Thesis Abstract & Published Papers

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Abstract:

Genotype by environment interactions (GxE) can form a potential source of inefficiency in animal breeding if selection decisions are made without accounting for their effects. The UK sheep industry covers an assorted range of farming systems and environments, with each flock having a unique and diverse set of resources and management styles. As a result, what may be the best performing genotype in one environment may not necessarily be the best performing genotype in another. This thesis reports on investigations into the presence of GxE within the UK sheep industry.

Pedigree and performance data, available from both hill and terminal sire breeds, were analysed using a number of different methods. When environments were defined as 2 individual hill farms, genetic correlations were estimated between farms, for a range of Scottish Blackface ewe and lamb traits. The majority of traits of traits measured in these hill sheep were not affected by GxE. Those correlations found to be significantly different from 1 (P<0.05), and therefore indicating the presence of GxE, were for lamb birth weight and ewe pre-mating weight.

Following on from the hill sheep study, fine-scale information on environmental and management factors obtained by a farmer questionnaire, from 79 different terminal sire flocks was combined with nationally-available climatic data and analysed using principle coordinate analysis and non-hierarchical clustering methods. Three distinct clusters of farm environments were identified, with grazing type, climatic conditions and the use of vitamin/mineral supplements proving to be the most distinguishing factors.

The presence of GxE was then investigated by estimating genetic correlations between the clusters identified, using performance data from Charollais lambs, for 21 week old weight (21WT), ultrasound back-fat (UFD) and muscle (UMD) depths. The correlations estimated between clusters 1 and 2, which had the highest number of common Charollais sires used, were all low and significantly different from 1 (P<0.05) suggesting GxE was evident in terms of both scaling and re-ranking.

Finally, the relationship between the level of concentrate feed used in each flock, as obtained from the questionnaire, and performance and climatic information available nationally for all flocks was
estimated using canonical correlation analysis. This allowed the development of a farm environment scale, applicable to all flocks within the UK, and the use of reaction norm analyses to investigate the presence of GxE. The reaction norm describes the phenotype of an individual animal as a function of the environment. The environment scale developed, using data from Texel flocks only, went from low performance averages and poorer weather conditions to high performance averages and improved weather conditions. The slope of the reaction norm measures the sensitivity of an animal to a change in the environment. For each trait, (21WT, UMD and UFD), evidence of both re-ranking and scaling of sires were observed. A number of “robust” sires, with a low level of environmental sensitivity, were also identified.

The findings from these analyses have implications for future sheep breeding programmes. Providing a suitable “measure of environment” can be agreed, the identification of sires that perform well in specific environments, as well as those who perform consistently across a number of different environments, would be beneficial for farmers. This would potentially remove any unwanted effects of GxE and allow the farmer to select animals best suited to their overall farm environment.

Published Papers: