# Exploring grass-based beef production under climate change by integration of grass and cattle growth models

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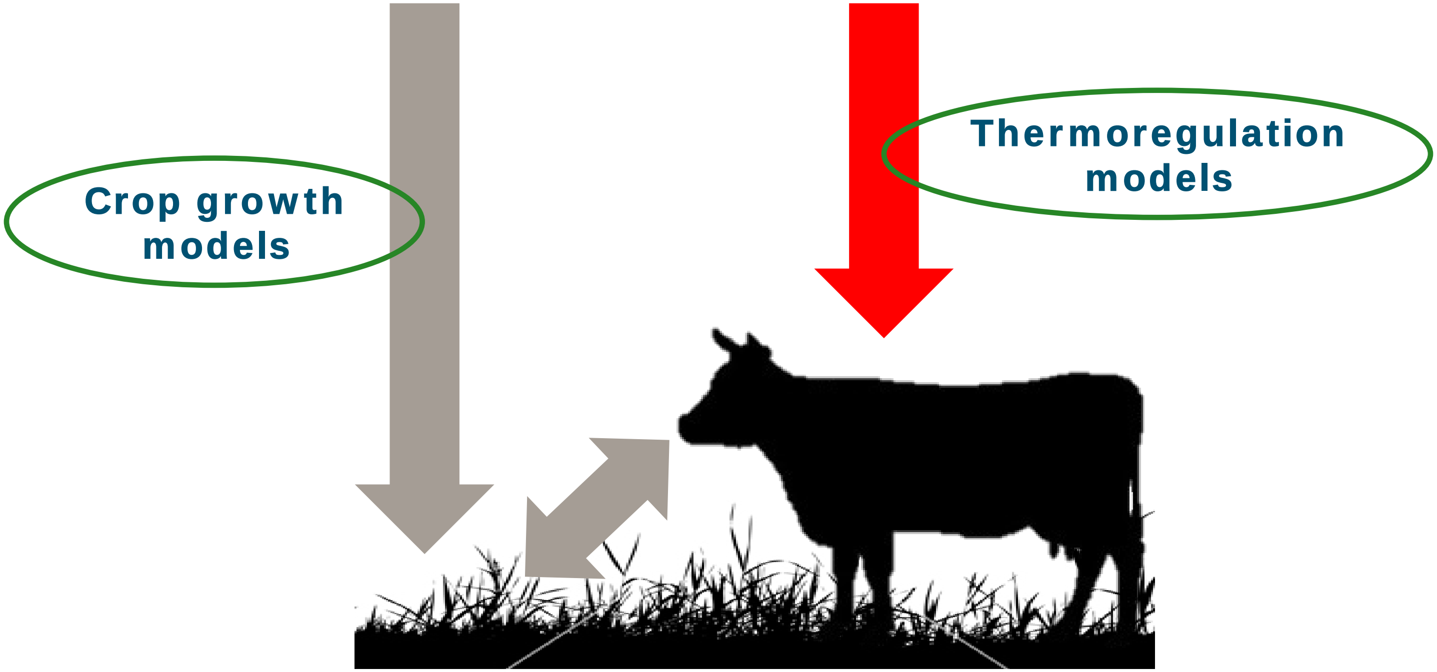
LiveM 2016 conference

# Introduction

- Climate change in grass-based systems




- Aim: to explore the effects of climate change on beef cattle in grass-based systems in France

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# Materials and methods

## System characteristics

- Location: Charolles, France
- Breed: Charolais
- Bulls, initial weight 315 kg
- Period: Grazing season (March 25$^{th}$-December 10$^{th}$)
- Continuous grazing

# Materials and methods

Scenarios for climate change:

1. Reference climate (1999-2006)
2. Smallest climate change in 2050
3. Largest climate change in 2050

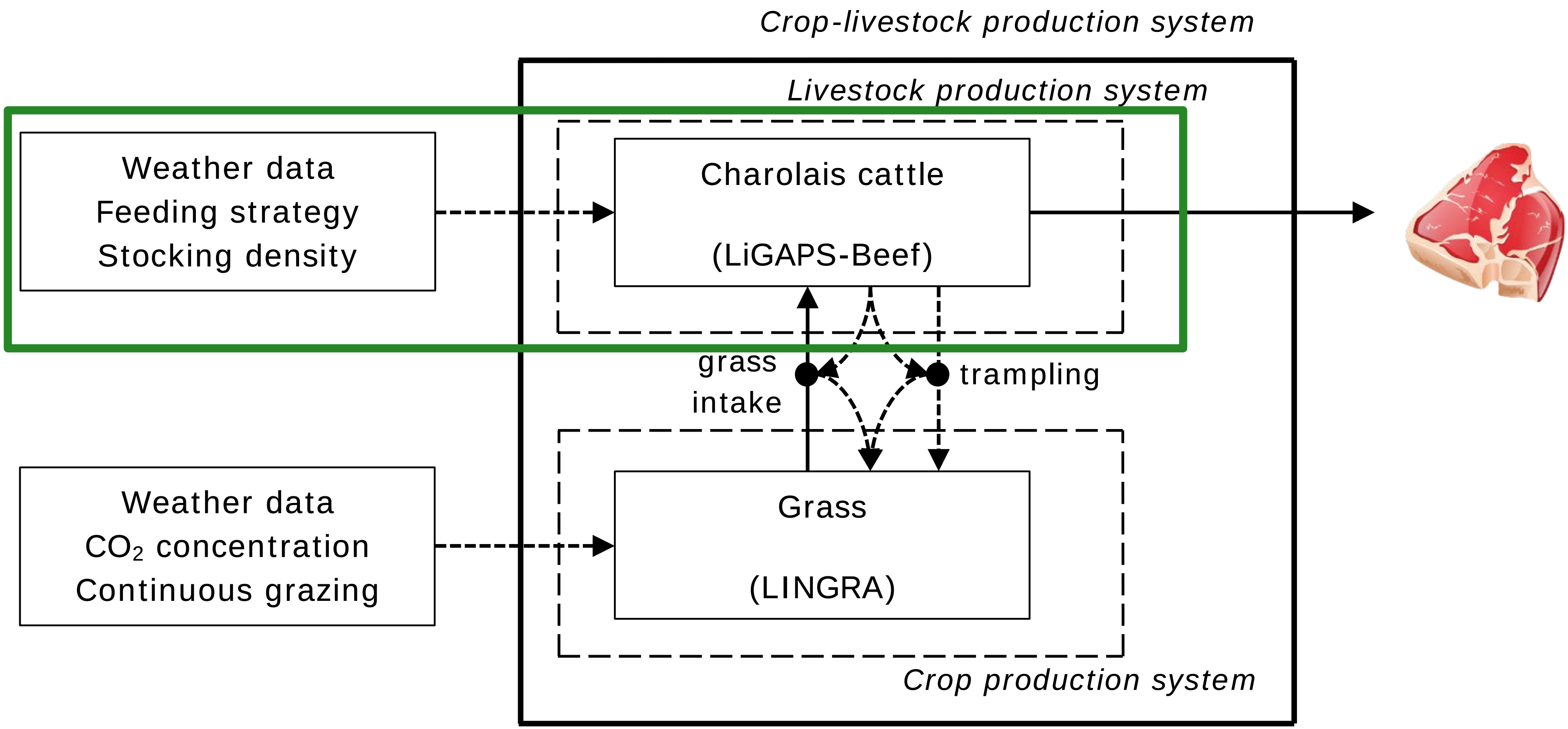
Smallest and largest climate change for Charolles, with 1999-2006 as a reference

| | Smallest CC | Largest CC |
|---|---|---|
| Temperature | + 0.7 °C | + 1.9 °C |
| Annual rainfall | - 4.5% | - 7.1% |
| $CO_2$ concentration | + 71 ppm (443 ppm) | + 168 ppm (541 ppm) |

Based on Representative Concentration Pathways 2.6 and 8.5

NASA (2016) and RCP database 2.0.5 (2016)

# Materials and methods

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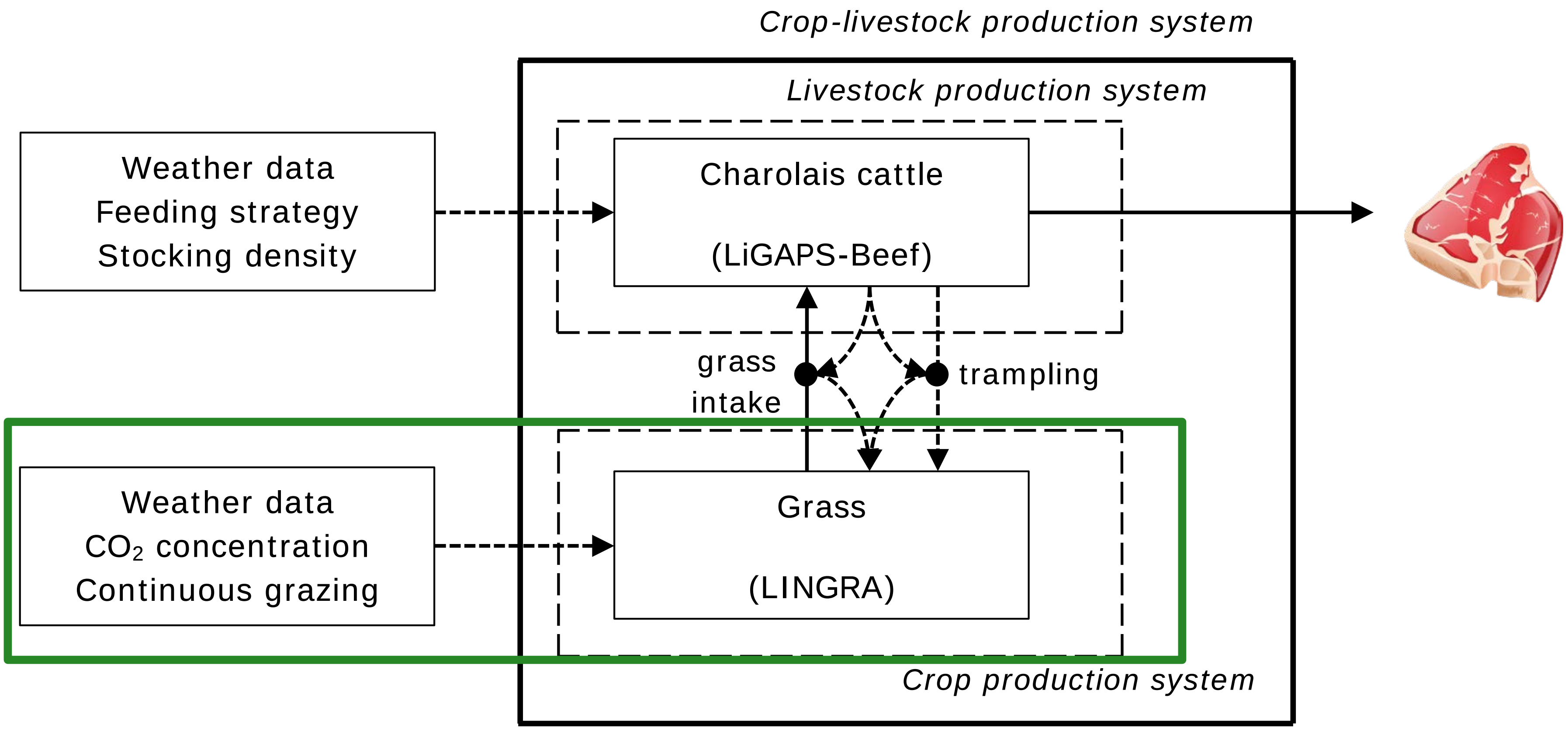
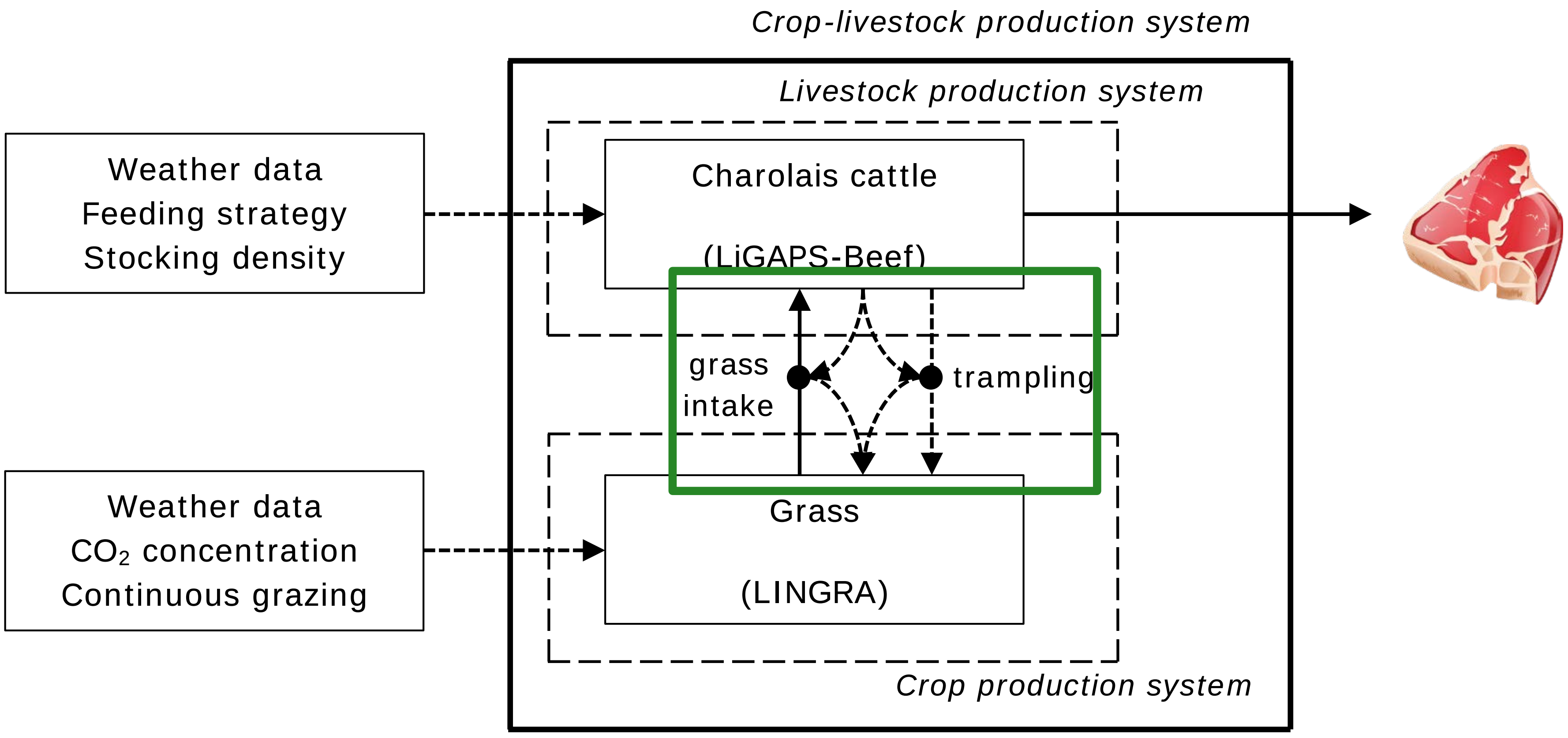
# Materials and methods



# Materials and methods



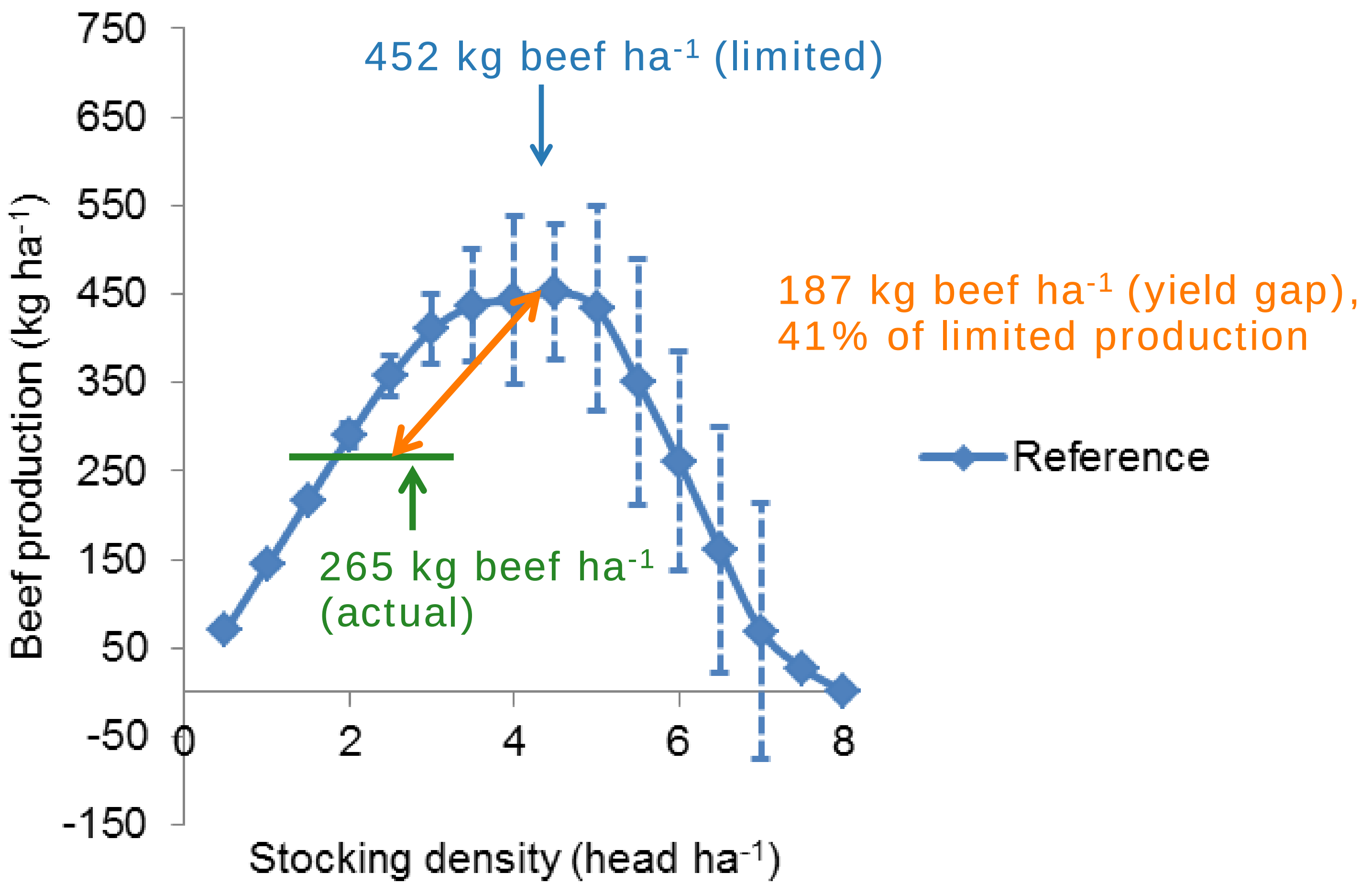
# Materials and methods

## Model simulations: limited production

- Rainfed, water-limited growth of grass
- Feed-limited growth of cattle
- Average optimum stocking density

## Literature: actual production

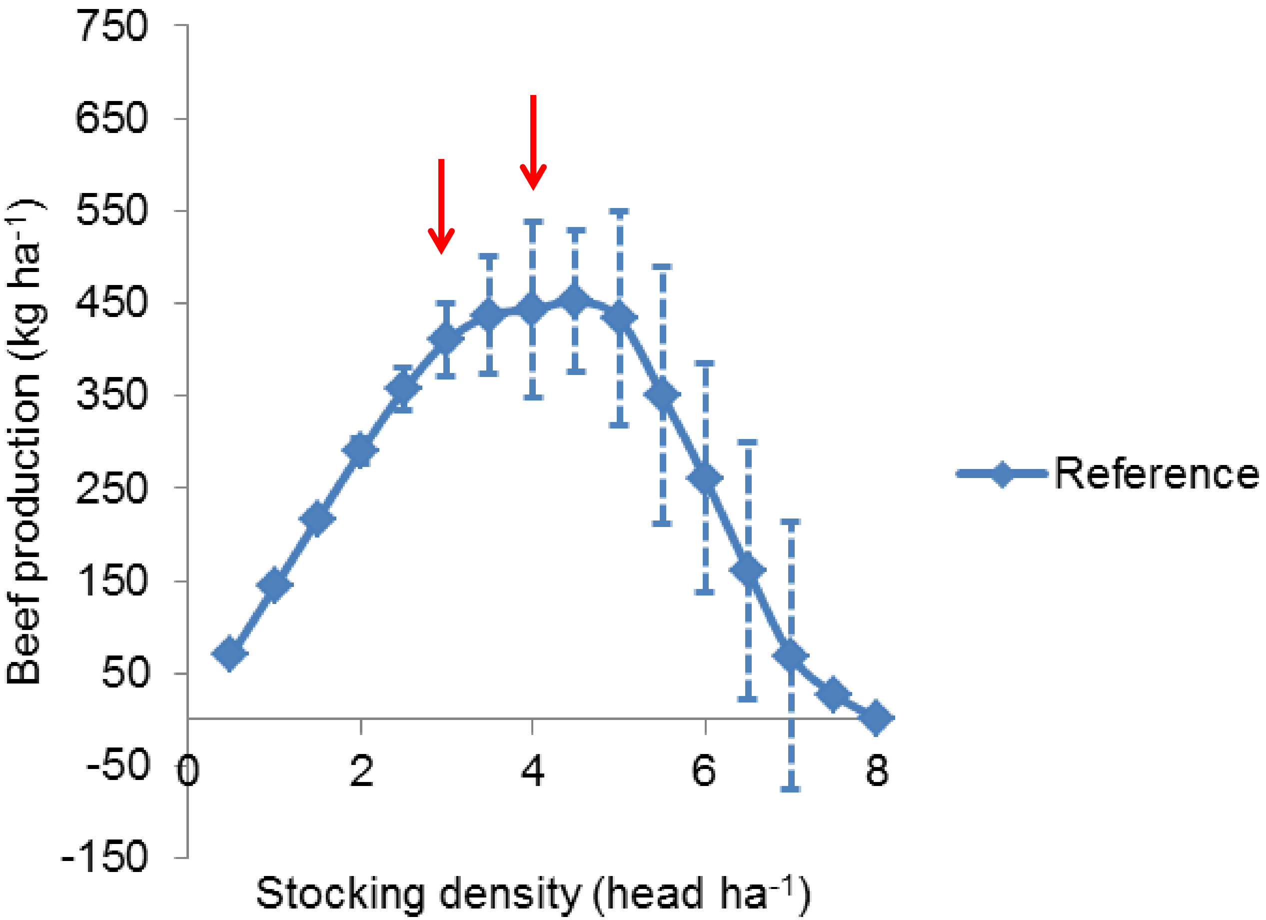
# Results and discussion



# Results and discussion

- Yield gap actual – limited → 41%
    - Nutrients for grass growth neglected
    - Mortality, diseases and stress
    - Risk aversion?

# Results and discussion

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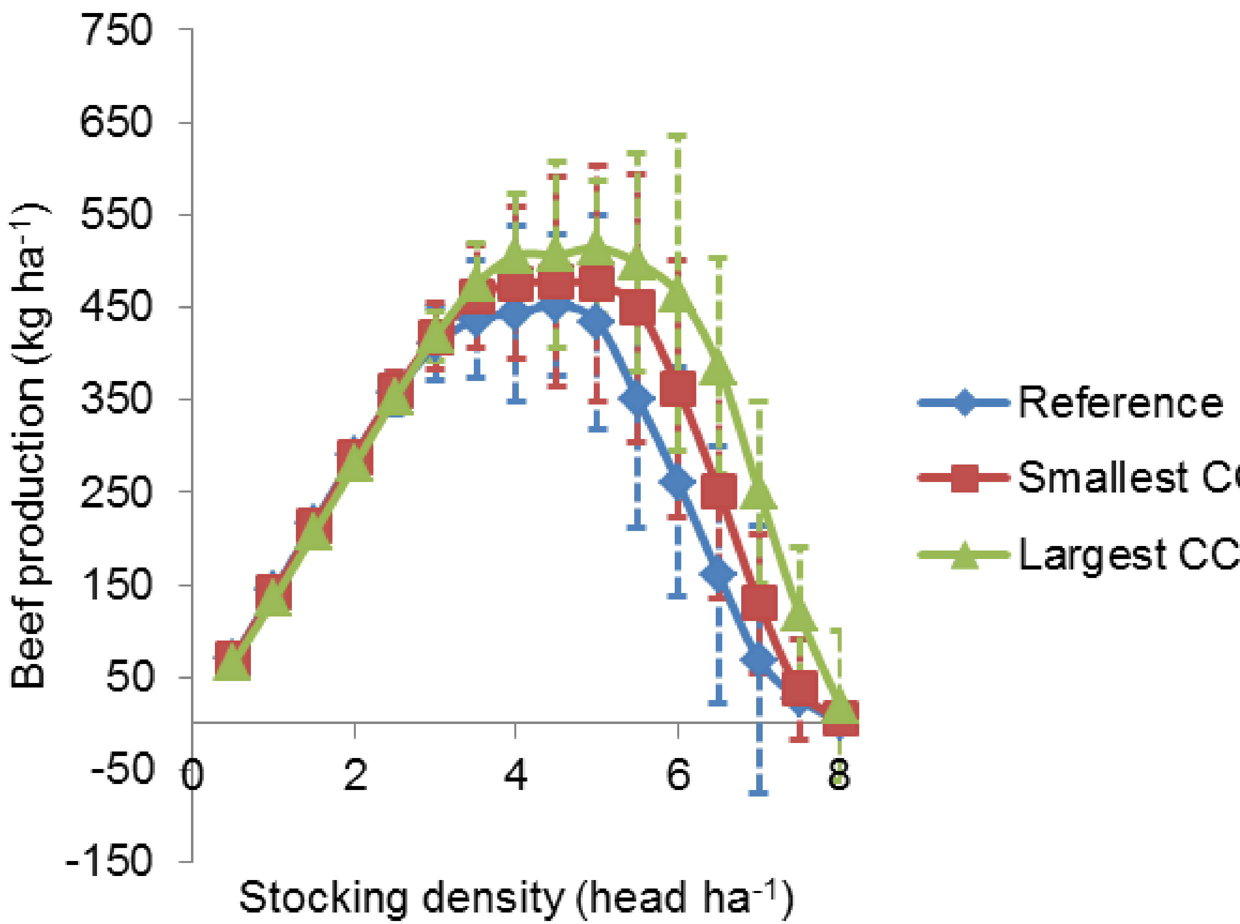
# Results and discussion

- Yield gap actual – limited → 41%
  - Nutrients for grass growth neglected
  - Mortality, diseases and stress in livestock
  - Risk aversion?
- Yield gap mitigation: economically attractive and practically feasible?

# Results & discussion

## Limited production, average over 7 years




Maximum prod.

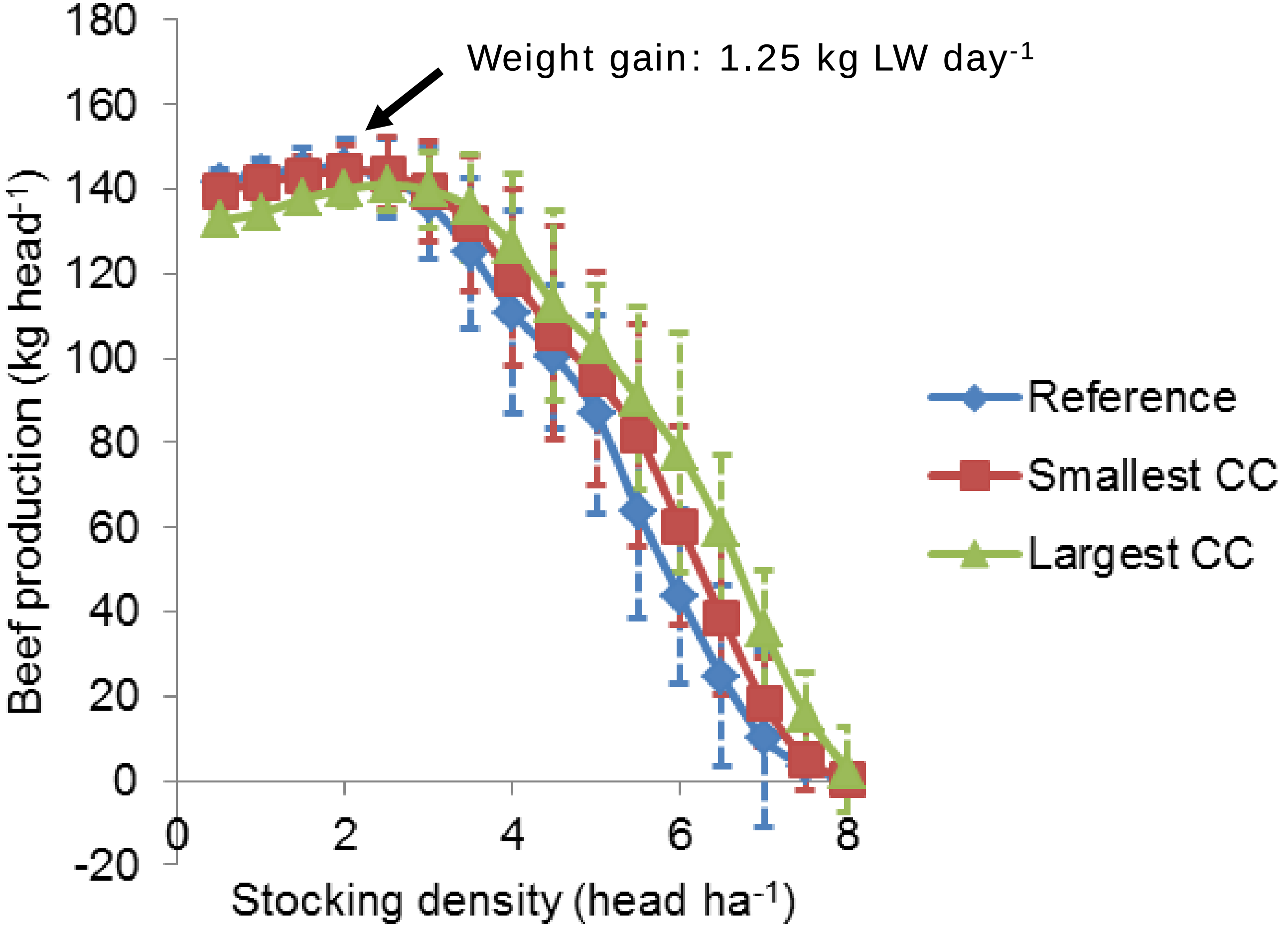
452 kg beef

+ 5.5%

+ 13.8%

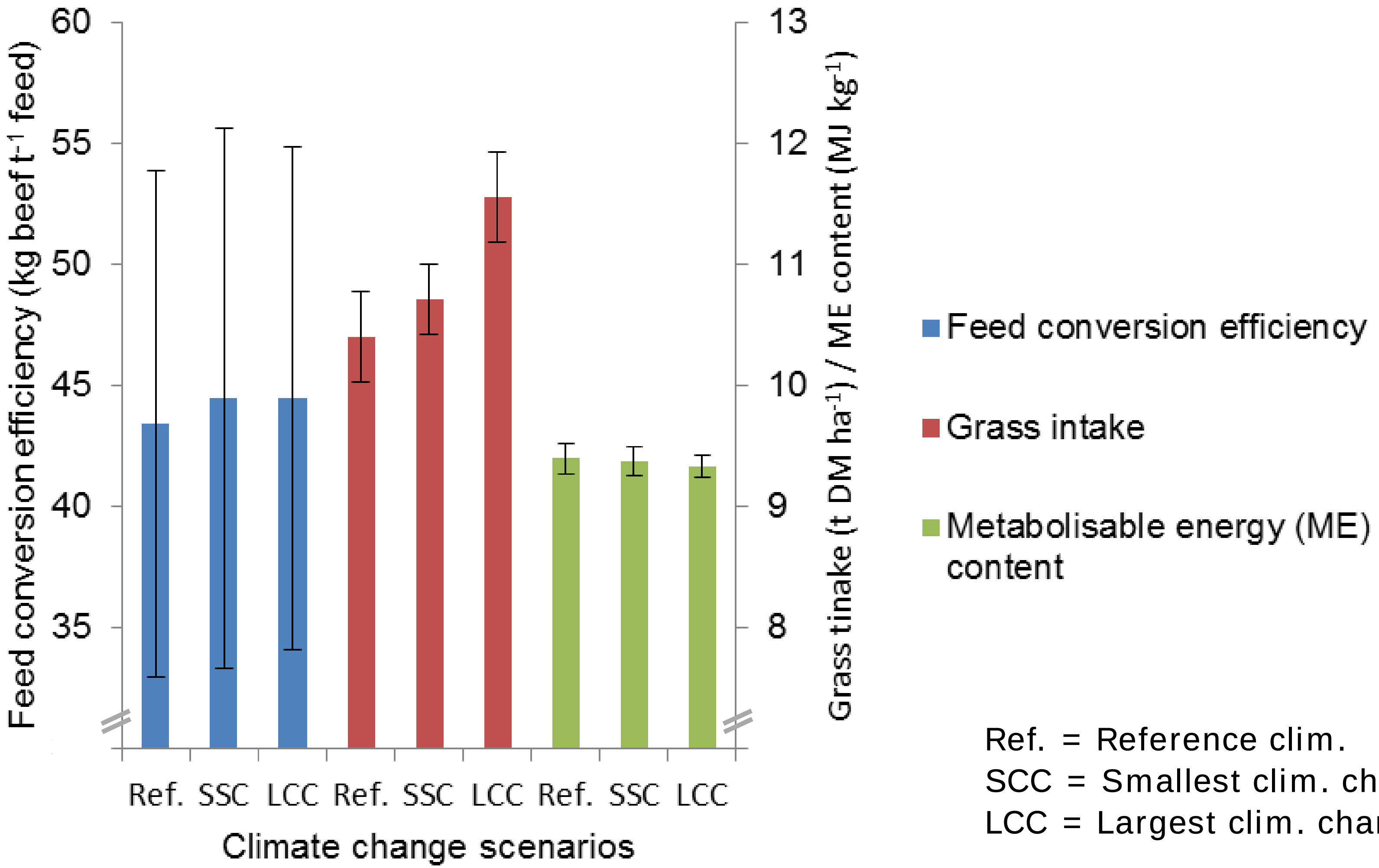
# Results & discussion

## Limited production



# Results & discussion

## Limited, and actual production




Ref. = Reference clim.
SCC = Smallest clim. change
LCC = Largest clim. change

# Discussion

- Production at animal level vs farm level
- Weather extremes
- Model validation in grazing systems
- Increasing actual production?

# Conclusions

- Integration of a grass and a cattle model allows to simulate beef production under climate change
- Actual grass-based beef production can be increased from a bio-physical perspective (yield gap 41%).
- Climate change increases limited beef production (5.5%-13.8%)

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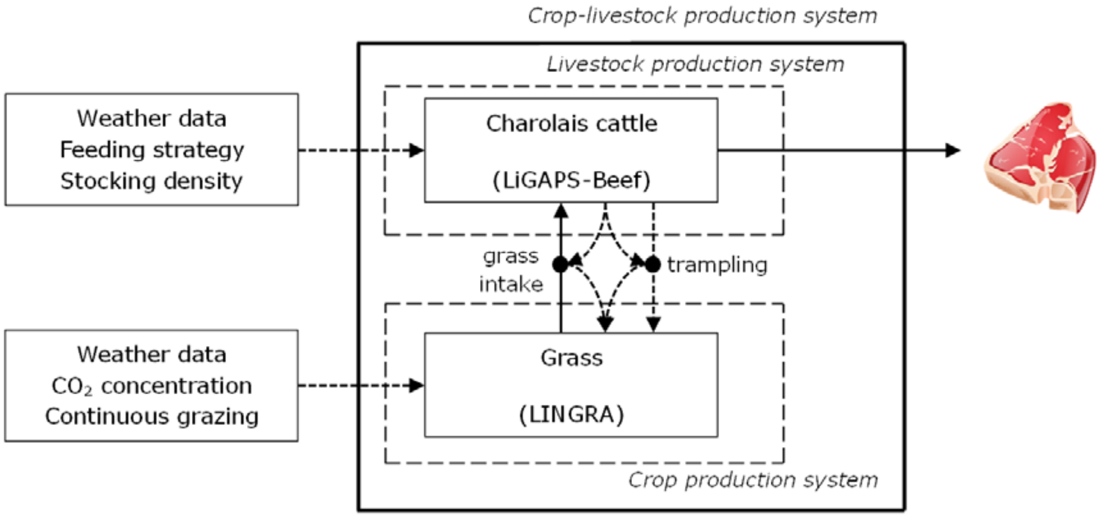
# Thank you for your attention!




| | Climate | | |
|---|---|---|---|
| | Reference | RCP 2.6 | RCP 8.5 |
| Limited production (kg) | 452 | 477 | 514 |
| Actual production (kg) | 265 | | |

+5.5%  +13.8%

41%

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Additional information:

Conference paper in Advances in Animal Biosciences

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# References


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Van der Linden A, Oosting SJ, Van de Ven GWJ, De Boer IJM and Van Ittersum MJ 2015. A framework for quantitative analysis of livestock systems using theoretical concepts of production ecology. Agricultural Systems 139, 100-109.

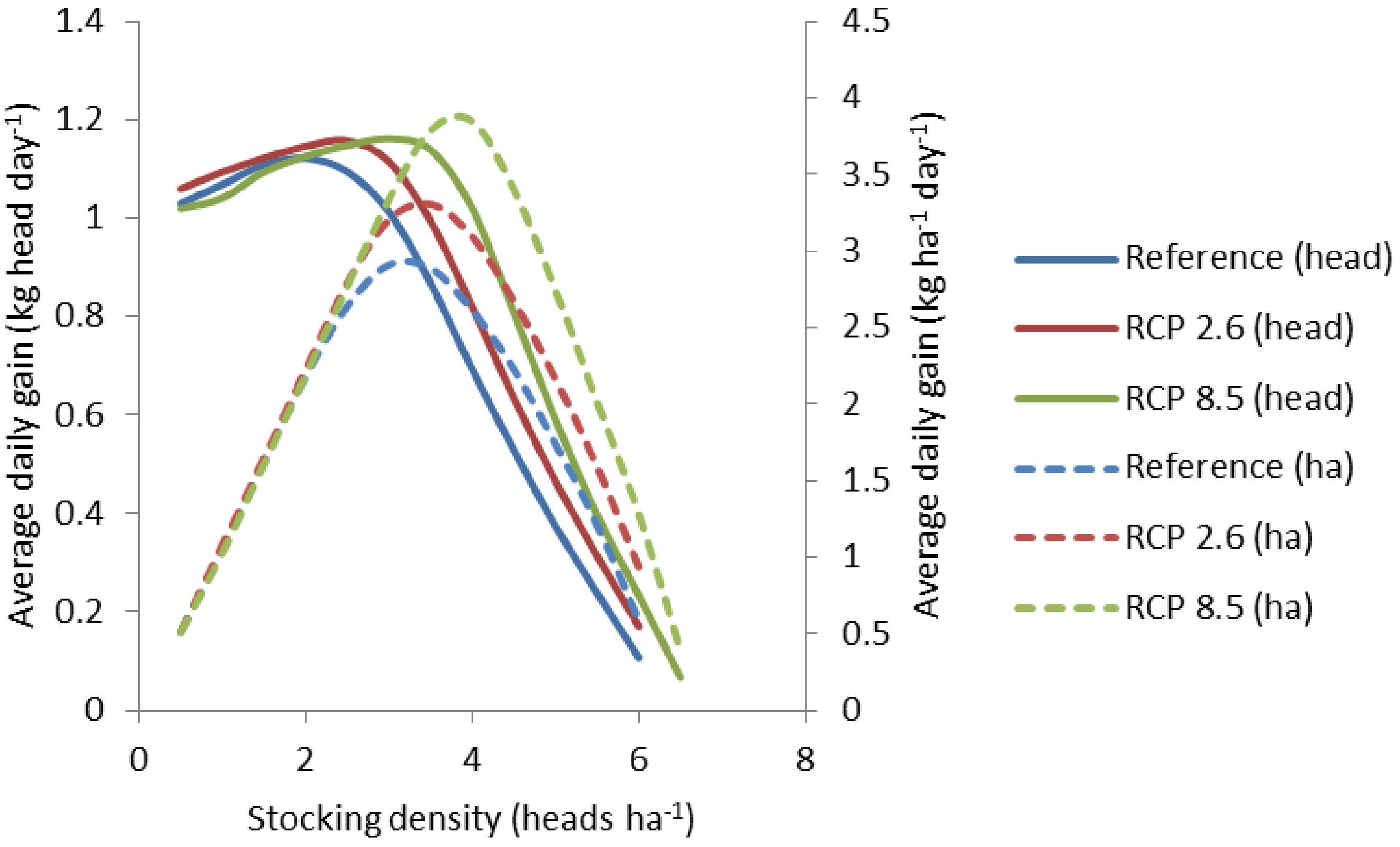
Van Ittersum MK, Cassman KG, Grassini P, Wolf J, Tittonell P and Hochman Z 2013. Yield gap analysis with local to global relevance-A review. Field Crops Research 143, 4-17.

# Websites climate change

- NASA, Forcings in GISS Climate Model, http://data.giss.nasa.gov/modelforce/ghgases/
- Representative Concentration Pathway database, version 2.0.5, http://tntcat.iiasa.ac.at/RcpDb/dsd?Action=htmlpage&page=compare
- GIS program, Climate Change Scenarios, https://gisclimatechange.ucar.edu/inspector

# Additional data

## 1999, Average daily gain (ADG) per head and per hectare

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# Additional data

- Grazing season: 260 days
- Days with reductions in feed intake due to heat stress:
  - Reference: 15.8 days (6.1%)
  - RCP 2.6: 17.8 days (6.8%)
  - RCP 8.5: 25.2 days (9.8%)

# Additional data

## Example heat balance in the thermoregulation sub-model