Environmental Clustering of New Zealand Dairy Herds

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Introduction Previous studies have found that milk yield (a proxy for feeding level) and temperature-humidity index (THI) are important factors in explaining genotype x environment (G x E) interactions, indicating differences between the abilities of genotypes to forage or consume concentrates effectively or to cope with thermal stress (Ravagnolo and Misztal, 2000; Zwald *et al*., 2003). The objective of this study was to quantify and cluster (CL) herd environments within New Zealand (NZ) based on production levels, a summer heat load index (HLI) and geographical location.

Materials and methods Production data consisted of 497,433 total lactation milk solids (fat + protein; MS) yields from LIC sire proving scheme animals from 1989-2003. Each data record had a map reference identifying the herd's location. Daily climatic data for the same period were obtained from 89 meteorological stations throughout NZ. Herd-year (HY) groups were clustered based on adjusted MS yield, summer HLI and latitude using the FASTCLUS procedure of SAS (SAS, 1999). Adjusted MS yield for each HY was obtained using the GLM procedure of SAS (SAS, 1999) fitting a model, which included the effects of HY, age, breed and days in milk. Summer HLI for each year was calculated for each weather station (where possible) using the HLI described by Castaneda *et al.* (2004). The HLI includes relative humidity, temperature (similar to THI), but also solar radiation and wind speed. The summer HLI average from the weather station (within a 50 km radius) nearest to each farm (found using ArcView GIS 3.2 (ESRI, 1999)) was used as the measure of climatic environment.

Results and discussion Five clusters were formed based on the Cubic Clustering Criterion. CL1 and CL2 consisted of low and medium MS yield herds, respectively in warm regions of the North Island (Table 1). CL3 was comprised of medium to low MS yield herds from Auckland (North Island) to the base of the South Island with a mild climate. CL4 herds had high MS yields and were located throughout NZ in mild climates. CL5 herds had the highest mean MS yield, and were primarily from the south of the South Island. There was significant variability in herd MS yield and in HLI between (and within) clusters. The top herds averaged in excess of 500 kg MS/cow in CL4 and CL5, whereas few herds averaged in excess of 350 kg MS/cow in CL1. Cluster means for HLI ranged from 60.9 to 67.9 in CL5 and CL1, respectively. A HLI of 67.9 is equivalent to 24 °C, a relative humidity of 80 % and a THI of 72.5, conditions that are considered thermo-neutral. However, individual farms throughout NZ experienced conditions (HLI>70 and THI>74), which correspond to some degree of heat stress.

Table 1 Summary of cluster means (s.d.)

	CL1	CL2	CL3	CL4	CL5
Number of HY	2611	3216	2554	1884	753
HLI	67.9 (1.7)	67.9 (1.4)	64.1 (1.5)	65.2 (1.6)	60.9 (1.8)
MS yield (kg cow/year)	240 (41.6)	293 (52.5)	269 (41.4)	337 (56.2)	343 (62.9)
Latitude	-37.1 (1.1)	-37.4 (1.0)	-39.8 (1.0)	-40.1 (1.5)	-45.4 (1.3)

Conclusions The results of the study demonstrate there is significant variability between clusters for MS yield and HLI within NZ. Subsequent analyses will identify sires, which are specifically suited to high or low MS yield or thermal stress environments.

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