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

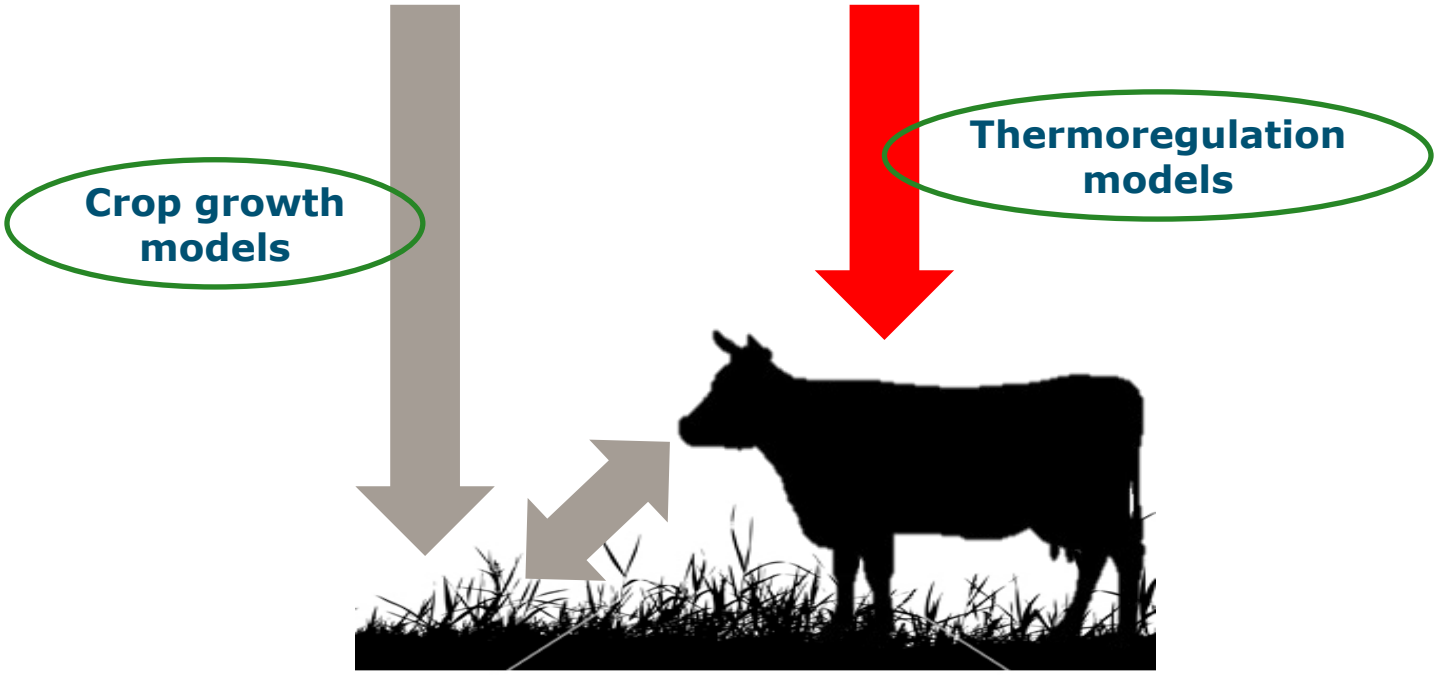
Aart van der Linden, Gerrie W.J. van de Ven, Simon J. Oosting, Martin K. van Ittersum & Imke J.M. de Boer

Animal Production Systems group, Wageningen University

Plant Production Systems group, Wageningen University

Introduction

- Climate change in grass-based systems



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

Materials and methods

System characteristics

- Location: Charolles, France
- Breed: Charolais
- Bulls, initial weight 315 kg
- Period: Grazing season (March 25th-December 10th)
- 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

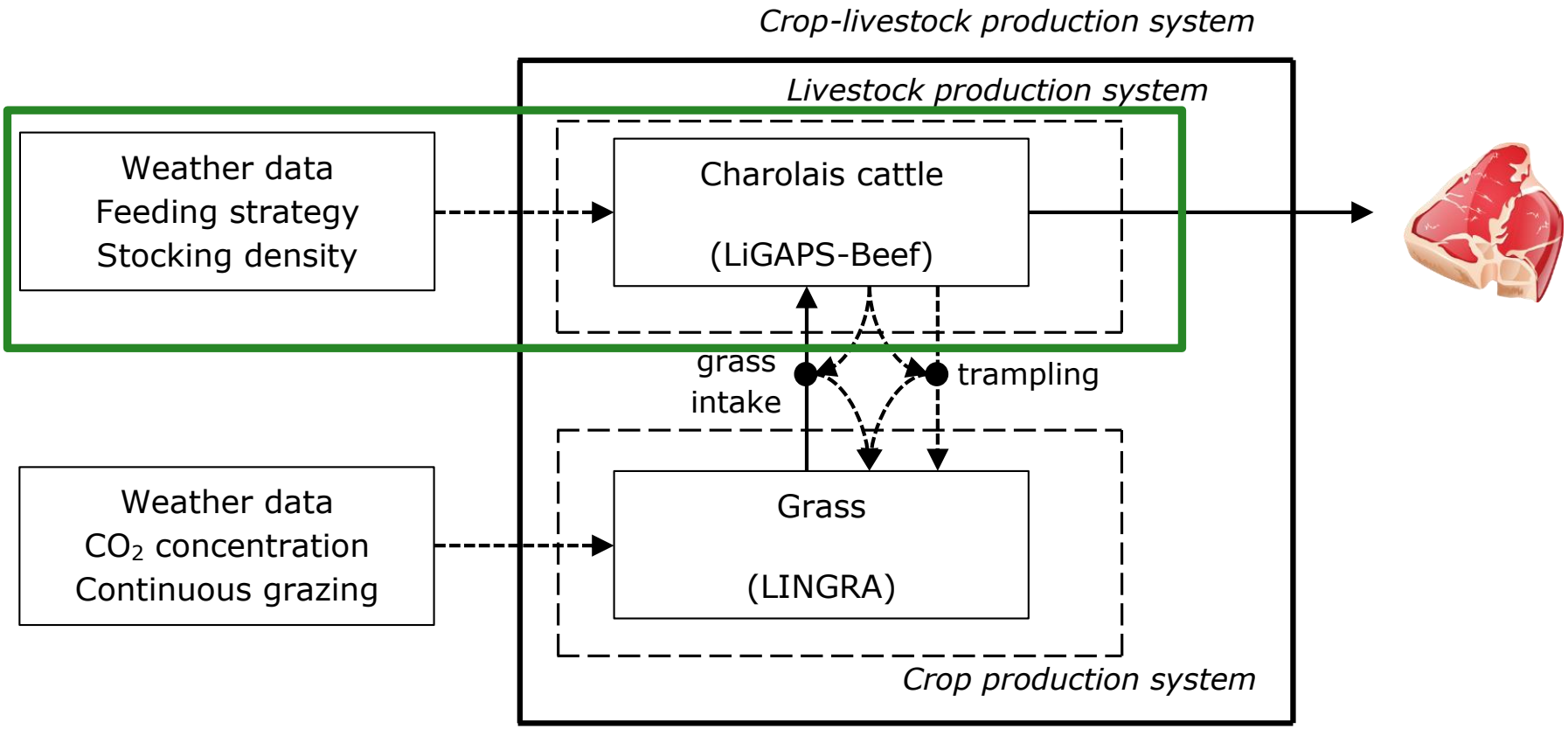
Smallest and largest climate change for Charolles, with 1999-2006 as a reference

	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)

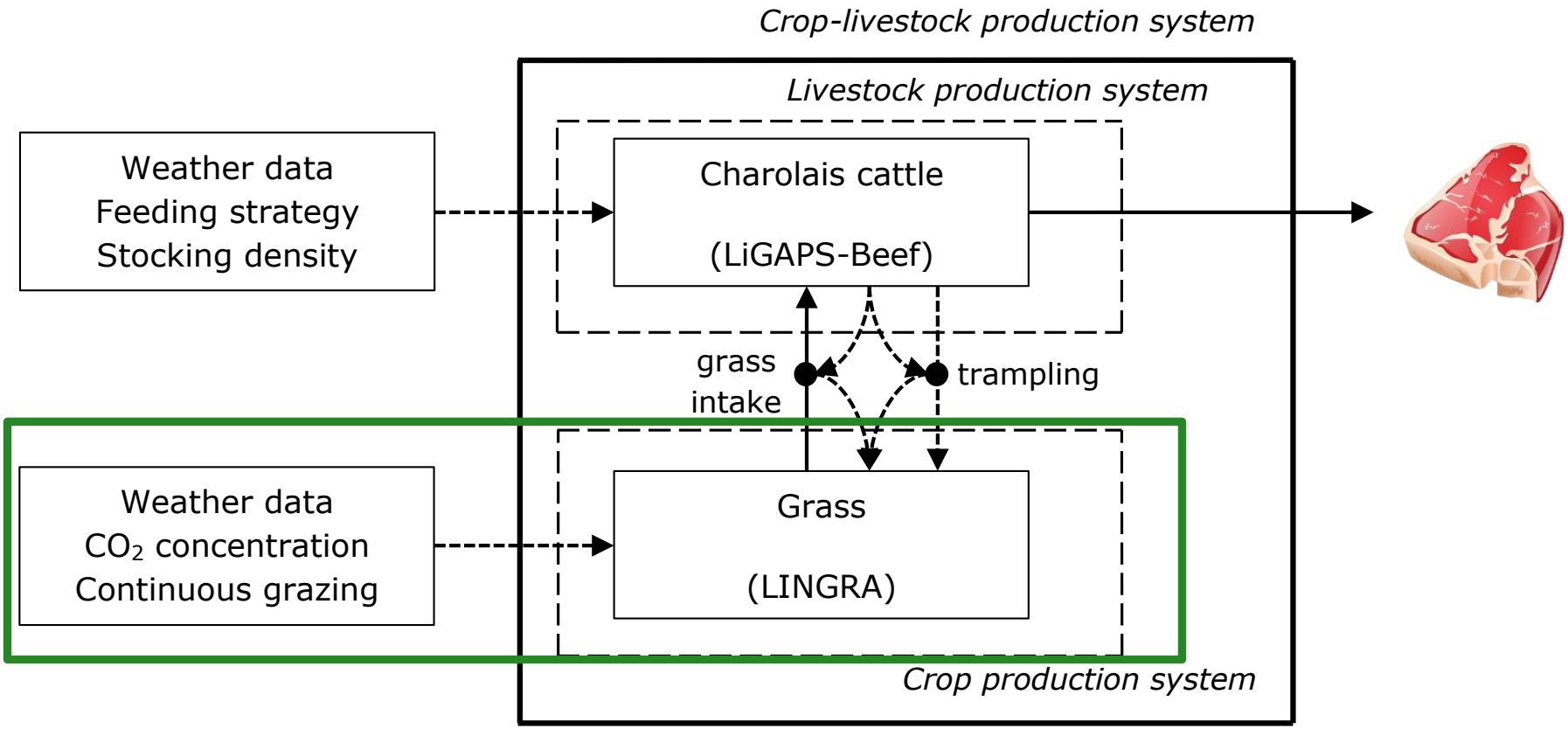
Based on Representative Concentration Pathways 2.6 and 8.5

NASA (2016) and RCP database 2.0.5 (2016)

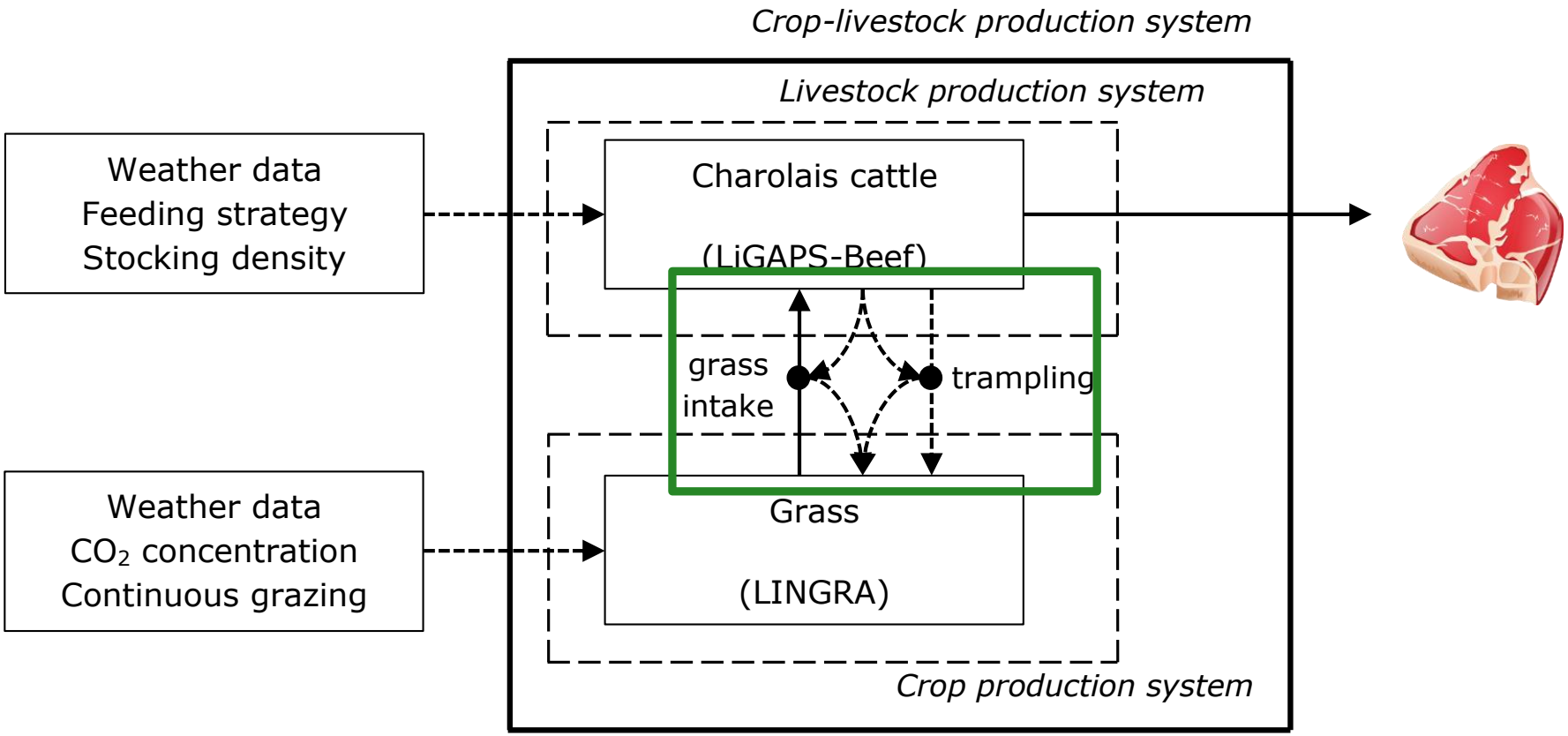
Materials and methods



Materials and methods



Materials and methods



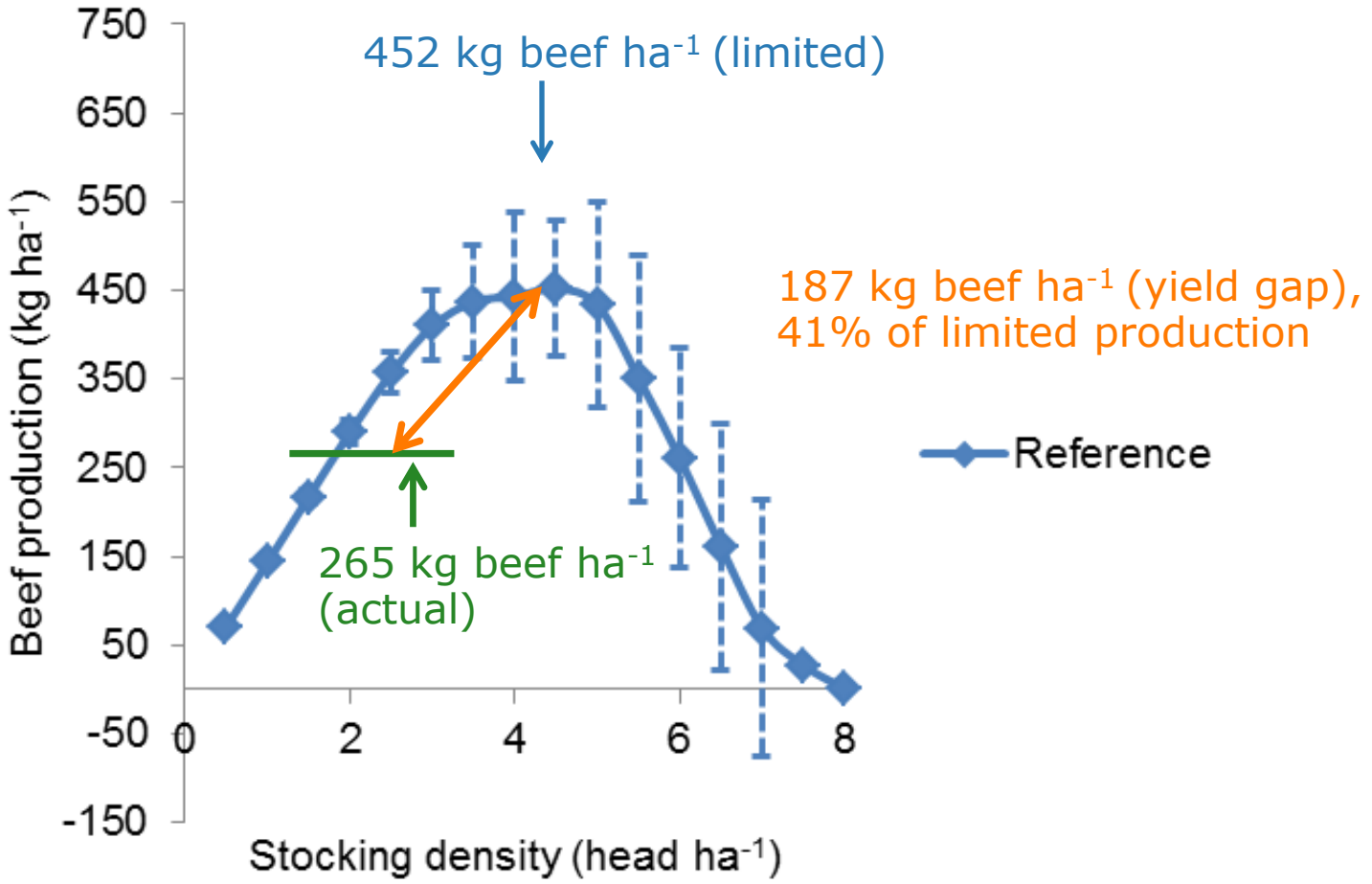
Materials and methods

Model simulations: limited production

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

Literature: actual production

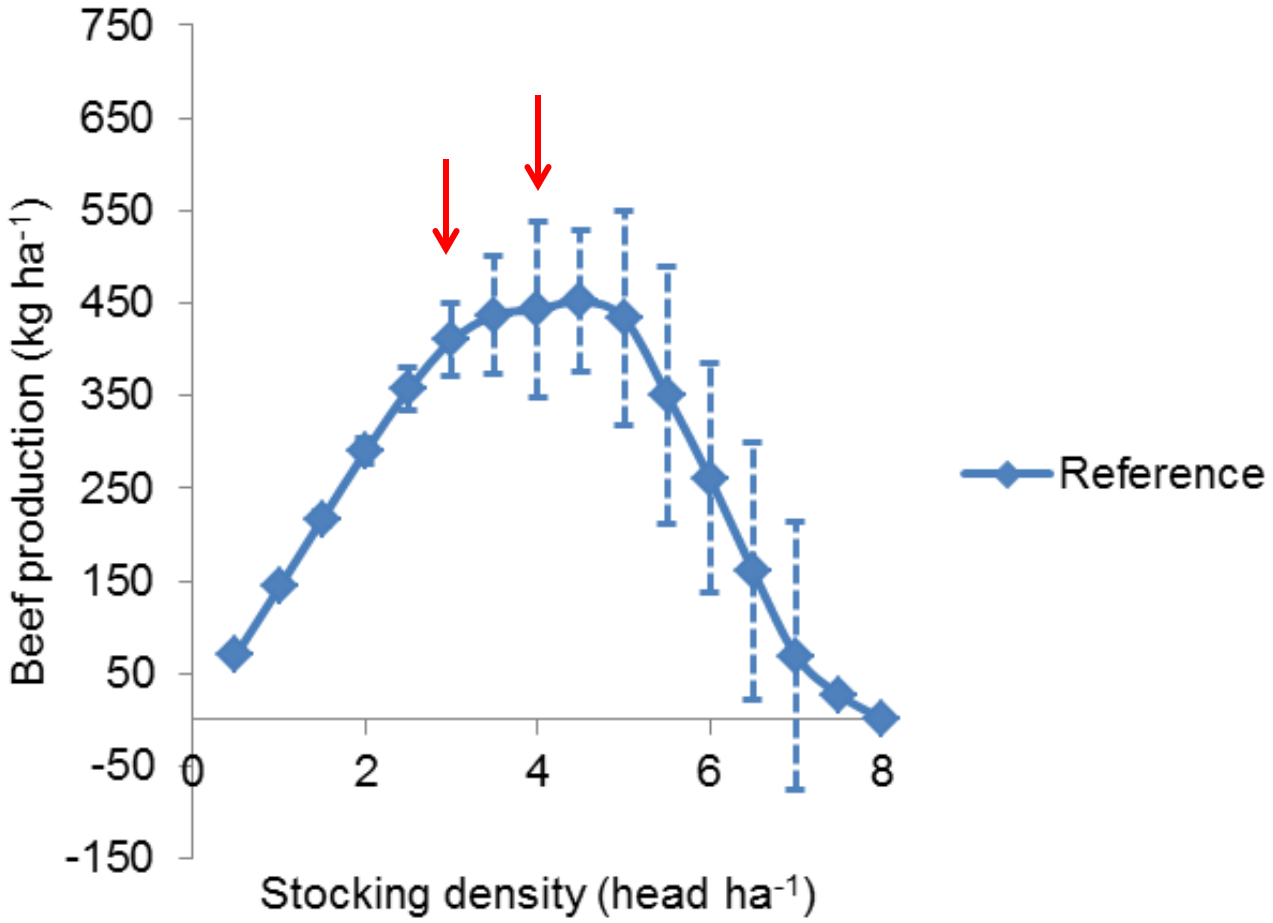
Results and discussion



Results and discussion

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

Results and discussion

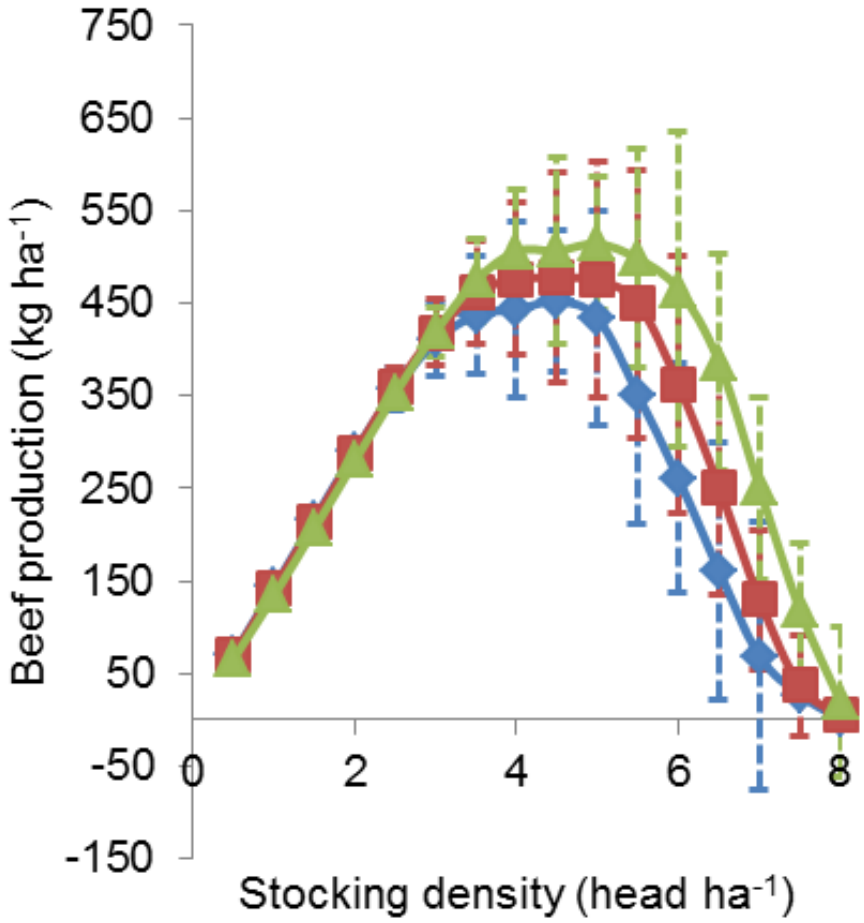


Results and discussion

- 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

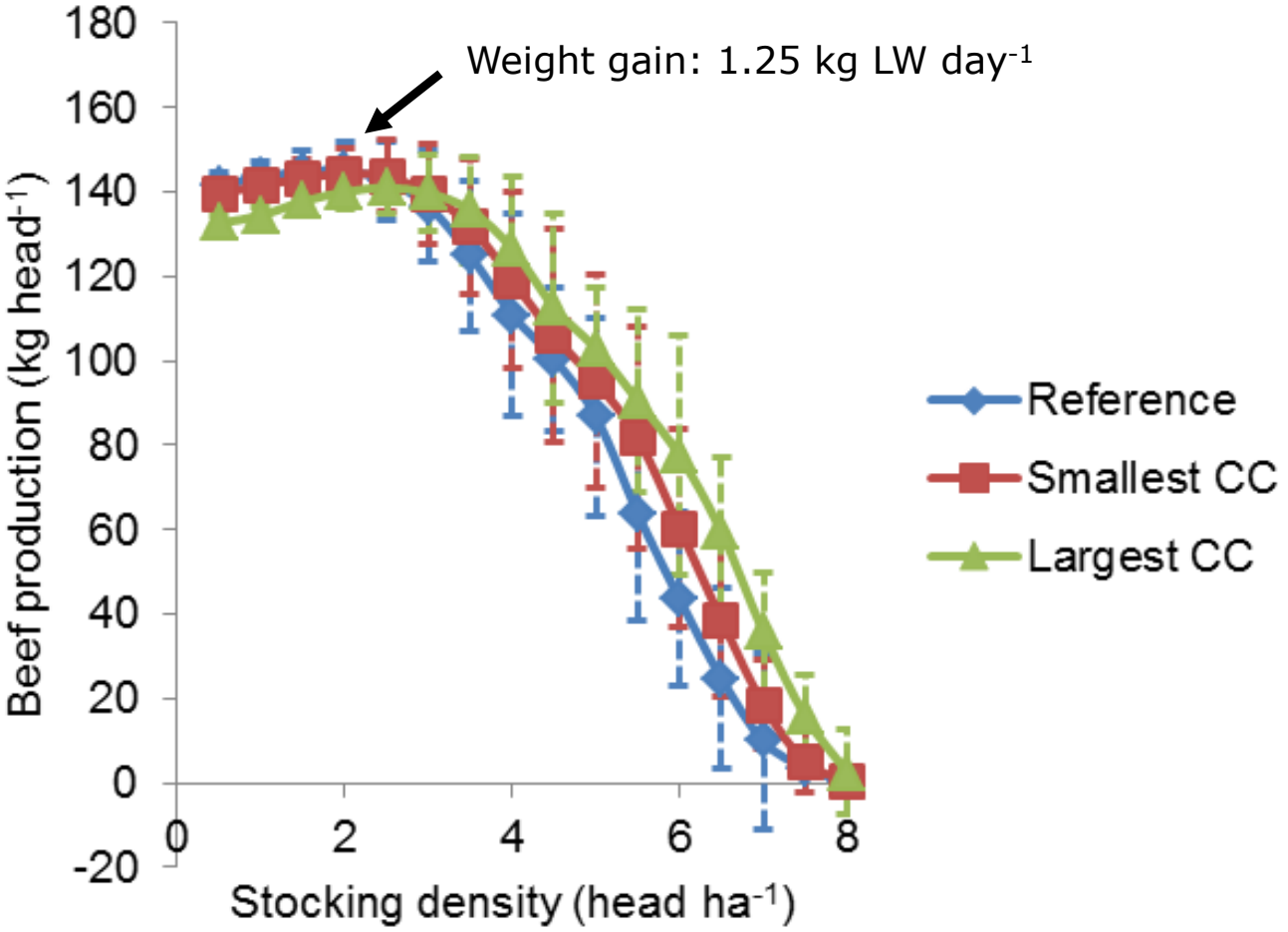
Limited production, average over 7 years



	Maximum prod.
Reference	452 kg beef
Smallest CC	+ 5.5%
Largest CC	+ 13.8%

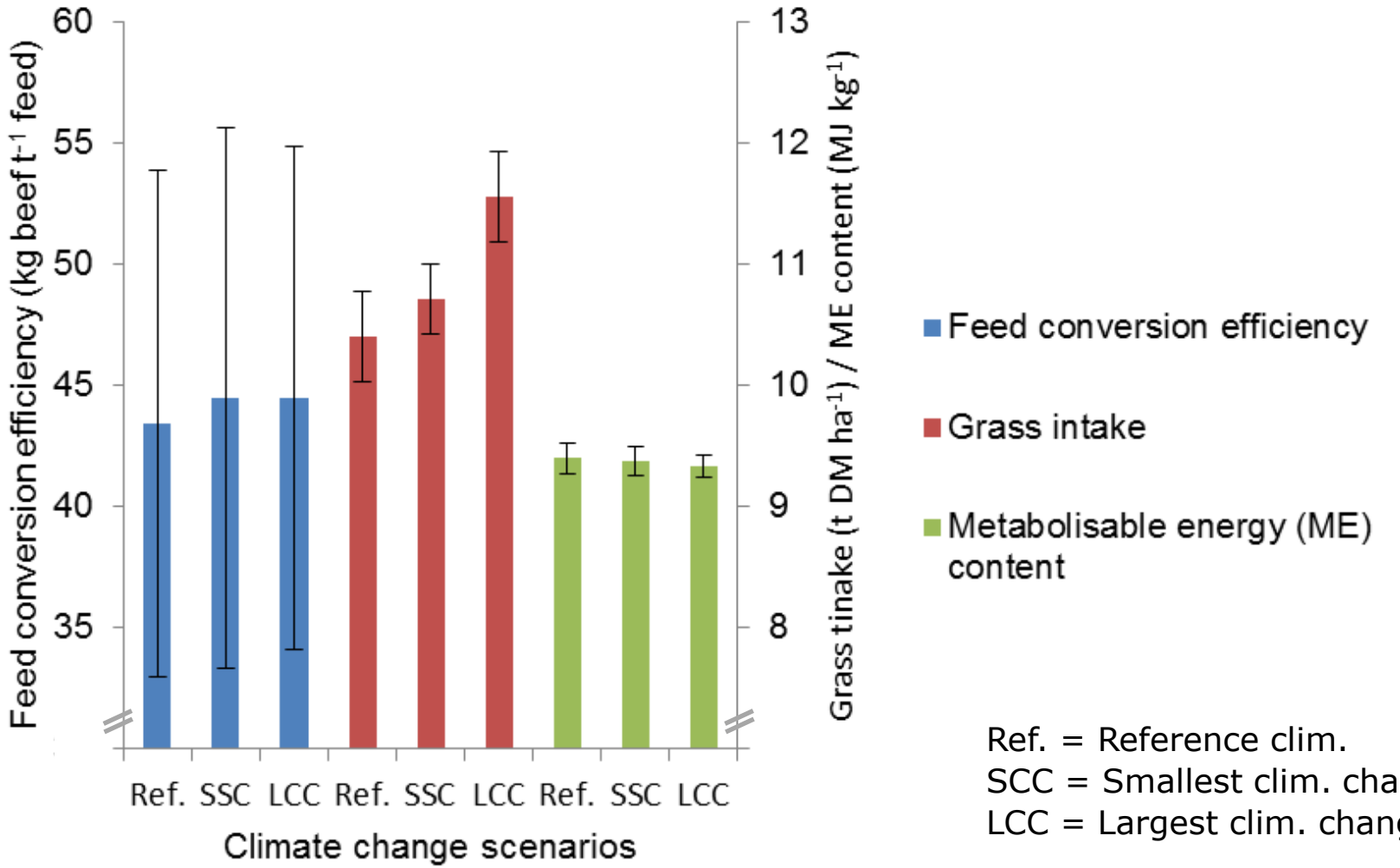
Results & discussion

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%)

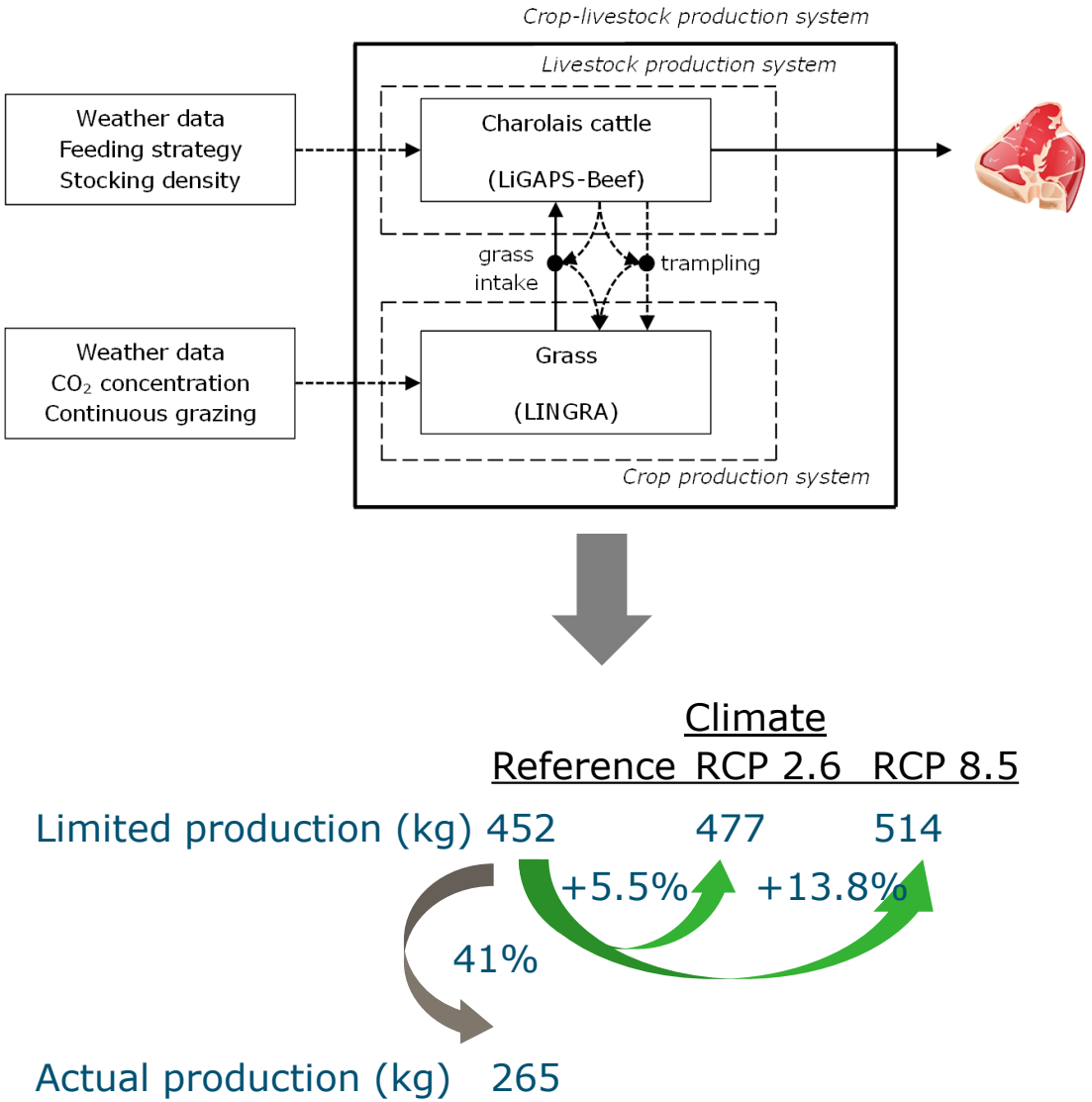
Thank you for your attention!

Contact:

aart.vanderlinden@wur.nl

Additional information:

Conference paper in Advances in Animal Biosciences



WAGENINGEN UR
For quality of life

References

Jones RJ and Sandland RL 1974. Relation between animal gain and stocking rate - derivation of relation from results of grazing trials. Journal of Agricultural Science 83, 335-342.

McGovern RE and Bruce JM 2000. A model of the thermal balance for cattle in hot conditions. Journal of Agricultural Engineering Research 77, 81-92.

Reseaux d'Elevage Charolais 2012. Conjuncture économique des systèmes bovins Charolais, Campagne 2012, 50pp. Reseaux d'Elevage Charolais, Paris, France.

Schapendonk A, Stol W, van Kraalingen DWG and Bouman BAM 1998. LINGRA, a sink/source model to simulate grassland productivity in Europe. European Journal of Agronomy 9, 87-100.

Van der Linden A, Van de Ven GWJ, Oosting SJ, Van Ittersum MJ and De Boer IJM 201X. LiGAPS-Beef, a mechanistic model to explore potential and feed-limited beef production: 1. Model description and illustration. Submitted to Animal.

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.

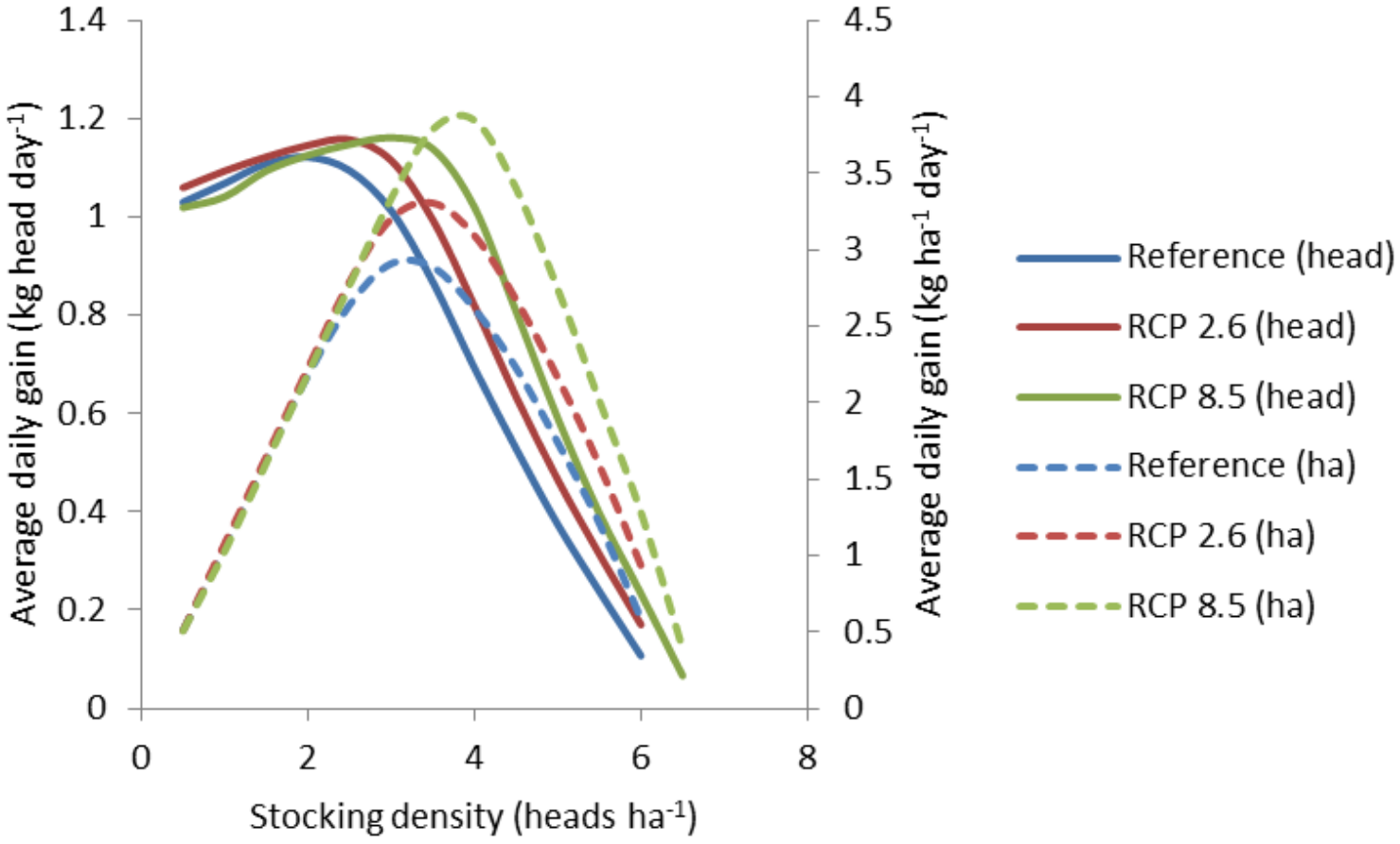
Van Ittersum MK, Cassman KG, Grassini P, Wolf J, Tittonell P and Hochman Z 2013. Yield gap analysis with local to global relevance-A review. Field Crops Research 143, 4-17.

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



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