Breeding and Genetics: EAAP Genetics Symposium: Breeding for environmental sustainability

259 Breeding goals to deal with climate change and food security. Eileen Wall*, *Scotland's Rural College (SRUC), Edinburgh, UK.*

In today's world, livestock production systems need to deliver a secure supply of food (locally and globally) with ever increasing competition for resources (land, water, feed/food, energy). As the competition for resources increases, the costs of production can increase and therefore farmers are challenged to improve efficiencies within their systems with both short and long-term sustainability in mind, trying to balance the profitability of the farming system while minimizing any negativity externalities of that production system (e.g., greenhouse gas emissions (GHG), animal welfare, land capability). As with the rest of society, livestock systems also need to consider potential climate change impacts in their longer term management options. Climate change is expected to have detrimental effects on milk yield and quality, fertility and health, putting further pressure on the sustainability of the sector and introducing new challenges for breeding goals and animal welfare. As climate change advances, indirect effects of weather on wider agricultural systems will become more important. An animal's ability to 'cope' with extreme weather could be further compromised if climate change decreases the availability of these resources, as predicted. This would result in increased competition for the water and nutrients needed to maintain cows' production and fitness. Therefore, incorporating longer-term challenges in our livestock breeding goals (e.g., climate resilience, optimizing production within farming system) is a crucial and timely goal. This paper takes an interdisciplinary approach to quantifying the potential output from livestock systems (dairy and beef) under projected climate change. This will be extended to breeding goals that optimize productivity and climate resilience while meeting GHG targets and wider goals for animal health and welfare. The results could be used to provide solutions to key challenges limiting the efficiency, productivity and sustainability of the livestock sectors.

Key Words: breeding goal, climate change, livestock efficiency

260 Genomic selection for the high-hanging fruit in livestock breeding programs. Donagh P. Berry*[1], Yvette de Haas[2], Roel F. Veerkamp[2], Mike Coffey[3], and Mario P. L. Calus[2], *[1]Animal & Grassland Research and Innovation Centre, Teagasc, Moorepark, Co. Cork, Ireland, [2]Animal Breeding and Genomics Centre, Wageningen UR Livestock Research, Wageningen, the Netherlands, [3]Animal and Veterinary Sciences, SRUC, Easter Bush Campus, Easter Bush, Edinburgh, UK.*

Genomic selection has by now been adopted for most of the "low-hanging" traditionally measured traits in developed breeding programs. The benefit of incorporating genomic information into genetic evaluations, however, is greatest for economically important traits not routinely recorded and thus where only low accuracy of selection is being achieved using traditional approaches. Irrespective of species, difficult to measure traits (i.e., the high-hanging fruit) include feed intake and efficiency, environmental footprint, product quality, and animal health and disease. Options to develop genomic predictions for these high hanging fruits include (1) collation of (inter)national databases which in themselves are too small to achieve high accuracy of predictions, (2) exploitation of low-cost, easy to measure predictors, (3) development of an optimal reference population based on phenotypic and genomic diversity (and possible financial incentives or investment in collection of same), and (4) detection and exploitation of the causal mutations. A successful international initiative (gDMI) based on the collation of feed intake data from 9 countries in dairy cows concluded that exchange of phenotypic and genomic information can augment the accuracy of genetic/genomic evaluations. Such an approach should also be embarked on for other breeds and species. Steps should, however, be taken now in anticipation of such an initiative including the exchange of germplasm between research centers or the use of a pan-global list of sires. Maximizing phenotypic and genomic diversity (within the constraints of relatedness to the candidate population) could improve the accuracy of genomic predictions; whole populations could be screened using low-cost predictor traits (e.g., sensors, mid-infrared spectroscopy) and divergent animals collated to a centralized unit for deep phenotyping. Combining transcriptomic and genomic data could aid in the detection of causal mutations. Successful genomic selection will also require a re-evaluation of current phenotyping strategies and may include measurements on the parents themselves (e.g., feed intake on bulls) as currently undertaken in other species or half-/full-sibs (e.g., deliberate infection with pathogens).

Key Words: genomic selection, phenotype, breeding scheme

261 Statistical approaches to increase resilience of animals towards environmental challenges and to increase homogeneity of animal products. Han A. Mulder*[1], Ewa Sell-Kubiak[1], Juanma Herrero-Medrano[1,2], Pramod K. Mathur[2], and Egbert F. Knol[2], *[1]Animal Breeding and Genomics Centre, Wageningen University, Wageningen, the Netherlands, [2]TOPIGS Norsvin BV, Beuningen, the Netherlands.*

In animal husbandry, there is a growing demand for animals that need less labor and are capable to handle diseases or other environmental challenges. For various markets, homogeneity of animal products is desired and uniform animals would ease management, e.g., less fluctuation in production in spite of challenges. Furthermore, due to globalization of breeding programs animals need to be capable to perform in a wide range of environments. Here we show 2 statistical approaches that can be used to breed for resilience and uniformity: a reaction norm model to breed for resilience and a double hierarchical generalized linear model (DHGLM) to breed for uniformity. Both were applied to reproduction traits such as total number of born piglets and number of piglets born alive in sow lines. For the reaction norm model, we first developed a challenge load indicator to estimate the level of challenge, based on drops in production. Subsequently, we used this challenge load indicator as a covariate in the reaction norm analysis. We found genetic correlations of 0.5–0.85 between healthy and diseased periods indicating substantial reranking of animals, or in other words genetic variation in resilience. We applied a DHGLM to total number born and found substantial genetic variation in residual variance of litter size with a genetic coefficient of variation at variance level of 0.17. Using deregressed variance EBV, we found a few highly significant genomic regions affecting the variance of litter size. These genomic regions could be utilized in genomic selection. Both statistical approaches can yield breeding values that could be used to select for increased resilience and uniformity of animal production. Due to its low heritability, accuracies of breeding values for resilience and uniformity are low, though substantial genetic variation is present. Accuracy of breeding values for these traits can be enhanced by genomic selection.

Key Words: statistical modeling, resilience, uniformity

262 The role of sustainable commercial pig and poultry breeding for food security. Pieter W. Knap*[1], Anne-Marie Neeteson-Van Nieuwenhoven[2], and Santiago Avendaño[2], *[1]Genus-PIC, Schleswig, Germany, [2]Aviagen, Newbridge, UK.*

The worldwide demand for animal products is increasing: global meat consumption is projected to double in the coming 35 years. At the same time, availability of resources such as land and water are decreasing. This requires livestock production to increase its productivity and its reproductive efficiency, and to reduce its environmental impact. Animal breeding must support this. Livestock breeding goals should then broaden in a balanced way, focusing on productivity and efficiency, subject to certain external constraints and internal restrictions. External constraints are due to feed availability and environmental load (which calls for genetic improvement of livestock feed efficiency, reproductive efficiency, gross production levels, and liveability), and to animal welfare (which calls for genetic improvement of liveability, adaptability and health). Internal restrictions are due to genotype by environment interaction (which calls for data recording at the producer level and using those data for genetic evaluation at the nucleus level), antagonisms between traits (which calls for wide data recording and balanced breeding goals incorporating all possibly antagonistic traits), and selection limits (which calls for proper strategies for restriction of inbreeding rate, and optimization of genetic contributions and mate allocation within populations). Commercial poultry and pig breeding goals have been evolving in that direction since the 1950s, and this logically extrapolates toward a shift of focus on animal robustness, feed efficiency, and product quality traits. At the same time, selection technology is becoming more powerful at a very fast rate, mainly due to molecular genetics tools. As a result of both these developments, animal breeding can make an increasing contribution to sustainable food security.

Key Words: food security, pig breeding, poultry breeding