Effect of Heat Stress on Swiss Dairy Cow Performance

A Big Data Statistical Analysis

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At what Temperature Humidity Index (THI) values do changes in dairy performance occur for the different dairy cow breeds in Switzerland?

Data – 130 Million Milk Samples since 1982

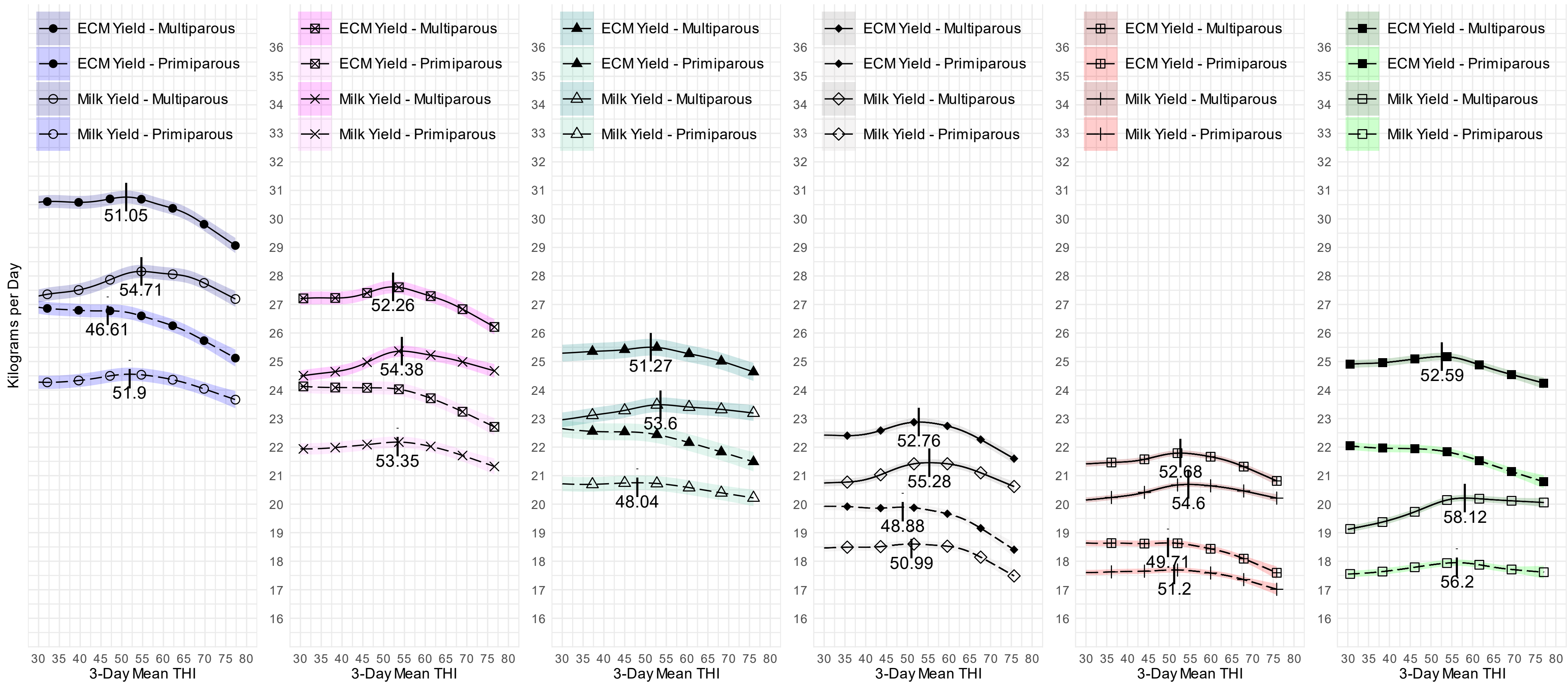
Milk samples from the major Swiss breeding associations matched with temperature and humidity data from MeteoSwiss. The dataset contains records from > 46'000 farms and > 4'200'000 cows. The data is sparse – only a few samples per cow and year are available. Farms enter and exit. Cows enter and exit the panel or change farms.

Method – Generalized Additive Models (GAM)

$$y = \mu + f(\mathrm{THI}) \cdot \mathrm{P} + f(\mathrm{DIM}) \cdot \mathrm{P} + \mathrm{P} + \mathrm{Y} + \iota + \phi + \alpha + \epsilon$$

$\boldsymbol{\mu}$: breed mean $\boldsymbol{f()}$: non-linear smooth term **DIM**: days in milk
P: parity **Y**: year $\boldsymbol{\iota}$: ZIP × month RI $\boldsymbol{\phi}$: farm RI $\boldsymbol{\alpha}$: cow RI
RI: random intercept **y**: dairy performance variable $\boldsymbol{\epsilon}$: error

Fit a separate model for each breed with data subsamples. Then, numerically determine the peak points of the smooth term f(THI).



- Uncommonly low peak THI values (expected around 68).
- Early component drop (ECM Yield) balances out large peak THI differences in volume drops (Milk Yield) across breeds.
- Primiparous peak THI values consistently lower than multiparous.
- Splitting data to pre and post 2010 leads to lower peak THI values for post 2010. Lower heat-resilience through breeding?