("ABP"), a vertically coordinated pork production system. ABP consists of three primary components: 1) proprietary Triumph genetics; 2) a USDA-approved process verification program; and 3) market hog purchase agreements. Within two years, producer participation in ABP has grown to more than 230,000 sows, which represents more than 55% of Farmland Foods' total processing capacity. From an industry perspective, independent producers will have less and less control in the future over major production decisions such as genetics, nutrition, and production practices as pork processors compete to satisfy customers' demands for quality, food safety, and price.

Key Words: Integrated system, Pork, Process verification

Genetics of Carcass Merit and Meat Quality

408 Genetic prediction for time to finish end points in beef cattle. B. L. Golden*[1], [1]*Colorado State University*.

In national beef cattle genetic evaluation programs recent attention has been given to the development of genetic predictions that are more useful for determining the effects on profit and risk of alternative selection and mating decisions. This is in part due to the fact that many current national beef cattle evaluation programs contain EPD for indicator traits. It has been shown that considering EPD for indicator traits, especially when EPD for the economically relevant traits are available, will actually decrease the accuracy of prediction associated with a selection decision. Because properly formed EPD for economically relevant traits should consider the contribution of the indicator trait, using indicator trait EPD results in a redundancy that increases prediction error and confusion among cattle breeders. A precept has resulted from this renewed understanding that has been termed the principle of economically relevant traits. Using this principle it is possible to identify appropriate traits for inclusion in national beef cattle evaluation programs. The principle has lead to an especially interesting set of recommendations for traits of carcass quality and yield. This is in part because of dogma and in part because carcasses are often valued based on traits that indicate a different desirable characteristic (e.g., marbling score versus tenderness, or subcutaneous fat thickness versus yield). Other livestock industries such as the swine industry have overcome these problems by using genetic predictions for amount of time to achieve finish endpoints. Work has begun to develop genetic predictions using random regression models for time to finish endpoints in beef cattle for weight, subcutaneous fat thickness, and quality grade. Having these three finish endpoint EPD will allow producers to not only predict the relative values of alternative selection decisions, but will also allow producers to predict appropriate finishing management programs for groups of slaughter cattle.

Key Words: Beef Cattle, Genetics, Prediction

409 Genetic influences on carcass merit of sheep. N. E. Cockett*[1] and G. D. Snowder[2], [1]*Utah State University, Logan, UT*, [2]*USDA, ARS U.S. Sheep Experiment Station, Dubois, ID*.

Sheep numbers have decreased from nearly 30 million head in the early 1960s to 7 million head in 2000. Total production of lamb and mutton has not declined as sharply because of an increase in lamb carcass weight. From 1960 to 2000, the average lamb carcass increased from 22 kg to 31 kg. This change in carcass size is in part the result of improved feed management and an increase in mature size due to direct genetic selection and the use of large terminal sire breeds. Also, lambs are now frequently over-finished because the profit margin often favors larger animals and packers discount only extremely heavy lambs. Heavier carcasses have resulted in increased fat thickness, with the average carcass now exceeding recommendations by the American Sheep Producer Council's Consumer Acceptability Task Force for fat depth. It is possible to produce heavier carcasses with lean lamb characteristics using later maturing breeds, but current production systems have not capitalized on this opportunity. The proportion of lean meat cuts has remained constant in heavier carcasses, except in callipyge and Carwell animals. Lambs expressing these phenotypes have 30 and 8% increases in lean meat, respectively, with associated decreases in fat of 8 and 0%, respectively. However, almost all studies have found decreased tenderness of the callipyge loin. A similar effect on tenderness has not been reported for Carwell carcasses. Consumer consumption of lamb continues to fall, with annual per capita consumption of lamb and mutton dropping from 2.3 to 0.5 kg over the 1960 to 1997 time period. Studies of consumer preference indicate a lamb product with reduced fat and less intense flavor would be more appealing. These changes can be achieved through genetic selection and the choice of breeds. Identification of QTL for carcass merit will also aid in these improvements.

Key Words: Ovine, Carcass, Genetics

410 First generation of QTL searches for carcass traits in beef cattle. R. T. Stone*, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE*.

Microsatellite-based linkage maps were developed with the expectation of being able to identify quantitative trait loci (QTL) emphasizing those traits for which phenotypic data were sex limited, expensive, or difficult to obtain. Currently, the publically available results for QTL searches for carcass traits are based on a few large half-sib families; five sires and approximately 1,000 offspring. Seven of these QTL are genome-wide significant (one false positive per 20 scans) while more than 20 are considered suggestive (one false positive per scan). Significant QTL affecting rib bone, carcass weight, dressing percentage (BTA5), predicted retail product yield (BTA2), marbling (BTA3), hot carcass weight (BTA4), and fat thickness (BTA8) have been reported. Of those QTL at the suggestive level of significance, some are for correlated traits at the same position or present in multiple families, indirectly suggesting that they are real. The first generation of QTL searches have demonstrated: 1) QTL with modest effects (0.5 standard deviations) can be detected, 2) the need for a much broader sampling of genetic variance, and 3) the need for sampling and statistical methods to detect interacting alleles. The second generation of QTL searches will likely be based on single nucleotide polymorphism (SNP) haplotypes because of their power in determining identity-by-decent and their suitability for high-throughput genotyping technology. The most logical resource populations will be half-sib families, many of which are small or have a limited number of off-spring with phenotypic data. Thus, the power to determine identity-by-decent is critical for both QTL and candidate gene analysis. Recently, 120,000 bovine expressed sequence tags (EST) have been assembled into about 20,000 clusters. Thus, an emerging EST or gene-based genetic map will coalesce into the functional and comparative genomics of humans and model organisms. Undoubtably, developments in genomics and genotyping technology will greatly impact future QTL studies in livestock and their utility in breeding programs.

Key Words: QTL Mapping, Carcass Traits

411 Dissecting the genetic control of carcass merit and meat quality in the pig. Max Rothschild*, *Iowa State University*.

Modern molecular biology and the science of genomics have opened up new and exciting possibilities to dissect complex phenotypic traits such as meat quality. To date over 4000 genes and markers have been added to the gene map of the pig. In addition to identifying and mapping genes and markers, animal geneticists have begun to search for the individual genes that affect meat and muscle quality in the pig. Meat and muscle quality traits are complex traits and some are often measured in a subjective manner. Measurement of these traits usually includes assessing backfat, intramuscular fat (marbling), loin eye area, pH, color, tenderness, juiciness, water holding capacity and flavor. For many of these traits heritabilities are moderate to high. While it is clear that these traits are likely to be controlled by many genes some individual genes may have large effects. To find these genes three approaches have been employed. The first has been to find or observe that "major" genes such HAL and RN are segregating in a population. The second approach is the "genomic scan" method which uses specialized crossbred resource families and random genetic markers to scan regions of the genome which are associated with meat quality traits. This approach has yielded many regions of the porcine genome associated with traits of carcass merit and meat quality. The final approach is the candidate gene approach and uses genes that by their very nature are expected to be associated with certain physiological functions. The purpose of this paper is to review

the remarkable progress made in identifying genes and genomic regions affecting meat quality traits in the pig.

Key Words: Pig, Meat Quality, Genetics

412 Validation of carcass merit quantitative trait loci (QTL's) and integration of QTL information into genetic programs for improvement of carcass merit. E. J. Pollak*[1], M. E. Dikeman[2], C. Gill[3], and D. W. Moser[2], [1]*Cornell University,* [2]*Kansas State University,* [3]*Texas A&M University*.

Genetic evaluations for traditional carcass characteristics have been published for limited numbers of sires by various beef breed associations. Collection of carcass information is difficult, which limits the amount of information generated for these traits. The routine carcass field data collected do not include observations for measures of tenderness or any information on sensory panel assessment of meat quality, prohibitive due to costs and logistics. An objective of the National Cattlemens Beef Association's Carcass Merit Project (CMP) was to collect data on tenderness and sensory panel assessments along with the traditional carcass characteristics from a set of legacy bulls from all breeds participating in the project. These data are being used to provide information for the calculation of expected progeny differences (EPD's) and to validate the segregation of quantitative trait loci (QTL's), discovered in the Texas A&M Angleton Project, in these breeds. Eleven QTL's are being validated, six for Warner-Bratzler shear force, three for marbling, and one each for sensory panel tenderness scores and rib eye area.
Estimates of heritability for shear force measures on Simmental and Angus cattle in the project were 0.22 and 0.25, respectively. Genetic evaluations, ignoring QTL information, for Simmental bulls in the CMP result in a spread of sire EPD's of 0.45 kg of shear force. To date, nine bulls representing four breeds have completed the progeny test required and the DNA analysis in the CMP. Five of the six tested shear force QTL's have been found to be heterozygous ($p \leq 0.05$) in at least one bull. One of the nine bulls has been found to be heterozygous for the QTL for the sensory panel score of tenderness. The difference in progeny group performance, groups defined by which marker allele was inherited for the tenderness QTL, in one Simmental bull was almost as large as the spread in sire EPD's for that breed. A pleiotropic effect of one QTL (tested as a shear force QTL) with marbling has been found. Evidence for segregation of the three marbling QTL and the rib eye area QTL has not been found in the nine tested bulls.

Key Words: Carcass traits, Quantitative trait loci, Expected progeny differences

413 Impact of breeding and genetics on poultry carcass and meat quality. D. L. Fletcher*, *University of Georgia, Athens, GA USA*.

The role of poultry breeding and genetics on carcass and meat quality issues has undergone constant change over the past 150 years. Early poultry breeding efforts were focused on such characteristics as fighting ability, egg production, and improving and maintaining the characteristics of pure bred stock. Poultry meat quality was not a major emphasis. After World War II, the poultry meat industry began to vertically integrate and with dramatic developments in nutrition, disease control, and management, the economics of production were so improved that poultry consumption skyrocketed. During this period, selection programs for commercial strains were also concerned primarily with economy of production including such factors, as growth rate, feed conversion, health, and uniformity. Quality issues included white feathering and fast feathering traits, as well as traditional livestock selection criteria for live animal and carcass conformation, fleshing, meat yield, and avoidance of skeletal defects. By the late 1970's through the 1990's, although most selection criteria were still related to economy of production, programs relative to market demands for increased breast meat yield and reduced carcass fat were given some attention. Other than for breast meat yield (both an economic and quality issue) and fat content, the only other area of selection interest relative to quality has been in attempting to reduce the PSE-like condition common in turkeys. With the dramatic changes in the marketing of broilers from a predominantly whole carcass market to further processed meat products, the issues relative to traditional quality attributes have almost completely disappeared. Current and future selection programs are likely to continue to focus on economy of production but may also begin to incorporate quality issues such as PSE-like conditions, meat and parts proportions (weights, thickness, "bun coverage", and trim waste), functional properties, possible composition modification (nutrient and health-based designer foods), and welfare.

Key Words: Poultry genetics, Poultry carcass quality, Poultry meat quality

Meat Thermoprocessing: Products and Processes

414 Thermoprocessing, products and processes: Introduction. S. M. Lonergan*, *Iowa State University*.

Development of new meat products continues to be a priority of meat processors interested in capturing and improving the inherent value of muscle foods. Pre-cooked products such as fully cooked bacon, beef crumbles and beef patties have been very successful in food service markets. Recently these products have gained a portion of the retail market. Growth of retail opportunities for these products is dependent on continued development of ingredient, processing, cooking and packaging technologies to ensure safety, consistency, quality and cost efficiency.

415 Thermodynamic cooking methods. J Gaydos*, *Stein Inc.*.

The thermodynamic merits of various available cooking methods used for a variety of prepared meat products will be discussed.

Key Words: Thermodynamic, cooking, methods

416 Thermal processing and microbial stability. B.P. Marks*, *Michigan State University*.

Growth in the fully-cooked market sector and evolving federal regulations are creating a need for better information related to thermal inactivation of pathogens. In particular, federal regulations governing the safety of fully-cooked meat products are shifting from a command-and-control basis to performance standards. This shift increases the burden on processors to ensure that a new or modified process achieves target lethality levels. Although product characteristics (e.g., fat content and pH) and process parameters are known to affect thermal resistance of bacteria, most reported information is from laboratory studies that encompass a limited range of conditions. The validity of using this information in evaluating process lethality is uncertain. Consequently, there is a significant need for validated technical tools that can be used to evaluate the lethality of dynamic cooking processes. This presentation will (1) summarize the current state-of-knowledge related to thermal inactivation of pathogens in meat products, (2) highlight limitations of available inactivation models, and (3) outline current research aimed at developing tools that are directly applicable to evaluating the lethality of commercial cooking processes.

Key Words: Pathogens, Cooking, Models

417 Enhancement of cooked meat quality and safety via packaging. Tom Rourke*, *Emmpak Foods, Milwaukee, WI*.

The standard packaging methods used to improve cooked meat quality and safety are vacuum and modified atmosphere. The efficacy of these systems is well documented when the residual oxygen level is 0.5% or less. Common modified atmosphere packaging (MAP) gas mixtures are 70-80% nitrogen and 20-30% carbon dioxide. Some success has been attained incorporating antimicrobial agents (fungicides, antibiotics, organic acids) directly into packaging films. Oxygen scavengers in the form of polymer additives of film-adhering packets have been extremely successful in preventing aerobic microorganisms, especially molds, on cooked meat products. Edible coatings and films as a final processed meat package is a promising area of research. They are commonly produced from lipids, polysaccharides or proteins and have several distinct advantages such as: biodegradability, edibility, excellent appearance and