# Characterization of thermal stress in Avileña - Negra Ibérica local beef cattle breed at feedlot

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# Why is important the identification of adaptation strategies to future climatic conditions in feedlot cattle?

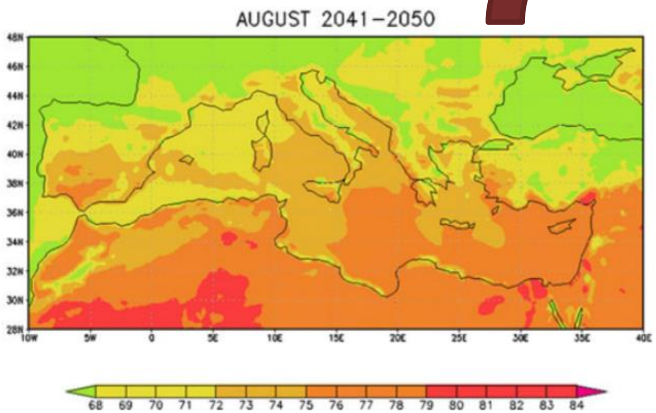
## Impact of climate change

**WEIGHT**

- ↓ Body weight
- ↓ Body condition scoring
- ↓ Average daily gain
- ↓ Feed intake
- ↓ Feed conversion efficiency

**Reduces production and increases economic losses**

# Why is important the identification of adaptation strategies to future climatic conditions in feedlot cattle?




# The aim of the study was to:

**To Characterize and Evaluate the magnitude of thermal-impact on weight in Avileña- Negra Ibérica local cattle breed**

**(1)** find **the lag of time** that better describes the interaction between thermal events and the animal performance

**(2)** define the **thresholds**, above or below animals are adversely affected by the thermal conditions and therefore characterize the comfort region

**(3)** **quantify thermal load and weight variation due to the thermal stress in the animals at feedlot.**

# **Material:** Animal data

- **23645 weight records of**

**5876** Avileña Negra-Ibérica calves

from a commercial feedlot own by ANI farmers.

- **Period of collection:** September 2005 - October 2017
- **Mean number of record per animal**

3 records (SD = 1.43)

# **Material:** Animal data

**Table 1.Summary statistics for weights and age of calves at entry and exit of the feedlot**

| | At entry in the feedlot | | | | At exit of the feedlot | | | |
|---|---|---|---|---|---|---|---|---|
| | **Mean** | **Min** | **Max** | **SD** | **Mean** | **Min** | **Max** | **SD** |
| **Age** | **266** | 145 | 450 | 47 | **437** | 312 | 620 | 50.7 |
| **Weight** | **314** | 143 | 562 | 65 | **527** | 355 | 600 | 35 |

# **Material**:Meteorological data

Provided by the Spanish Agency for Meteorology (AEMET)

The station of ***Gotarrendura*** was selected as the most representative of this study due to proximity to the feedlot

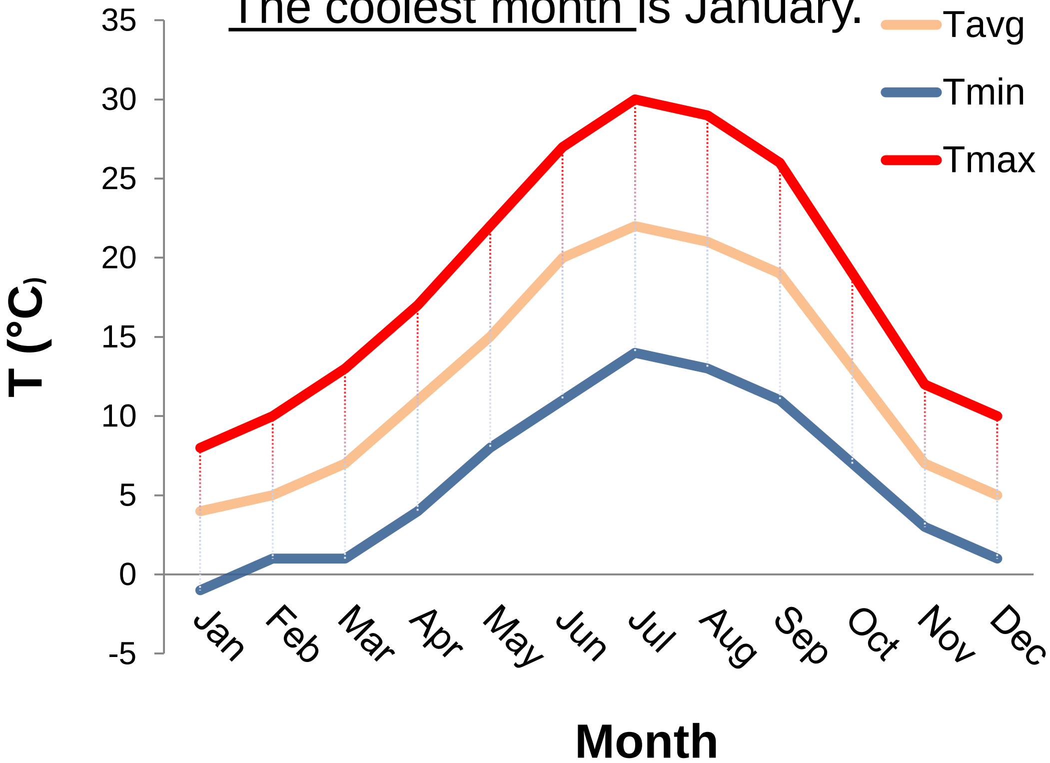
From hourly data we calculated the **minimum, maximum and average daily values** of each climatic factor:

- Temperature ( T °C)
- Humidity (RH %)
- Wind speed ( WS m/s)
- **Temperature – humidity index (THI)** *(Ravagnolo et al., 2000)*
- **Wind chill index ( WCI )** *Siple and Passel (1945)*

# **Material:** Meteorological data

## Mean of climatic variables for each month over the years 2005 to 2017

**Hot period :** June, July and August.
**Cold period**: Jan, Feb, Nov, Dec.
The warmest month is July.
The coolest month is January.

# METHODS: the lag period

The analysis was performed using a **lag non-linear model (*DLNM R package*) for time series data,** (**Gasparrini, 2011**)

This approach allowed us to select the **lag** of the ***lth* day** previous to recording (l = 0,…,30) that better reflect the impact of each predictor (climatic variable, in our case), on weight

This model is based on a ***bidimensional space function*** that **simultaneously** describes:

1) **The shape of the relationship of the lag** period (0-30 days before the weight recording) with weights (**Three degree polynomia)**

2) **The heat load** dimension with weights (**Four degree polynomia)** .

# **METHODS:** the lag period

The combination of these bi-dimensional space function is represented by ***a cross-basis matrix***

| T (°C) | Lag 0 | Lag 1 | …… | | | Lag 30 |
|---|---|---|---|---|---|---|
| - 4 | W (kg) | | | | | |
| - 3 | | | | | | |
| - 2 | | | | | | |
| …. | | | | | | |
| 25 | | | | | | |
| 26 | | | | | | |
| 27 | | | | | | |

**Weight – temperature curve along the lag space**

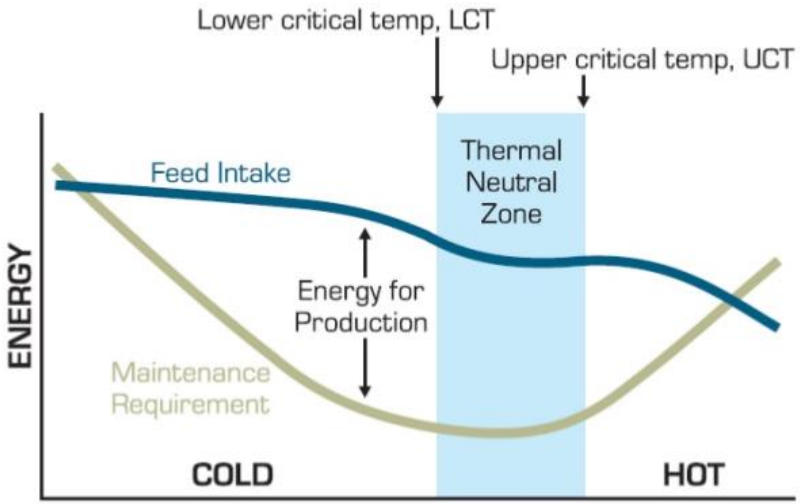
**Weight – temperature curve along the space of T (the weather variable used in this exemple)**

The final result is an overall picture of the association varying along these two dimensions.

# **METHODS**: Definition of comfort region

**Estimates of thermal load effect ($w_{im}$)** obtained from solving a repeated-measures designs model, were used as independent variables to estimate the **thermal thresholds** through the methodology proposed by **Muggeo et al. (2003).**

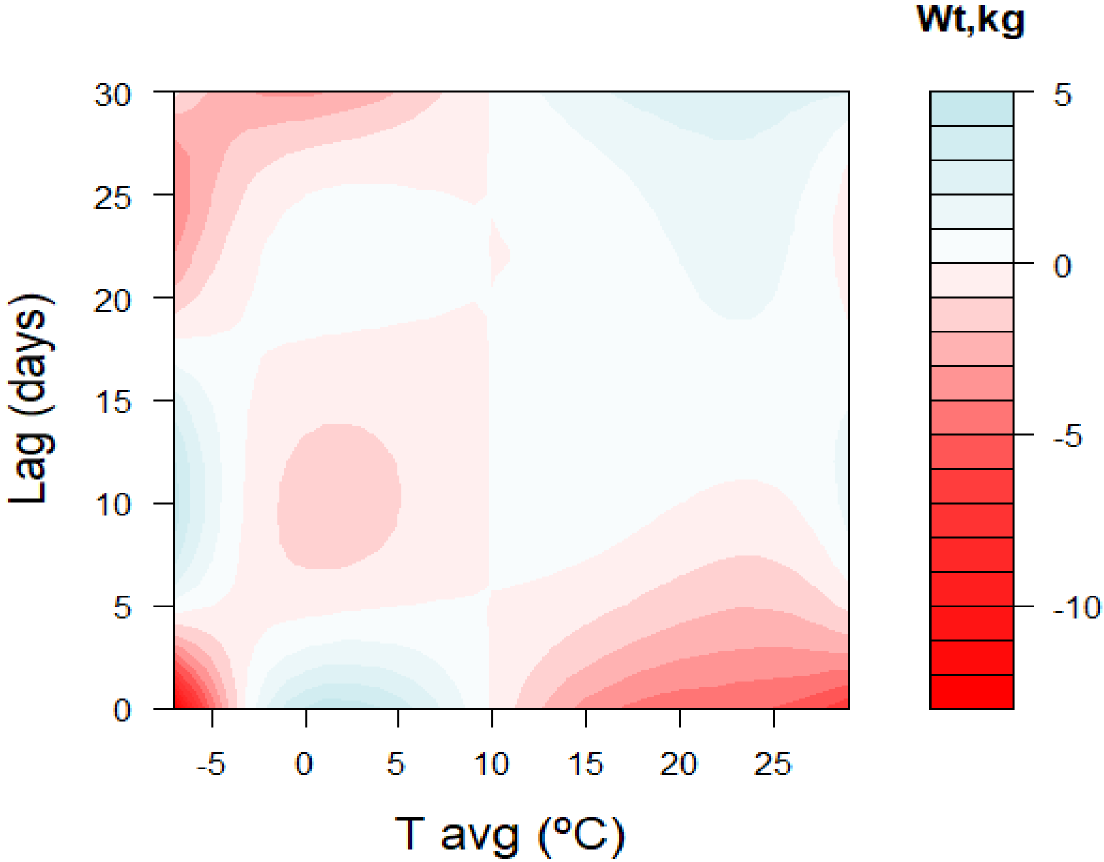
***Segmented*** package of R




Intended to measure:
**the heat threshold**
**the cold threshold**

# **RESULTS:** the lag period

## Estimation of lag effect of thermal load on weight



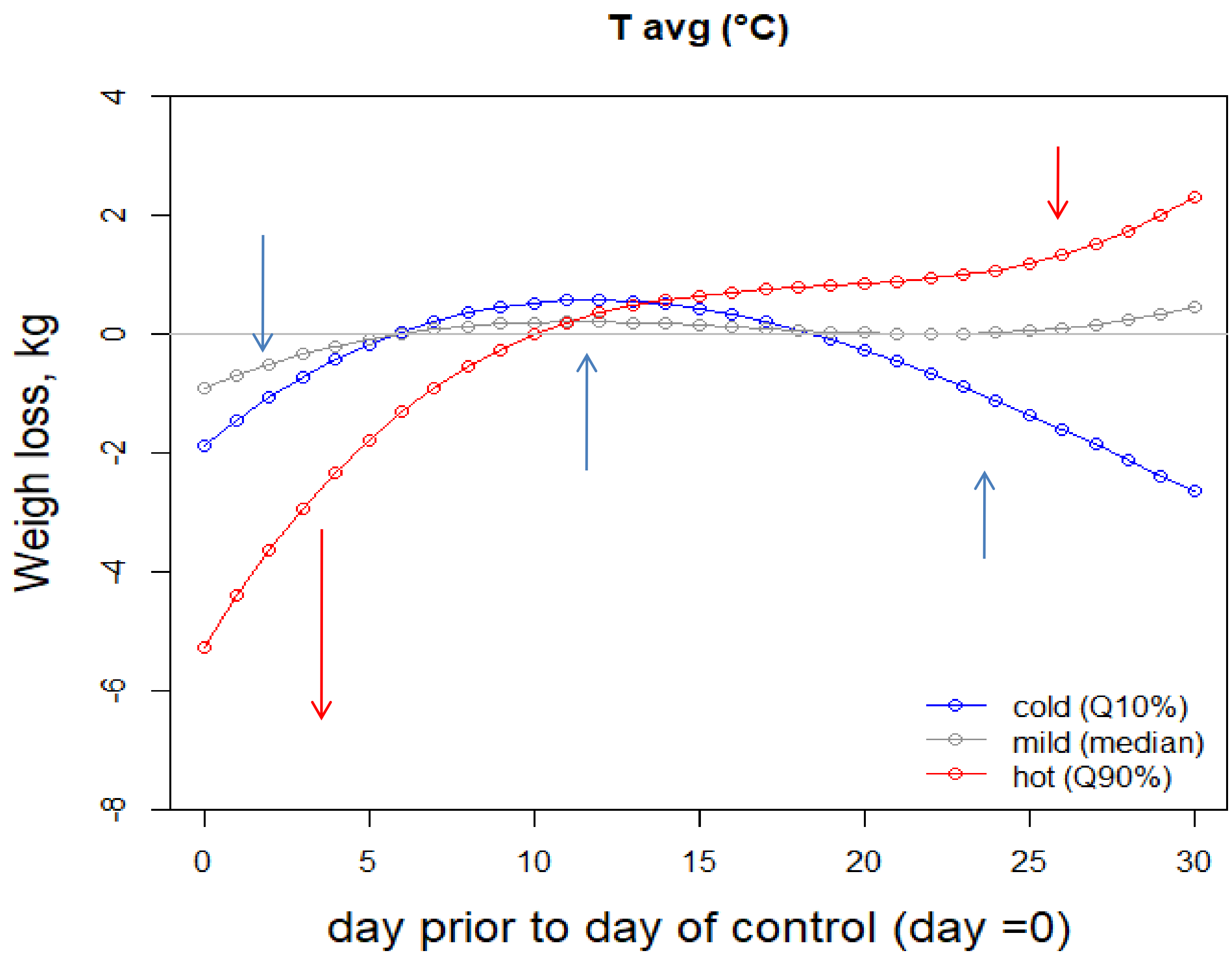

**Cold (Q10%)**

**Mild (Q50%)**

**Hot (Q90%)**

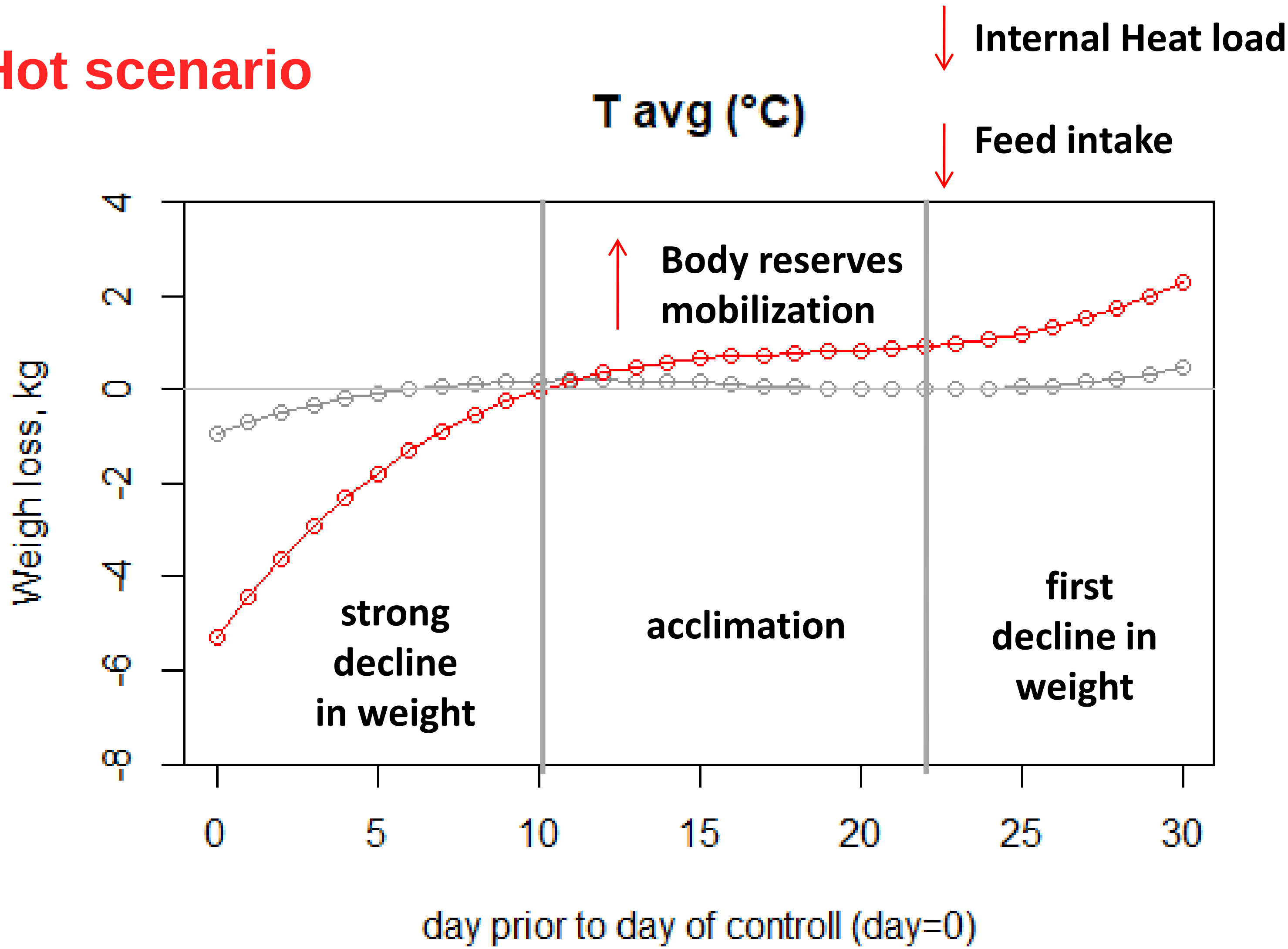
# Results

**Heat stress effects on performance resulted in higher magnitude than cold stress for weight losses.**



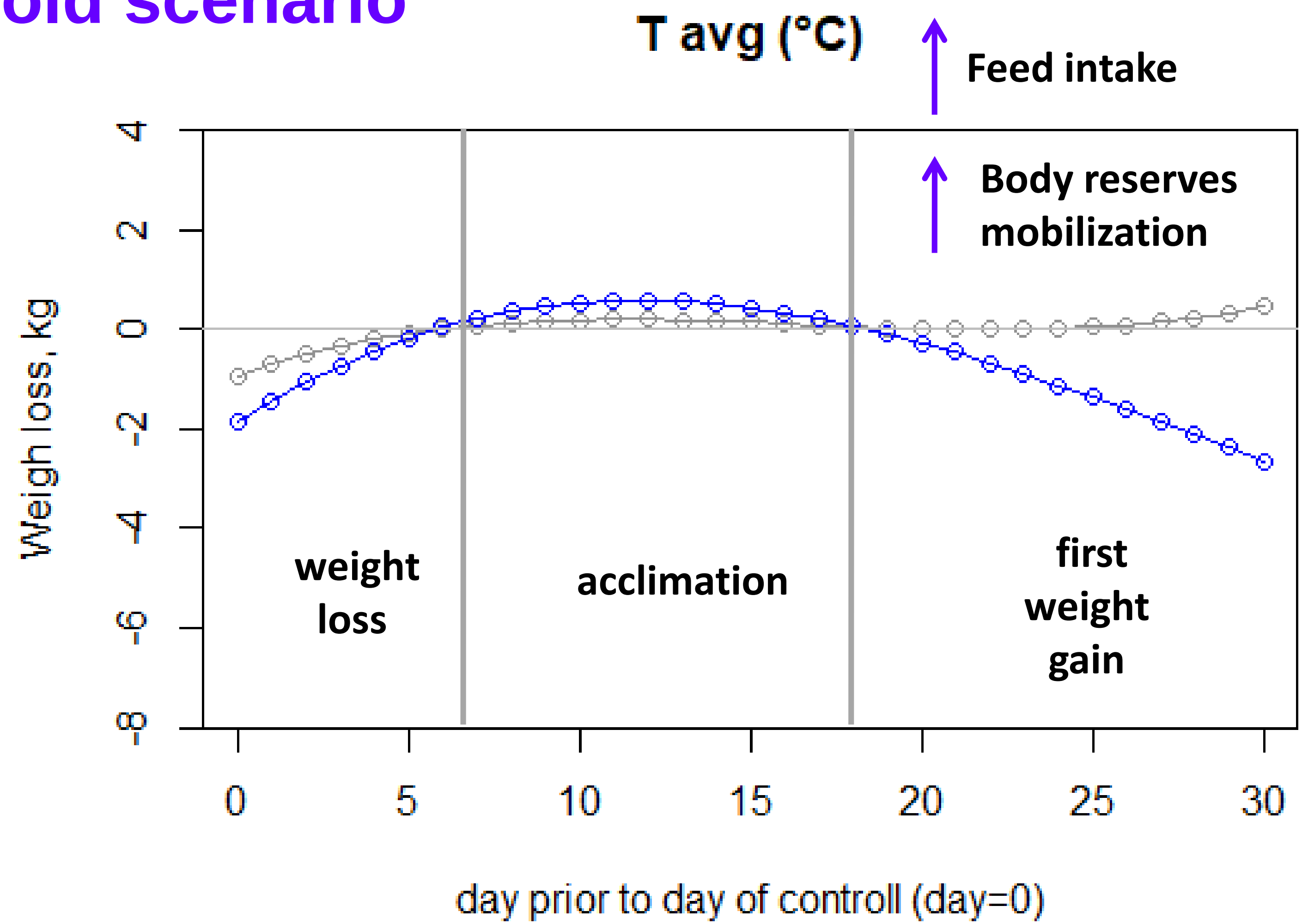
# RESULTS

## Hot scenario



# RESULTS

## Cold scenario

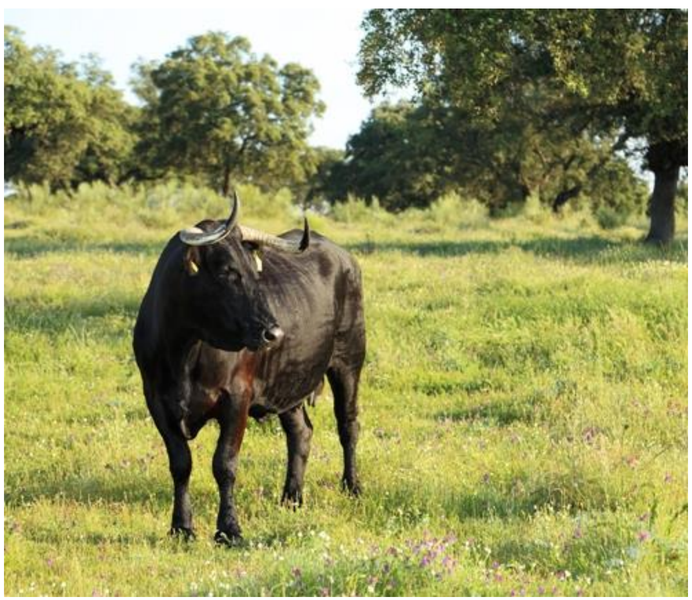


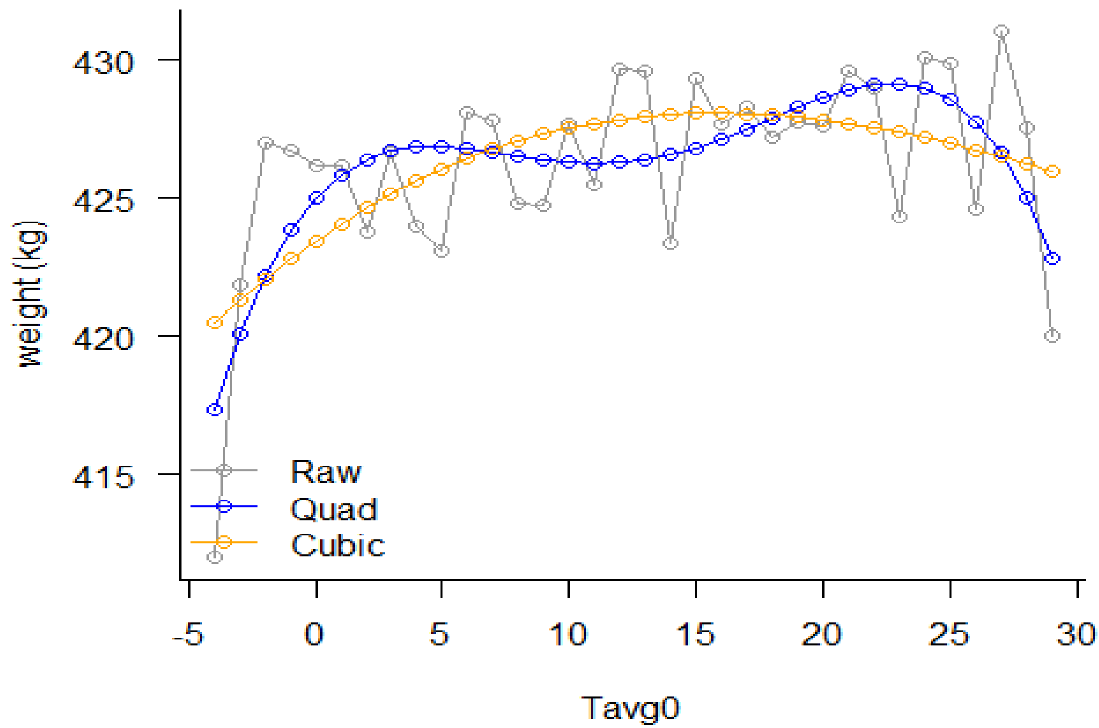
# RESULTS

## Estimate thrsholds the comfort zone for weight of T avg

| Climatic variable | $Thr_{cold}$[1] | $Thr_{hot}$[2] |
|---|---|---|
| $T_{avg}$ | - 0.33 | 25.5 |

**$Thr_{hot}$ = the heat threshold**
**$Thr_{cold}$ = the cold threshold**





# Conclusions

**1.- Conditions on the test day (lag 0) and the 2 d or 3d before mainly determine how ANI calves respond to thermal stress.**

**2.- ANI seems to be more adopted to cold than hot weather conditions.**

**3.- WIDE Comfort zone, between -1 and 25°C of average daily temperature (Tavg)**

# Acknowledgments

- **Erasmus Placement programm**
- **Regional Operational Programme of the European Social Fund (ROP ESF)**

# Statistical Analysis

## Estimation of the Lag Value and Thermal Load Effect on Production

In order to define the dependent variable, **residuals** from a linear regression model [1] were used;

$$\mathbf{Y}_i = \mathbf{CG}_j + \boldsymbol{GA}_{ki} \qquad [1]$$

Where

✓$\mathbf{Y}_i$ = *ith* raw weight record of the animal *m* at the day of recording;

✓$\mathbf{CG}_j$ **=** contemporary group defined as the combination of year and conventional seasons in which $y_i$ was recorded (j=1,…,47);

✓$\boldsymbol{GA}_{ki}$ **=** is the interaction $k^{th}$ group of entry to the feedlot (2 levels; age ≤ 247 and age > 247 days)

- age of the animal at the day of recording.

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# Statistical Analysis

## Definition of comfort regions

A model to estimate the unstructured (with no assumption about the shape of the response function) response of weight to the thermal load in the day of the optimal lag was fitted as follows:

$$y_{ijkm} = CG_j + GA_{km+} w_{im} + a_m + e_{ijkm}$$

✓**$Y_i$** = *ith* raw weight record of the animal *m* at the day of recording

✓**$CG_j$ =** contemporary group in which $y_i$ was recorded (j=1,…,47)

✓**$GA_{km}$ =** interaction between k^th group of entry to the feedlot (2 levels; age ≤ 247 and age > 247 days)

- age of the animal at the day of recording

✓**$W_{im}$** is the thermal load thermal load in the day of the optimal lag

✓**$a_m$** is the random effect ($N(0,\sigma^2_a)$)of the animal producing the weight

(m=1,…,5876)

✓ **$e_{jklm}$** is the random error ($N(0,\sigma^2_e)$).

# Results

## Pearson correlation coefficients between the weather conditions including on 0 d

| | Climate variable | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Tavg** | **Tmax** | **Tmin** | **THIavg** | **THImax** | **THImin** | **WCIavg** | **WCImin** | **WCImax** |
| **T avg** | | 0.97 | 0.94 | 0.99 | 0.96 | 0.96 | 1 | 0.94 | 0.97 |
| **T max** | 0.97 | | 0.85 | 0.97 | 0.99 | 0.91 | 0.98 | 0.85 | 1 |
| **T min** | 0.94 | 0.85 | | 0.93 | 0.84 | 0.97 | 0.94 | 1.00 | 0.85 |
| **THI avg** | 0.99 | 0.97 | 0.93 | | 0.97 | 0.97 | 0.99 | 0.93 | 0.97 |
| **THI max** | 0.96 | 0.99 | 0.84 | 0.97 | | 0.90 | 0.97 | 0.84 | 0.99 |
| **THI min** | 0.96 | 0.91 | 0.97 | 0.97 | 0.90 | | 0.96 | 0.98 | 0.90 |
| **WCI avg** | 1. | 0.98 | 0.94 | 0.99 | 0.97 | 0.96 | | 0.94 | 0.97 |
| **WCI min** | 0.94 | 0.85 | 1 | 0.93 | 0.84 | 0.98 | 0.94 | | 0.85 |
| **WCI max** | 0.97 | 1.00 | 0.85 | 0.97 | 0.99 | 0.90 | 0.97 | 0.85 | |