mammary growth in primiparous animals and may have minimal production effects in multiparous cows treated with bST. In addition, profitability in multiparous cows was improved through increased net milk income generated by omitting the dry period. In multiparous cows, treatment 4 improves net milk income over controls by $130/cow for the first 17 wk of the subsequent lactation. The partial budget included: last 60 d of gestation milk, 17 wk of subsequent lactation milk, extra feed and bST costs, and dry cow costs not acquired. Further research is required to examine the effects of continuous milking and bST on mammary involution and mammary proliferation.

Key Words: Continuous lactation, Shortened dry period

608 Effects of varying dry period length and prepartum diet on metabolic profiles and lactation of periparturient dairy cattle. R. R. Rastani*, R. R. Grummer, S. J. Bertics, A. Gümen, M. C. Wiltbank, D. G. Mashek, and M. C. Rich, *University of Wisconsin, Madison.*

Sixty-five Holstein cows were utilized in a randomized block design to evaluate different management schemes involving altered dry period lengths on subsequent milk production and metabolic variables. Cows began the experiment 90 d prior to expected calving date, were fed a common diet for 34 d, and were assigned to one of three treatments: traditional 56 d dry period (cows fed a low energy diet from -56 to -28 d and a moderate energy diet from -28 d to parturition; T), 28 d dry period (cows continuously fed a high energy diet; S), and 0 d dry period (cows continuously fed a high energy diet; Z). Contrasts were 56 vs. 28 d dry management scheme (T vs. S) and 28 vs. 0 d dry period (S vs. Z). Prepartum (PRE) DMI was 13.9, 16.8, and 18.1 kg/d for T, S, and Z, respectively (T vs. S, $P < 0.01$; S vs. Z, $P < 0.01$). There were no differences in concentrations of PRE non-esterified fatty acid (NEFA), glucose, liver triglyceride (TG), PRE and postpartum (POST) -hydroxybutyric acid, and POST DMI. Liver TG were greater for S compared with Z at 1 d POST (8.82 vs. 5.23, % DM; $P < 0.02$) and at 35 d POST (5.54 vs. 3.23, % DM; $P < 0.02$); liver TG were similar for T and S ($P > 0.15$). There were no differences in POST NEFA between T and S, but NEFA were greater for S compared with Z (394 vs. 235 Eq/L; $P < 0.01$). Postpartum glucose concentrations were lower for S compared with Z (55.0 vs. 59.3 mg/dl; $P < 0.01$) and there was a tendency towards lower glucose concentrations for T vs. S (52.5 vs. 55.0 mg/dl; $P < 0.12$). There was no difference in POST 4.0% FCM yield in cows on T vs. S (42.4 vs. 41.5 kg/d; $P > 0.15$). However, there was a tendency towards lower POST 4.0% FCM yield in cows on Z vs. S (36.1 vs. 41.5 kg/d; $P < 0.11$). In summary, T and S management schemes have similar response on FCM yield and metabolic variables in the subsequent lactation. Shortening the dry period length from 28 to 0 d may improve metabolic status, but decrease FCM yield.

Key Words: Dry period length, Transition period

609 Milk production from Holstein half-udders after concurrent 30 and 70d dry periods. M. S. Gulay*, K. C. Bachman, M. J. Hayen, and D. R. Bray, *University of Florida, Gainesville.*

The objective of this study was to determine whether the half of a bovine mammary gland that had been dry for 30d would produce as much milk, during the subsequent lactation, as the other half-udder that had been dry concurrently for 70d. Multiparous Holstein cows were assigned randomly to control (C, n=14) and treatment (T, n=26) groups. All mammary quarters of cows in C group were allowed to have a full 70d (67±10) dry period. At 80d before expected calving dates (ECD), milk production of left and right half-udders for cows in T group was measured for 10d. No difference was detected in the yield or distribution of milk produced by left (8.00 kg/d; 50.9%) and right (7.70 kg/d; 49.1%) half-udders. At random, within each cow of the T group, one half-udder was dried off at 70d before ECD while milk removal from the other half-udder continued twice daily until 30d before ECD. Average daily yields and distribution of milk produced from 80 to 70d before ECD for the half-udders (n = 12L, 14R) subsequently dry for 68±9 d (7.74 kg; 49.3%) did not differ from the values for the half-udders (n = 14L, 12R) subsequently dry for 27±7 d (7.96 kg; 50.7%). During the postpartum period, milk removed from the left half-udder was measured using a Tru-test® milk meter and total-udder milk production was obtained from the parlor meter. Right half-udder production was estimated by difference. Through 30 DIM, the two mammary quarters within the 30d dry half-udders produced less milk (P<0.01) than the two mammary quarters within the 70d dry half-udders (14.2 vs. 18.3 kg/d; 43.7 vs. 56.3%). C group, managed with the T group, produced more milk through 30 DIM (38.3 vs. 32.2 kg/d; P<0.01). Mean BW (kg) did not differ at calving (C=684.5 vs. T=671.9) or postpartum (C=648.9 vs. T=669.2). Although mean BCS did not differ at calving (C=3.54 vs. T=3.57), T group lost less body condition during the first 30 DIM (C=3.17 vs. T=3.33; P<0.1). Milk yield results from this within-cow experimental design suggest that a 30d dry period decreases subsequent milk production.

Key Words: Dry period, Milk yield, Days dry

610 Effect of delayed breeding and POSILAC® on milk production and reproduction of dairy cows during 2 lactations. M. McGrath*[1], S. Bettis[1], C. Bilby[1], R. Hintz[1], E. Plunkett[1], J. Vicini[1], D. Armstrong[2], J. Fetrow[3], D. Galton[4], J. Shearer[5], and J. Smith[6], [1]*Monsanto, St. Louis, MO,* [2]*Univ. of Arizona, Tucson,* [3]*Univ. of Minnesota, St. Paul,* [4]*Cornell Univ., Ithaca, NY,* [5]*Univ. of Florida, Gainesville,* [6]*Kansas State Univ., Manhattan, KS.*

Extended voluntary wait (VW) and POSILAC (POS) were evaluated in 26 US herds. Primiparous (Prim, N=2331) and multiparous (Mult, N=1384) Holstein cows were studied in one complete lactation (L1). Prim cows from L1 that followed treatment protocol were also examined in the subsequent lactation (L2). Cows were assigned to a: 1) 60-day VW with no POS (C60), 2) 60-day VW with POS (P60), or 3) 165-day VW with POS (P165). POS was administered per label (500 mg bST every 14 d from 57-70 DIM to end of lactation). A 135-day breeding period followed each VW. Testday milk (kg) was evaluated from 60 to 195 DIM (M1) or 196 to 315 DIM (M2). Persistency was evaluated as the slope of declining production from 100 to 195 DIM (M3) and in M2. Total milk yield was greater in P60 and P165 vs. C60 for both parities ($P<0.05$) in M1 and M2 in both L1 and L2. Milk yield was greater in P165 vs. P60 ($P<0.05$) during M2 for both parities in L1 but no difference was detected in L2. P165 Prim and Mult cows were more persistent vs. P60 ($P<0.05$) in late lactation (M2) during L1. No significant difference in persistency was detected in L2. Milk production at dry-off (MPD) for Prim cows was greater in P60 vs. C60 or P165 ($P<0.05$). MPD was not affected by treatments for Mult cows. Days dry was shorter ($P<0.05$) for all P60 cows vs. P165 cows in both lactations. Days dry was not different for C60 vs. P60. Days to first insemination after the VW were less for P165 cows vs. C60 or P60 cows in both lactations and both parities ($P<0.05$). A greater percentage of P165 Prim cows became pregnant in the L1 breeding period vs. P60 Prim cows ($P<0.01$). There was no difference in percent pregnant between P165 vs. C60 Prim cows in L1 or among any of the Mult groups in L1 or L2. There was no effect of POS or delayed breeding on mastitis case rate.

Key Words: Delayed breeding, Milk production, Reproduction

611 Induced lactation: the need for enhanced mammary development and differentiation. B. A. Crooker*[1], R. J. Collier[2], J. L. Vicini[3], M. F. McGrath [3], and W. J. Weber[1], [1]*University of Minnesota, St. Paul,* [2]*University of Arizona, Tucson,* [3]*Monsanto Agricultural Group, St. Louis, MO.*

Induction of lactation has the potential to increase farm profitability through retention of healthy reproductive culls for one or more additional lactations. Of the approximately 1 million dairy cows culled in the US due to reproductive failure each year, about half are healthy and in appropriate condition for another lactation. These potential culls would be retained if they were profitable. Methods to induce lactation have been described for more than 50 years and most utilize twice daily subcutaneous injections of 17β-estradiol (0.05 mg/kg BW/injection) and progesterone (0.125 mg/kg BW/injection) for 7 d with a secondary treatment such as dexamethasone (0.05 mg/kg BW/d). However, these methods have been plagued by considerable variation in the proportion of treated cows that actually produce milk and their subsequent milk yield. Recent efforts to improve the technique have included administration of bST during the induced lactation and inclusion of bST in both the induction treatment phase and subsequent lactation. Although these efforts have increased milk yield, variation in response and in yield relative to previous production remain greater than desired. Clearly the pregnancy and parturition dependent processes of extensive ductal and lobuloalveolar development, proliferation of alveolar cells, and terminal differentiation of these secretory epithelial cells is not mimicked adequately by current methods to induce lactation. More recent efforts to induce lactation have attempted to enhance mammary development and/or differentiation by intramammary infusion of mammogenic compounds. Results from a half-udder model indicate intramammary infusion of prostaglandin E_2 either enhanced mammary development or differentiation which resulted in increased milk yield from cows induced to lactate. Continued refinement of this technology is warranted and required before it can be considered as a practical on-farm technology.

Key Words: Induced lactation, Mammary development, Differentiation

Nonruminant Nutrition Symposium: Energy density of pig diets

612 Energy density of pig diets: effect of energy evaluation system, technology and pig body weight. J. Noblet*[1] and J. van Milgen[1], [1]*INRA, UMRVP, Saint Gilles, France.*

The feed cost is the most important cost in pig production and energy represents the greatest proportion of this cost. Ad libitum energy intake depends on many animal and environmental factors in which feed energy density (or its chemical composition) play an important role. Under satisfactory protein supply, performance of animals depends directly on the energy supply. Finally, nutrient requirements must be expressed relative to energy intake in order, for instance, to take into account changes in the partitioning of energy gain between protein and lipid during growth. It is then important to express feed energy value on an appropriate basis. Both energy supply (a diet characteristic) and requirement (an animal characteristic) should be expressed using the same system. From that point of view, a NE system may be a good compromise. Energy density depends on the nutrient composition which differ markedly in GE content (23.0, 39.0, 17.4, and 18.4 kJ/g for CP, fat, starch (ST) and dietary fiber (DF), respectively). In addition, nutrient digestibility is variable so that the contribution of nutrients to DE supply in growing pigs ranges from 31.7 kJ/g for fat to 22.4 kJ/g for CP, 17.2 kJ/g for ST and only 3.2 kJ/g for DF. Nutrient composition also affects the metabolic utilization of ME: the ratio of NE to ME varies from 90% for fat to 82% for ST and 60% for CP. Consequently, the relative energy density of feeds for pigs depends on the energy system (DE, ME or NE). For instance, the energy values (relative to a conventional diet with corn, wheat, soybean meal and fat containing 14.2, 13.6 and 10.3 MJ/kg of DE, ME, and NE, respectively) of corn, soybean meal and animal fat are 100, 104 and 235 on a DE basis, 102, 99 and 244 on a ME basis, and 107, 79 and 289 on a NE basis. The existing confusion about energy systems is partly due to the existence of different NE systems and care has to be taken when combining values obtained from different systems. The energy density of pig feeds can also be affected by technology. For instance, pelleting increases markedly the fat and energy digestibilities in corn or full fat rapeseed. Finally, digestion of DF becomes more efficient with increasing BW with subsequent differences in energy density of feeds according to pig BW.

Key Words: Pig, Feed, Energy value

Animal Behavior & Well Being: Production challenges

613 Is iodide responsible for the heat-relief effects of *Ascophyllum nodosum*? P. A. Eichen*[1], M. J. Leonard[1], M. A. Kozma[1], B. M. Kronk[1], L. E. McVicker[1], D. E. Spiers[1], and D. P. Colling[1], [1]*University of Missouri, Columbia, MO,* [2]*Acadian AgriTech, Kansas City, MO.*

Previous studies indicate that adding seaweed (*Ascophyllum nodosum*) extract (Tasco-EX®) to the diet results in decreased core body temperature (Tc) in rats experiencing heat stress and fescue toxicosis. A rat model was used to test Tasco-EX (Acadian Seaplants Limited, Nova Scotia) versus ethylenediamine dihydroiodide (EDDI, International Nutrition, Omaha), at an iodide level equal to Tasco-EX (1215 μg I/g). Experiment I was designed to observe changes during each phase of treatment/temperature exposure. Diets contained no additive, 1% Tasco-EX or EDDI. Male rats (n=72; 372 g av BW) were maintained at thermoneutrality (TN; 21°C) for 5 days before treatment to record baseline feed intake and BW. Treatment diets were fed for seven days at TN, followed by exposure to heat stress (HS; 31°C) for 14 days, with a final seven days at TN. Body weight and feed intake were recorded daily. Six rats from each treatment were sampled for organ weight, and blood T3 and T4 at the end of each phase (four sample weeks). Experiment II was designed to look at Tc response to treatment/temperature. Male rats (n = 24; 288 g av BW) were implanted with telemetric temperature transmitters (Mini Mitter, Bend, OR) to record Tc and activity under conditions similar to Experiment I. At the end of week four, all rats were euthanized for determination of organ weights and blood T3 and T4 levels. Feed intake and weight gain were not different for any of the treatments. There were no T3 differences by treatment or sampling time. In contrast, T4 was lower in all treatment groups at the end of week three ($P<.004$), and was higher in rats receiving either Tasco-EX or EDDI ($P<.007$) compared to controls. Rats fed Tasco-EX or EDDI tended to have lower average daily Tc compared to control animals during HS. Average daily maximum Tc of rats receiving Tasco-EX was decreased below control level during a period of HS. These results indicate that dietary iodide is associated with some, but not all, responses to Tasco-EX.

Key Words: Heat stress, Seaweed, Telemetry