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Genetic analysis of heat tolerance in dairy cattle performing in sub-Saharan Africa

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Abstract

Given the ongoing climate change, selective breeding aimed at enhancing animals' resilience to rising temperatures, while still sustaining milk production, is crucial for the long-term viability of dairy systems in sub-Saharan Africa (SSA). However, specific indicators of heat tolerance have not yet been established for production systems in SSA, hindering their incorporation into breeding objectives. This study examined how milk production responds of cows to high heat load conditions as a measure of heat tolerance. A total of 65,261 first-parity weekly average milk yield records from 1,547 crossbred cows performing in semi-arid and semi-humid agroecological zones of Kenya were analyzed. Temperature-Humidity Index (THI) was calculated from weather data generated online from the NASA POWER project and used as a measure of heat stress. Random regression models, including reaction norm functions, were fitted, adjusting for significant fixed effects. A THI value of 85 was chosen based on the population-level reaction norm to reflect heat stress conditions. The intercept of the reaction norm model (Intercept) for each cow was used as its mean production. Two resilience indicators were defined at THI 85: the slope of the reaction norm (Slope) reflecting a directional change in milk yield in response to heat stress and the absolute value of this slope (Absolute) showing the stability in milk production during heat stress conditions. Animals with 50 % *Bos taurus* genes and those performing in the semi-arid environment were the most thermotolerant. The Intercept, Slope, and Absolute had heritability estimates of 0.20±0.05, 0.25±0.05, and 0.12±0.05, respectively. Slope had a high negative correlation (-0.93±0.02) with Intercept, revealing that higher milk-producing cows are more vulnerable to heat stress and vice versa. A significantly moderate positive correlation (0.63±0.19) was observed between Intercept and Absolute. This implied that lower milk-producing cows have a more stable production profile under heat-stress conditions. This study demonstrated the potential effectiveness of utilising reaction norm functions to assess the resilience of dairy cattle to heat stress in SSA. These findings hold significant implications for enhancing the heat tolerance of livestock species via genetic selection, particularly in low-income countries located in tropical regions.

Keywords: African tropics, climate change, heat stress, livestock, reaction norms

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