Relationships among enteric methane, body-surface temperature, and body condition score in tropical smallholder dairy cattle

AUTHORS

C. Lindlohr, K. Tirimba
(Dept. of Animal Breeding and Husbandry in the Tropics and Subtropics, University of Hohenheim, Germany)

B. Kawonga
(Animal Science Dept., Lilongwe University of Agriculture and Natural Resources (LUANAR), Malawi)

M. Chagunda
Centre for Tropical Livestock Genetics and Health, University of Edinburhg, United Kingdom)

1. Introduction

- Enteric methane represents a loss of metabolizable energy, reducing both milk and meat yields.
- While feed-methane links are well studied, the role of physiological traits is less understood.
- The study investigated pre-selected animal and environmental variables to examine their influence on enteric methane emissions in smallholder dairy systems in Malawi.

2. Methodology

- 110 cows and heifers on 72 smallholder farms across 6 milk collection zones (MBGs)
- Similar feeding practices in terms of quality and quantity across farms

Methane emissions:
measured for ≥6 min per animal using a Laser Methane Detector (Fig. 2 top)

Body Surface Temperature (BST):
recorded via infrared thermal imaging (Fig. 2 middle)

Body Weight (BW) & Body Condition Score (BCS):
estimated with a weighing band and assessed on a standardized 5-point scale (1 = emacitated; 5 = obese) (Fig. 2 bottom)

Temperature-Humidity Index (THI):
calculated from on-farm temperature and humidity readings

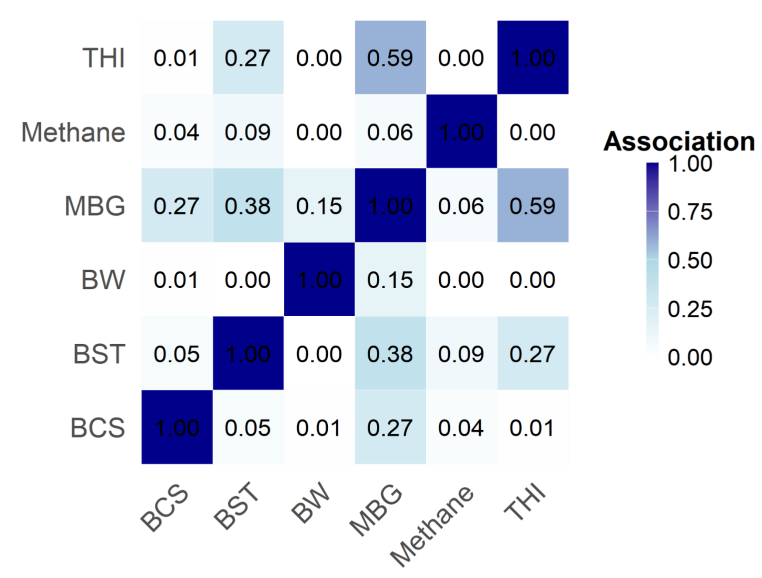
Analysis:
linear mixed-effect models, model selection, and predictor importance

3. Results

- **Significant association:** BST ($p = 0.0058$)
- **Observed trend:** higher methane at BCS 2.5-3 (81 ± 22.4 ppm-m) vs. BCS 2 and 3.5 (241 ± 31.6 ppm-m).
- **Best model:** BCS + BST + MBG + THI ($R^2 = 0.174$)
  → BW excluded, due to low explanatory value (AICc)
- **Correlation Trends:**
  - Methane is weakly correlated with all variables ($R^2/Eta^2 < 0.1$) (Fig. 3)
  - Moderate correlations among BCS, BST, MBG, and THI (Fig. 1)
  - BCS and BW are largely independent of other variables. (Fig. 1)

4. Conclusion

- BST showed the strongest association with methane emissions
  → linked to thermoregulation & metabolism
- BCS not significant, but animals in optimal condition tended to produce more methane → likely due to higher feed intake
- Combined predictors improve explanation of methane variability (17.4%)
  → much variation remains unexplained
- Correlation of MBG and THI due to geography and shared weather
  → BST is further influenced by local factors
- Future studies should include additional variables for better prediction



	BCS	BST	BW	MBG	Methane	THI
THI	0.01	0.27	0.00	0.59	0.00	1.00
Methane	0.04	0.09	0.00	0.06	1.00	0.00
MBG	0.27	0.38	0.15	1.00	0.06	0.59
BW	0.01	0.00	1.00	0.15	0.00	0.00
BST	0.05	1.00	0.00	0.38	0.09	0.27
BCS	1.00	0.05	0.01	0.27	0.04	0.01

Fig. 1. *Correlation Matrix. Heatmap colors indicate association strength (white = low, dark blue = high). Methane shows minimal correlations with all variables ($R^2/Eta^2 < 0.1$), while moderate correlations exist among environmental/management factors: MBG ↔ THI (0.589), MBG ↔ BST (0.381), BST ↔ THI (0.267). Both BCS and BW are largely independent of other variables. While BCS and other predictors reflect energetic and metabolic states relevant for methane, BW mainly captures size and transient weight changes, providing an additional rationale for its exclusion from the final model.*

Fig. 2. *The different measurements. Enteric methane was measured using a Laser Methane Detector, which was pointed between the nostrils of the cows (up). The body-surface temperature was derived from thermal images, while only the body area of the lower abdomen was considered (middle). Body weights were measure with a weighing band, and body conditons scores were assessed on a standardized 5-point scale 1=emaciated; 5=obese)*

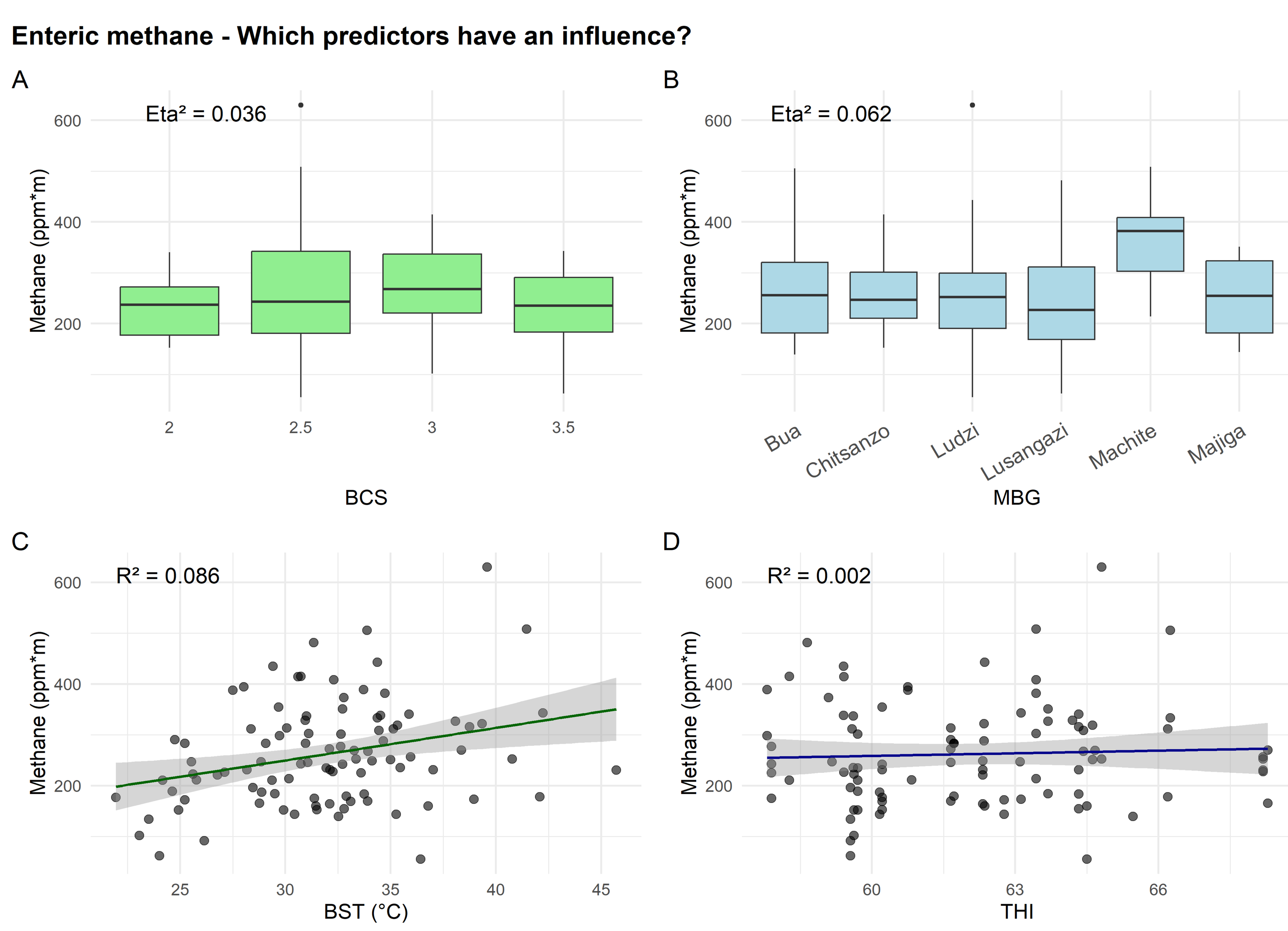


Fig. 3. *Influence of physiological and environmental predictors on enteric methane emissions. Boxplots illustrate differences in methane emissions by body condition score (BCS) (A) and milk bulking group (MBG) (B) (categorical data), while scatterplots show relationships with body-surface temperature (BST) (C) and temperature-humidity index (THI) (D) (numeric data). The effect sizes, calculated in relation to the final model, indicate that BST ($R^2 \approx 0.086$) and MBG ($\eta^2 \approx 0.062$) explain the largest portions of variation in methane emissions, whereas THI ($R^2 \approx 0.002$) and BCS ($\eta^2 \approx 0.036$) have smaller contributions.*

CONTACT

Carmen Lindlohr
carmen.lindlohr@uni-hohenheim.de

Tropentag 2025