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Phenotypic Dairy Cattle Trait Expressions in Dependency on Rural-Urban Gradients

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Abstract

In dairy cattle breeding programs in Europe or in North America, phenotypic trait expressions have been studied within distinct environmental classes, e.g., conventional versus organic production systems. The aim of the present study was to enhance such concepts via trait modelling in dependency of continuous explanatory variables, considering both social and ecological descriptors simultaneously. Obvious social-ecological challenges for dairy production due to obvious social-ecological heterogeneity might exist in rising megacities on rural-urban gradients. Consequently, following the logic of rural-urban indexes, a simplified survey stratification index (SSI) was calculated based on building density and distance to the city centre for the chosen megacity Bangalore, located in the South of India. Dairy trait recording focused on the generation of a longitudinal data structure, covering a recording period from June 2017 to February 2018, and including 391 dairy cows from 105 herds in urban (SSI < 0.3), mixed ($0.3 - 0.5$) and rural (SSI > 0.5) districts. Traits from repeated farm visits reflected the categories production (daily milk yield: MY), energy efficiency (body condition score: BCS), cow wellbeing (udder hygiene score: UHYS, leg hygiene score: LHYS), and health (locomotion score: LOC, mastitis: MAST). The statistical models for repeated measurement analyses considered the fixed effects of lactation, days in milk, breed, year-season of trait recording, and SSI as a covariate. For SSI, different functions based on Legendre polynomials 1 to 4 were tested in consecutive runs for all traits. Random effects included the cow (genetic plus permanent environment), the herd, and the residual component. Model evaluation criteria were AIC and BIC values. Throughout smallest AIC and BIC values indicating model superiority were achieved with Legendre polynomials of order 1 (reflecting a linear regression) and of order 4. Quadratic functions (Legendre 2) were associated with large AIC and BIC values for all traits. MY and BCS were higher in the urban regions, associated with reduced MAST and better hygiene scores for UHYS and LHYS. Such obvious differences in phenotypic trait expressions due to social-ecological heterogeneity might contribute to a deeper understanding of physiological mechanisms underlying genotype by environment interactions.

Keywords: Dairy cattle, rural-urban farms, social-ecological systems, survey stratification index (SSI)

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