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

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Leading the way in Agriculture and Rural Research, Education and Consulting
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
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

• Closest weather station to each farm

• $\text{THI} =$

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

• Moving means across week before test day

NRC, 1971
Model fit by REML

\[ y \sim \mu + \text{Weather} + \text{Management} + \text{Weather} \times \text{Management} + \text{Feed Group} + \text{Genetic Group} + \text{FG} \times \text{GG} + \text{Farm} + \text{Lactation no} + \text{Days in milk} + \text{cow id} + \text{calving date} + \text{test date} + e \]

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

- \( \text{Weather} = \)
  - 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

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

9% of days
Outdoors: lower yield at THI extremes

THI ≥55 on 39% of days

Indoors: overall decrease with THI
- Differences in diet
- Warmer inside shed

Hill & Wall, Dairy cattle in a temperate climate, Animal (forthcoming)
THI & management influence fat %

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

Hill & Wall, Dairy cattle in a temperate climate, Animal (forthcoming)
THI & management affect protein %

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

Hill & Wall, Dairy cattle in a temperate climate, Animal (forthcoming)
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
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http://mets-trading-dairy.blogspot.co.uk