

Simulating pigs to understand their behaviour, welfare and productivity

The use of agent-based modelling to gain insight in sustainability of animal (and plant) production systems

Iris Boumans, Eddie Bokkers, Gert Jan Hofstede, Imke De Boer
Animal Production Systems Group & Information Technology Group



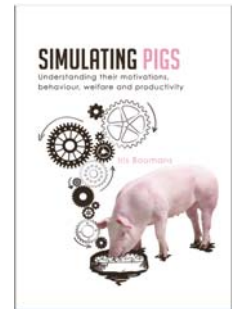
WAGENINGEN UNIVERSITY
WAGENINGEN

February 14, 2018

This talk

The use of agent-based modelling for:

- Understanding mechanisms
- Sustainability research



WAGENINGEN UNIVERSITY
WAGENINGEN

Pig production systems



Common fattening pig housing
(Picture: Dutch ministry of Economic Affairs)



- Sustainability concerns
- Housing & management practices to improve pig behaviour
- Lack of understanding behaviour



WAGENINGEN UNIVERSITY
WAGENINGEN

3

Introduction | Aim | RQ 1 internal | RQ 2 external | RQ 3 sustainability | To conclude

Agent-based modelling (ABM)

What is ABM?

- Computer simulation with agents (individuals)
- Set of rules/heuristics
- From micro- to macro-level

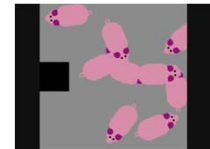


Why ABM?

- Space, time or dimension effects
 - Allows heterogeneity & interaction
- Insight in underlying mechanisms

Use of ABM

- E.g. social sciences, ecology



Tail biting behaviour in pigs
(Boumans et al., 2016)

WAGENINGEN UNIVERSITY
WAGENINGEN

4

Introduction | Aim | RQ 1 internal | RQ 2 external | RQ 3 sustainability | To conclude

Aim PhD project

Increase understanding of emergent pig (feeding) behaviour and related animal welfare and productivity

Research questions:

- What essential internal factors and mechanisms affect feeding behaviour?
- What essential external factors and mechanisms affect feeding behaviour?
- How is behaviour related to animal welfare and productivity?

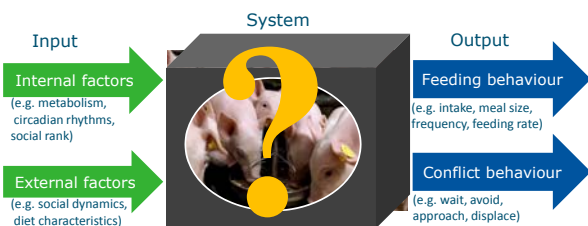


WAGENINGEN UNIVERSITY
WAGENINGEN

5

Introduction | Aim | RQ 1 internal | RQ 2 external | RQ 3 sustainability | To conclude

RQ 1 & 2: causation of feeding behaviour



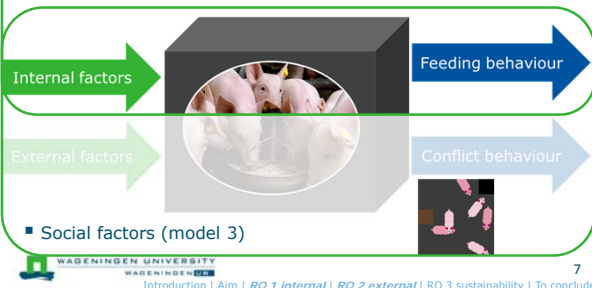
WAGENINGEN UNIVERSITY
WAGENINGEN

6

Introduction | Aim | RQ 1 internal | RQ 2 external | RQ 3 sustainability | To conclude

RQ 1 & 2: Modelling in phases

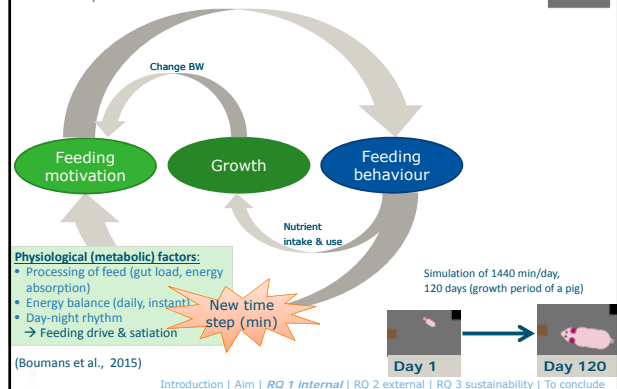
- Physiology (model 1)
- Circadian rhythms (model 2)



7

Feeding model 1: physiology

Concept

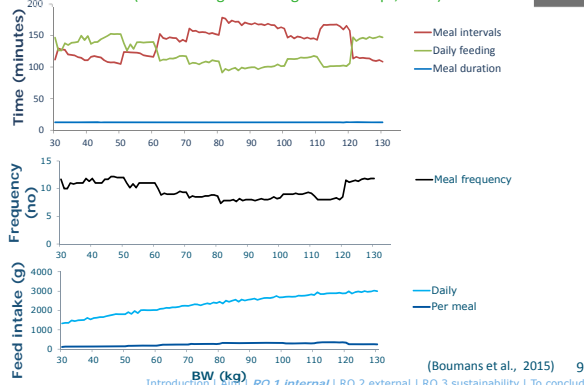


(Boumans et al., 2015)

Introduction | Aim | RQ 1 internal | RQ 2 external | RQ 3 sustainability | To conclude

Feeding model 1: physiology

Model results (with feeding rate of Bigelow & Houpt, 1988)



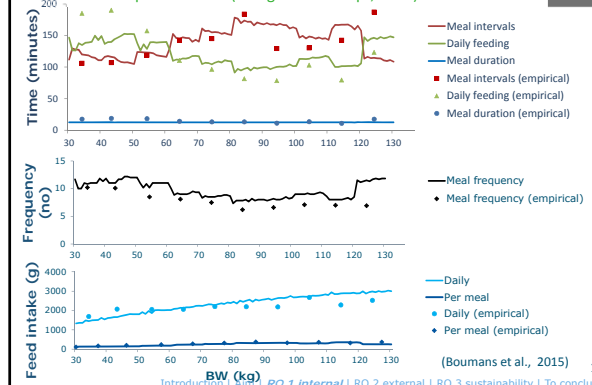
(Boumans et al., 2015)

9

Introduction | Aim | RQ 1 internal | RQ 2 external | RQ 3 sustainability | To conclude

Feeding model 1: physiology

Model & empirical results (of Bigelow & Houpt, 1988)



(Boumans et al., 2015)

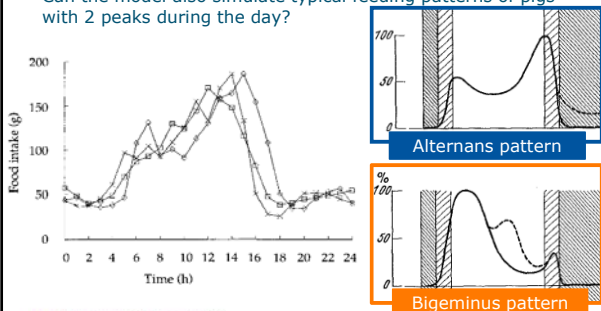
10

Introduction | Aim | RQ 1 internal | RQ 2 external | RQ 3 sustainability | To conclude

Feeding model 2: hormonal effects

Empirical results from De Haer & Merks (1992)

Can the model also simulate typical feeding patterns of pigs with 2 peaks during the day?



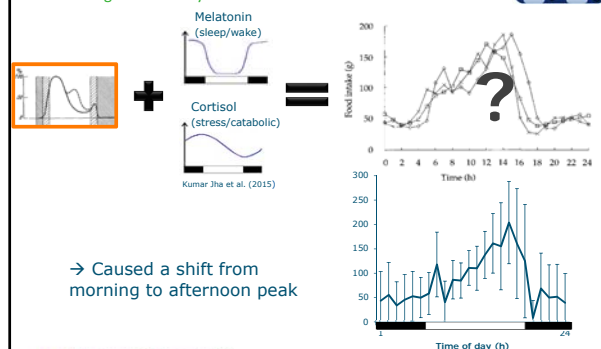
(Figures from Aschoff, 1957)

11

Introduction | Aim | RQ 1 internal | RQ 2 external | RQ 3 sustainability | To conclude

Feeding model 2: hormonal effects

Including circadian rhythms of melatonin & cortisol

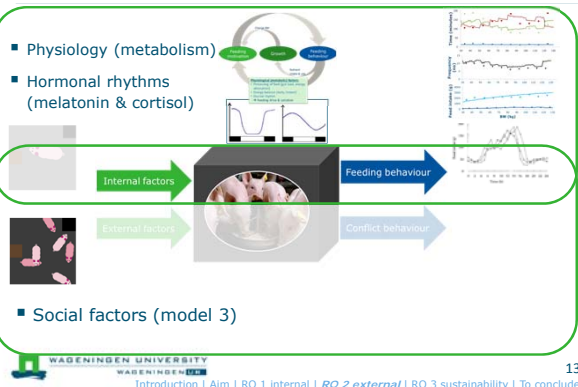


(Boumans et al., 2017)

12

Introduction | Aim | RQ 1 internal | RQ 2 external | RQ 3 sustainability | To conclude

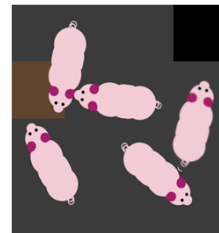
Next step: external (social) factors



13

Feeding model 3: social effects

Competition (conflicts) & behavioural strategies



Conflict? How to respond?
Avoid, approach? Move, resist?



And if more competition?

Boumans et al. (under review)



Introduction | Aim | RQ 1 internal | RQ 2 external | RQ 3 sustainability | To conclude

14

Feeding model 3: social effects

Test scenarios

- Group size 1 – 30 (competition effect)



Behavioural strategies
in conflicts

Effect social
facilitation?

Scenario 1	Avoid (wait)	-
Scenario 2	Approach (displace)	-
Scenario 3	Avoid & approach → social rank & hunger dependent	-
Scenario 4	Avoid & approach	+ Social facilitation



Boumans et al. (under review)

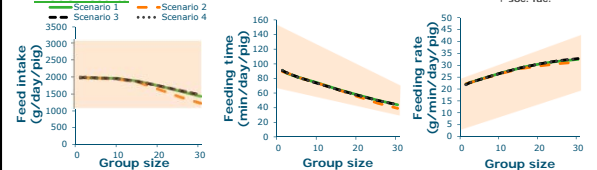
15

Introduction | Aim | RQ 1 internal | RQ 2 external | RQ 3 sustainability | To conclude

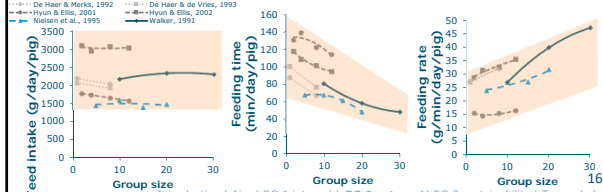
Feeding model 3: social effects

Scenario 1: Avoid (wait)
Scenario 2: Approach (displace)
Scenario 3: avoid & approach
Scenario 4: avoid & appr.
+ soc. fac.

Model results



Empirical results



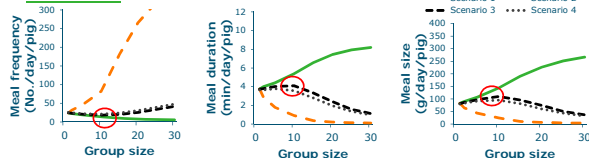
16

Introduction | Aim | RQ 1 internal | RQ 2 external | RQ 3 sustainability | To conclude

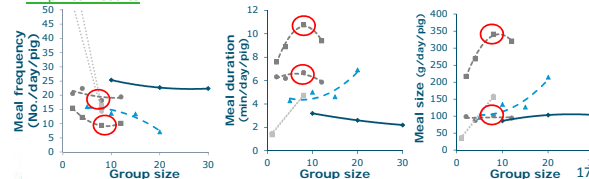
Feeding model 3: social effects

Scenario 1: Avoid (wait)
Scenario 2: Approach (displace)
Scenario 3: avoid & approach
Scenario 4: avoid & appr.
+ soc. fac.

Model results

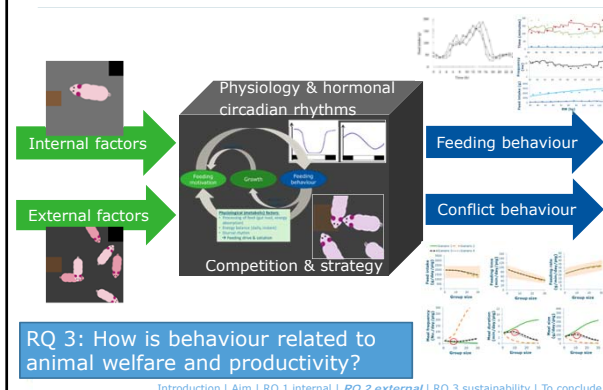


Empirical results



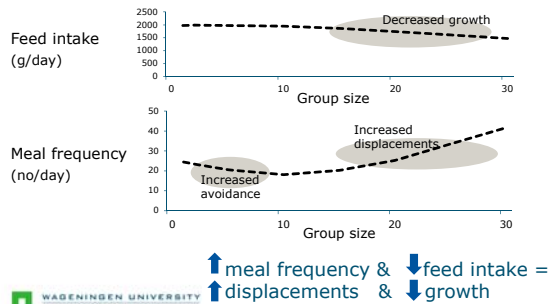
Introduction | Aim | RQ 1 internal | RQ 2 external | RQ 3 sustainability | To conclude

RQ 1 & 2: summary



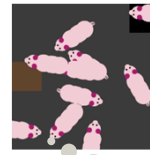
RQ 3: behaviour & sustainability

How is behaviour related to animal welfare and productivity?



WAGENINGEN UNIVERSITY
Introduction | Aim | RQ 1 internal | RQ 2 external | **RQ 3 sustainability** | To conclude

RQ 3: behaviour & sustainability



Daily average of group:

Low feed intake = Indication: aggression & reduced growth
High meal frequency due to competition

Pig with lowest feed intake & highest meal frequency

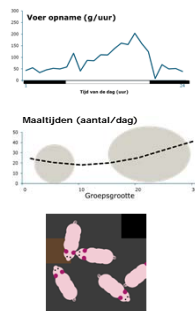
= pig with most welfare & growth problems?

Not necessarily!
Depends on body & behavioural characteristics

WAGENINGEN UNIVERSITY
Introduction | Aim | RQ 1 internal | RQ 2 external | **RQ 3 sustainability** | To conclude

To summarise model results

- Internal physiological and circadian processes explain feeding behaviour
- External social processes mainly affect meal patterns
- Behaviour relates to welfare & productivity
 - Can indicate aggression & reduced growth
 - But how differs between individuals



WAGENINGEN UNIVERSITY
Introduction | Aim | RQ 1 internal | RQ 2 external | **RQ 3 sustainability** | To conclude

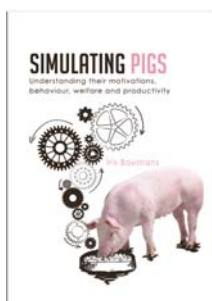
To conclude

ABM can contribute to:

- Understanding mechanisms underlying behaviour related to welfare & productivity in pigs
- Gaining insight in sustainability of systems
- Interpretation of (big) data & recognising patterns



WAGENINGEN UNIVERSITY
Introduction | Aim | RQ 1 internal | RQ 2 external | RQ 3 sustainability | **To conclude**



For more information:
iris.boumans@wur.nl
www.wageningenur.nl/aps

WAGENINGEN UNIVERSITY
WAGENINGEN



Thank you for
your attention!