Temperature & humidity influence milk yield & quality in Scottish dairy cows

Davina Hill & Eileen Wall
davina.hill@sruc.ac.uk

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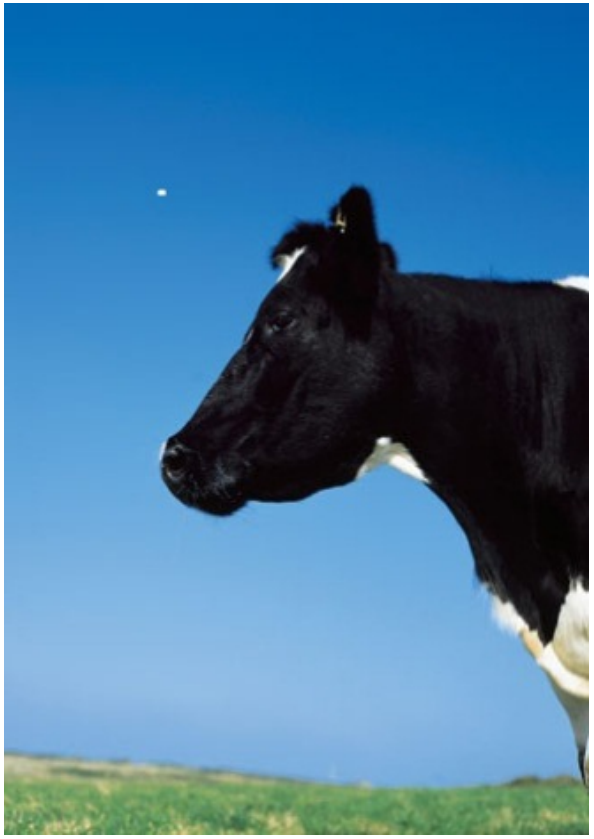
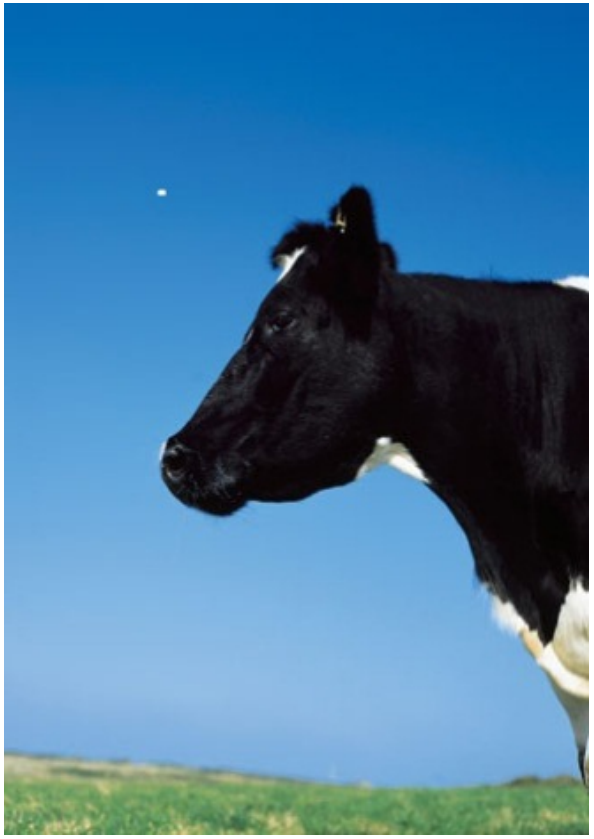
Climate change & livestock

- Farming must adapt to a changing climate
  - Increases in temperature & extreme weather events
- Heat stress
  - affects productivity, fertility & health
  - occurs when animals experience conditions outside thermal comfort zone



Heat stress

- Tolerance to high temperatures depends on humidity
- Temperature Humidity Index (THI)
  - indicator of conditions causing heat stress
- Temperate regions
  - animals have lower tolerance



Aim

- How does THI influence milk yield & quality?
  - Holstein Friesian cows in Scotland
- Predictions for 2080 for S. Scotland
  - increased temperature
    - mean daily maximum increase 4.3°C
  - 0-5% ↓ in humidity
- Hypotheses
  - Performance declines at extremes of THI
  - Depends on management

Subjects & maintenance

- 2 genetic lines:
  - Select *vs* Control for kg fat + protein
  - Managed together
- 2 diet groups:
  - High *vs* Low Forage

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Management at 2 research farms

Farm 1

- 1990 - 2002
- Calving: Sept-Jan
- Indoors for ~200 days from day calved → out
- End of June → out

- Milked 2x a day

Farm 2

- 2002 - 2011
- LF: continuously housed
- HF: indoors, summer grazing

- Milked 3x a day

Animal data

- 4-305 days in milk
- 12 months' acclimatisation
- Cows inside or outside on test day – 'management'

- 1362 cows
  - 752674 daily yield records
  - 87446 weekly fat & protein records

Weather data

5 weather elements

- Temperature (T_{db})
- Humidity (RH)
- Precipitation
- Wind speed
- Sunshine

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recorded daily at 0900h

number of hours over 24h

- Closest weather station to each farm
- **THI** =

$$(1.8 \times T_{db} + 32) - \left((0.55 - 0.0055 \times RH) \times (1.8 \times T_{db} - 26)\right)$$

NRC, 1971

- Moving means across week before test day

Model fit by REML

y ~ μ + **Weather** + **Management** + **Weather×Management**
+ Feed Group + Genetic Group + FG×GG
+ Farm + Lactation no + Days in milk
+ cow id + calving date + test date + e

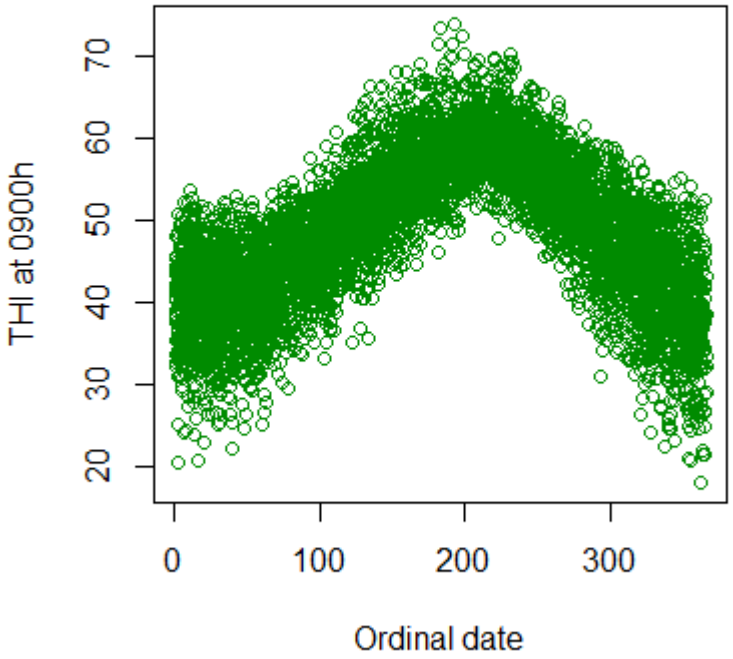
- y =
  - Milk yield (kg)
  - Fat content (%)
  - Protein content (%)

- Weather =
  - THI
  - Wind speed
  - Sunshine
  - Precipitation

THI, wind, sun:
tested for linear, quadratic, cubic & quartic terms
Days in milk:
Linear & quadratic terms

Results

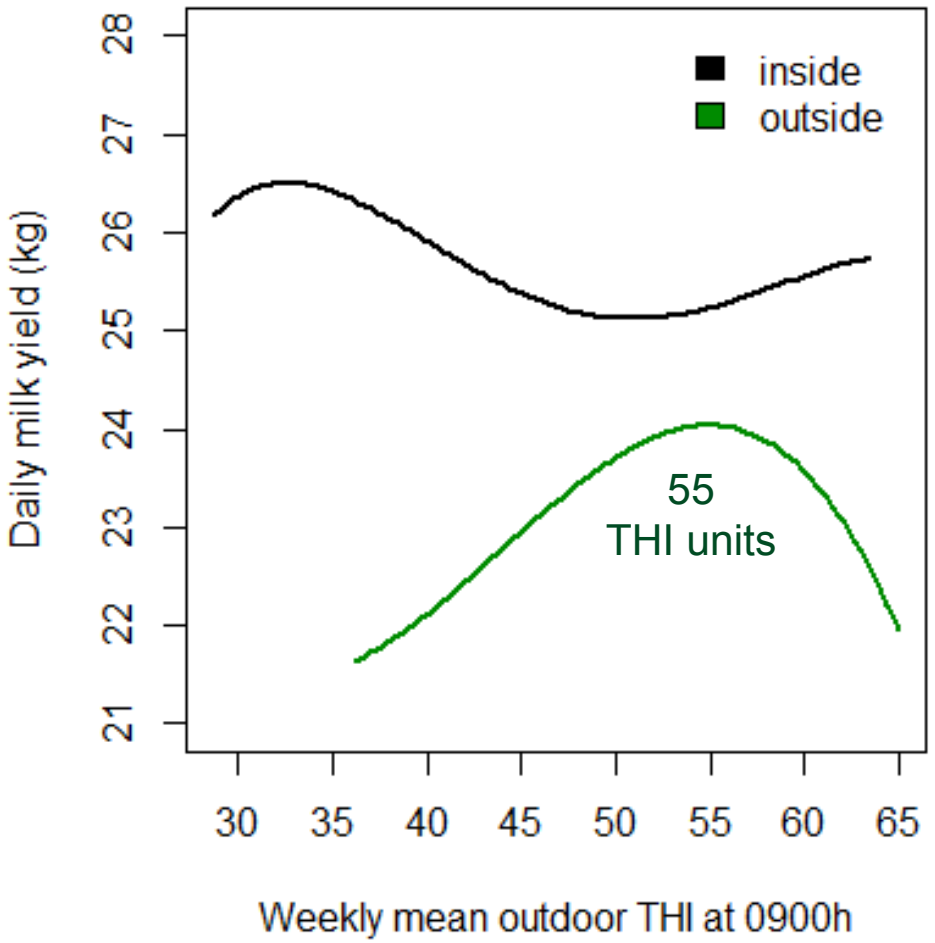
- Mean THI at 0900h: 49 ± 0.1



9% of days

- THI influenced milk yield & quality
  - Effects depended on whether cattle were inside or outside on test day

THI & management influence milk yield



- Outdoors: lower yield at THI extremes
- THI ≥55 on 39% of days
- Indoors: overall decrease with THI
  - Differences in diet
  - Warmer inside shed

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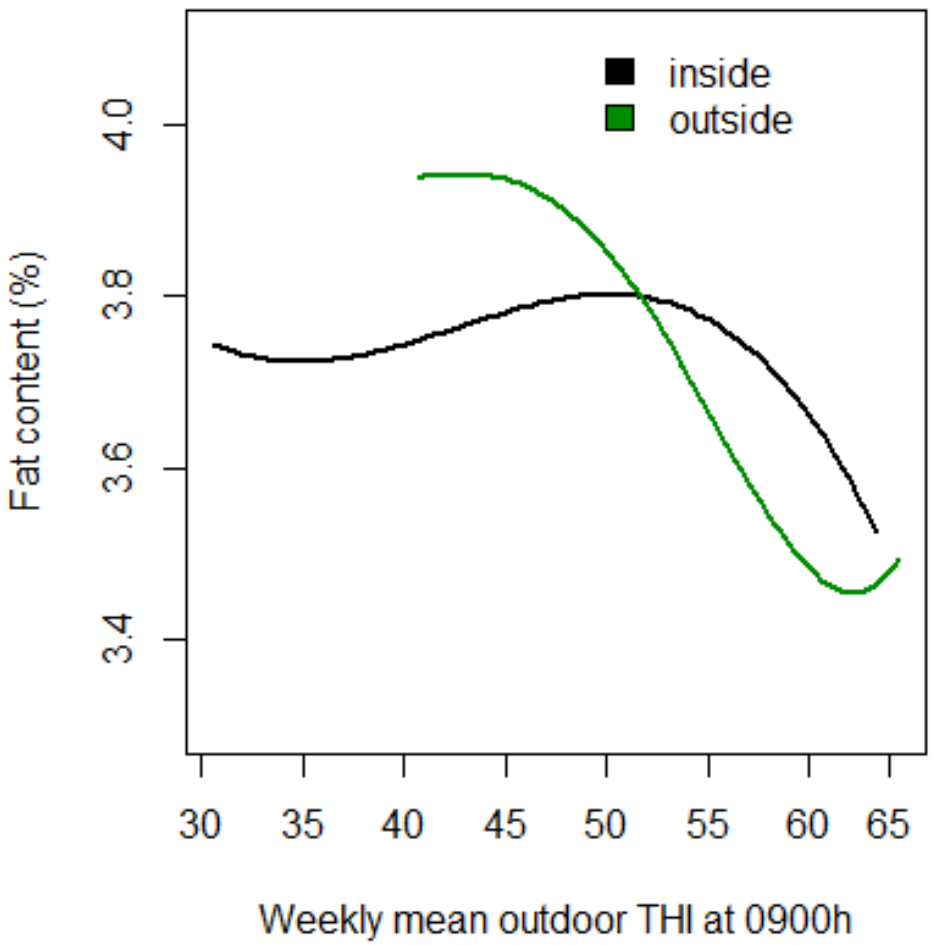
THI & management influence fat %



- Outdoors: fat % decreases with THI
- Indoors: higher fat % at intermediate THI

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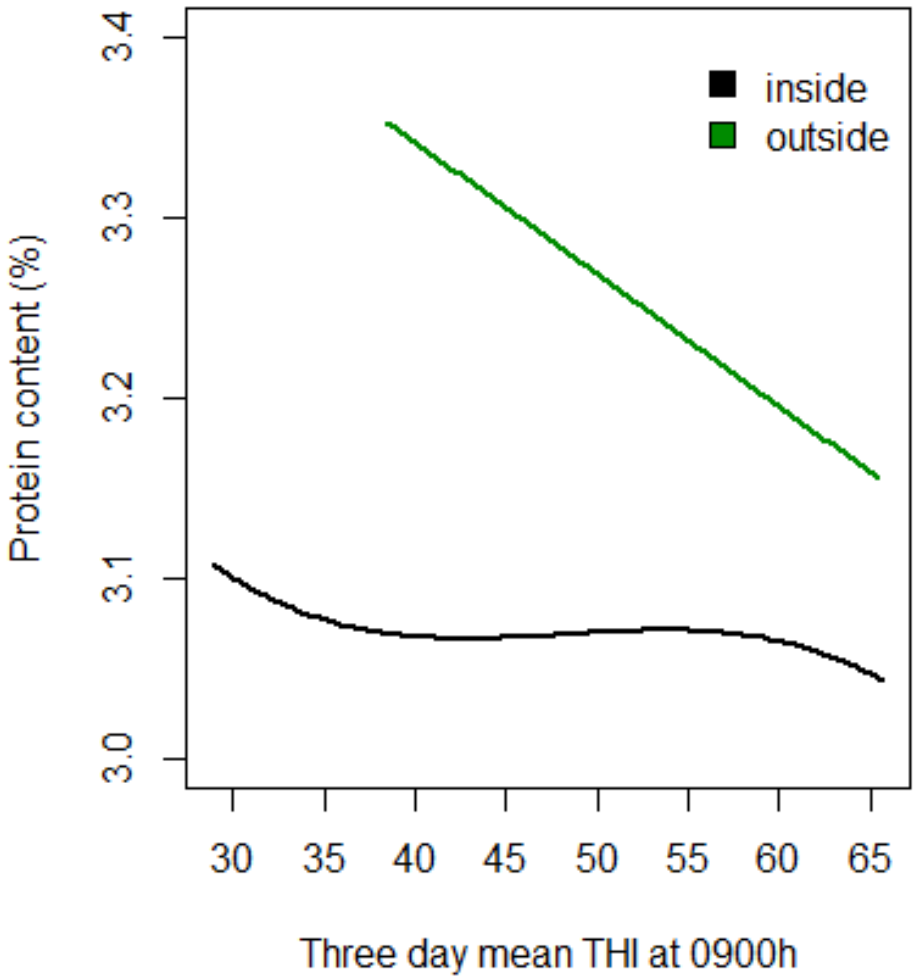
THI & management affect protein %



- Protein % decreases with THI
- More pronounced decline in animals outdoors

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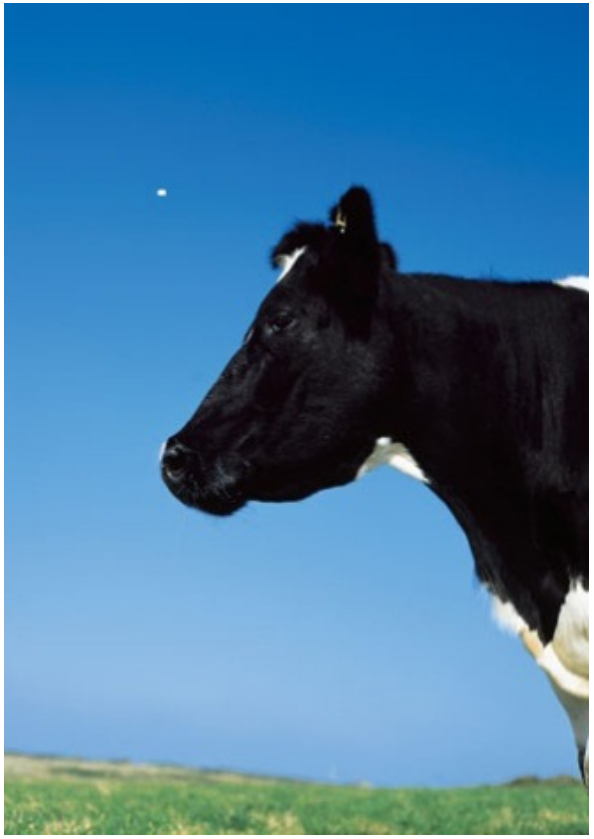
Conclusions

- Extremes of THI currently impact dairy productivity in Scotland
- THI predicted to increase over 21st century
- Effects of THI depended on management
  - Potential to offset losses through changes in diet & housing



Acknowledgements

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