UNIVERSITY OF GEORGIA

Selection to mitigate heat stress in pigs

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ASAS 2018

●●●●○ H2O LTE 9:32 AM 67%

ATHENS
GEORGIA

MAP HUMIDITY UV

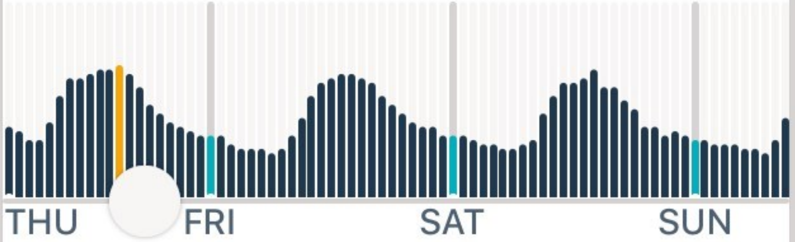
HOURLY FORECAST

TEMPERATURE | REALFEEL® | PRECIPITATION

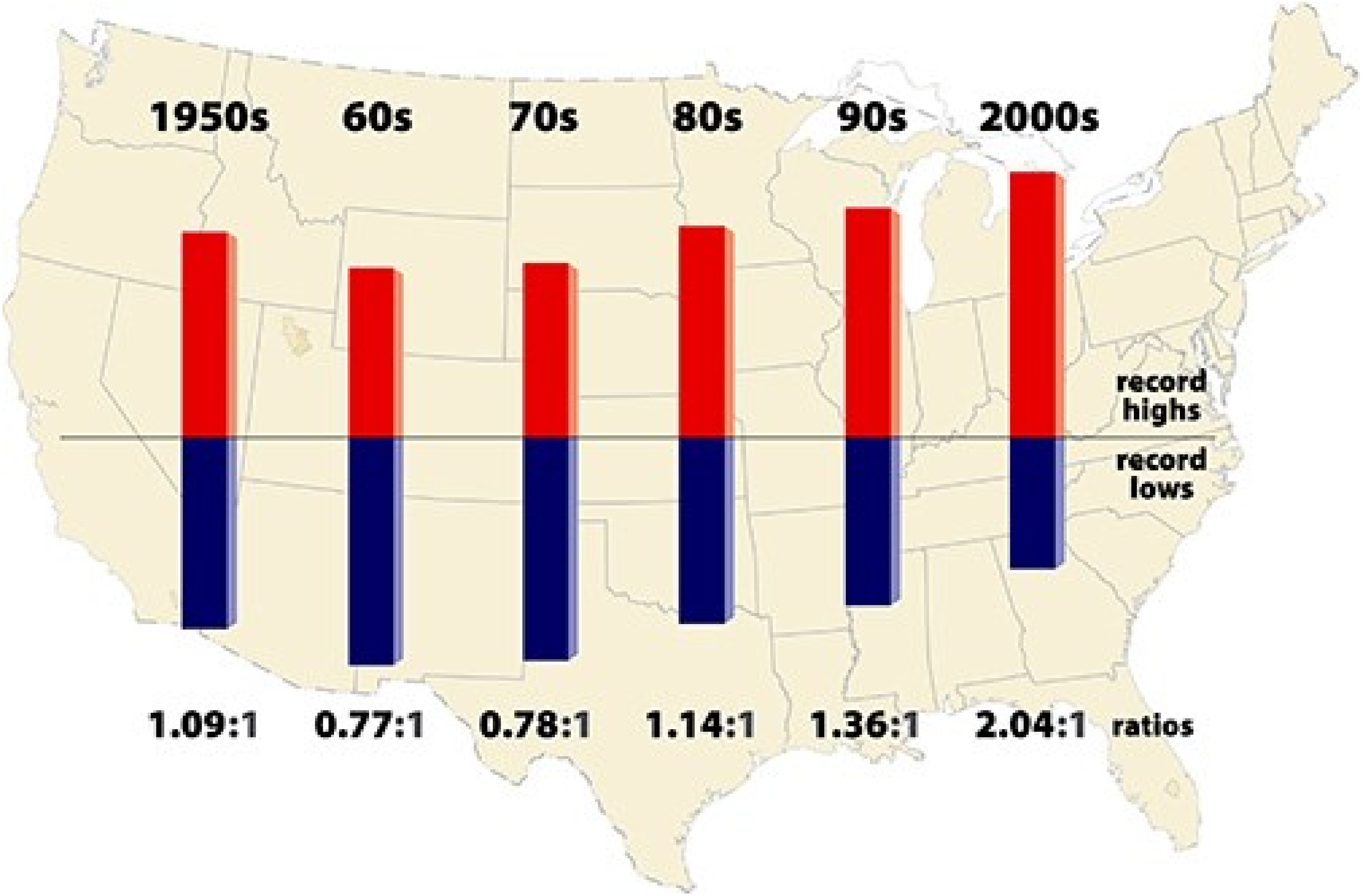
Partly sunny

THURSDAY

1PM	2PM	3PM	4PM	5PM
45°	45°	46°	44°	41°



Are hot days becoming more common?



©UCAR, graphic by Mike Shibao; data from Meehl et al., 2009

How livestock deal with heat stress

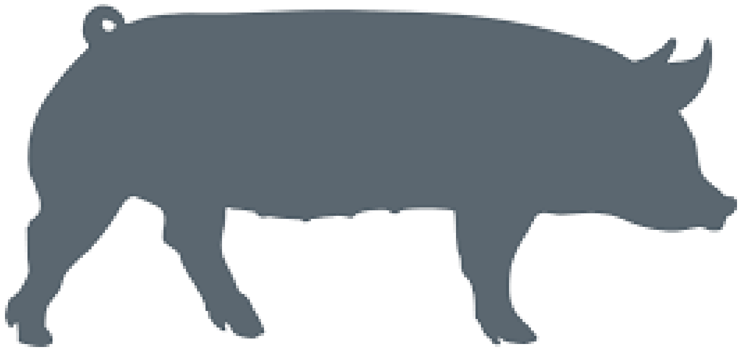
https://www.ag.ndsu.edu/publications/livestock/dealing-with-heat-stress-in-beef-cattle-operations

How livestock deal with heat stress

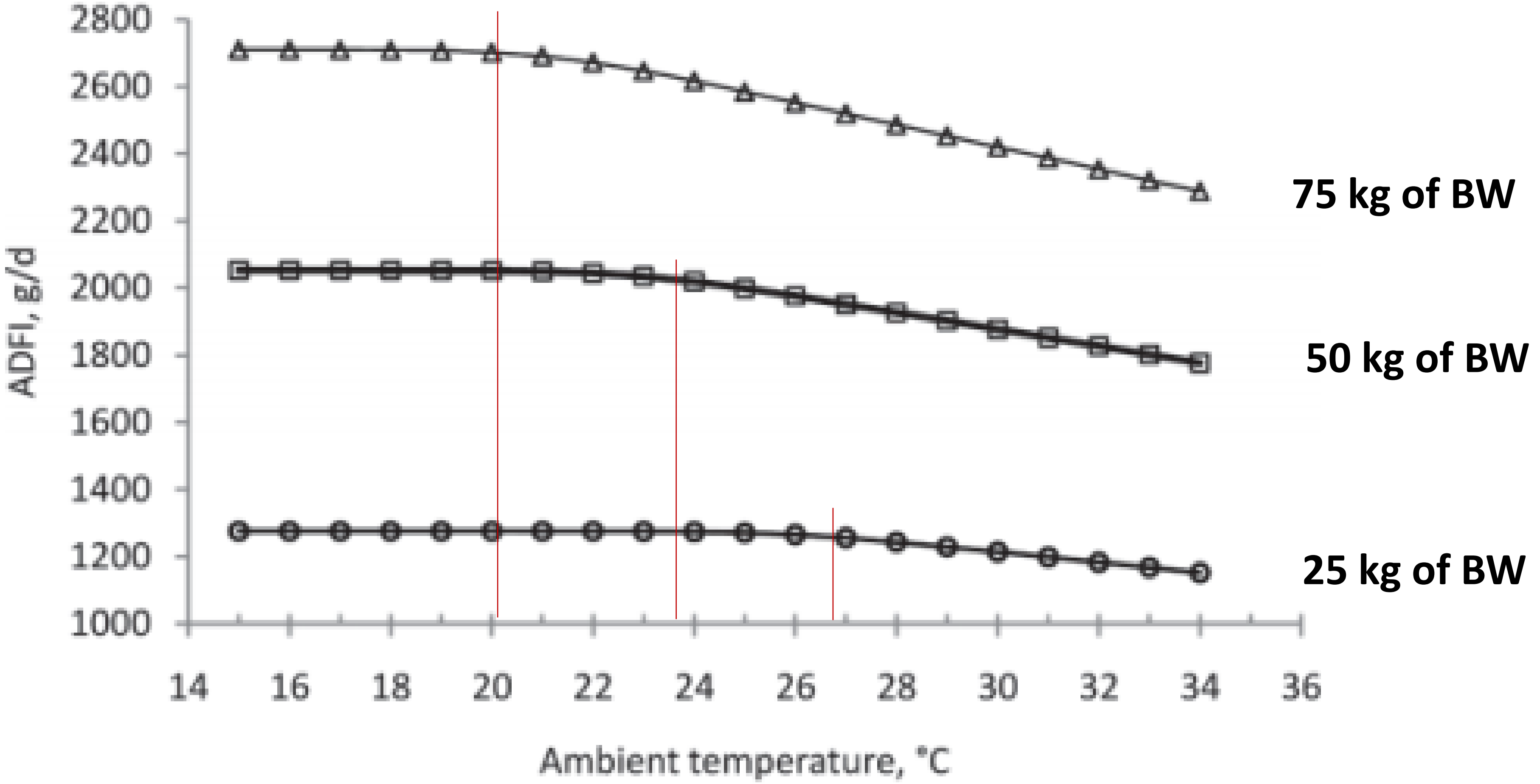
Impact of heat stress in pigs

- Pigs do not sweat
- Small lungs
- Thick subcutaneous fat

Main adaptation to reduce heat production

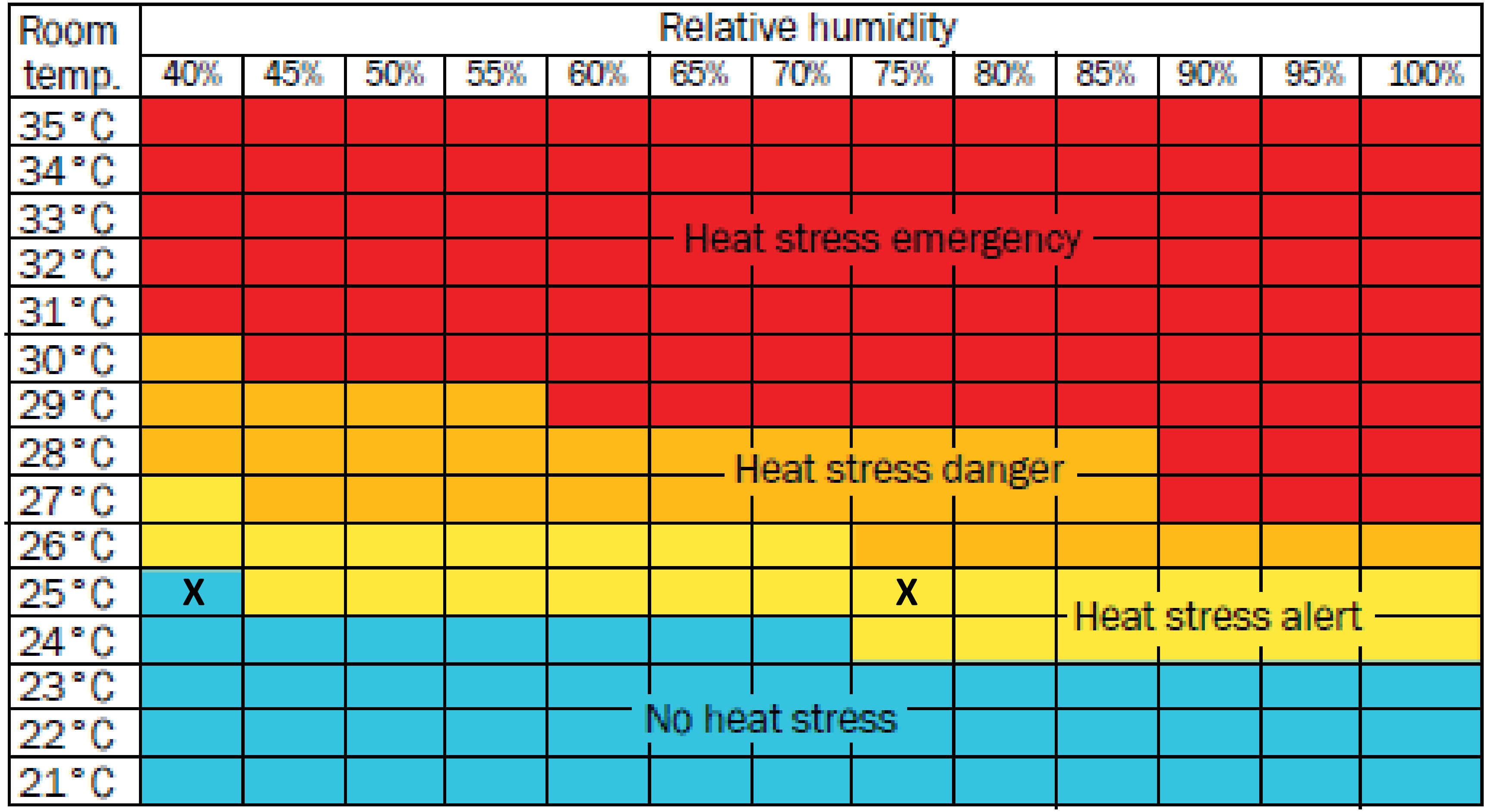


Impact of heat stress in pigs



Renaudeau et al., 2011

Temperature + Humidity



Heat Stress Index for grow-finish swine
Source: Iowa State University

Economic losses due to heat stress in pigs

- $113 million for sows

St-Pierre et al., 2003

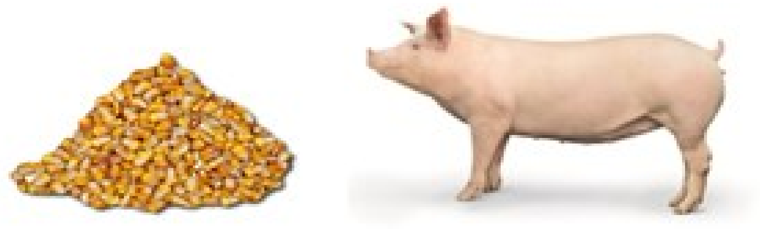
- $203 million for growing-finishing pigs

- What can we do?
    - Improve management
    - **Improve genetics**
        - **Traditional or Genomic**

Genetic selection in pigs

Feed = 379 kg
mkt weight = 100 kg

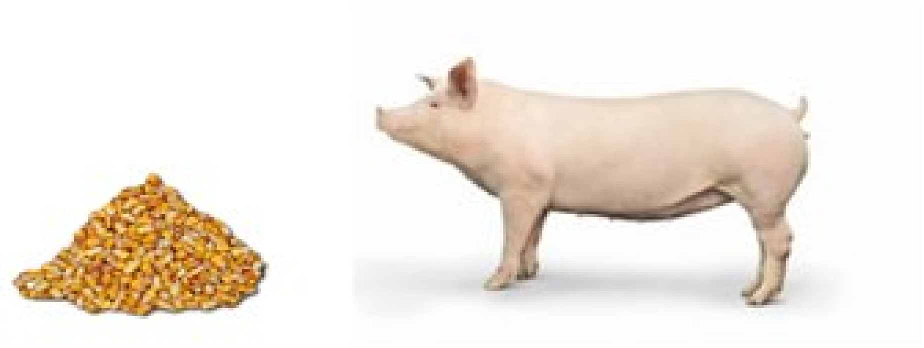
FCR = 3.8



1972

Feed = 324 kg
mkt weight = 125 kg

FCR = 2.6



2007

Figure 2. **Improvements in feed conversion ratio.** Feed requirements moved from 836 lbs to produce a 220 market hog in 1972 to 715 lbs of feed in 2007 to produce a 275 lb market hog. (Adapted from Graham Plastow, 2012)

- Heat production increased 20%
- More susceptible to heat stress

Brown-Brandl et al., 2003

Selecting for heat stress in pigs

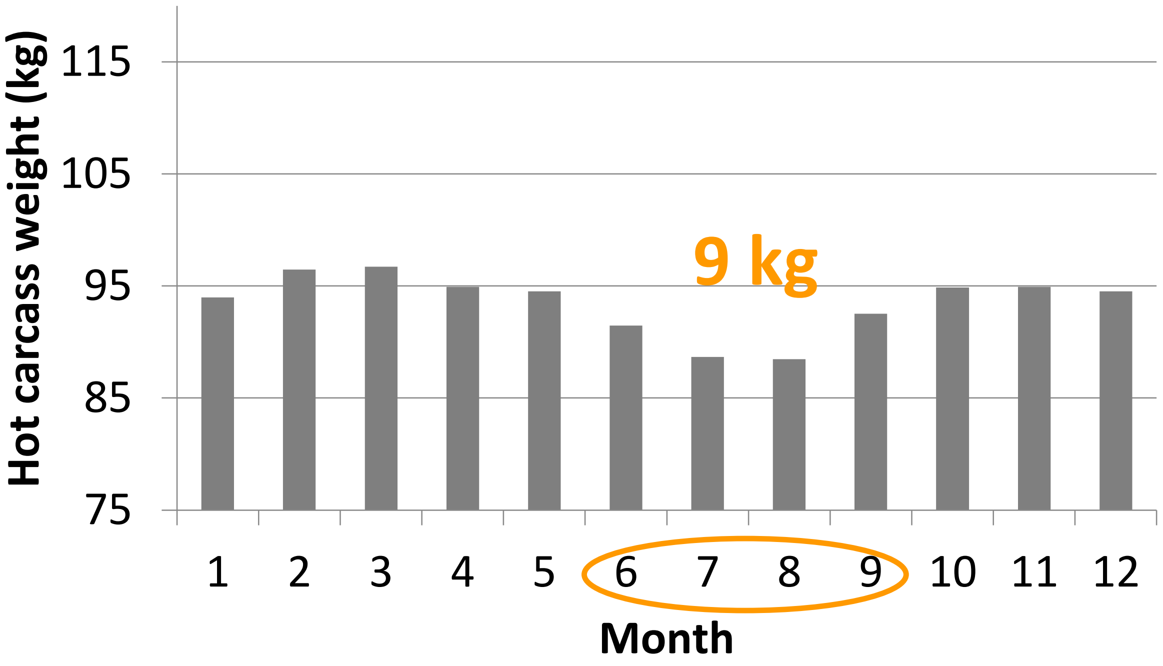
1) **Investigate the impact of heat stress in the population**
    - Losses in traits of interest
2) **Define and measure heat stress**
    - Threshold for heat tolerance
3) **Find ways to model heat stress**
    - How to account for heat stress
4) **Identify heat tolerant animals - genetics**
    - Identify major genes if they exist

1) Impact of heat stress in a breeding population

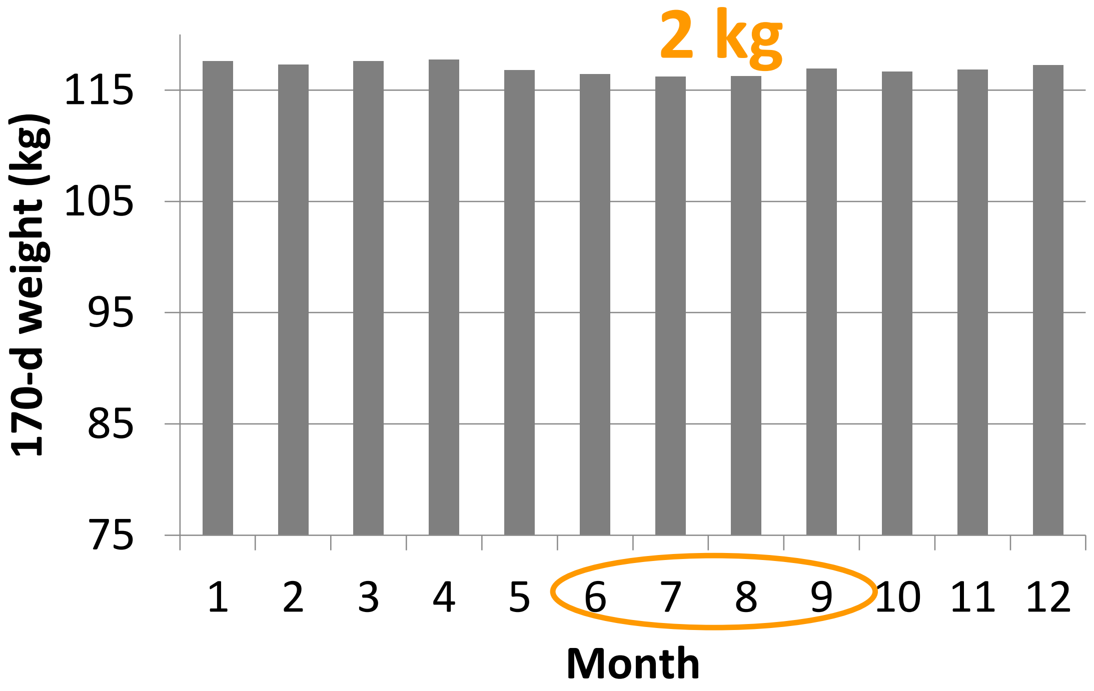
Fragomeni et al., 2016

Smithfield

Crossbred



Purebred



- 228k Duroc X Landrace x Large White
- North Carolina and Missouri

- 207k Duroc (8k genotyped)
- North Carolina and Texas

2) Defining and measuring heat stress

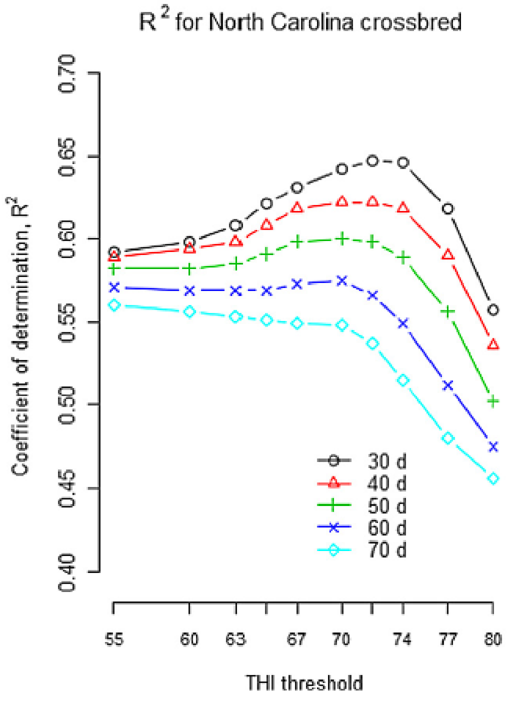
- Temperature-humidity index (THI)

NOAA (1976)

- THI $= t - (0.55 - (0.0055 * rh))*(t - 58)$
  - t = temperature (F)
  - rh = relative humidity (%)
- Airport weather stations

2) Defining and measuring heat stress

- Relationship between THI and phenotype to define threshold

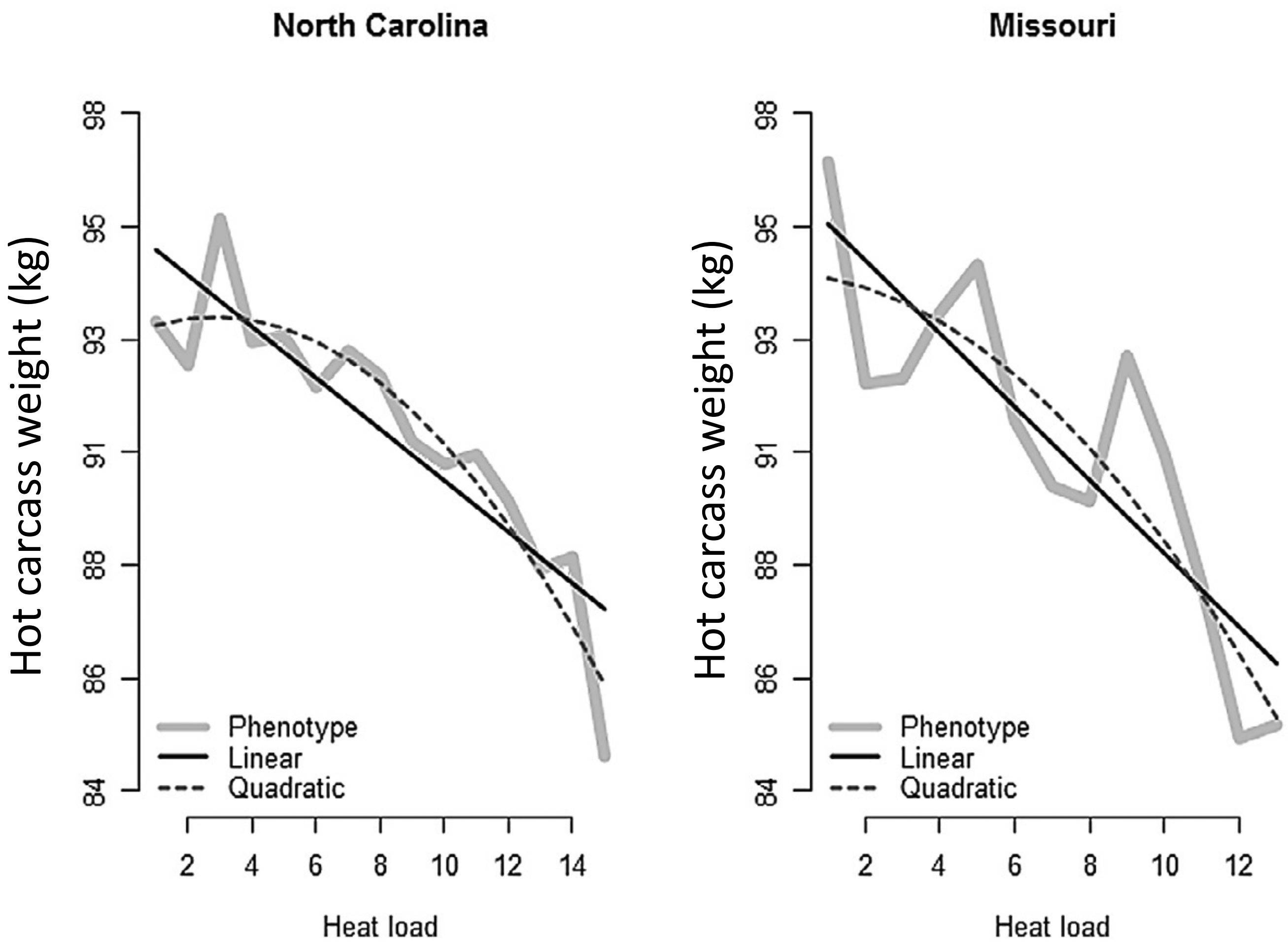


- THI = 70 (ºF) or 21 (ºC)
- 30 days before phenotyping

- Heat load function: degrees of THI above a threshold

$$\mathrm{HL} = \mathrm{maximum}(0, \mathrm{THI} - \mathrm{THI_T})$$

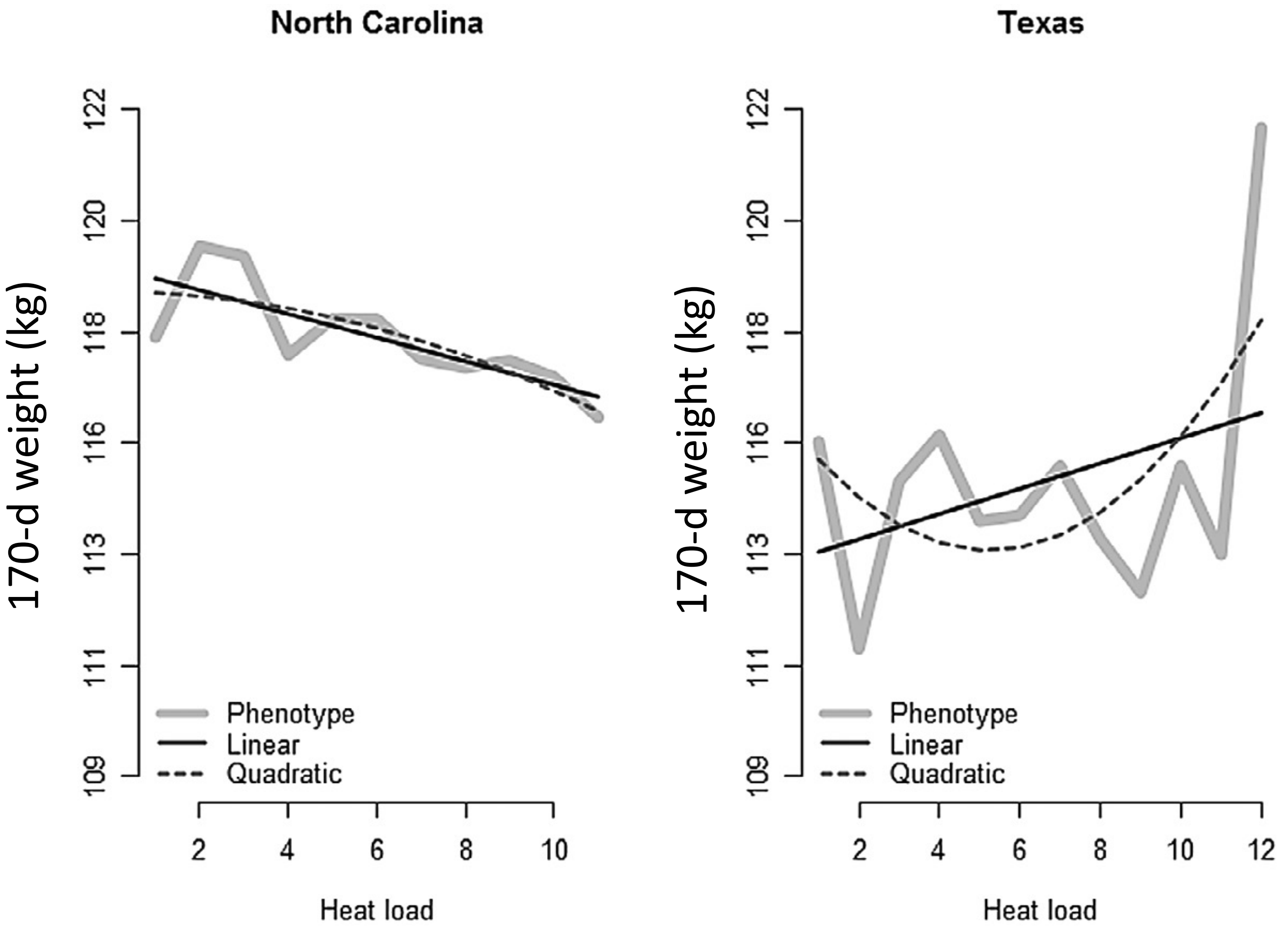
2) Defining and measuring heat stress



Crossbred

$$\mathrm{HL} = \mathrm{maximum}(0, \mathrm{THI} - 70)$$

2) Defining and measuring heat stress

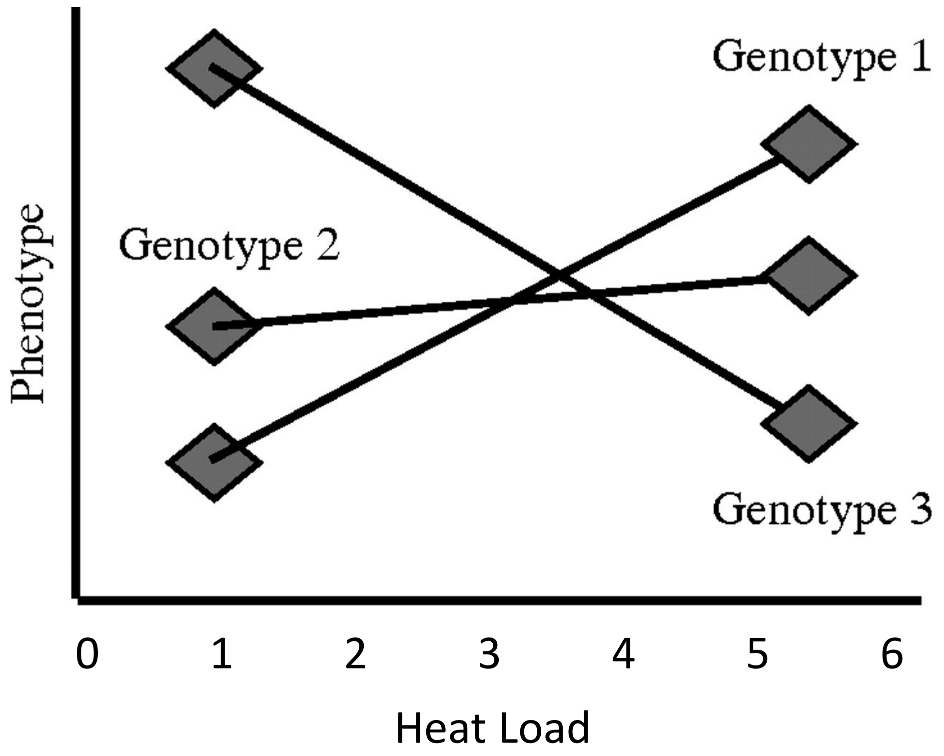


Purebred

$$\mathrm{HL} = \mathrm{maximum}(0, \mathrm{THI} - 70)$$

3) Finding ways to model heat stress

- **Reaction norm models**
  - Model phenotypes over a continuous HL scale
  - Genetic parameters and EBV for all HL in the data

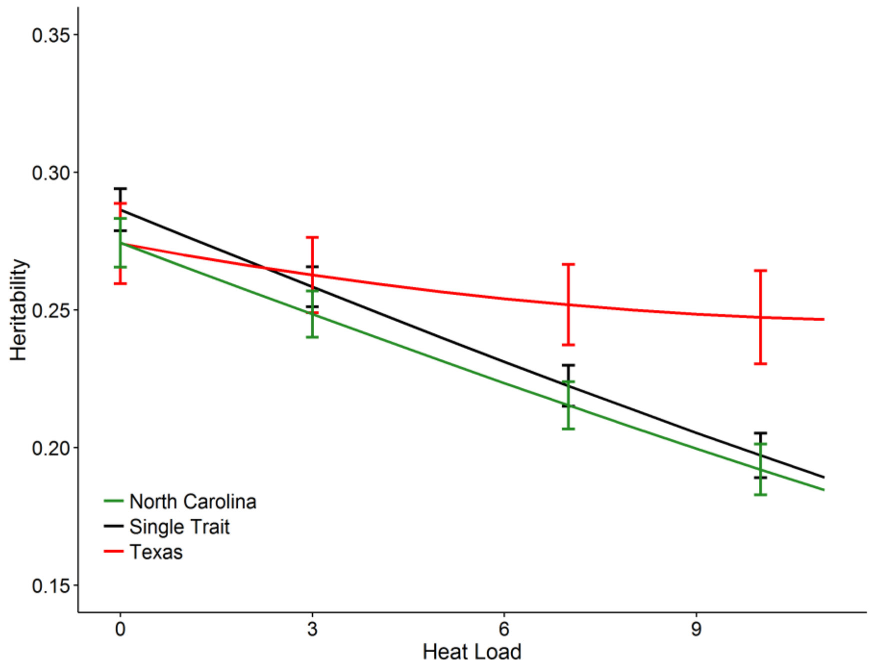


Adapted from
Pigliucci et al., 2006

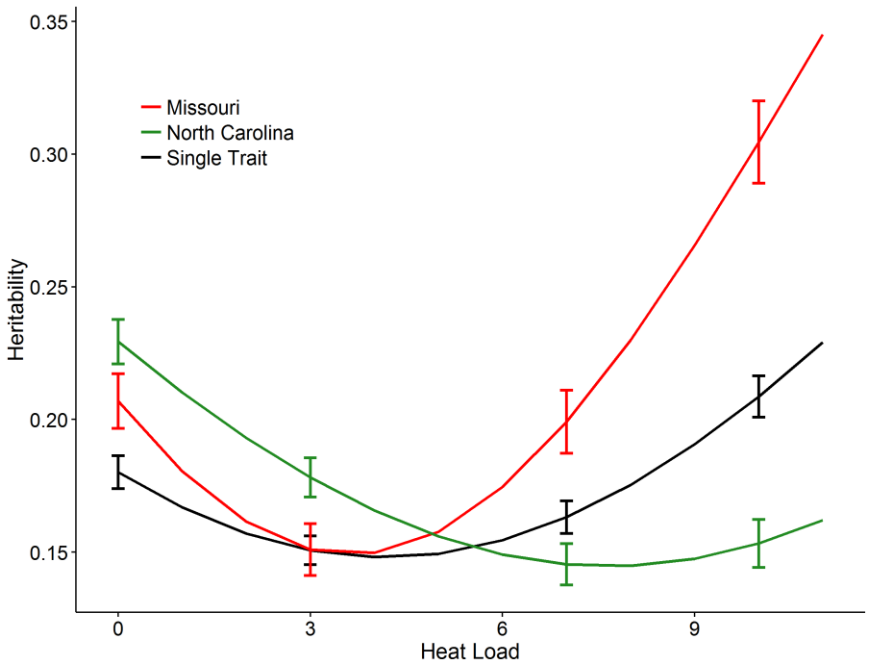
3) Finding ways to model heat stress

- **Reaction norm models**
  - Separate for pure and crossbred
  - Single or two-trait based on State

Fragomeni et al., 2016



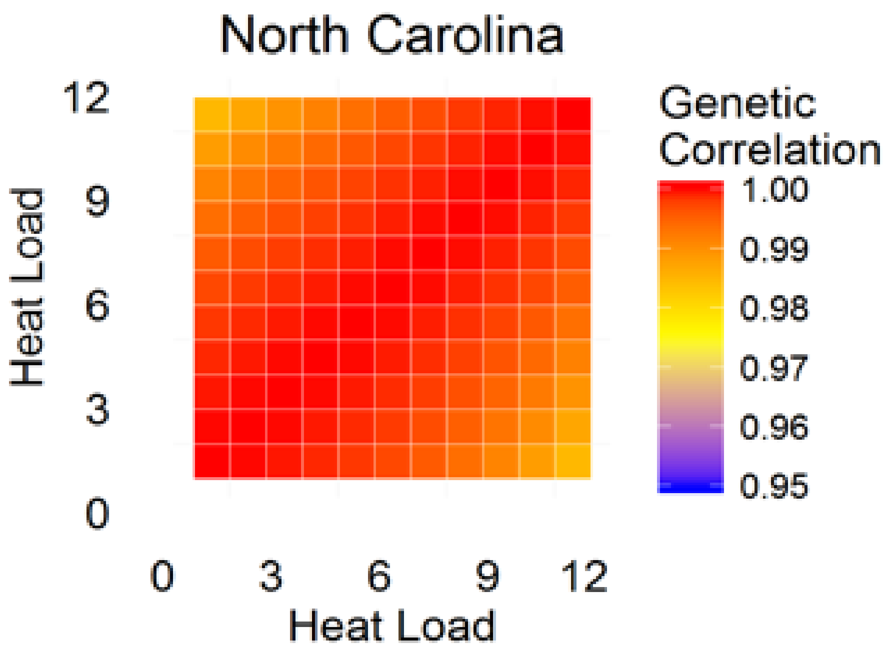
Purebred

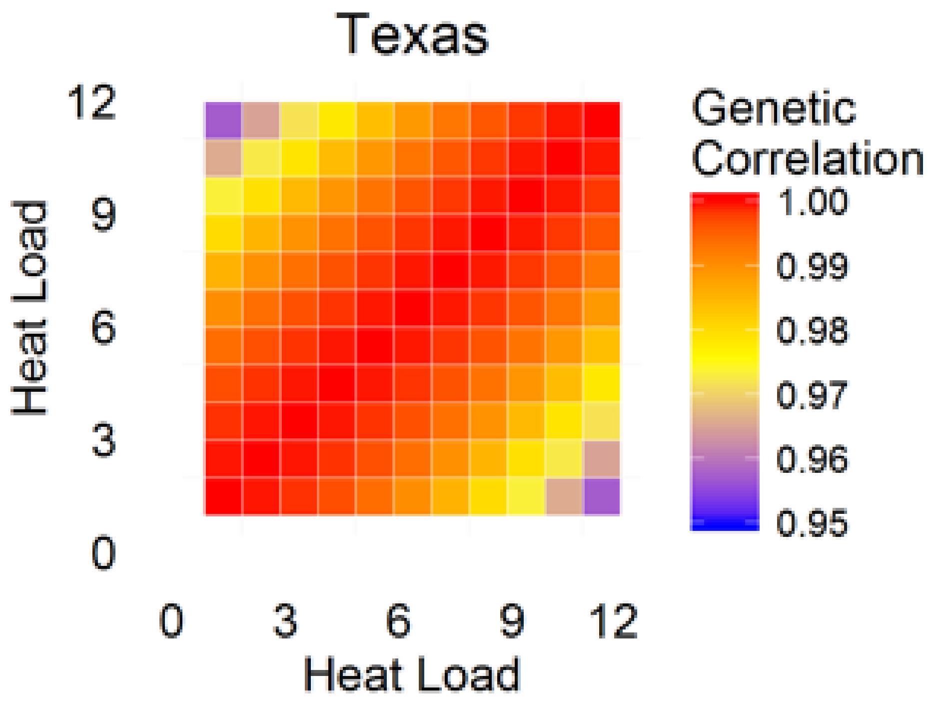


Crossbred

3) Finding ways to model heat stress

- **Reaction norm models – Genetic correlations for Purebred trait**

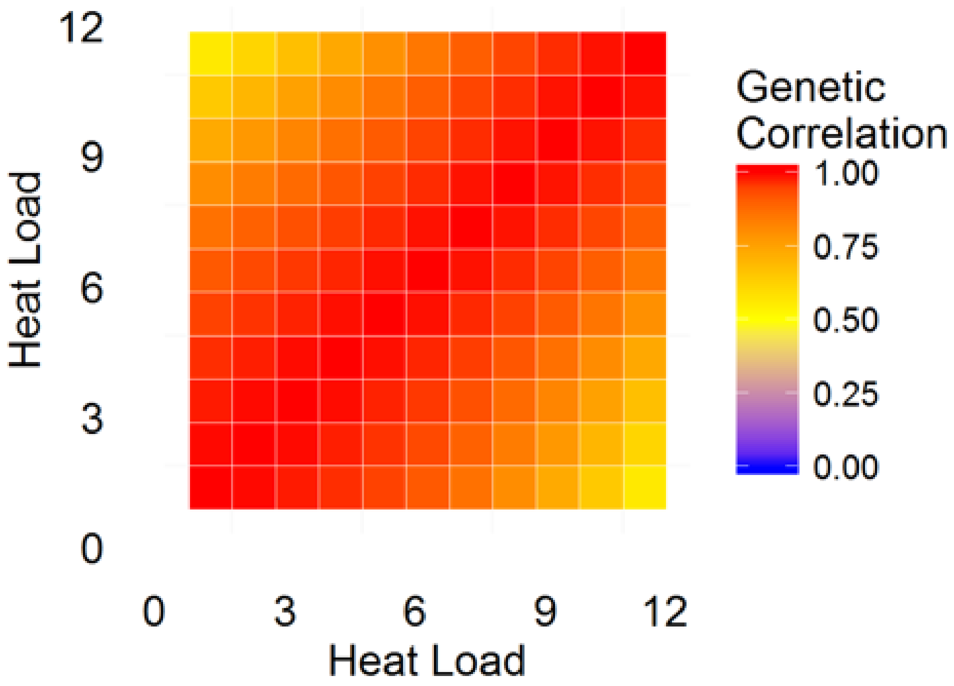




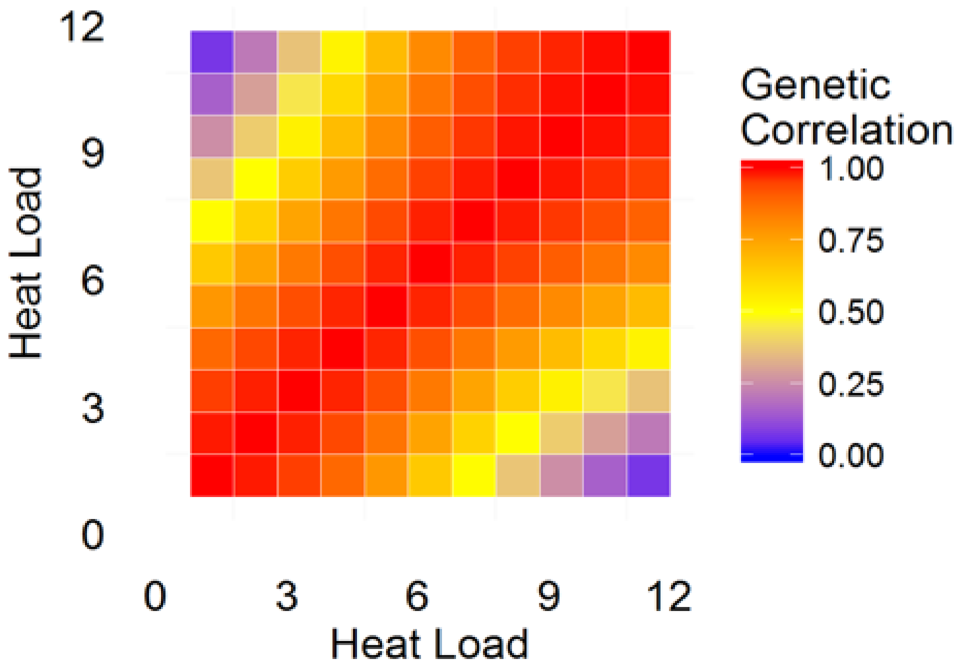
3) Finding ways to model heat stress

- **Reaction norm models – Genetic correlations for Crossbred trait**

North Carolina

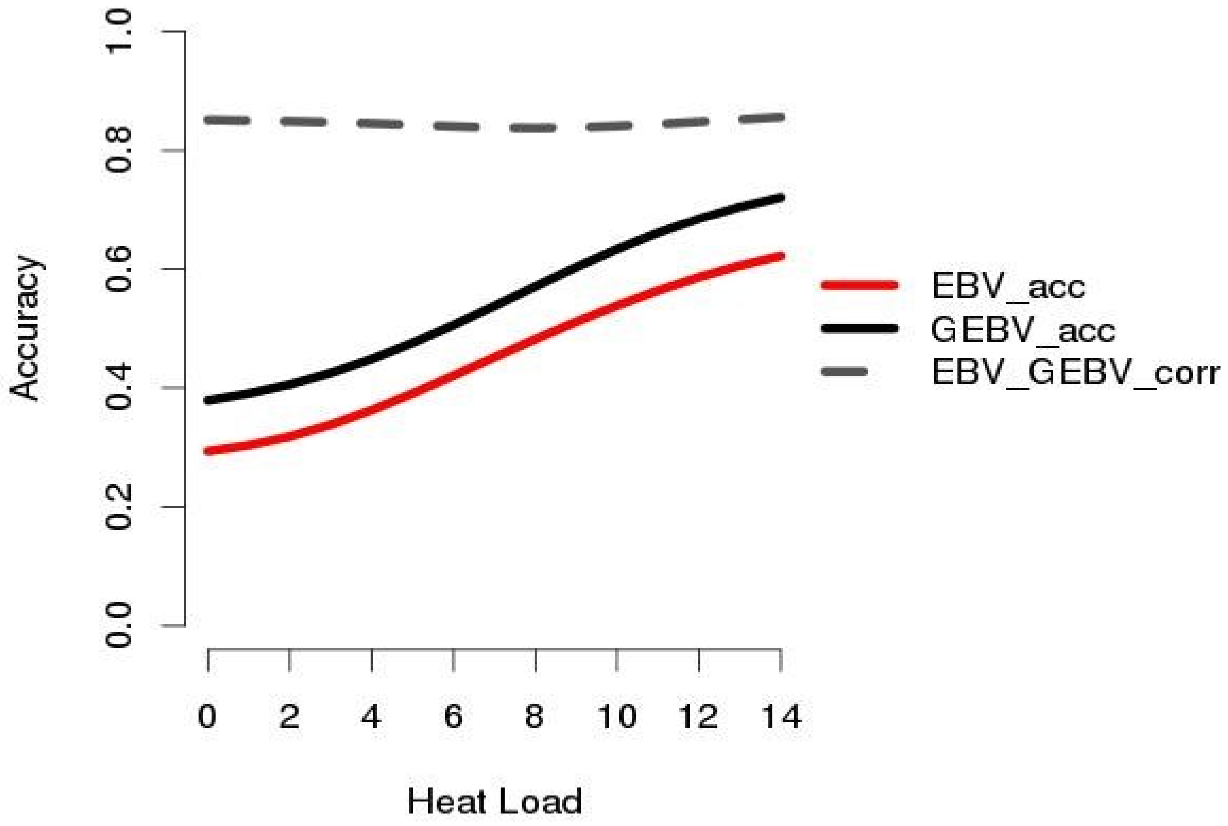


Missouri



3) Finding ways to model heat stress

- **Reaction norm models + Genomic info**
  - Compare traditional and genomic models



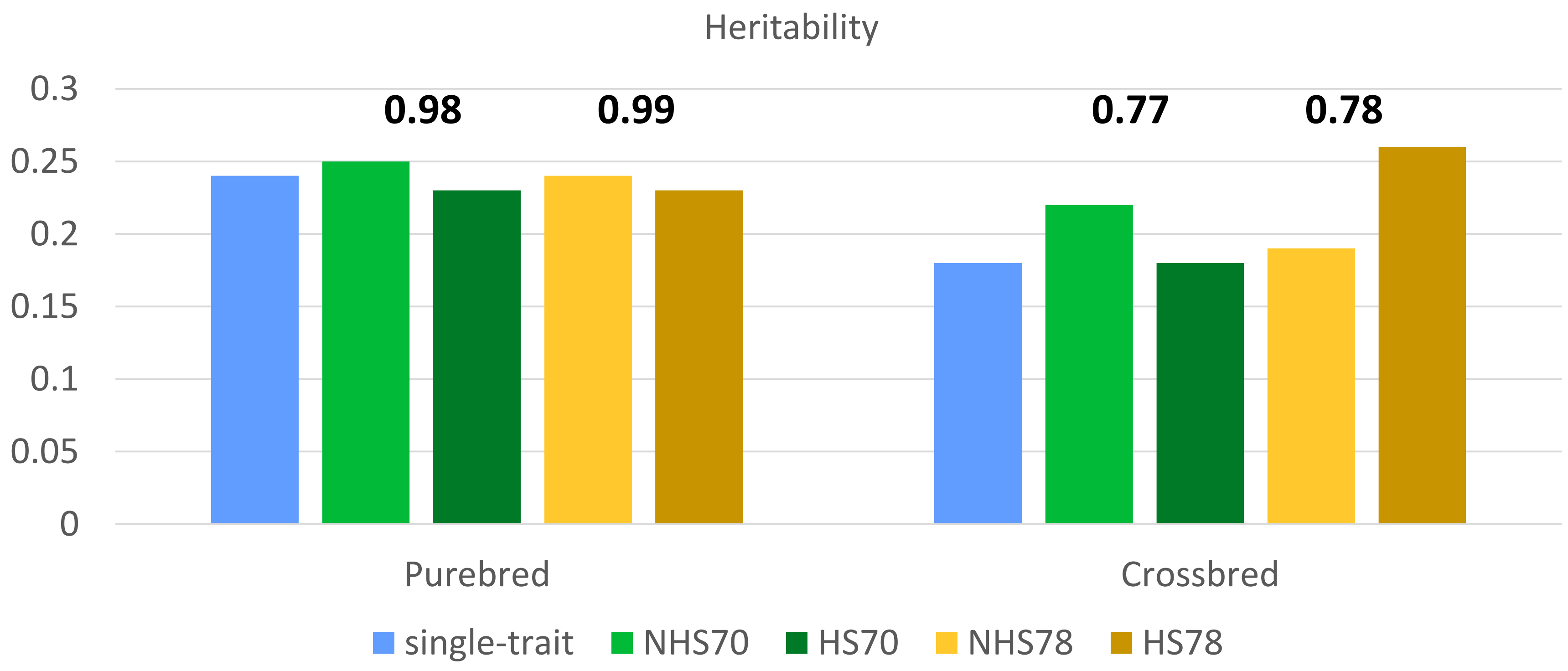
3) Finding ways to model heat stress

- Problems with reaction norm models
  - More complex
  - More parameters
  - Higher computing time
  - How to use this information to select animals?
    - $EBV_{HL} = b_0 + b_1{*}HL$
  - Is there another way to model heat stress?

3) Finding ways to model heat stress

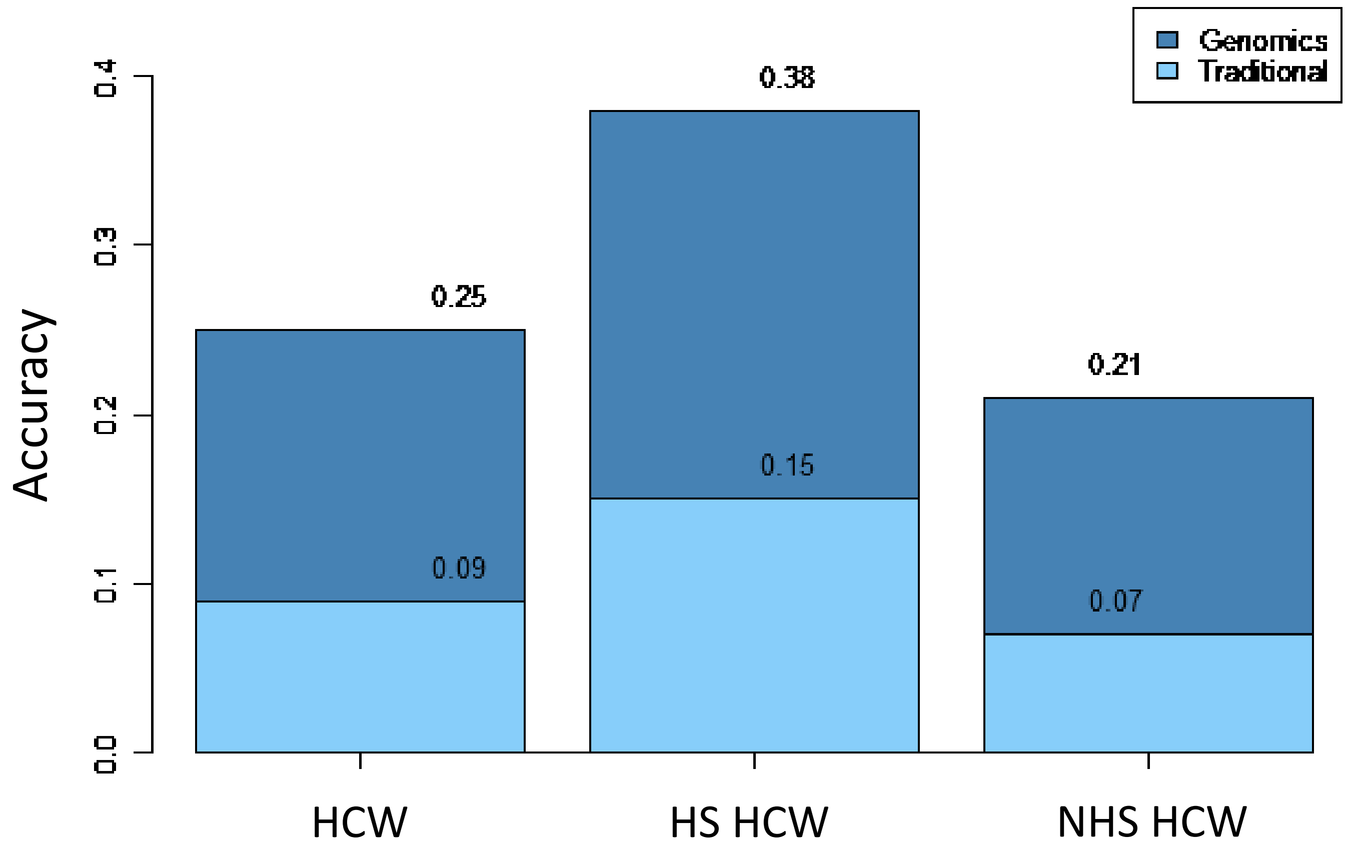
- **2-trait model with new trait definition**
  - Non-heat stress (NHS)
  - Heat stress (HS)
  - Thresholds at 70 ºF (21 ºC) and 78 ºF (25.5 ºC)

Fragomeni et al., 2016

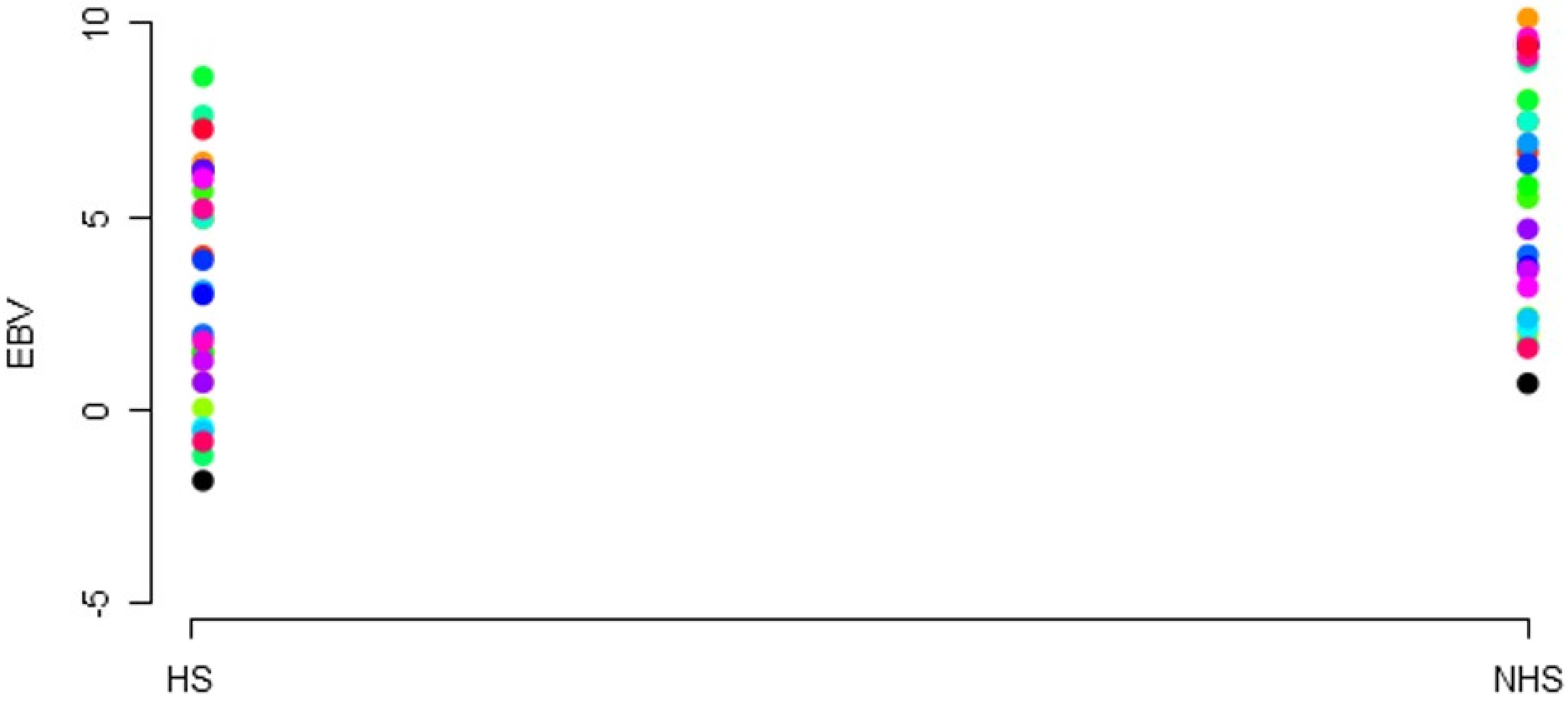


3) Finding ways to model heat stress

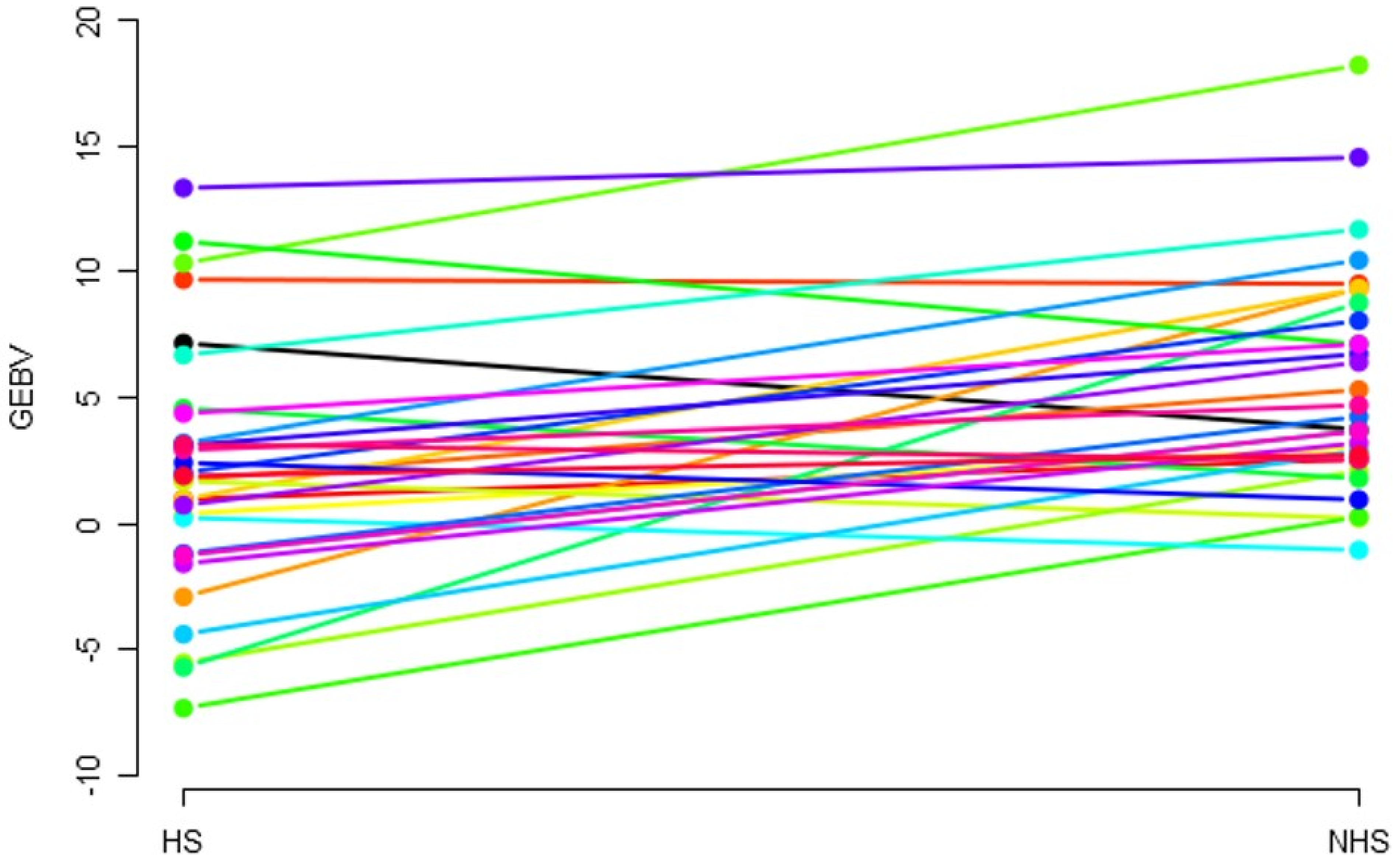
- **2-trait model with new trait definition + Genomic info**
  - Compare traditional and genomic models



4) Identifying heat tolerant animals



4) Identifying heat tolerant animals

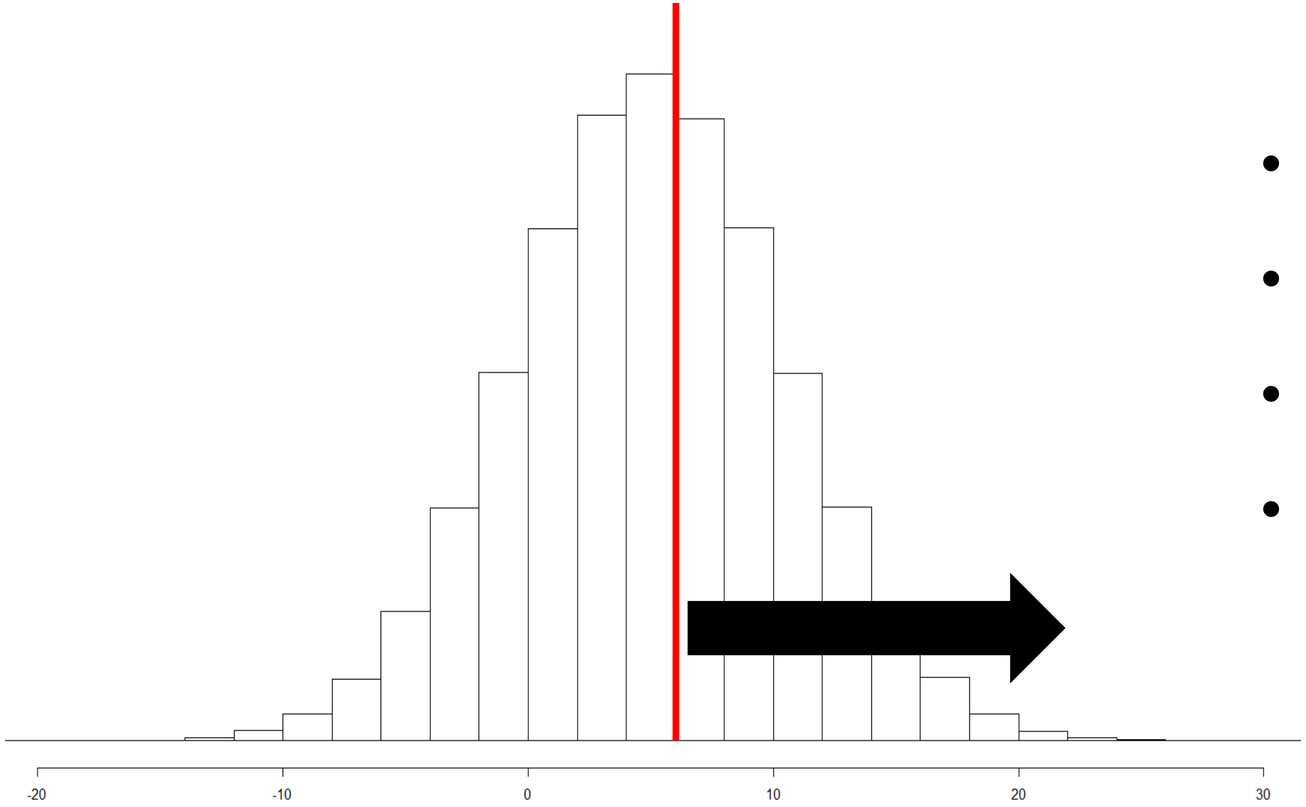


4) Identifying heat tolerant animals

- Commercial population
  - Boars with equal EPD for HCW single-trait
  - Different EPD for HS HCW

How to use this information for selection?

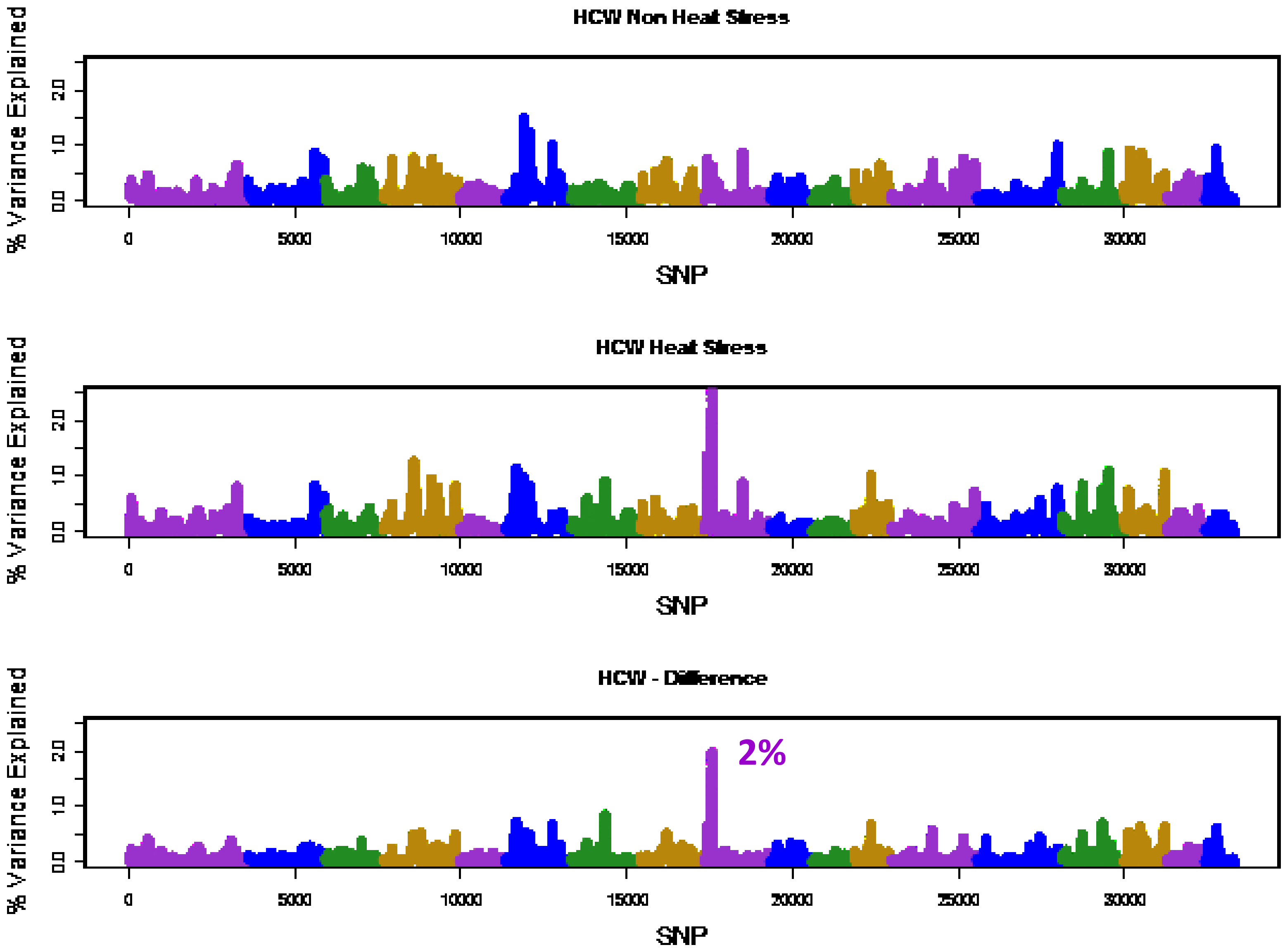
- 2-trait model with threshold at 78 ºF (25.5 ºC)



EBV for weight above 78 ºF (25.5 ºC)

- Independent culling level HS EBV
- Include HS EBV in the index
- Select tolerant pigs only in the hot season
- Information from major genes?

Are there major genes for heat stress?



Non-heat stress

Heat stress

Difference

Conclusions

- Genetic evaluation for heat tolerance in pigs is possible
- Requires proper definition of heat stress/tolerance
  - Proper modeling
    - Multiple-trait models or Reaction norm models
- Genomic information can help to identify heat tolerant animals
- Impact of heat stress depends on genetics and management
  - Evidence of heat stress in crossbred
  - Purebreds have better housing conditions

Acknowledgements

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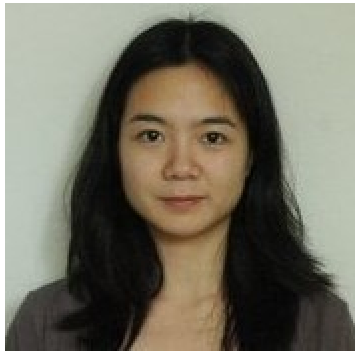

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