ARPAS Symposium: Feed Efficiency: Opportunities for improvement, economics, and integration with environmental sustainability

316 Feed efficiency: Basic principles and opportunities for improvement. M. VandeHaar*[1], L. Armentano[2], D. M. Spurlock[3], J. Patience[3], and J. Taylor[4], [1]*Michigan State University, East Lansing,* [2]*University of Wisconsin, Madison,* [3]*Iowa State University, Ames,* [4]*University of Missouri, Columbia.*

The efficiency of converting feed to meat and milk in the US has increased in over the past century largely as the indirect result of increased productivity (faster lean accretion or more milk per cow) and the resulting dilution of maintenance requirements. Further increases in productivity have a diminishing impact on feed efficiency, and, in fact, if digestibility is depressed at higher intakes, increased productivity has the possibility of decreasing efficiency. Therefore, we must find new ways to improve lifetime feed efficiency through enhanced efficiency of digestion, metabolism, and product formation without impairing health or fertility. Ideally, feed efficiency should incorporate all inputs and outputs of energy, protein, and other nutrients as well as land, fuel, and human-edible foods during an animal's lifetime. However, the traits that are routinely measured in individual animals are outputs such as growth rate or milk yield and not feed inputs; thus the feed efficiency phenotype for most animals is not known. In 2011, USDA-NIFA funded 3 large projects to improve the efficiency with which the beef, dairy, and swine industries use feed. All target genetic improvement using genomic selection. Genomic selection makes use of a reference population of animals with both phenotypic and genotypic data to develop models of predicting genetic merit from genotype, thus enabling genetic selection without phenotypic data. Because the heritability of feed efficiency is likely in the range of 20 to 40%, the reference population must include thousands of animals to produce estimates of breeding value with reasonable accuracy. Our research aims are to develop these reference populations, better characterize the genetic and biological basis of feed efficiency and its interactions with diet, and develop marker-assisted and genomic selection tools for feed efficiency. We will use residual feed intake as our measure of the feed efficiency phenotype and medium/high-density whole genome SNP panels for genotypes. Decision tools and on-farm demonstrations are being developed to enhance adoption of best management practices, and teaching programs are underway to nurture scientists who will lead future improvements in the feed efficiency of animal agriculture.

Key Words: feed efficiency, genomic selection, genetics

317 Impact of milk yield, herd size, and feed efficiency on economic change between and within California dairies from 2006 through 2010. L. Rodriguez*[1], G. Bethard[2], D. Tomlinson[1], and M. McGilliard[3], [1]*Zinpro Corporation, Elk Grove, CA,* [2]*G & R Consulting, Blacksburg, VA,* [3]*Virginia Tech, Blacksburg.*

Milk and feed prices have been volatile in the California (CA) dairy industry in the last 5 years, bringing stress and difficult strategic decisions to managers. Our objective was to find financial and production trends that improved profitability of CA dairies. The CA Department of Agriculture milk production cost farm database from 2006 to 2010 (705 herd-years) included milk yield, herd size, feed efficiency (FE), housing type and milking frequency, as well as measures of milk income and various expenses. Variables of expense per 45.5 kg, FE and profit per 45.5 kg were analyzed with a model that included year, breed, linear and quadratic effects of either yield, size, or FE, and all interactions with breed. A second analysis was limited to 97 Holstein (H) herds present in all 5 years to estimate intra-herd linear relationships. Grouped into categories, H herds producing less than 31.8 kg/d differed from those greater than 36.4 kg/d of solids-corrected milk (SCM) in total cost/45.5 kg (TC) of $14.97 and $13.49, respectively. Jersey herds producing less than 25.0 kg/d differed from those greater than 29.5 kg/d of SCM with TC of $17.67 and $15.58. Holstein herds with FE (SCM/DMI) exceeding 1.45 compared with less than 1.33 were $1.29 lower in TC. Milk net income (MNI) per 45.5 kg SCM was -$0.29 versus $1.12 in H herds with less than 31.8 kg/d and more than 36.4 kg/d SCM. Jersey herds producing less than 25.0 kg/d and more than 29.5 kg/d of SCM differed in MNI, -$1.36 and $0.72. The TC decreased linearly and quadratically for larger herds, with H herds of more than 2,000 cows having $1.31 smaller TC compared with herds with fewer than 1,000 cows. Jersey herds of more than 2,000 cows were $2.09 less in TC compared with herds of fewer than 500 cows. From 2006 to 2010, TC increased $0.40/yr in H herds. In H herds increasing SCM by 0.91 kg/yr TC increased only $0.26/yr. In H herds decreasing SCM by 0.91 kg/yr TC increased $0.73/yr. Change in FE/yr and change in MNI/yr increased linearly as SCM change per year increased. Efficient herds had higher profitability in the CA dairy industry.

Key Words: dairy profitability, feed efficiency, herd economics

318 Integrating productivity and whole-farm efficiency to achieve environmental sustainability. J. L. Capper*[1] and D. E. Bauman[2], [1]*Washington State University, Pullman,* [2]*Cornell University, Ithaca, NY.*

Environmental sustainability (ES) is a crucial consideration for livestock producers as consumers, retailers and policy-makers become more aware of resource use and greenhouse gas (GHG) emissions associated with animal agriculture. Optimal environmental sustainability can only be achieved by improving efficiency throughout the food production system; yet on-farm productivity (resource use per unit of output) and production processes make the greatest contribution to environmental impact and thus offer the greatest opportunity for mitigation. Popular perceptions of ES are often associated with extensive livestock systems, with the concept of "efficiency" being regarded as undesirable. Nonetheless, deterministic models of ruminant production have revealed that improved productivity in modern intensive systems confers considerable reductions in resource use and GHG emissions per unit of food product from dairy or beef. Environmental gains through this "dilution of maintenance" effect result from a combination of improved productivity in the productive (growing or lactating) sector of the population diluting resource requirements over greater output; and reducing resource requirements within the non-productive sector of the supporting population by requiring a smaller number of animals to maintain total output. A significant contribution may also be made via "reduction of maintenance" - reducing the total bodyweight of animals within the supporting population through the use of smaller breeds, while maintaining total animal protein output. Whole-farm analysis may be used within dairy production, yet is an inadequate measure of ES in a fragmented industry such as beef production, where interactions between the cow-calf, stocker and feedlot operation can have long-lasting consequences. For example, despite the perception that feedlot operations are major contributors to GHG emissions, whole-system analysis demonstrates that the cow-calf operation accounts for 72% of carbon output. Ultimately however, the considerable interaction between dairy and beef production systems necessitates a combined dual-system analysis to define the practices that contribute to true sustainability.

Key Words: productive efficiency, carbon footprint, dilution of maintenance