SRUC

Weather influences milk yield, feed intake & feed efficiency in dairy cows

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

Producing enough food in a changing climate

- Improving feed efficiency (FE)
  - amount of meat or milk produced per unit of dry matter
  - increase output while minimizing feed costs & environmental impacts

Feed efficiency (FE)

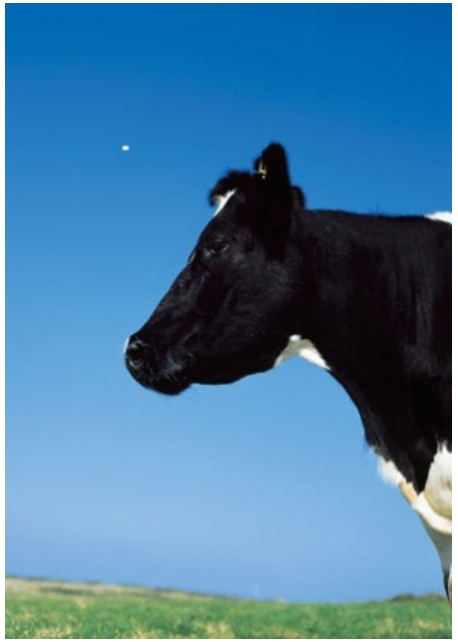
- Individual dairy cows differ in
  - feed intake
  - amount of manure, methane & carbon dioxide per unit DMI
  - abilities to generate & conserve heat energy

	More efficient cows	Less efficient cows
Metabolic heat production (as % of gross energy intake)	lower	higher
Skin surface temperature	lower	higher

- More efficient dairy cows might be less susceptible to thermal stress
  - stresses associated with high or low temperatures

Milk production influences heat production

- Heat stress occurs when environmental conditions exceed the body's thermoneutral zone
  - range of ambient conditions at which metabolic heat production & heat loss are balanced
- High yielding cows
  - need high metabolic rates
    - high metabolic heat loads
  - experience heat stress at lower temperatures than lower yielding cows

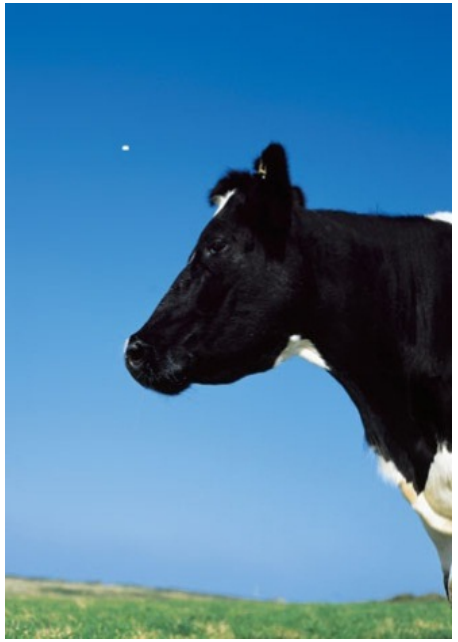


Research question

- How do
  - milk yield,
  - dry matter intake (DMI),
  - feed efficiency (FE; amount of milk per unit dry matter)

vary with weather in dairy cows of high & average genetic merit?

  - Temperature Humidity Index (THI)
    - indicator of environmental conditions causing heat stress
    - evaporative cooling hampered by humidity



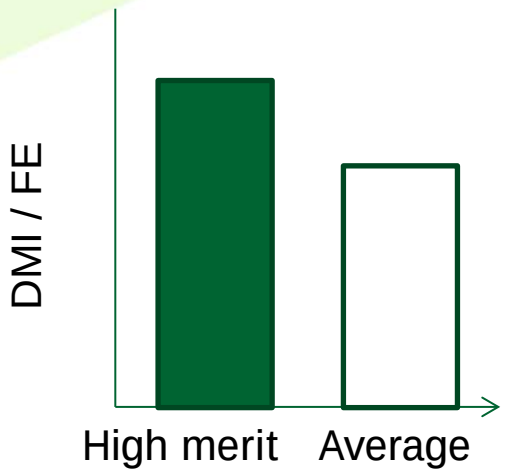
Predictions

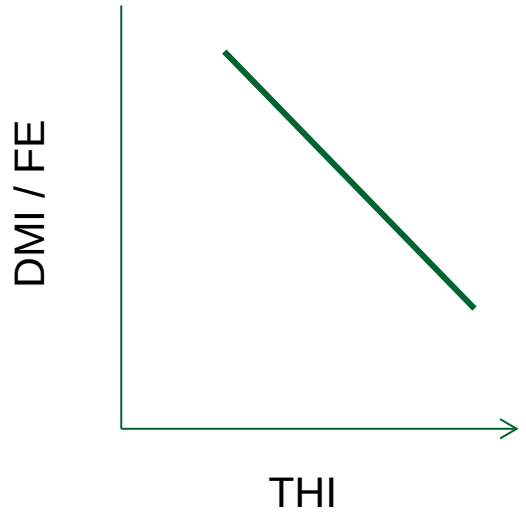
1. Cows of high genetic merit for milk traits
   - consume more feed
   - are more efficient (higher FE)

   than cows of average merit
2. As THI ‘ , DMI & FE “

Decrease metabolic heat production

Divert resources from production to keeping cool





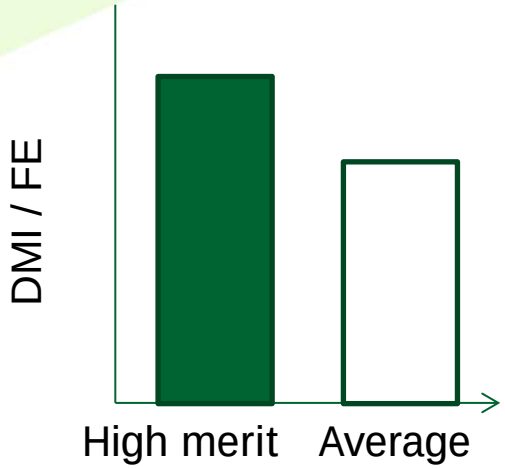
Predictions

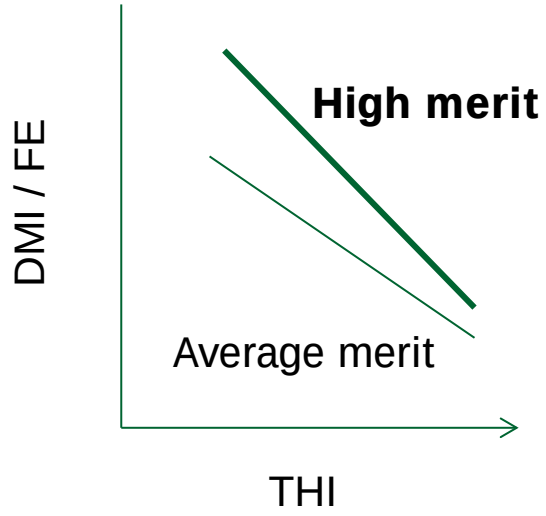
1. Cows of high genetic merit for milk traits
   - consume more feed
   - are more efficient (higher FE)

   than cows of average merit
2. As THI ‘ , DMI & FE “
3. Impact of THI on DMI & FE is greater in cows of high than average merit

Decrease metabolic heat production

Divert resources from production to keeping cool



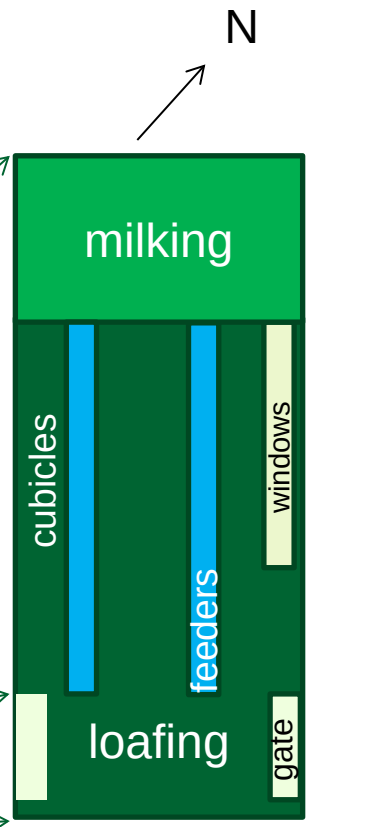


Methods

- Langhill Holstein Friesian dairy herd
  - 2004-11
- Cows belonged to 2 genetic lines:
  - high genetic merit for kg fat + protein (Select)
  - UK average (Control)
- Lines managed together

Methods: housing

- Housed year round in a single building
  - natural ventilation
  - open windows
  - gated but otherwise open sections at either side of a loafing area
  - Yorkshire boarded upper walls
- corrugated cement fibre roof with Perspex skylights



Not to scale

Methods: animal management

- Cows received a mixed ration
  - ad libitum
  - automatic feed measurement gates
- Milked 3

Methods: cow data

- Milk yield was expressed as daily fat & protein corrected mik yield (FPCMY)
- FE was FPCMY/DMI

HOKO automatic feed measurement gates

Holstein Friesians at SRUC Dairy Research Centre

Weather data

- Daily measurements of
  - Temperature
  - Wind speed
  - Relative humidity
  - No. hours of sunshine

Met Office weather station

- THI was calculated:

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

NRC, 1971

- 3-day moving means
  - test day & 2 days before the test day

General Linear Mixed effects Model using REML

MY, DMI, FE

THI, wind speed, sunshine

Select or Control

1-5

1-3

$$y \sim \mu + w + \text{Genetic Group} + w \times \text{Genetic Group} +$$

$$\textbf{Lact no + Days in milk + Live weight + Condition score +}$$

$$\textbf{calving date + test date} + \textit{cow id} + e$$

- Linear, quadratic & cubic terms of continuous fixed effects
- Continuous terms mean-centred

~73,000 daily records from 328 cows

THI affects MY, DMI, FE

Fig 1. MY

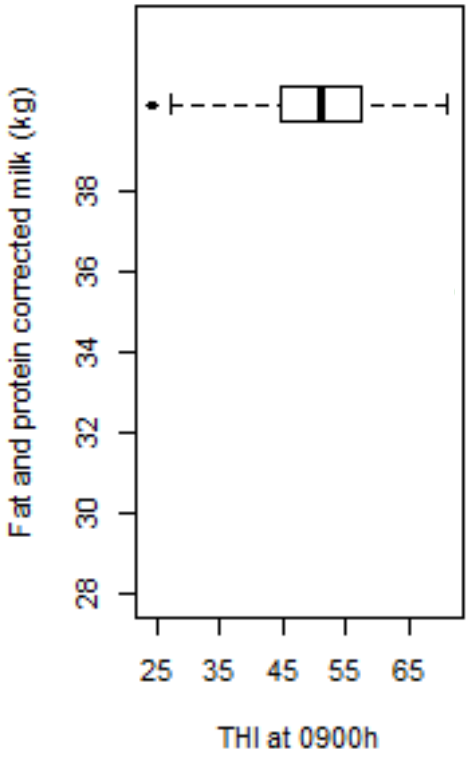


Fig 2. DMI

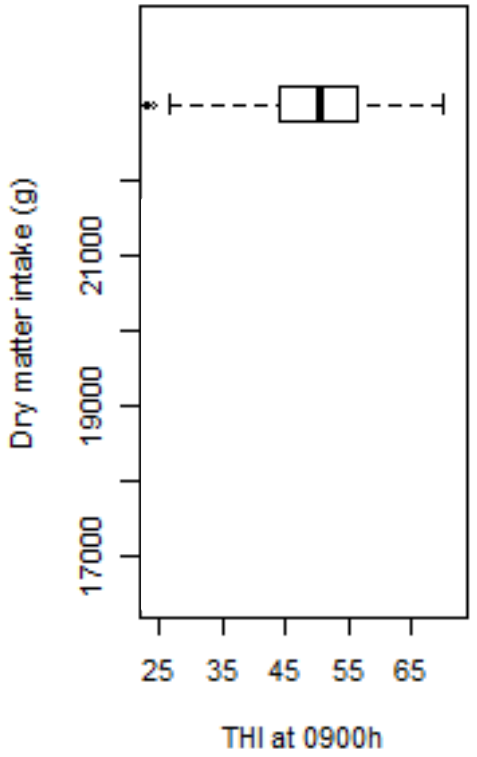
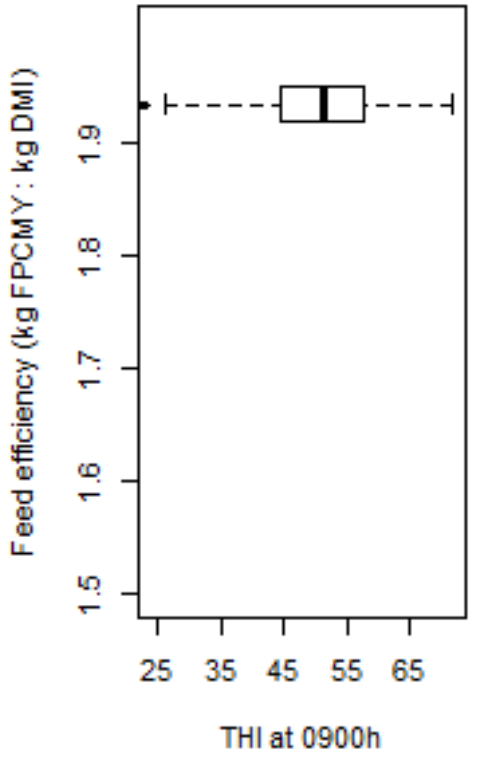


Fig 3. FE



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Weather influences feed intake & efficiency

Curves are least squares means adjusted for all significant effects in the models

THI affects MY, DMI, FE

FE ‘ with THI under mild conditions;
“ when heat stress becomes more severe

Fig 1. MY

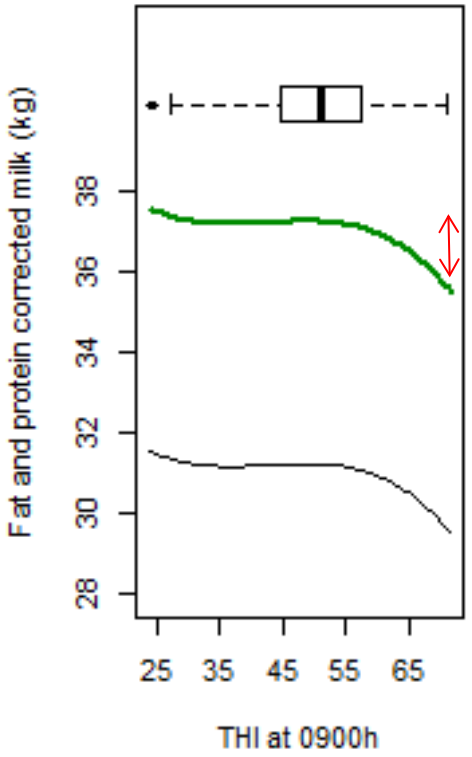


Fig 2. DMI

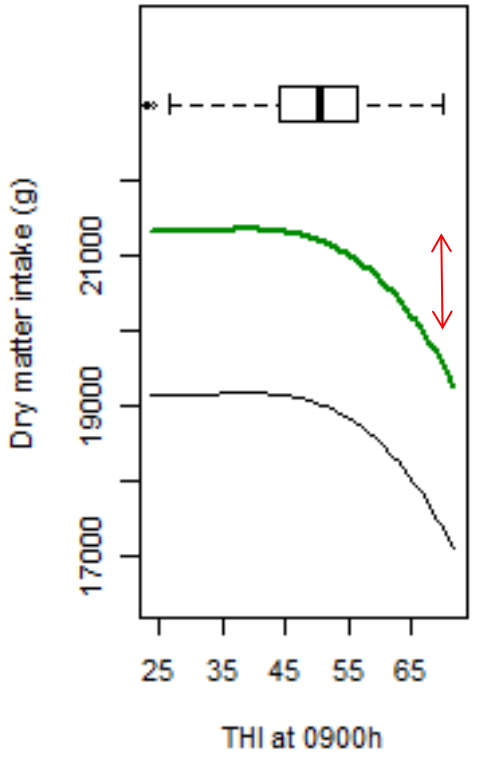
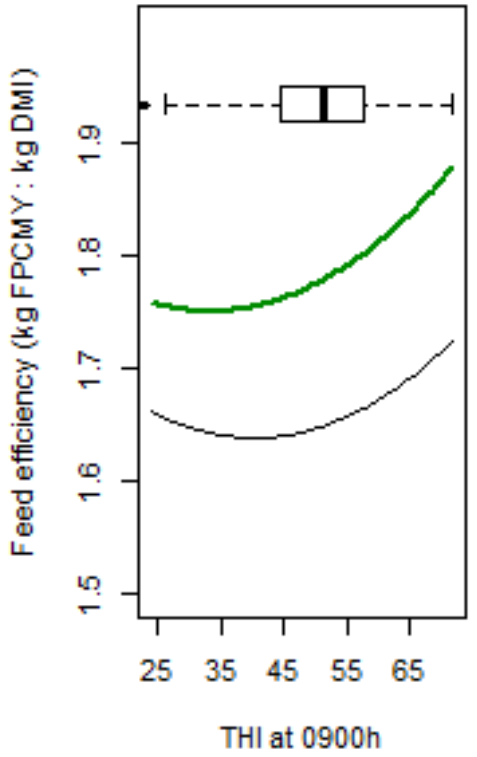


Fig 3. FE



THI*GG on MY, NS
THI*GG on DMI, NS
THI*GG on FE, *P*=0.036

Select (high merit) cows

Control (average merit) cows

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Curves are least squares means adjusted for all significant effects in the models e.g. condition score, live weight

Effects of WS on DMI & FE

Fig 4. DMI

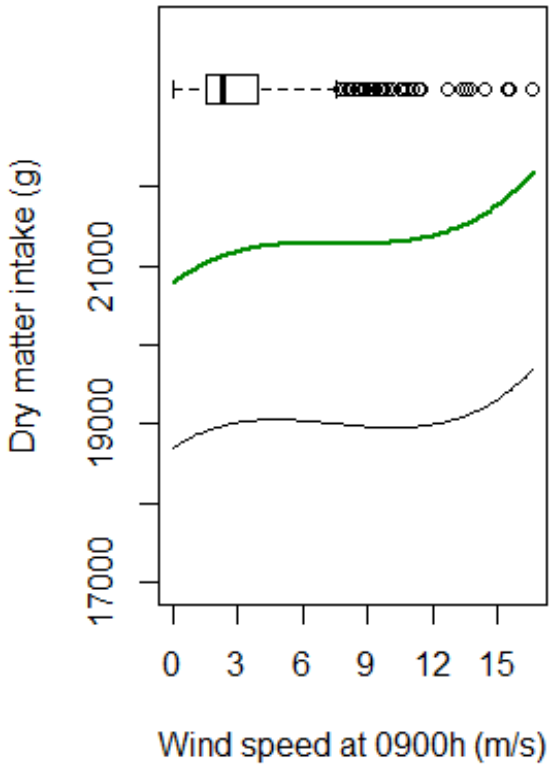
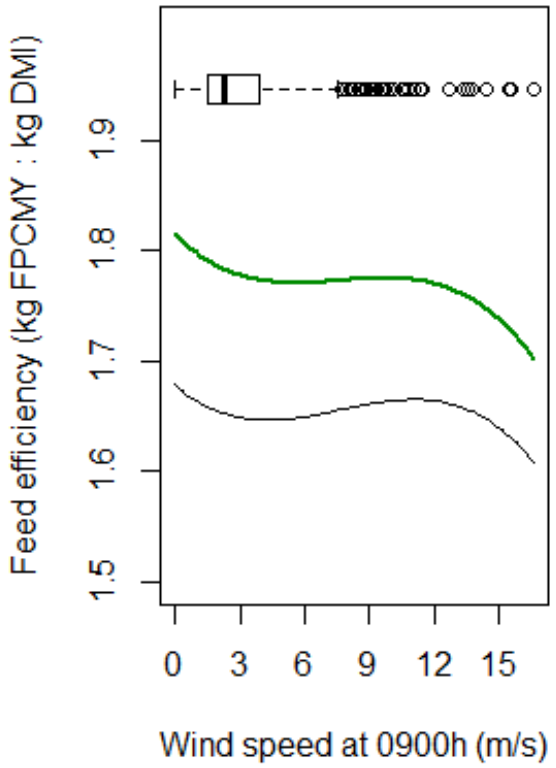


Fig 5. FE



WS*GG on DMI, *P*=0.022
WS*GG on FE, *P*=0.049

Select (high merit) cows

Control (average merit) cows

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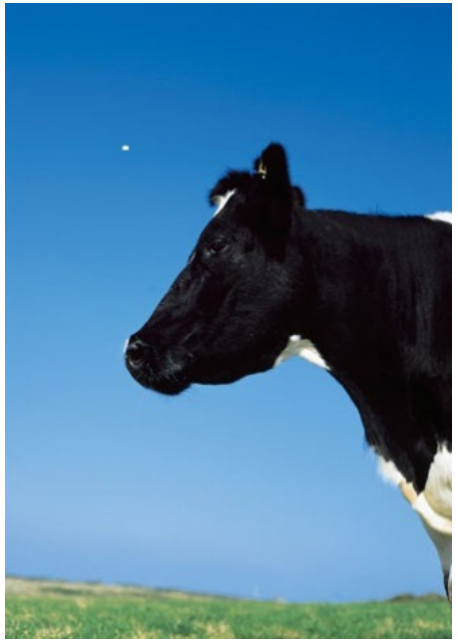
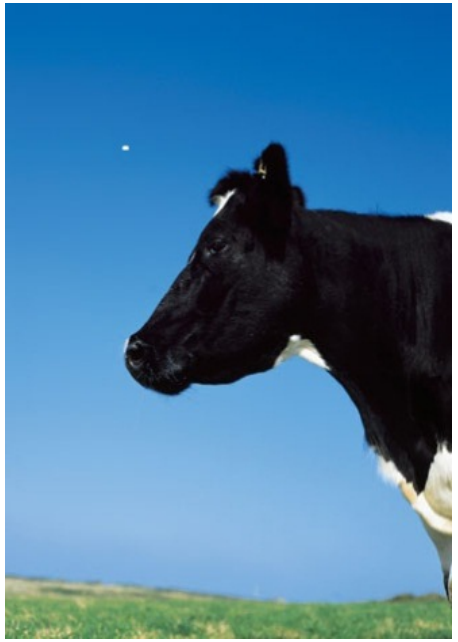
Summary

- As THI increased
  - milk yield and DMI “
  - FE ‘
    - Improvements in the efficiency of converting feed to milk may partially offset costs of reduced MY in a warmer future climate



Implications

- Understanding how weather influences productivity & efficiency
  - make predictions using climate scenarios. e.g. UKCP09 models
  - use weather forecasts to inform management
  - breed livestock with improved resilience
- May help adaptation to climate change



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