On-Farm Certification Programs

43 Auditing procedures. David Meisinger*[1], [1]*National Pork Producers Council*.

Any certification program must have audits in order to ensure that the product, process or system meets the requirements intended for the program and that they continue to follow these procedures. Audits are intended for control or compliance. This paper will deal with the different types of audits, how they are conducted and who usually conducts them. The procedures used in any audit have been standardized by the American Society of Quality and will be outlined in this paper. These procedures include preparation for the audit including the phases in the process and the steps in preparation. These steps include performance standards and the checklist to be used in the audits. The second phase is performance of the audit including how facts are gathered and how conclusions are reached. The next phase involves reporting of the results in a meeting and in a formal report. The last phase is closure with corrective action and formal closure. This brief presentation will provide attendees with a quick view of these accepted procedures used in auditing for certification purposes.

Key Words: Audits, Quality audits, certification

44 Certification programs on farm animal care issues. John McGlone*, *Texas Tech Univeristy*.

Farm animal care involves both animals at institutions who teach and conduct research (such as universities & companies) and on commerical farms. The public demands – to varying degrees – that farm animals be treated humanely both in publically-funded activities, most notably teaching and research, and in production systems that supply animal products. The main question is not if the public demands will be met, but how best to meet the consumer wants and wishes for humane teatment of farm animals. Animals used in biomedical research are now overseen by an ACUC and a number of checks and balances are in place to assure adequate animal care. These assurances extend to vendors who produce laboratory animals (lab animal "farms"). Furthermore, veterinarians can be board-certified in laboratory animal medicine. Parallel assruances and certifications are only partly in place for farm animals at public institutions and on commercial farms. FASS has recently taken the leadership in developing peer-reviewed animal care training materials. Commodity groups have developed quality assurance programs – most of which lack third-party verification – that often include a small animal care component. ARPAS has an opportunity now to participate in new areas of certification that might include new programs such as (a) institutional professional board certification in farm animal care, (b) farm animal worker certification, perhaps on at least two levels, and (c) on-farm worker certification.

Key Words: Animal Care, FASS, ARPAS

45 Certification of nutrition professionals. L. E. Chase*[1], [1]*Cornell University*.

The American Association of Feed Control Officials (AAFCO) has propsed licensing of nutrition professionals. In response to this proposal, the American Registry of Professional Animal Scientists (ARPAS) established a work group to examine this issue and develop a position statement. The work group agreed that the concept of licensing is appropriate. The rationale for licensing should be to provide assurance of professional competency of nutrition professionals. The work group indicated that the licensing process must include measures of knowledge, experience and expertise. It was proposed that an examination process be used as part of the licensing process. This would require development of a new exam. An initial or temporary license could be granted to individuals until the licensing program and exam were fully developed. The work group concluded that a college degree should not be a requirement for obtaining a license. Continuing education credits would also be required to maintain the license. The ARPAS group indicated a willingness to work with AAFCO and others to move this licensing process ahead.

Key Words: Certification, Licensing, Nutrition professionals

46 Verfication of good production practices which reduce the risk of exposure of pigs to Trichinella. D.G. Pyburn*[1], H.R. Gamble[2], L.A. Anderson[1], and L.E. Miller[1], [1]*USDA, APHIS, VS,* [2]*National Research Council*.

Control of Trichinella infection in pork has traditionally been accomplished by inspection of individual carcasses at slaughter or by post-slaughter processing to inactivate parasites. Declines in prevalence of this parasite in domestic swine during the last twenty to thirty years coupled with improvements in pork production systems offer the opportunity to document pork safety at the farm level. We report here on a certification pilot study using an on-farm audit to document good production practices for swine relative to the risk of exposure to trichinae. Based on the results, improvements in the program have been made and further studies will be undertaken prior to launching the voluntary Trichinae Certification Program in the United States.

Key Words: Pre-harvest Pork Safety, Trichinae, Food Safety

Conservation and Management of Animal Genetic Resources

47 Managing Genetic Diversity, Selection and Inbreeding in Livestock. P Bijma*, *Wageningen Institute of Animal Sciences (WIAS)*.

Genetic drift is caused by random sampling of alleles that contribute to the next generation, and results in loss of genetic diversity in populations. There are two sampling processes. First, sampling between families, i.e. some families become parents of the next generation, whereas others don't. Second, Mendelian sampling of alleles within individuals. Without selection, both processes contribute approximately equal to loss of diversity. With selection (e.g. livestock), between family sampling causes the majority of the loss of diversity. Thus maintenance of diversity requires restriction of between family selection. Drift per unit of time is quantified by the variance of gene frequency change that can be attributed to a single generation or cohort, ${\sigma_q}^2$. Drift causes homozygosity by descent (inbreeding), and drift variance and rate of inbreeding (ΔF) are equivalent measures of the loss of diversity, ${\sigma_q}^2$ = q(1-q)ΔF. In livestock, the challenge is to genetically improve populations while maintaining diversity, i.e. to maximize gain (ΔG) while restricting ΔF. The long-term genetic contribution theory reveals a relationship between ΔG and ΔF; $\Delta G = \Sigma ra$ and $\Delta F = {}^*\Sigma r^2$, where r is the long-term genetic contribution of an individual, a is its Mendelian sampling term and the sum is taken over all individuals per unit of time. It follows that the theoretical maximum gain with restricted inbreeding is achieved by a linear increase of r with a. This provides a general measure of genetic efficiency of selection programs. Selection tools that maximize gain while restricting inbreeding try to establish this linear relationship by determining the optimum contribution of selection candidates to the next generation, which implicitly restricts between family selection. With restricted ΔF, minimum coancestry and factorial mating increase ΔG. In addition, molecular markers enable reduction of Mendelian sampling drift, but benefits are small for livestock. Thus it is technically feasible to maximize ΔG while restricting ΔF. The commercial situation, however, may prohibit this. In particular in dairy cattle, global competition, availability of genetic material, and information on genetic quality (Interbull) causes breeding companies to focus on short-term improvement.

Key Words: Genetic Diversity, Inbreeding, Selection

48 Identification of germplasm for preservation from pedigreed populations. M. D. MacNeil*[1], W. R. Lamberson[2], and B. L. Golden[3], [1]*USDA-ARS, Fort Keogh LARRL, Miles City, MT,* [2]*University of Missouri, Columbia,* [3]*Colorado State University, Fort Collins*.

Cryogenic conservation programs seek to maximize genetic diversity in the conserved sample of germplasm. Breed associations record and maintain extensive pedigree databases for a wide variety of livestock

populations. The objective of this research was to develop methods for identifying genetically diverse samples of animals from pedigree databases. Candidates for cryopreservation can be initially identified by appropriate criteria. Given the list of candidates and their pedigrees, coefficients of relationship (R) among them can be calculated. For large numbers of candidates, one suitable approach is to generate a list of "pseudo progeny" from all possible pairs of candidates and compute the inbreeding coefficient for each of them. The R for each pair of candidates is then twice the inbreeding coefficient of their pseudo progeny. The R can be used directly as in a procedure proposed for use in swine. That algorithm is initiated with an arbitrary animal or a set of preselected animals (perhaps ones that already have pools of semen available) and sequentially selects the animal with the lowest cumulative relationship to the previous set until a desired complement is attained. This procedure was tested on a simulated set of relationships among 100 animals. Repeated sets of 10 animals were chosen from the population by three methods: 1) random sampling; 2) use of the algorithm initiated with a random seed animal; and 3) use of the algorithm initiated with a set of five random seed animals. The mean of the relationships for the three procedures were: 0.102, 0.067, and 0.076, respectively, and SD were 0.014, 0.005, and 0.006, respectively. Alternatively, the R may be transformed (reciprocal, 1-R, etc.) to distance measures. A cluster analysis procedure can then be used to identify a set of animals for cryopreservation. Alternative distance measures and clustering methods need to be evaluated as does the similarity of outcome using pedigree vs using allelic frequencies at several loci.

Key Words: Genetic Distance, Diversity, Conservation

49 DNA sequence diversity and haplotype relationships at gene loci in U.S. beef cattle populations. M. P. Heaton*, *USDA, ARS, U.S. Meat Animal Research Center*.

Single nucleotide polymorphisms (SNPs) are useful as DNA markers because they occur at a high density in U.S. cattle populations, they are genetically stable over evolutionary time scales, and they are amenable to a variety of high-throughput technologies developed from the Human Genome Project. To capture the breadth of sequence diversity in U.S. beef cattle, a panel of 96 cattle DNA samples was designed for automated DNA sequencing of small amplicons at gene loci. The beef breeds comprise greater than 99% of the germplasm used in the U.S. beef cattle industry, based on the number of registered progeny for each breed. This beef cattle diversity panel (MBCDP2.1) is expected to allow a 95% probability of detecting any allele with a frequency greater than 0.016 in the group. Because the information content of an individual SNP is inherently low (biallelic), the set of SNP alleles residing on a specific segment of a chromosome may be used as a group (i.e., DNA segment haplotype) to discern additional allelic variants and thereby enhance measurements of genetic diversity. Defining the relationships between DNA segment haplotypes allows them to be considered in an evolutionary context and provides an objective means of identifying potentially ancient DNA segments.

50 Cryopreservation of rooster sperm. S.P. Gill*[1] and Guy Barbato[2], [1]*BioPore Inc, State College, PA.*, [2]*The Pennsylvania State University, University Park, PA*.

Cryopreservation of poultry sperm likely can benefit individuals interested in maximizing fertility with sperm from males of lines that are on the verge of extinction or elimination. In the past, fertility of cryopreserved chicken sperm has been unacceptably low, unless impracticably high numbers of sperm per insemination and frequent artificial insemination (AI) are combined. There are at least 2 reasons. First, cryoprotectant (e.g., glycerol) must be present at >13% (v/v; 1.8 M) concentration for retention of motility or viability, but has to be reduced to <0.7% (v/v; 0.1 M) before AI due to its contraceptive effect. Second, a protein important in sperm-egg binding is stripped from sperm during cryopreservation and that causes greater reduction in fertility than predicted on the basis of post-thaw sperm motility. Most procedures tried with rooster sperm rely on slow dilution of thawed semen plus centrifugation and resuspension of sperm in a small volume, to reduce glycerol concentration. A new method for cryopreservation uses special containers with major faces formed from "gated-pore" membranes. It allows automated removal of cryoprotectant and circumvents the need for dilution or centrifugation. Sperm from different lines of layers and broilers was frozen with this method. Sixty-seven percent of eggs laid had a viable embryo after AI of only -170 x 10^6 sperm every 4 days. However, significant differences were observed within lines to the amount of cryoprotectant and fertility. Exposure of thawed rooster sperm to synthetic pro-fertility peptides increased ($P<0.01$) fertility by 20-40% above that obtained with untreated (control) sperm. Through non-surgical intramagnal insemination, it was possible to obtain some fertility from line whose sperm did not tolerate cryopreservation very well. Rare or experimental lines, whose sperm quality and fertility is exacerbated by cryopreservation can be recovered using intramagnal inseminations and addition of pro-fertility peptides to the thawed sperm before AI.

Key Words: Sperm, Cryopreservation, Intramagnum

51 Preserving/conserving germplasm by incorporating embryo-related technologies. R.S. Prather*, *University of Missouri-Columbia, Columbia, MO*.

Embryo-related technologies, for the purpose of this talk, is defined as any technology that uses the unfertilized egg or early embryo. These technologies may include preservation of sperm, unfertilized eggs, embryos, or cells. Haploid genetic material might be preserved in the form of sperm or unfertilized eggs, while diploid genetic material might be preserved in the form of pre-attachment stage embryos or as cells harvested from live animals. Term development has resulted from cryopreservation of unfertilized eggs followed by fertilization and embryo transfer. Preservation of sperm is no longer limited to cryopreservation, as freeze-dried sperm have been rehydrated and injected into unfertilized eggs. This technology is termed intracytoplasmic sperm injection (ICSI). Nuclear transfer (NT) technology, i.e. the transfer of diploid nuclei to enucleated eggs, has also resulted in the production of offspring. These latter two technologies, ICSI and NT, are dependent upon adequate numbers of mature unfertilized eggs being readily available.
While ICSI will permit the production of offspring from half of the desired genotype, NT will result in offspring that are entirely derived from the nucleus of the donor cell. While both of these technologies offer great promise, there are a number of limitations. The first limitation is that large numbers of meiotically mature unfertilized eggs are required. The second limitation is that these eggs influence the entire genetic makeup of the resulting animal. This is because the eggs contain mitochondria that have their own genome. Thus, if there is an incompatibility between the proteins whose production is directed by the nucleus and proteins whose production is directed by the mitochondria, then the resulting embryo could fail to develop, or fail to reproduce the desired phenotype as an adult. A third limitation, observed in cattle, is the production of animals that fail to thrive, and up to half die during the first few weeks postnatally.
When considering the use of such technology, one should remember that phenotype is directed by both genetic makeup and environment.

Key Words: Cloning, Nuclear Transfer, Embryo-Technologies

52 Conservation and preservation of poultry genetic resources: a review of issues and progress. Mary Delany*, *University of California, Davis CA 95616*.

The landscape of extant poultry genetic resources is complex and thus considerations for conservation and preservation are complicated by a number of interwoven issues. Issues for consideration include but are not limited to: (1) the variety of species, (2) the types of populations, (3) the heterogeneity of purposes, (4) inherent difficulty in predicting future utility and needs, (5) financial resources, (6) paucity of genetic diversity assessment, (7) only the male germplasm can be cryopreserved. We know that (1) hundreds of research genetic lines have been eliminated over the last two decades and such elimination is ongoing, (2) the number of independent primary breeder companies has declined through industry mergers and anecdotal discussion indicates entire groups of lines are often dropped in the process, (3) several recent molecular genetic studies suggest reduced diversity for industry White-Leghorn based populations, (4) U.S. poultry breed population status is currently unknown although assessment is underway by the American Livestock Breeds Conservancy. The National Animal Germplasm Program poultry species committee consists of academic, industry and government geneticists, researchers and administrators committed to improving the status quo of poultry genetic resources. Many of the committee members are directly involved in maintaining and managing poultry genetic resources. Committee work during the last 12 months focused on assessing what our committees' priorities should be and the two top areas include promotion of cryopreservation research and preservation of living-stocks

collections. In regard to the latter, a recognition letter has been designed to alert university-based administrators of the value of poultry genetic resources. The committees' present administrative goals include development of priority guidelines for repository deposits of semen at the Ft. Collins NAGP facility, development of poultry-specific parameters for the GRIN database, establishment and distribution of useful guidelines/advice for handling and cryopreservation of semen by non-experts.

Key Words: Poultry, Conservation, Genetic resources

53 Dairy cattle contributions to the National Animal Germplasm Program. L. B. Hansen*, *University of Minnesota, St. Paul.*

Genetic diversity within the six recognized breeds of dairy cattle in the US was viewed as the key area of concern for the dairy cattle committee of the National Animal Germplasm Program. The ten-member dairy cattle committee has a membership roster as follows: two from the land-grant universities (L. Hansen, U. of MN, Chair, and M. Schutz, Purdue U.), two from USDA/ARS (M. Ashwell and C. Van Tassell), two from AI companies (D. Funk, ABS Global, and C. Sattler, Select Sires), one from NAAB (to be named), one from a breed association (C. Wolfe, American Jersey Association), the USDA/ARS Executive Secretary for NAGP (H. Blackburn), and an ex officio member from USDA/CSREES (R. Frahm). Committee members will have terms with fixed years of service, and the terms will have staggered years for final year of service. The key goal of the dairy committee is for each A.I. organization in the US to submit 30 units of frozen semen from progeny test sires to the repository for the germplasm program at Ft. Collins, CO. Frozen semen is requested from each 10th Holstein sire entering progeny testing as well as every bull entering progeny test for the other five breeds. The dairy cattle committee will be charged with the responsibility of reviewing requests for use of dairy cattle germplasm in the repository.

Key Words: Germplasm preservation, Dairy cattle, Genetics

Energy Nutrition of Ruminants

54 Energy nutrition of ruminants: keeping books. C.L. Ferrell*, *USDA, ARS, Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, NE.*

Goals of energy metabolism research with ruminants have historically been to 1) develop an accurate means for evaluating feedstuffs and stating animal requirements, and 2) establish the tissue and biochemical origin of heat production or energy expenditures. Techniques employed in nutritional energetics of ruminants have classically been concerned with the partitioning of dietary energy into fecal, urinary, methane, heat, and recovered or product energy. Attributes of feeds that influence the partition of dietary energy has received limited attention recently. Indirect respiration calorimetry and comparative slaughter techniques continue to be important energetics research tools. Carbon dioxide entry rate techniques have found application in goat, sheep, and cattle studies. The use of heart rate as an index of energy expenditure may have application to the free ranging animal. Techniques utilizing blood flow, thermal dilution and gas analyses to quantify and separate heat generated from the GI tract into aerobic and anaerobic origins has been successfully applied to ruminants. Assessment of tissue energy metabolism from blood flow and substrate flux across the PDV, liver, gravid uterus, fetus, mammary gland, and hind limb have contributed substantially to our understanding of tissue energy expenditures and sources of their variation. Studies at the organ, tissue, cellular, and subcellular levels, including substrate turnover and channeling, ion transport, proton leakage, and uncoupling proteins have increased our understanding of the biochemical processes involved. Regulation of those processes through hormonal and other means is beginning to be understood. A major challenge of the future lies in not only establishing the biological and biochemical bases for energy expenditures, but also in determining the genetic and biological bases for differences among animals. It is equally critical that we be able to translate fundamental knowledge gained through these endeavors to functional understanding that can be applied to the whole animal.

Key Words: Cattle, Heat, Energy metabolism

55 Economics of visceral nutrient metabolism in ruminants - toll keeping or internal revenue service? C. K. Reynolds*, *The University of Reading, UK.*

Measurements across a range of productive states show that the portal-drained viscera (PDV) and liver, or the total splanchnic tissues, account for 40 to 50 % of body oxygen consumption or heat. This high rate of metabolism is in part attributable to high rates of protein turnover and thus amino acid utilization, as well as other 'service' functions supporting nutrient assimilation and 'waste management'. This metabolic intensity and the anatomic position of absorptive and liver tissues has led to the assumption that the tissues that assimilate and process incoming nutrients from the diet exact a toll in payment for their entry. This 'toll' is believed to reduce the extent to which absorbed nutrients gain admission to the arterial blood pool and reach 'productive' organs such as the mammary gland or skeletal muscle. Measurements of net nutrient flux generally support this concept of splanchnic metabolism 'restricting entry' and thus dictating supply, as on a net basis the appearance of the major carbon-based nutrients absorbed into the portal vein is typically low compared to their rate of disappearance from the gut lumen. An alternative interpretation is that this low net recovery of absorbed nutrients across splanchnic tissues is attributable to extensive metabolism of nutrients from the arterial pool, which masks true rates of absorption. In this scenario any tax to support community services is paid using internal funds. Measurements of nutrient kinetics based on isotopic labelling support the latter scenario. In the case of the liver, catabolism of amino acids is driven in part by supply and demand, with over-population dealt with by deportation, restructuring or the metabolic equivalent of cremation. Similarly, relative rates of amino acid metabolism by the gut and mammary gland vary with requirement. Organ metabolism of many energy-yielding nutrients varies with supply, demand and the need for waste management and other community services.

Key Words: Organ metabolism, Energy, Amino acids

56 Endocrine and gene expression profiles in relation to energy metabolism. G. Murdoch[1], W.D. Dixon[1], V.E. Baracos[1], E.K. Okine[1], D. Balcezak[1], J.A. Moibi[1], B.T Li[1], R.J. Christopherson*[1], and R.J. Christopherson[1], [1]*University of Alberta, Edmonton, Canada, T6G 2P5* .

In order to test hypotheses regarding regulation of energy metabolism, heat production (HP) was examined in response to adrenergic agonists and/or blocking agents in ruminants. Low doses of adrenaline, acting via β adrenoceptors, increases HP ($P< .05$) in cattle (40%) and in sheep (30-45%). Increases in HP of sheep in response to adrenaline averaged 32% ($P< .05$) while increases in the portal drained viscera and hindquarter metabolic rates were 50 % ($P< .05$) and 61 % ($P< .05$) respectively and were abolished by beta adrenergic blockade. Increases in whole body and hindquarter HP during acute cold exposure were reduced by 20-50 % by β blockers. Alpha-2 selective agonists suppress heat production in ruminants by 20-23 % ($P< .05$), suggesting a role in energy conservation. HP was positively related to β receptor density in the heart muscle, but a negative relationship was observed in non-cardiac tissues. Lipogenic enzymes (ACC and FAS), in subcutaneous and mesenteric adipose were positively correlated ($P< .05$) to HP. Expression of other target genes have recently been determined in skeletal muscle, adipose depots, rumen, abomasum and duodenum in cattle, using PCR. The expression of leptin receptor and NPY receptor type II genes were correlated ($P< .05$) in peripheral tissues, such as Biceps femoris ($r=0.91$) and subcutaneous adipose ($r=0.70$). These were not as well correlated in mesenteric adipose and perirenal adipose. Receptor gene expression was not detected in GI tissues. The expression levels of UCP1, UCP2, and UCP3 in tissues that we have screened using RT-PCR, ranged from undetectable to 100 densitometric units. We observed variable expression of leptin mRNA in adipose depots which may pertain to various functions of this peptide. Positive correlations between HP and urinary excretion of 3-MH ($P< .39$) and hydroxyproline ($P< .51$) paralleled changes in expression of genes for proteolytic enzymes. Compilation of information relating to the expression of specific genes