Quantifying responses to hot conditions in divergent sheep breeds in South Africa

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Photo by Stefan Els

Introduction

- South Africa is arid with large areas only suitable for extensive livestock production
- Sheep have provided farmers with stable and reliable income
- Climate likely to become more unstable:
  - More extreme heat during summer
  - More cold snaps during winter
- Sheep and goats are more resilient to heat than other livestock species

- Limited local knowledge on:
  - Responses to elevated temperatures
  - Effectiveness of interventions such as breed substitution

Introduction

- Important to:
  - Assess available breeds for their ability to withstand an increased temperature
- Understand adaptive mechanisms under heat stress
- Quantify differences between:
  - Breeds
  - Individuals within breeds
- Aims:
  - Evaluate sheep breeds for heat stress indicators under thermo-neutral and more challenging conditions
  - Estimate repeatability and reranking effects between cooler and more challenging conditions

Material and Methods

Locality and genetic resources

- Conducted Langgewens research farm in the Mediterranean region of South Africa
- Average maximum temperature in midsummer > 30 ˚C
- Recorded 80 mixed-age ewes of 8 breeds – 10 per breed:
  - Merino: International wool breed
  - Dohne: Wool composite
  - SAMM: Dual-purpose (meat and wool)
  - Dormer: Composite terminal sire
  - Ile de France: International terminal sire

} Temperate

  - Dorper: Meat composite (temperate and heat-adapted) — 50 % heat adapted
  - Meatmaster: Meat composite (Dorper and heat-adapted) — 75 % heat adapted
  - Namakwa Afrikaner: Unimproved, indigenous — Heat adapted

Material and Methods

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Experimental outlay and data recorded

- Online weather forecast services used to identify a period with temperature > 30 ˚C
- Animals recorded on 3 mornings and 3 afternoons from 25 to 27 January 2022
- Three heat stress indicator traits were recorded:
  - Skin temperature: laser-based thermometer
  - Respiration rate: respiratory side movements (/30 sec * 2)
  - Rectal temperature: standard clinical thermometer
- Ewes divided into smaller unsheltered paddocks for recordings
- Neck tags used to allow identification from a distance

Material and methods

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Climate data and temperature-humidity index (THI)

- Tinytag Plus 2 data logger and weather screen (Stevenson-type)
- Centre of experimental area at sheep head-height
- Recorded relative humidity (%) and temperature (°C) at 10 min intervals
- Used to derive the THI as:

$$THI = TC - ((0.31 - 0.31 \times RH/100) \times (TC - 14.4))$$

with:

THI – temperature-humidity index

TC – ambient temperature (°C)

RH – relative humidity (%)

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Statistical analyses

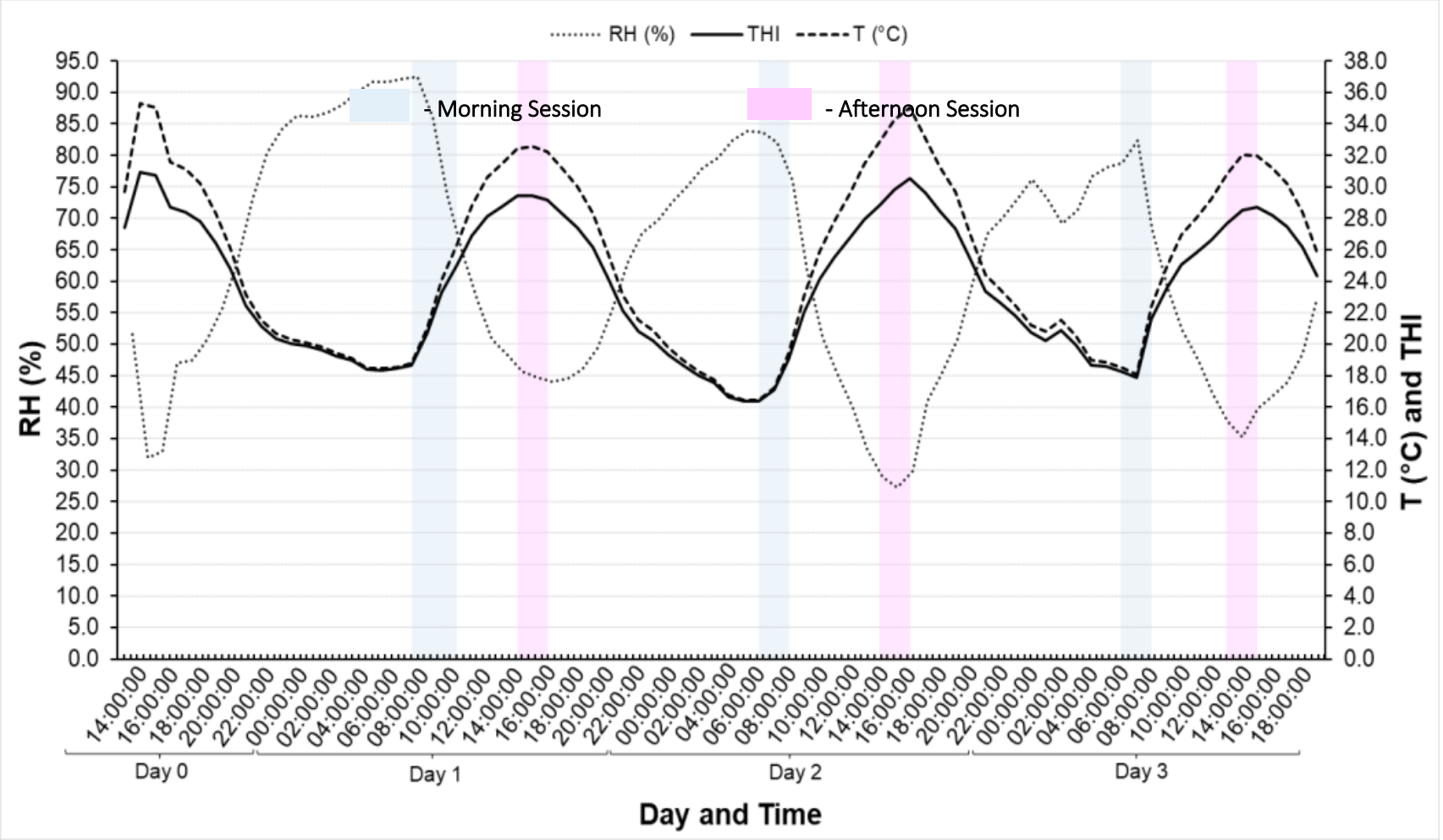
- Mixed model using ASReml (V4.1)
- Fixed effects fitted:
  - Ewe breed
  - Day (Day 1 to Day 3)
  - Time of day (Morning or Afternoon)
  - Interactions
- Random effects:
  - Ewe
  - Ewe x time of day for re-ranking
- Between-ewe variances used to estimate repeatability

Results

- **THI, T and RH** differed between **morning** & **afternoon** sessions

- **Morning**
  - 06h00 – 09:30
  - THI = avg. 19.4
  - Non-existent to slight levels of heat stress

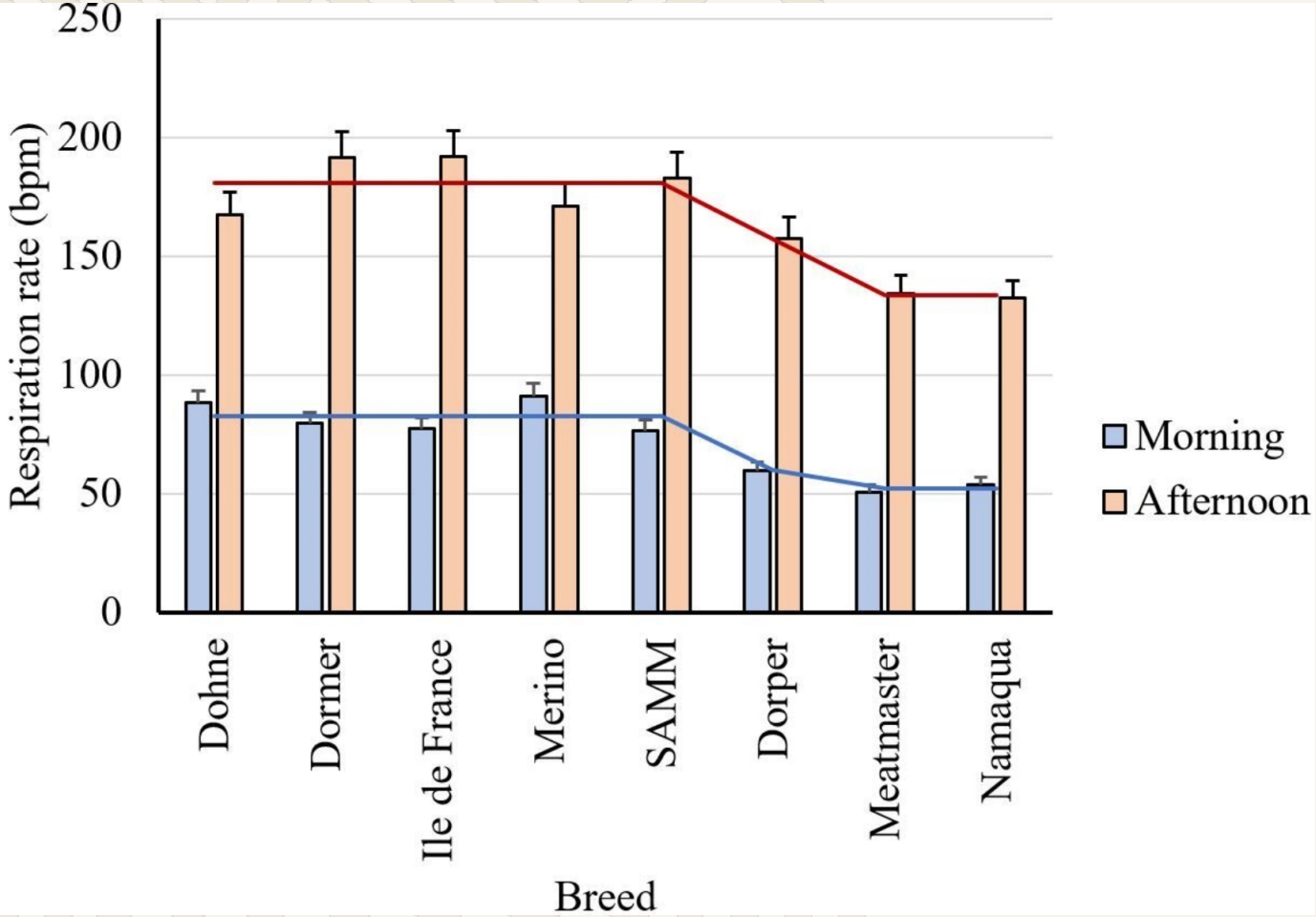
- **Afternoon**
  - 14h00 – 16h00
  - THI = > 27
  - Dangerous heat stress levels



The environmental temperature, relative humidity (RH), and temperature-humidity index (THI, where T was expressed relative to °C) for the duration of the trial (24 – 27 January 2022) at Langgewens Research Farm.

Results

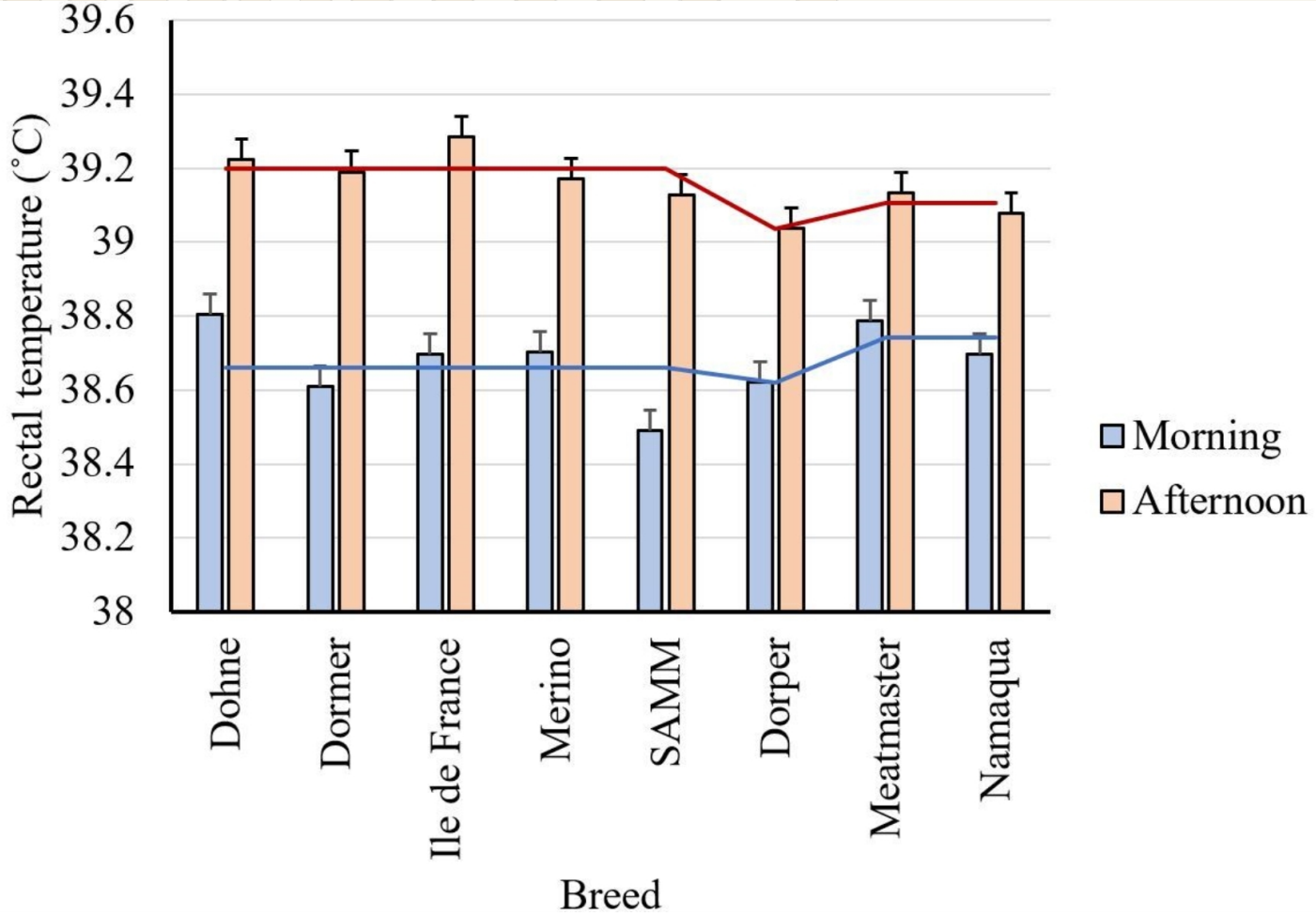
Morning and afternoon respiration rates



- Ranged from 52.4 for the Meatmaster and the Namaqua Afrikaner to 59.9 for Dorpers and an average of 82.8 for the temperate breeds (range: 77 in the SAMM to 91 Merino)
- Corresponding averages in the afternoon were 133.3, 157.4 and 181.2 (range: 167 in the Dohne Merino to 192 in the Dormer and Ile de France)

Results

Morning and afternoon rectal temperatures



- Morning values ranged in a narrow band of 38.5˚C (SAMM) to 38.8˚C (Dohne and Meatmaster)
- Temperatures increased to between 39.0˚C (Dorper) and 39.3˚C (Ile de France) in the afternoons

Results

- Morning and afternoon skin temperatures

- Skin temperature increased from cooler mornings to hotter afternoons
- Increased temperatures particularly evident in Namaqua Afrikaner and Dorper ewes with dark heads
- As the readings were taken outside, the recordings was prone to be affected by solar radiation, particularly in the afternoon
- Not considered further

Results: Repeatability

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Repeatability and re-ranking effects

Trait	Repeatability (re-ranking)	Re-ranking
Respiration rate (bpm)	0.16 ± 0.06	N.A.
Rectal temperature (˚C)	N.A.	0.20 ± 0.05
Skin temperature (˚C)	0.17 ± 0.07	0.21 ± 0.08

Conclusions

- Rectal temperature, respiration rate and spot temperature increased when hotter
- Spot temperature not a very good parameter for future studies
  - Seemingly affected by solar radiation
- Short-term rectal temperatures were lowly to moderately repeatable
- Potential role of traits in current-flock selection hinges on repeatable differences sustained over a longer term
- Re-ranking of ewes needs further study
- Long-term ewe effects across a more continuous heat stress gradient needs further study

Take home messages and future outlook

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- All breeds maintained their rectal temperature in a relatively narrow band
- Breeds from temperate regions needed a higher respiration rate to achieve this
- This additional energy need could compete with energy required for other production functions if heat stress conditions persist
- Breeds with indigenous content may adapt better to the anticipated hotter conditions expected in future
- Long-term studies planned for future:
  - Aim to study the sheep breeds used here over an entire summer period
  - Intra-ruminal temperature measuring devices to be used
- Anticipated to provide more reliable estimates of long-term heat stress

Acknowledgements

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Student: Shannon Steyn
Colleagues: Brink van Zyl and Tertius Brand

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Thank you