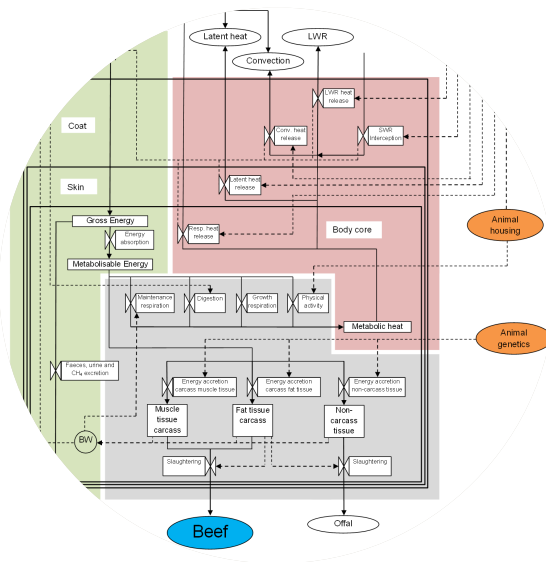


Applying production ecology to livestock: model development and evaluation

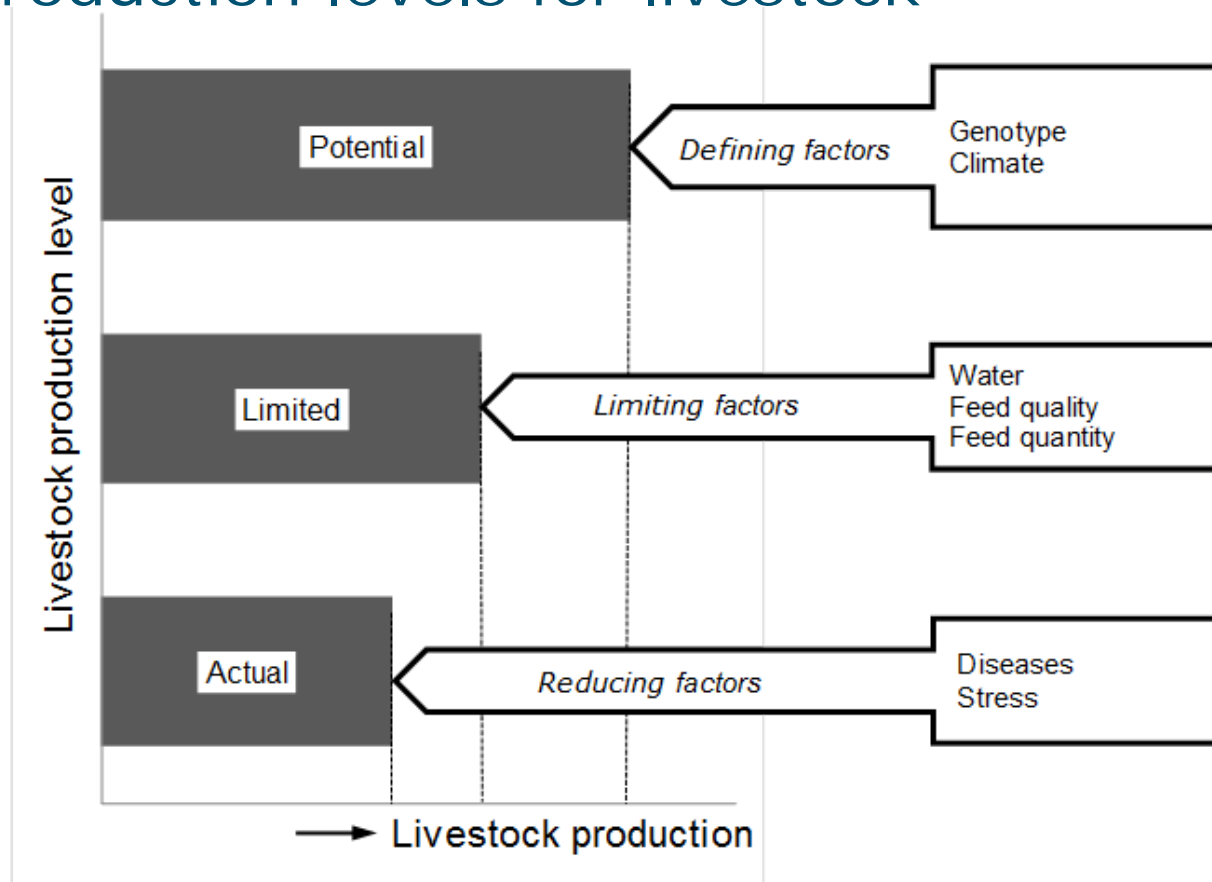
WaCASA meeting

10th June 2015



Introduction

Production levels for livestock



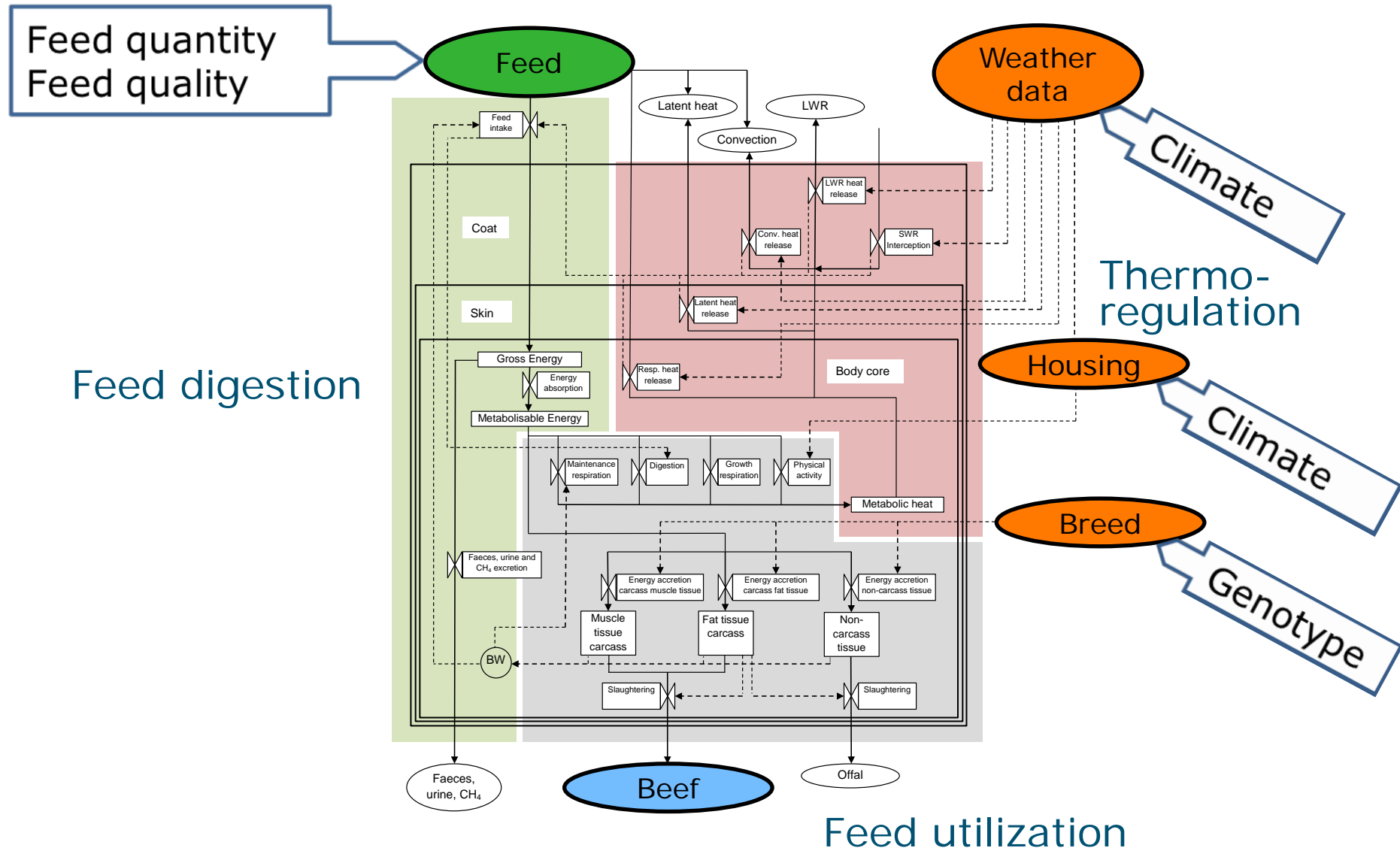
Adapted from: Van de Ven *et al.* (2003)



Contents

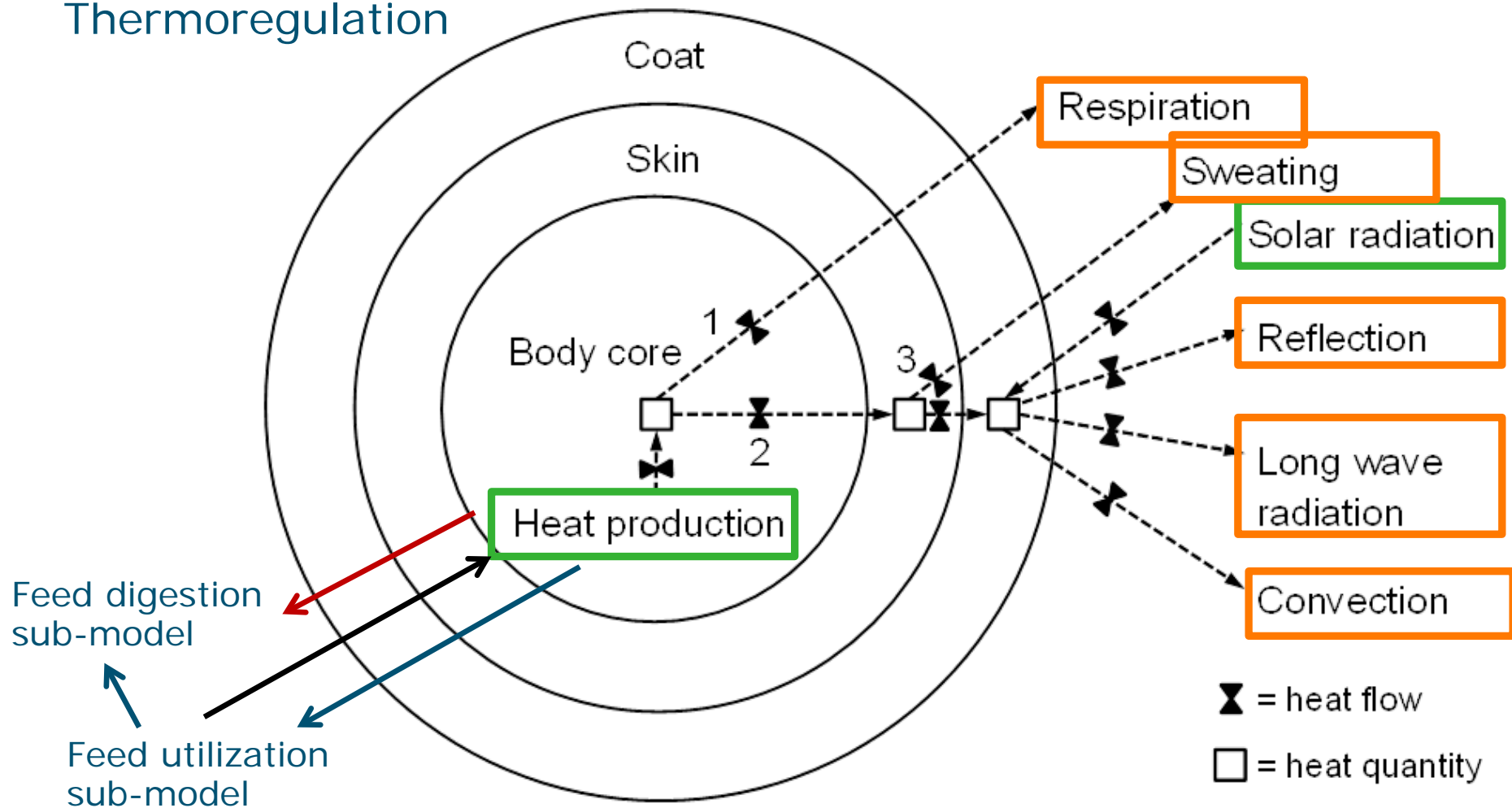
- Model development
- Model evaluation
- Crop-livestock systems

Model development



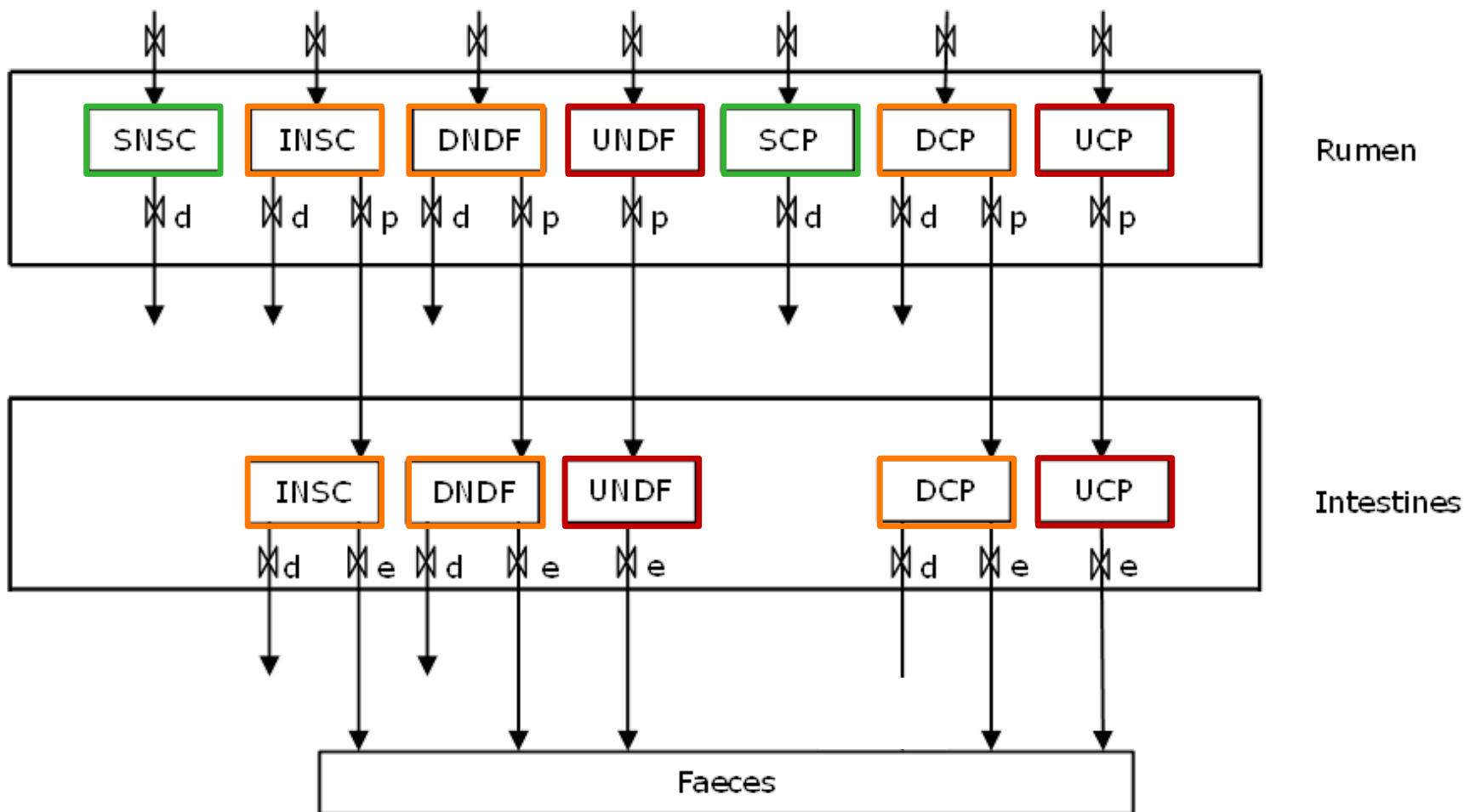
Model development

Thermoregulation



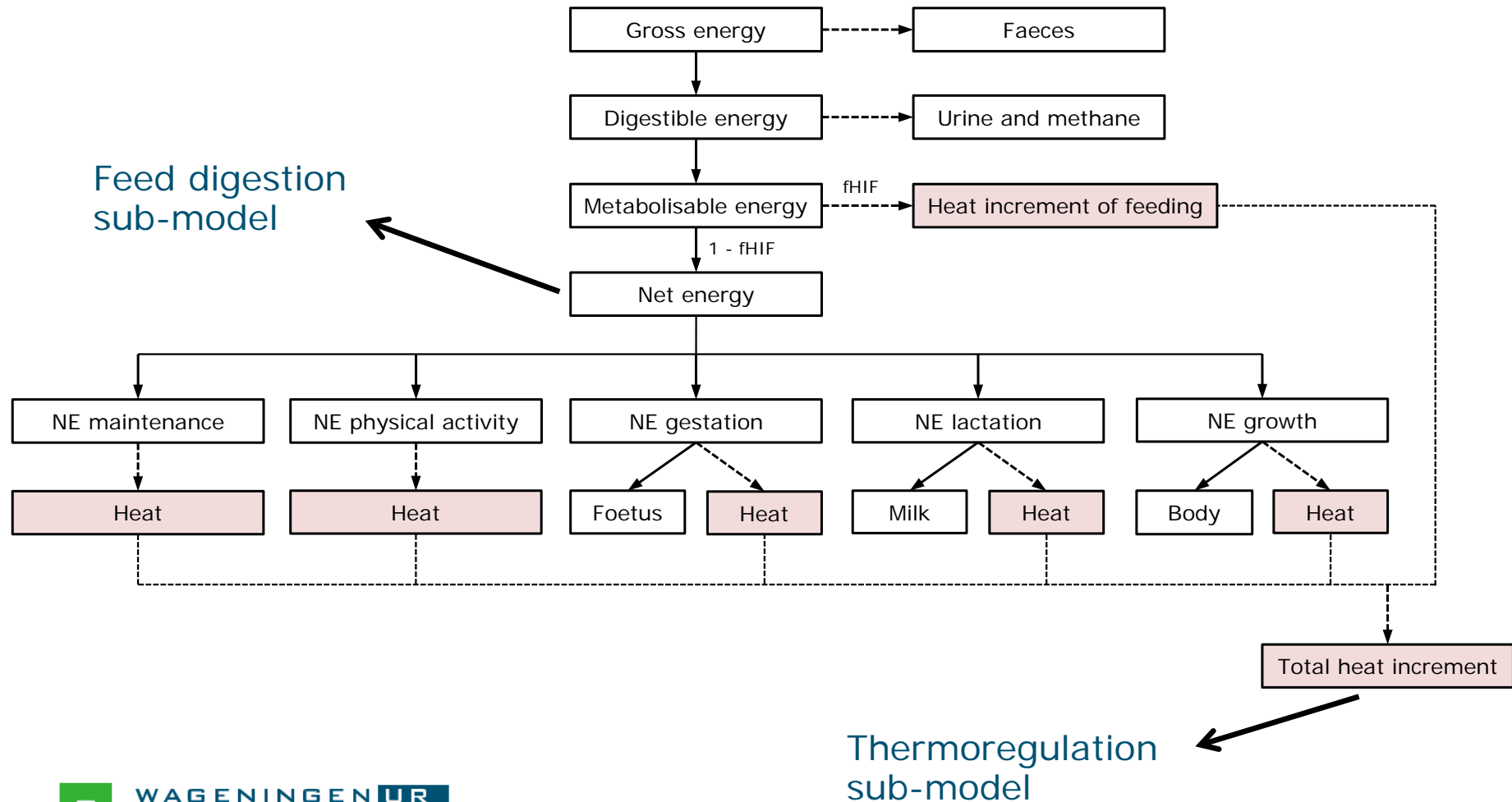
Model development

Feed digestion



Model development

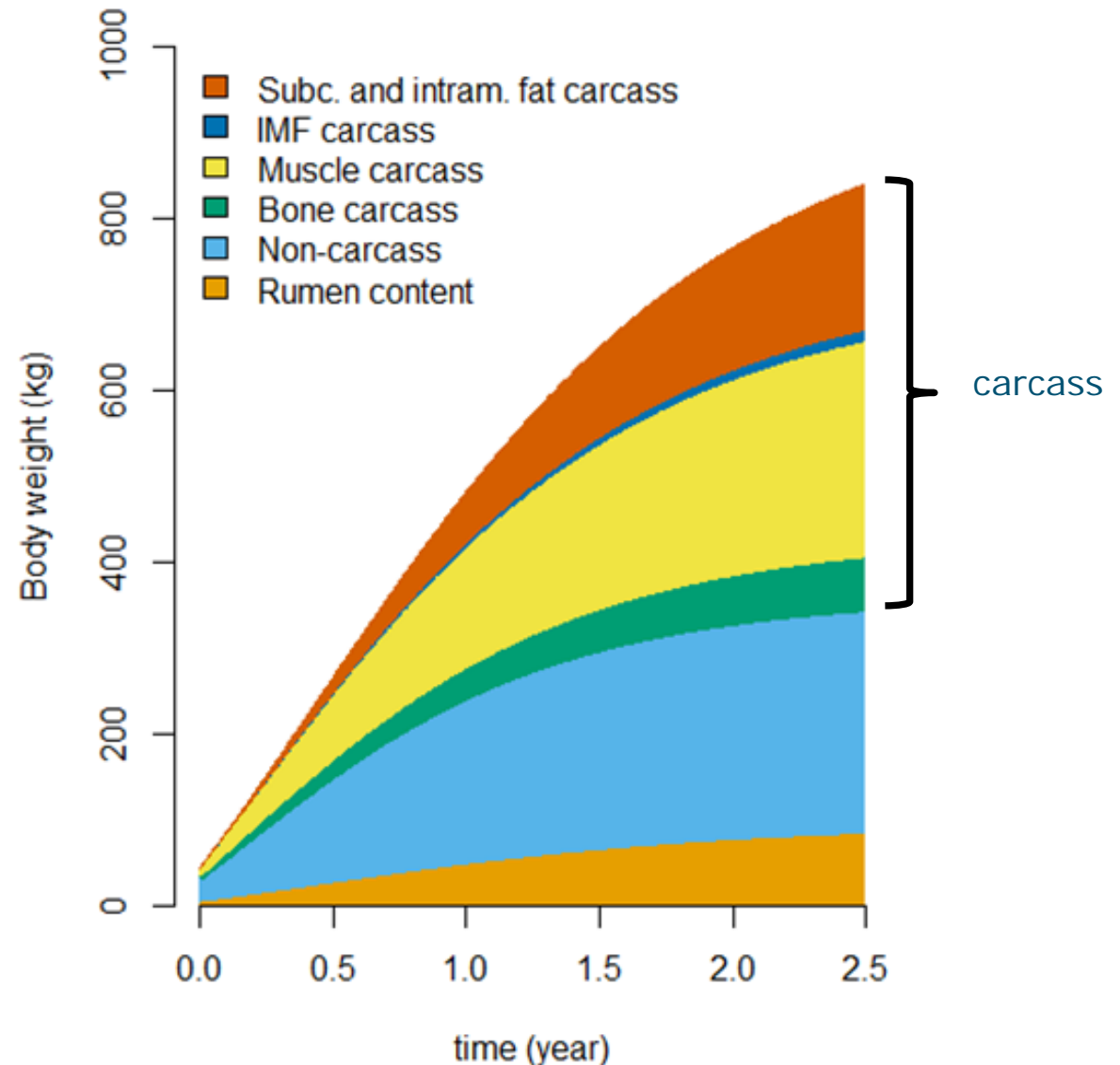
Feed utilization





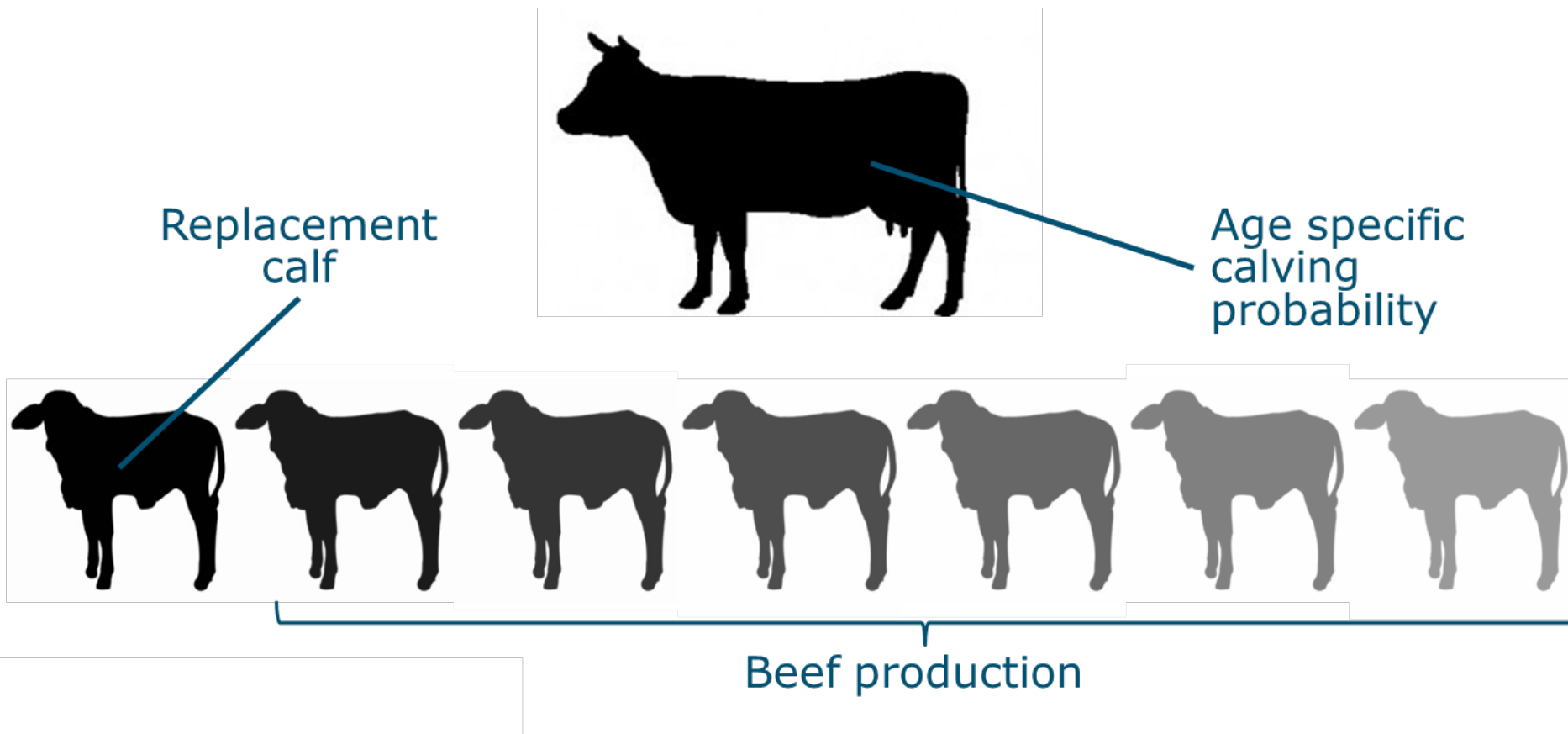
Model development

Feed utilization



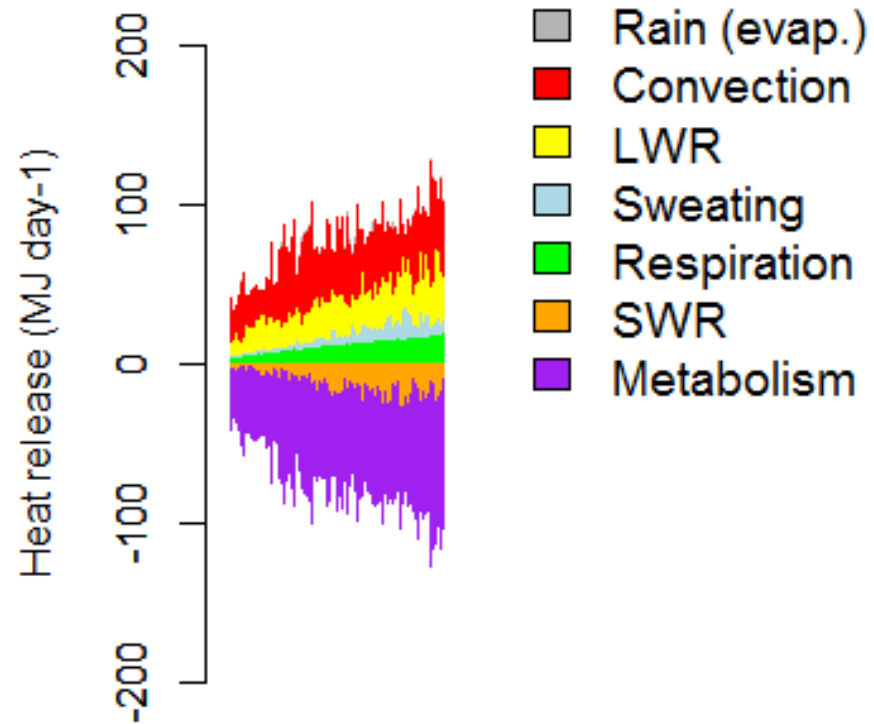
Model development

Upscaling to herd level: a herd unit



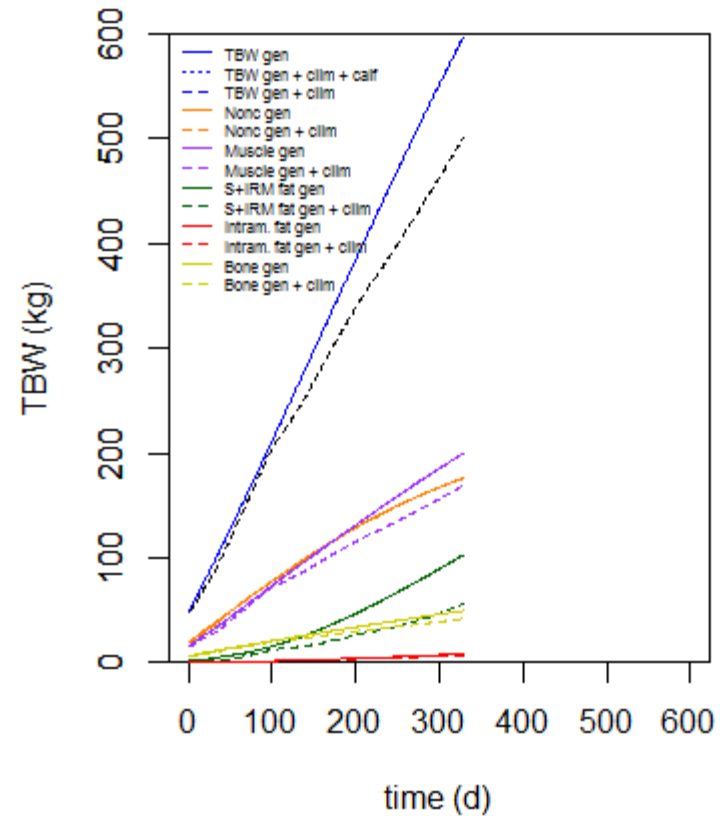
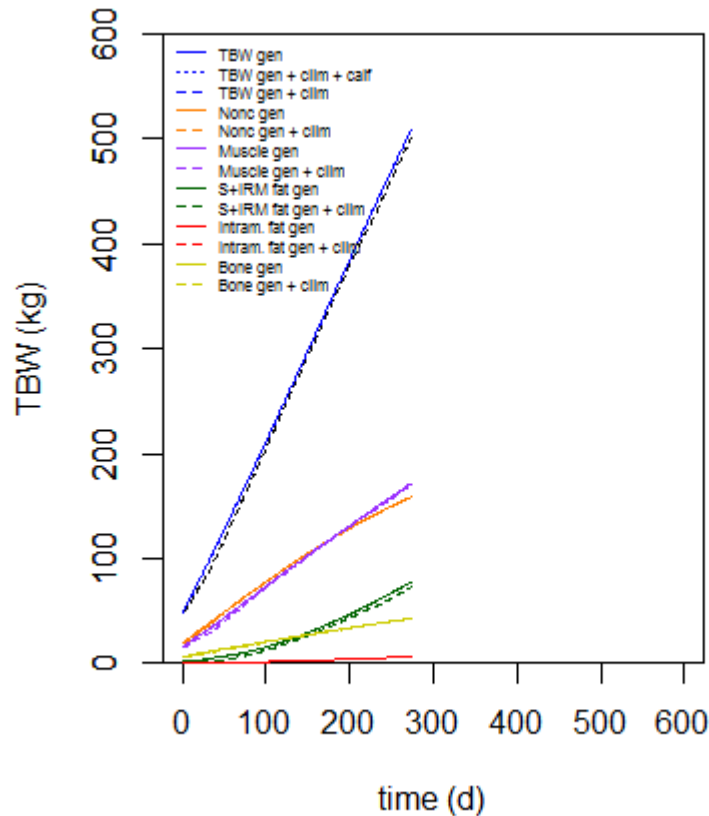
Model development

Model outputs



time

Model development





Model evaluation

- Evaluation of sub-models
- Evaluation at animal level
- Evaluation at herd level



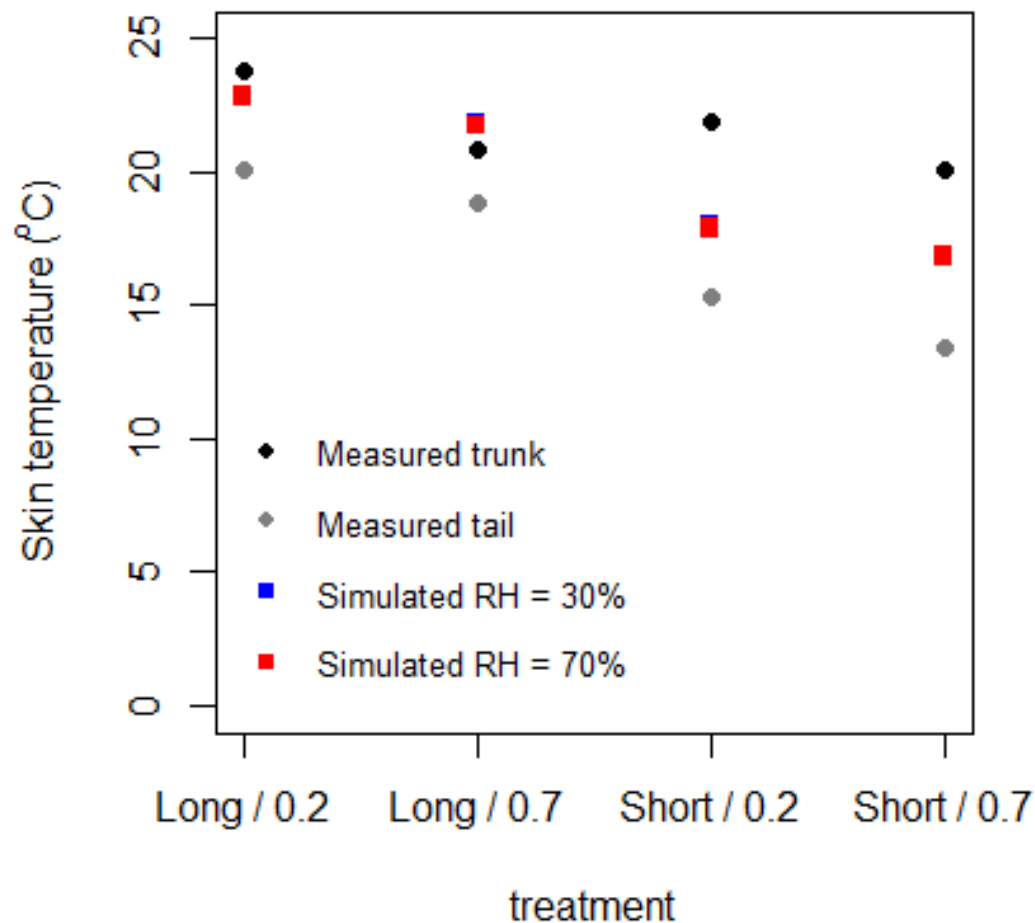
Model evaluation

- Evaluation of sub-models
- Evaluation at animal level
- Evaluation at herd level

Model evaluation

Thermoregulation

- Steers, 336 kg
- Temperature = 0 °C
- Long vs short coat
- Wind speed 0.2 and 0.7 ms⁻¹

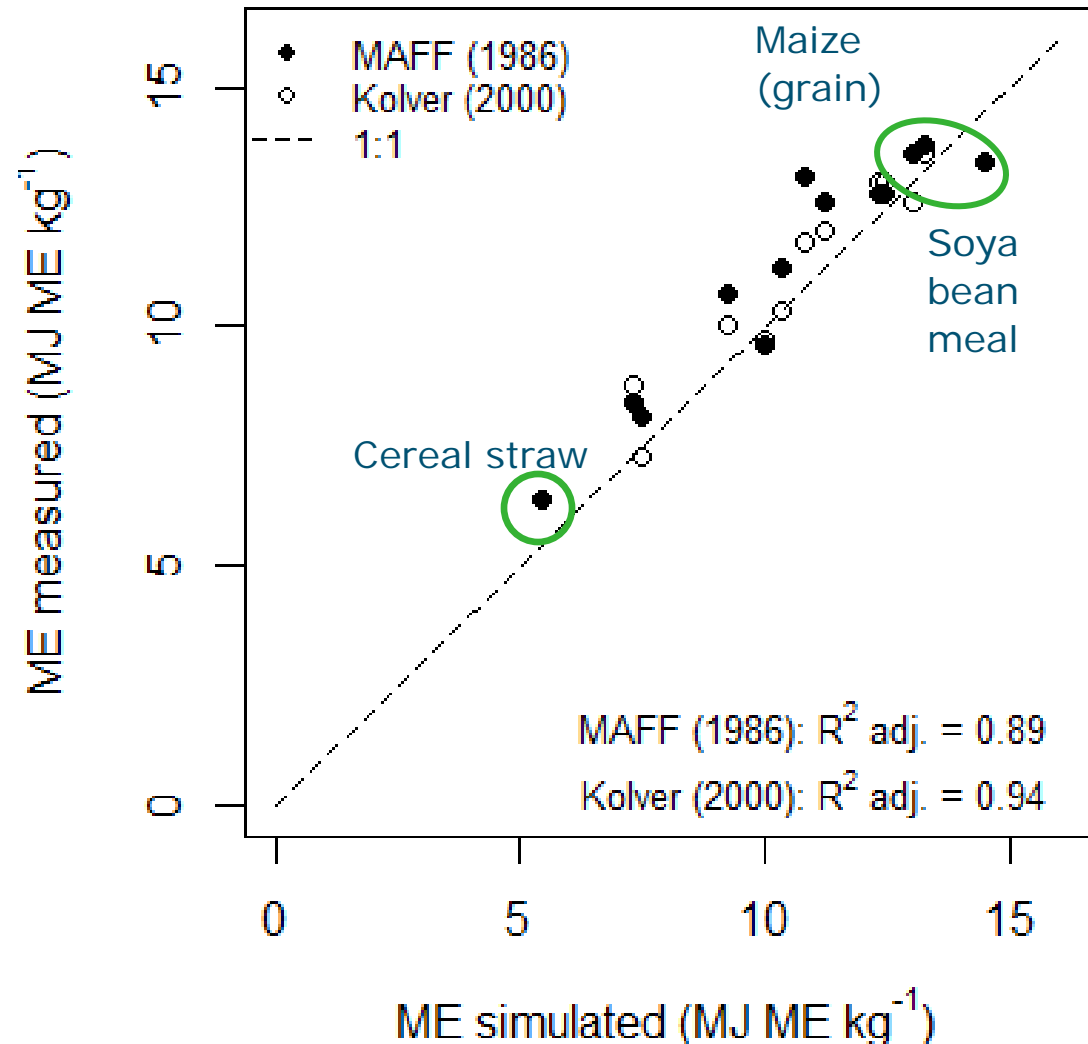


Blaxter and Wainman (1965)

Model evaluation

Feed digestion

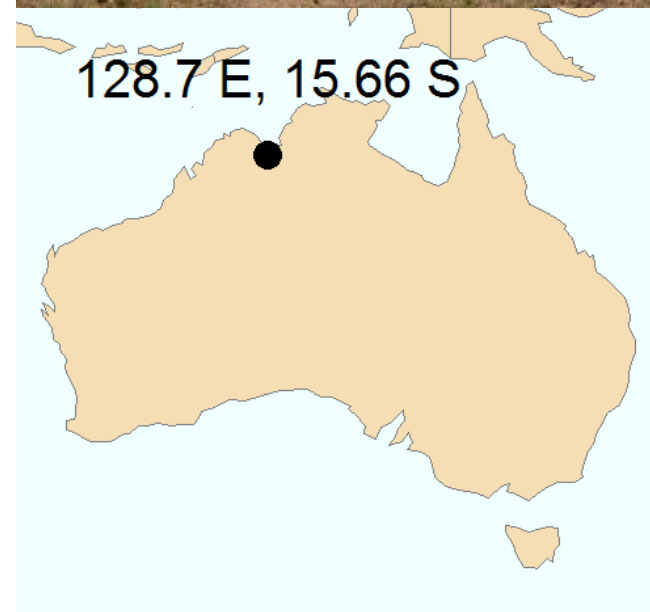
- 13 feeds
- Simulated: ME (metabolisable energy)



Model evaluation

Animal level

- $\frac{3}{4}$ Brahman \times $\frac{1}{4}$ Shorthorn cattle
- Western Australia, Australia
- Irrigated pasture with tropical grass and *Leucaena* (legume), *ad libitum*
- Supplementation with maize
- Calibration and comparison with independent datasets

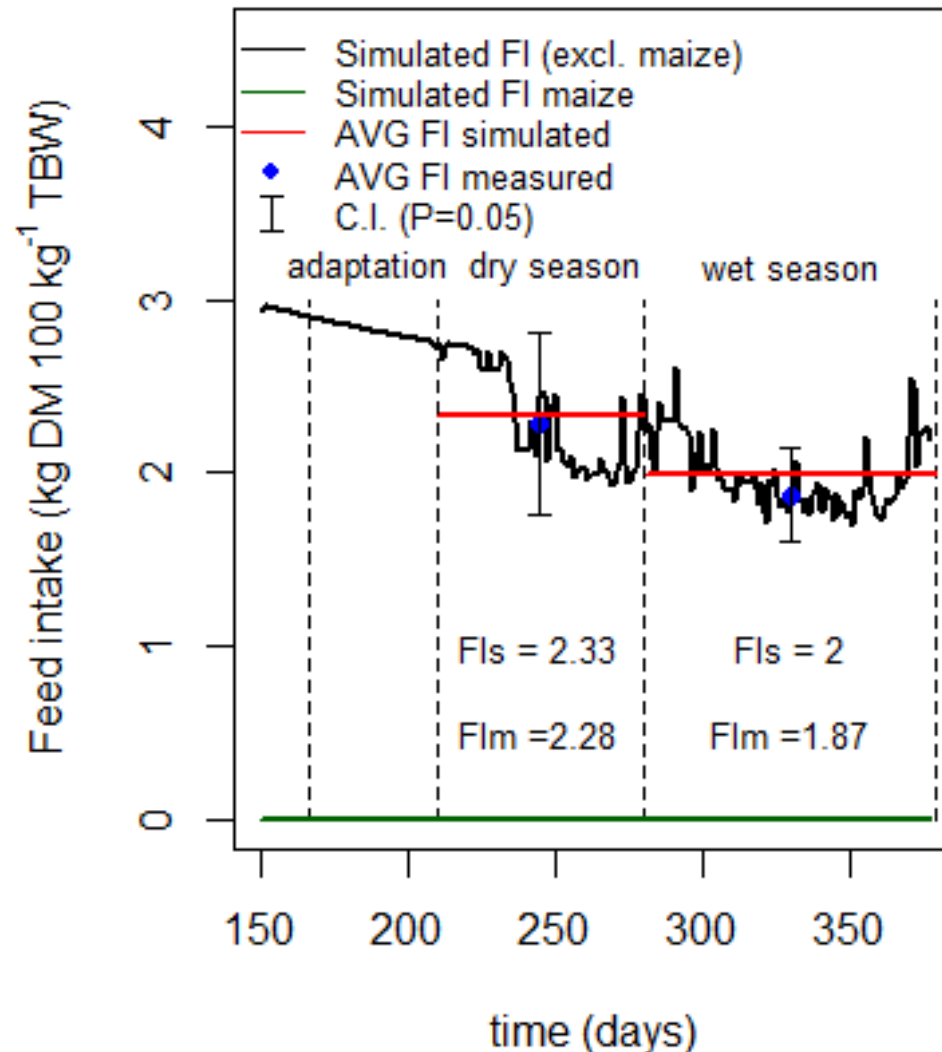


Model evaluation

Calibration

Petty *et al.* (1998)

- 1992/1993
- Control + 4 levels of maize supplementation

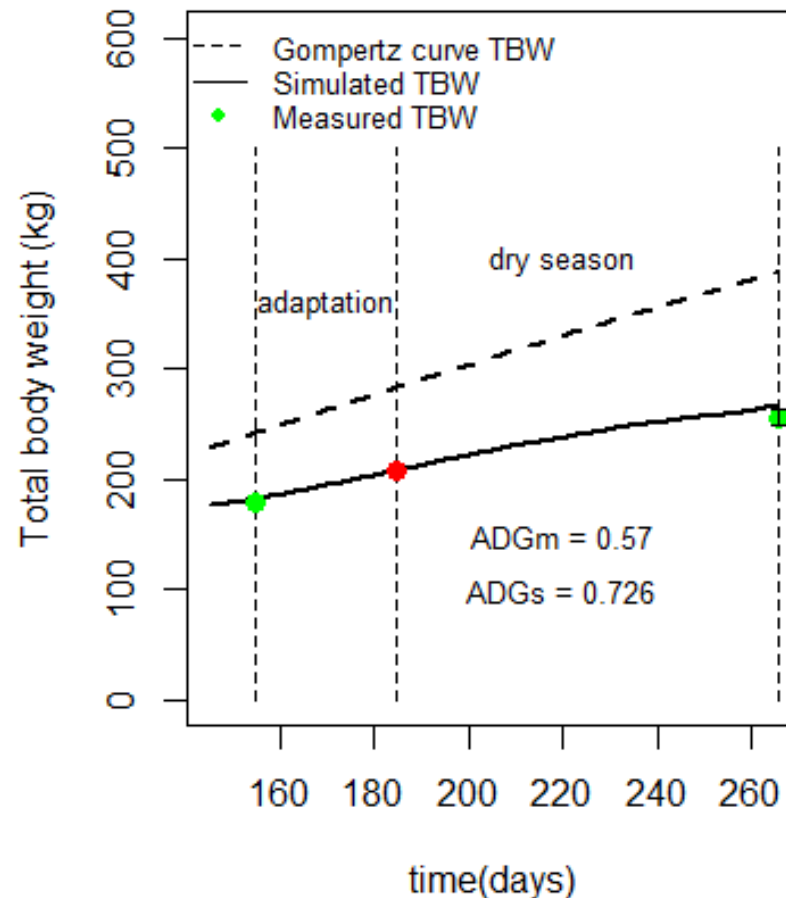


Model evaluation

Comparison with independent data sets / validation

Petty and Poppi (2008)

- 1995
- Dry season
- Control

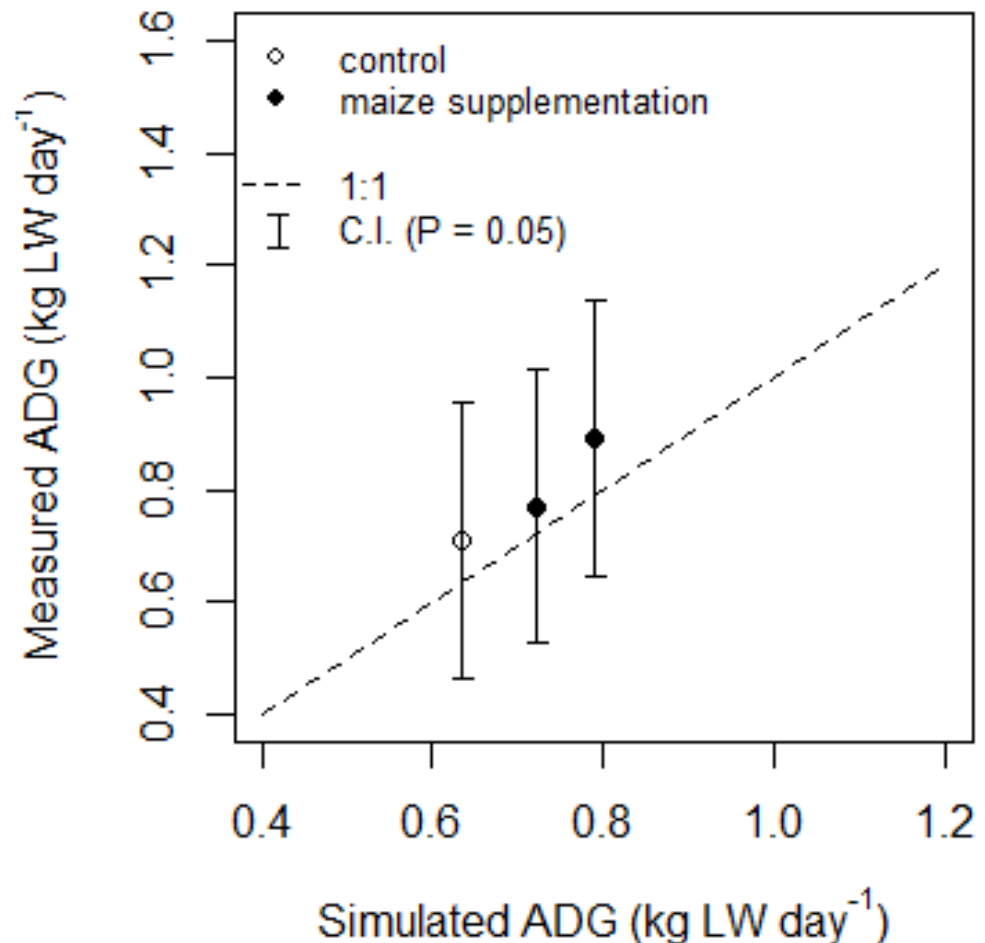


Model evaluation

Comparison with independent data sets / validation

Petty and Poppi (2012)

- 1994
- Dry season
- Control
- 2 levels of maize supplementation





Crop-livestock systems





Crop-livestock systems

■ Potential beef production

- highest feed efficiency (kg beef t⁻¹ DM intake) at herd level
- Genetic potential for growth → Gompertz curves
- Climate neglected
- Feed quality: 65% wheat, 35% hay
- Feed quantity: *ad libitum*
 - Feed intake calculated from net energy requirements

Crop-livestock systems

■ Actual beef production

Farm characteristic	System A	System B
LW ^b production (t year ⁻¹)	85.5	61.1
Grassland area (ha)	280	130
Area arable crops (ha)	0	150
Concentrates fed (t FM year ⁻¹)	87	190
Slaughter LW males (kg animal ⁻¹)	460	430
Slaughter LW females (kg animal ⁻¹)	435	413
Reproductive cows	215	92
Grazing period (days year ⁻¹)	260	240



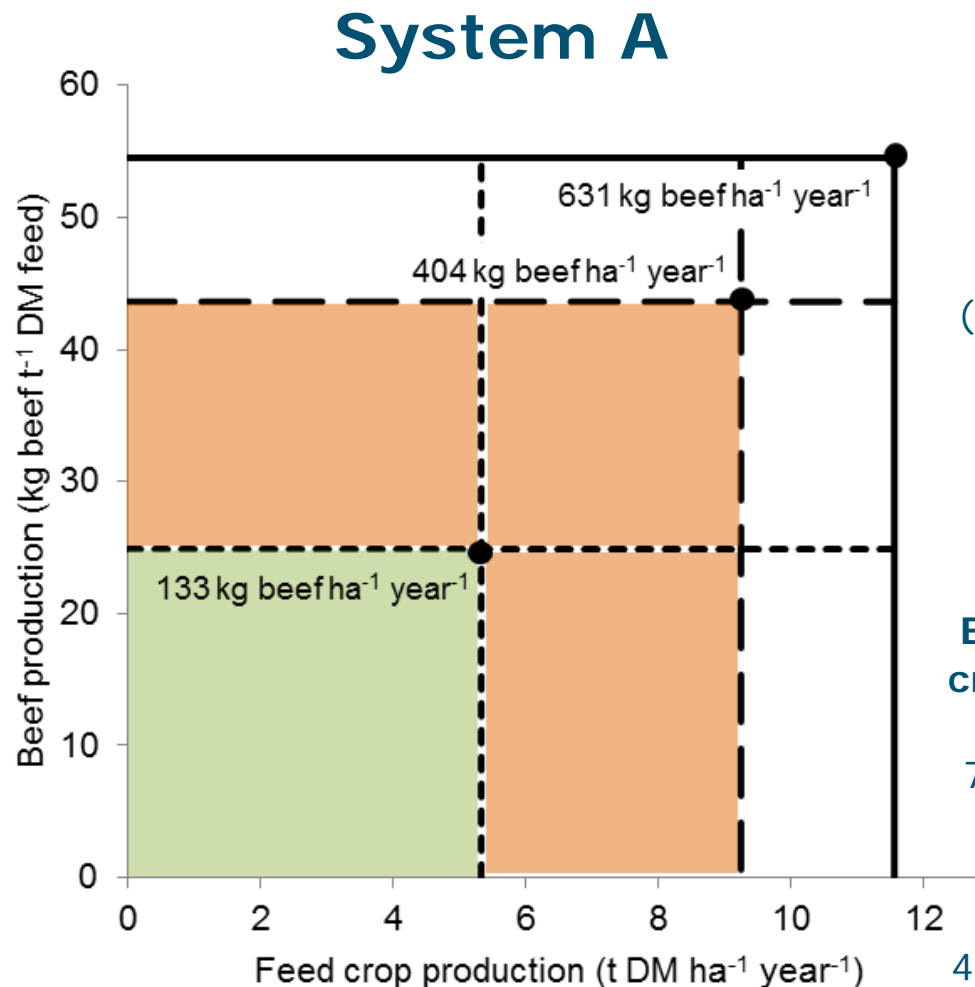
Crop-livestock systems

- Combine feed livestock and crop production!

$$\frac{\text{kg beef}}{\text{t DM}} \times \frac{\text{t DM}}{\text{ha year}} = \frac{\text{kg beef}}{\text{ha year}}$$

- Potential and actual feed production
 - Potential: 65% wheat; 35% hay
 - Actual system A: 4.8% wheat
 - Actual system B: 18.3% wheat
- Potential and actual feed production → literature

Crop-livestock systems



Yield gap crop-livestock system

$$(631 - 133) / 631 \times 100\% =$$

79%

Exploitable yield gap crop-livestock system

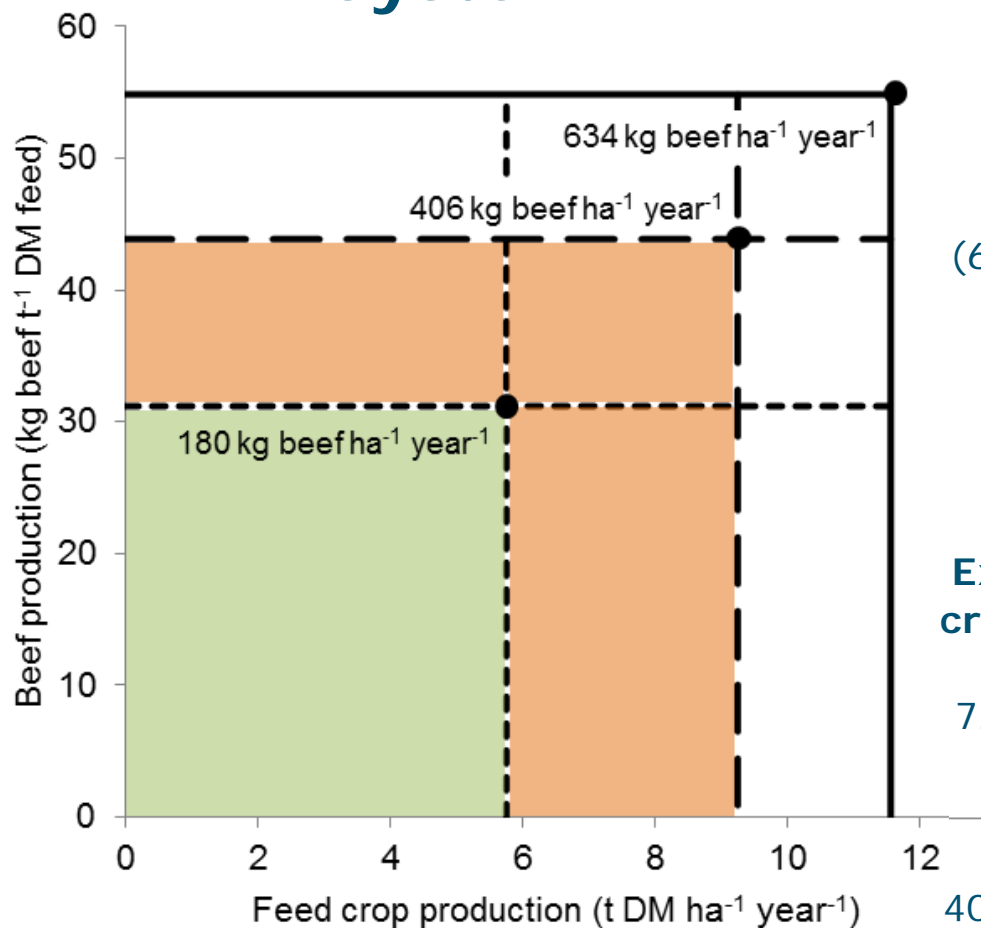
$$79\% - 100\% + 64\% =$$

43%

$$404 - 133 = \mathbf{271 \text{ kg}}$$

Crop-livestock systems

System B



Yield gap crop-livestock system

$$(634 - 180) / 634 \times 100\% =$$

72%

Exploitable yield gap crop-livestock system

$$72\% - 100\% + 64\% =$$

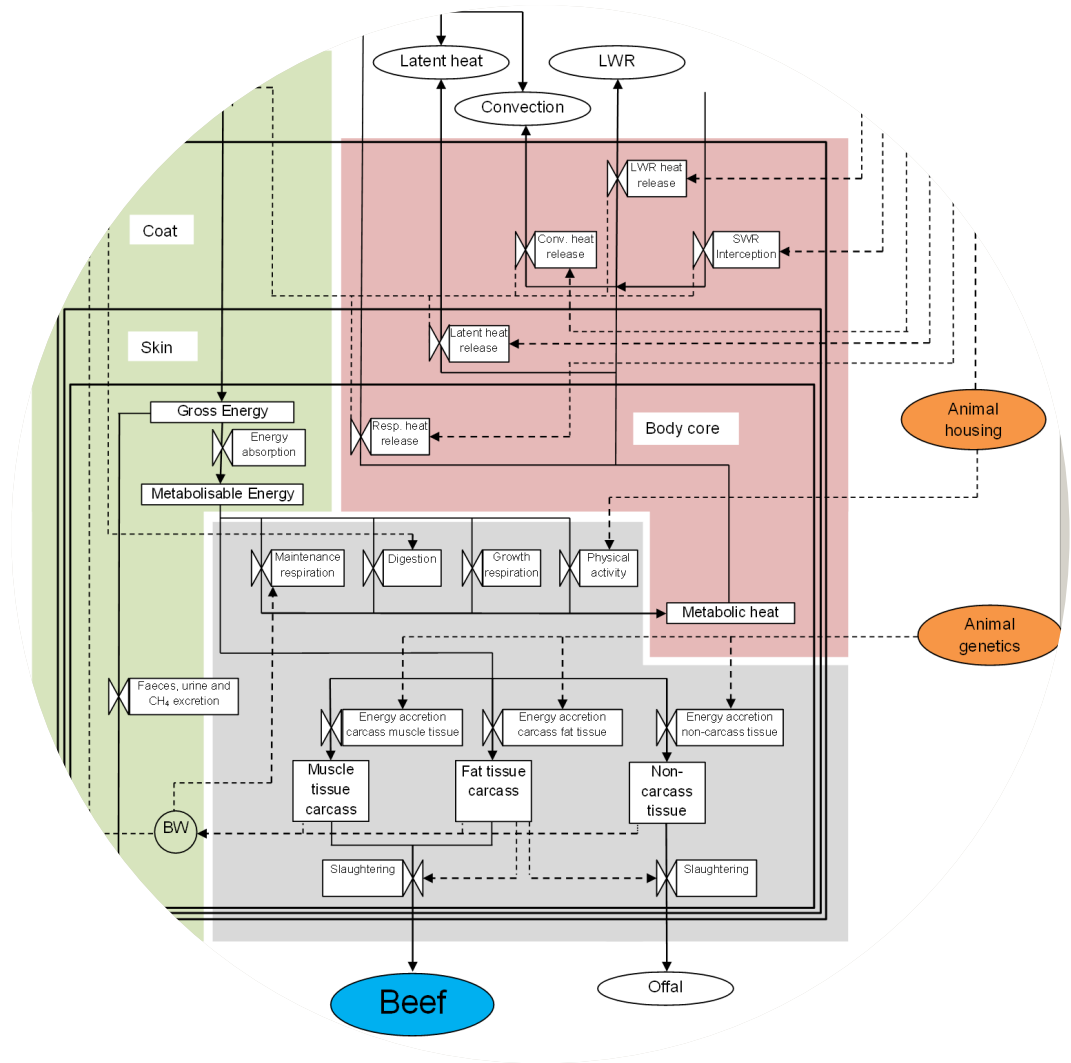
36%

$$406 - 180 = \mathbf{226 \text{ kg}}$$

Conclusions / key messages

- Production ecological concepts can be applied to livestock
- Livestock growth models simulating potential and limited production are being developed
- Evaluation of models gives mixed results
- Scope to quantify yield gaps in crop-livestock systems

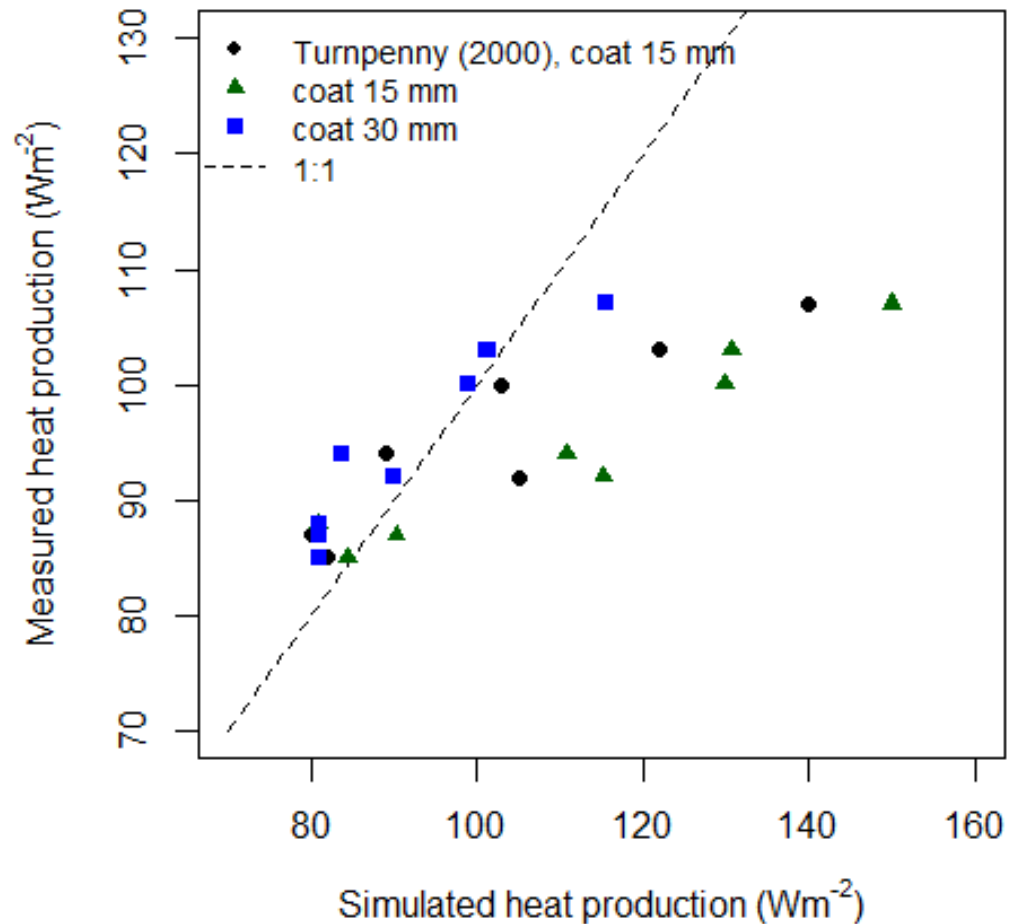
Thank you for your attention!



Model evaluation

Thermoregulation

- Friesian calves, 38 kg
- Temperature 3 – 20 °C
- Coat length 15 mm
- Coat length? Or more compact posture in the cold?



Holmes and McLean (1975); Turnpenny (2000)



Model evaluation

Calibration

Petty *et al.* (1998)

Forage intake
(excl. maize)

