Reconsidering resources acquisition and allocation in animal nutrition models to better understand efficiency

Puillet L., Réale D., Friggens N.C.

Context

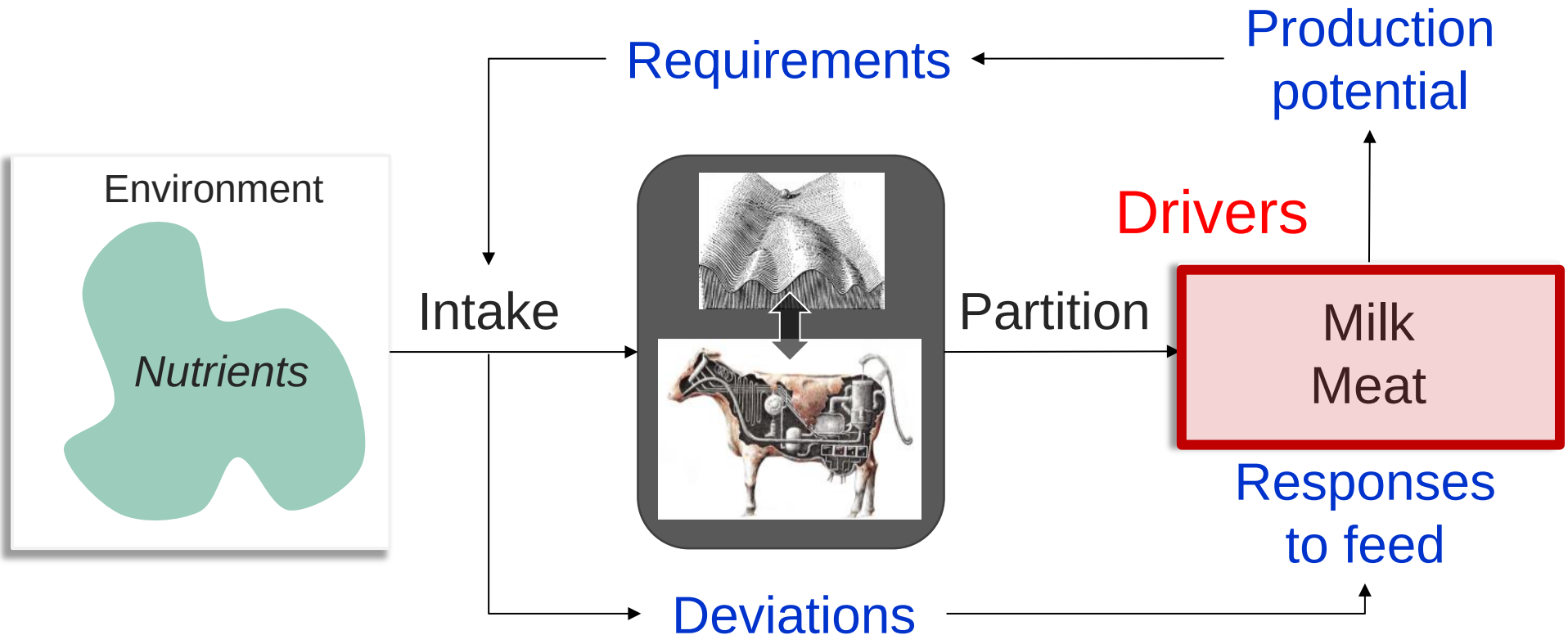
- Change in animal production paradigm

  → efficiency as a key animal trait

- Which efficiency ?
  - Energy | nitrogen
  - Short-term | long-term
- Understanding relationships among efficiencies
  - Potential trade-offs
  - Predicting effects of management & breeding strategies

Context

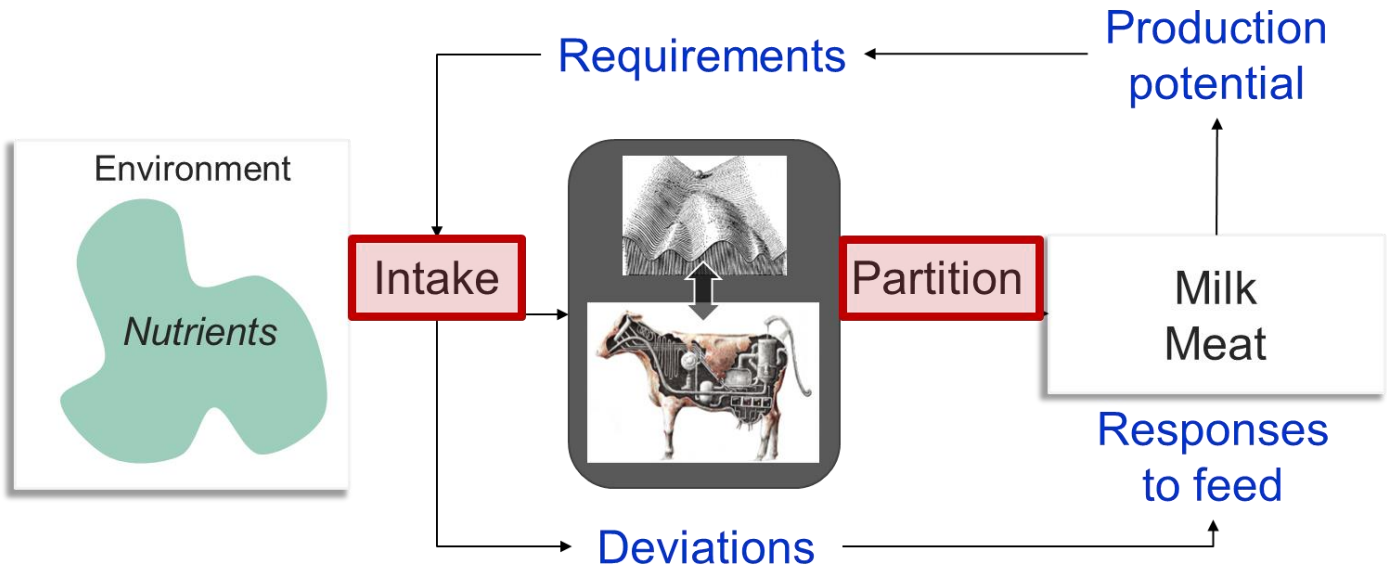
- Efficiency core processes
  - Resource acquisition and allocation
- Using nutrition models to study efficiency components



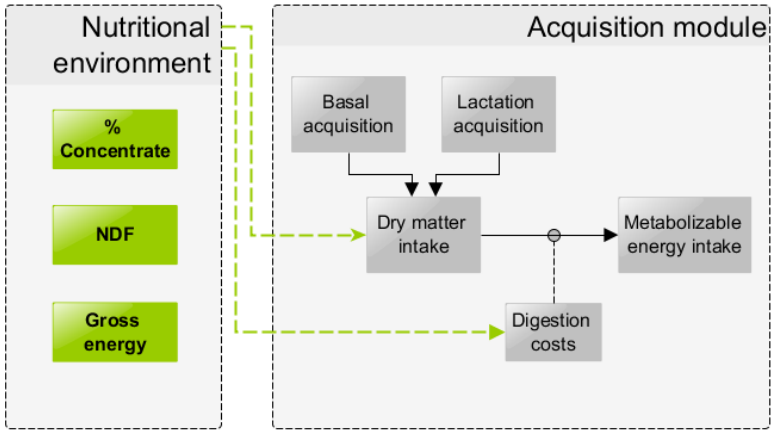
Objective

- Developing a animal model with resource allocation and acquisition as **drivers** of **energy utilization**

- Evaluating the effects of different acquisition and allocation strategies on short and long-term efficiencies



Model description: structure



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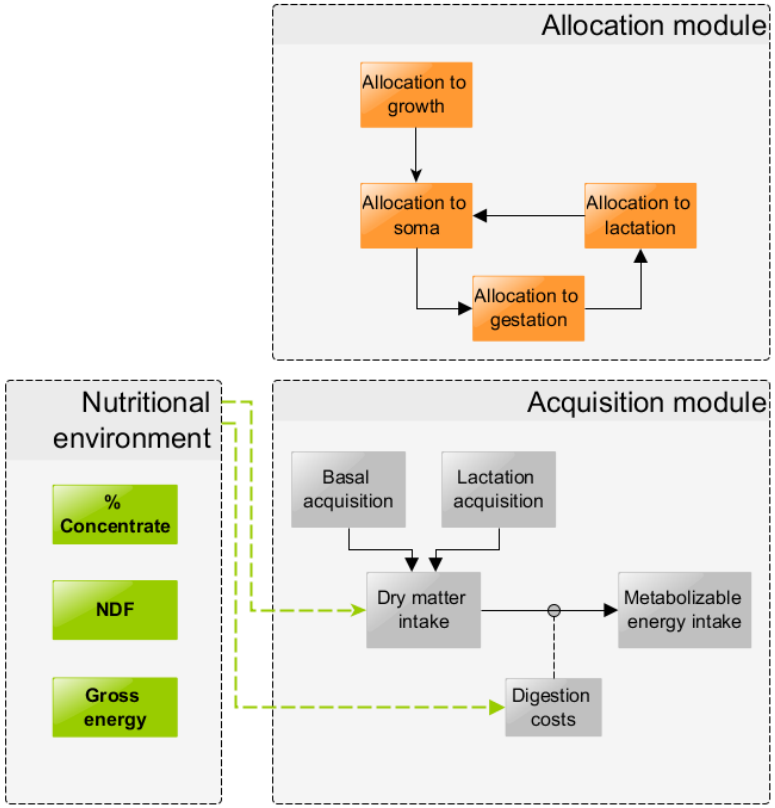

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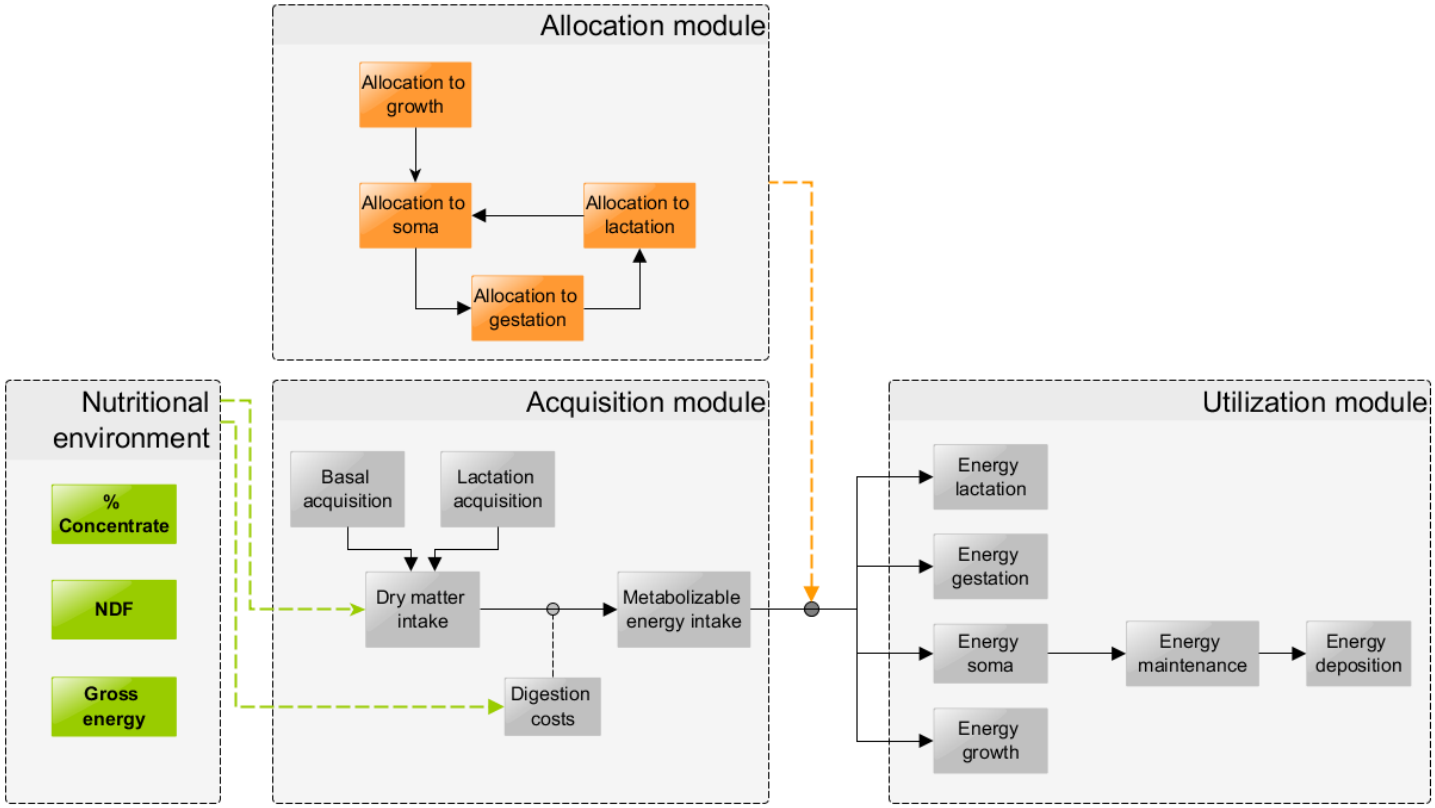

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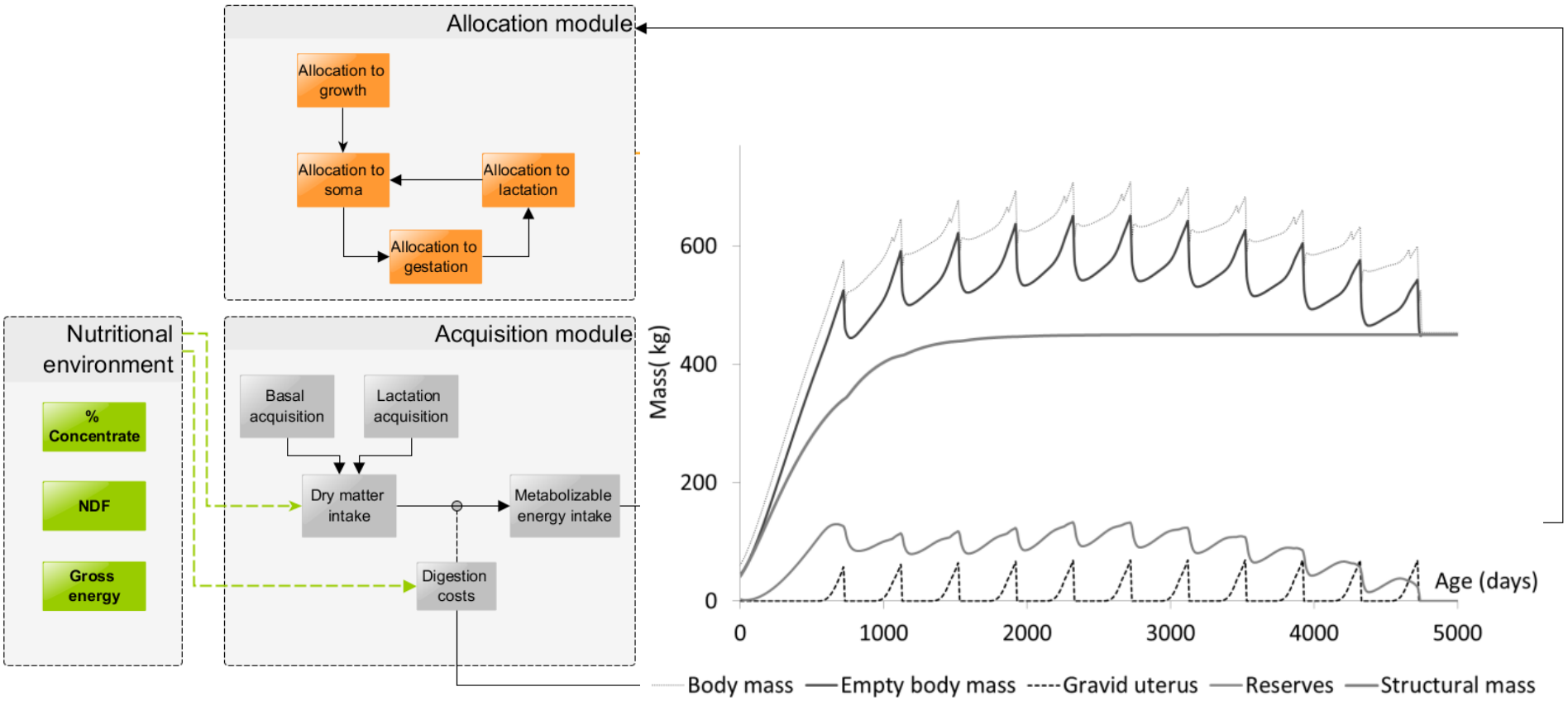


A generic structure, applied for dairy cows

Martin & Sauvant, 2010
Phuong et al., 2015

Model description: simulations

$$\textbf{Short-term efficiency} = \frac{\sum E_{lactation}}{\sum E_{intake}} \quad \textbf{lactation n°2}$$

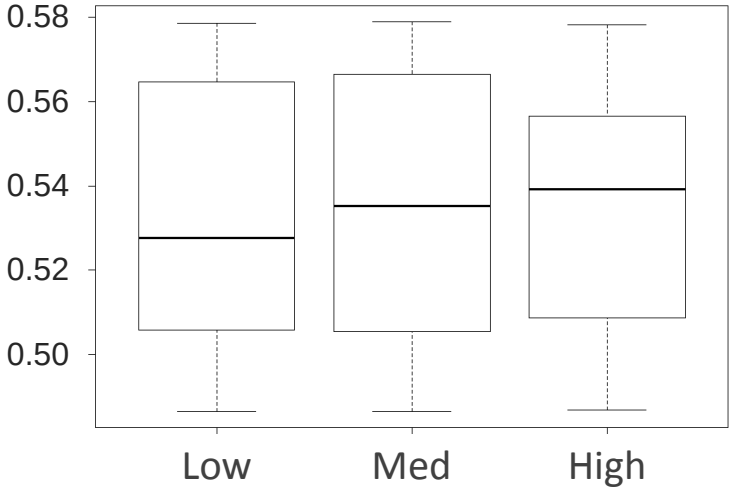
$$\textbf{Long-term efficiency} = \frac{\sum E_{lactation}}{\sum E_{intake}} \quad \textbf{lifespan}$$

Relative influence of acquisition & allocation on efficiency metrics?

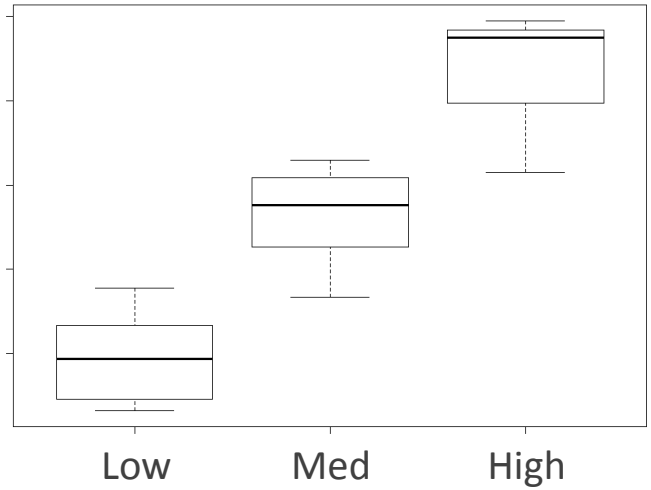
- 4 parameters x 3 levels | 20 replications | *n = 1620*
  - Allocation to growth
  - Allocation to lactation
  - Basal acquisition
  - Lactation acquisition

Results: short-term efficiency

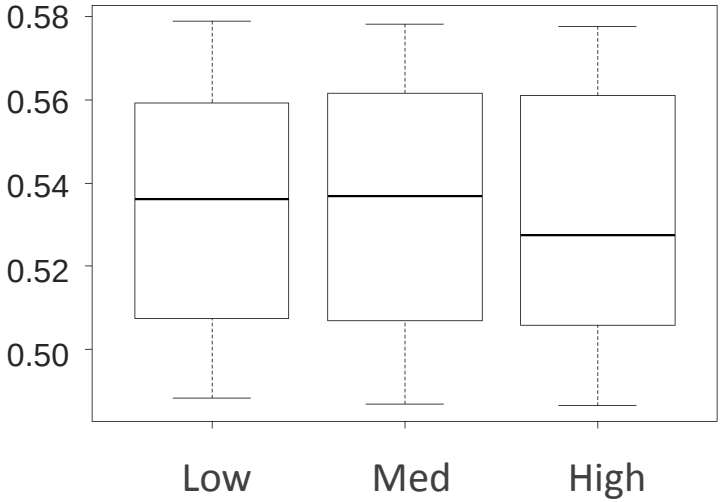
Allocation to growth



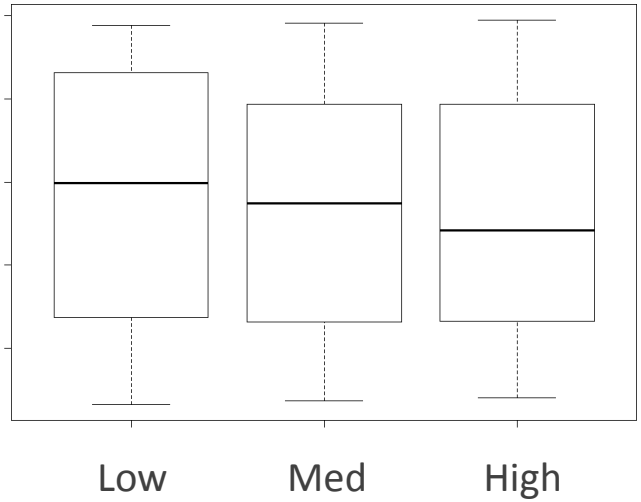
Allocation to lactation



Basal acquisition

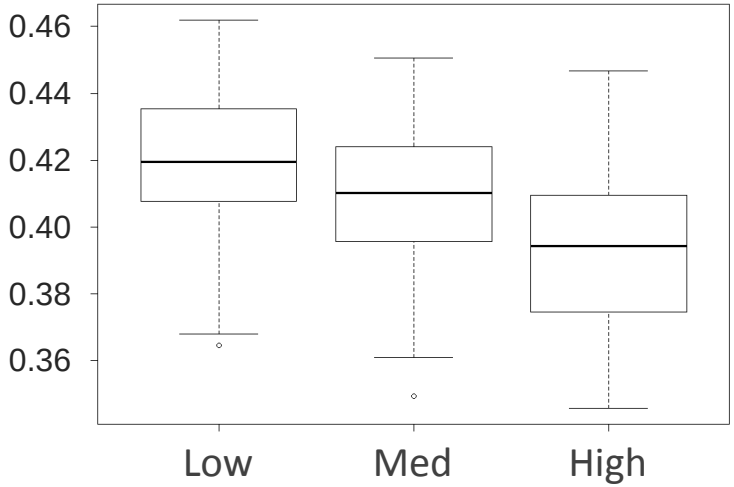


Lactation acquisition

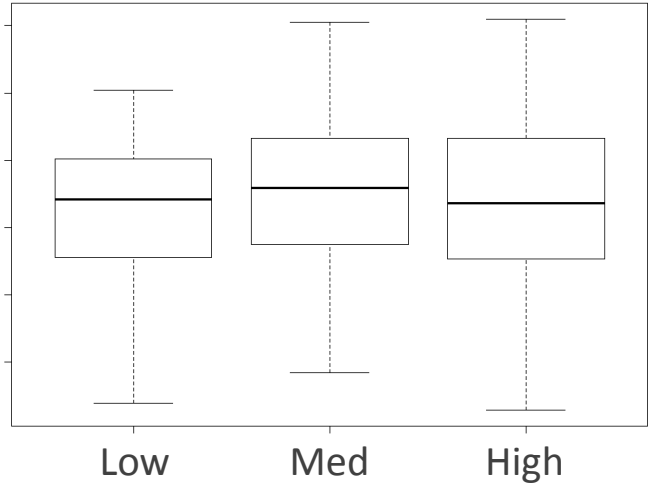


Results: long-term efficiency

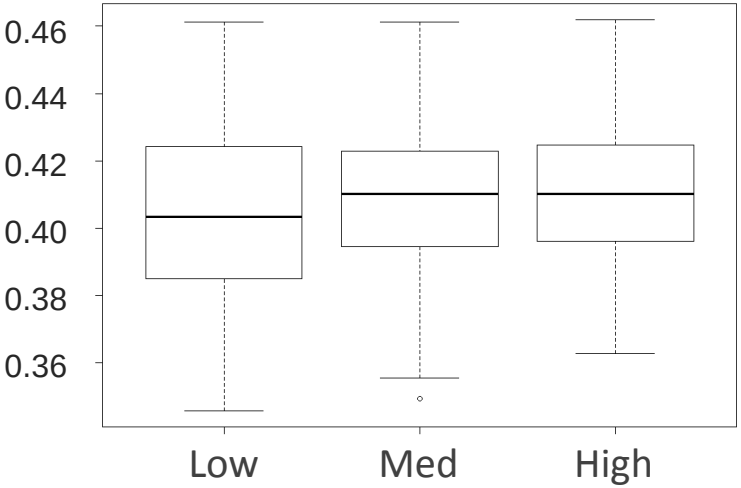
Allocation to growth



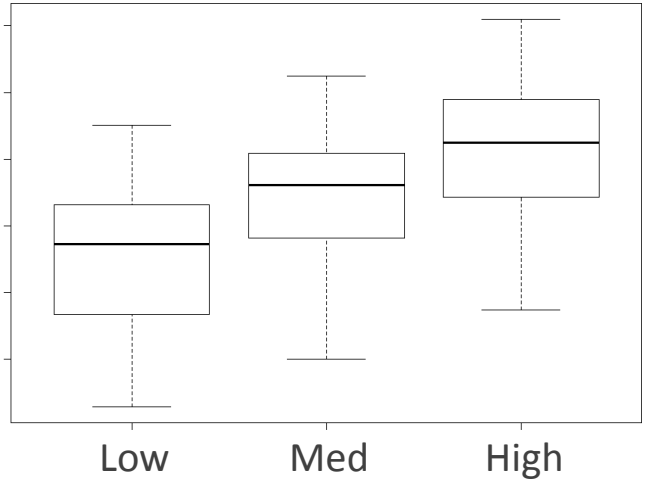
Allocation to lactation



Basal acquisition



Lactation acquisition



Results: summary

- Short term efficiency is improved by:
  - A high allocation of energy to lactation
  - *A low competition of gestation @ end of lactation*

$$\textbf{Short-term efficiency} = \frac{\sum E_{\text{lactation}}}{\sum E_{\text{intake}}} \quad \textbf{lactation n°2}$$

- Long term efficiency is improved by:
  - A low allocation of energy to growth
  - A high acquisition of energy during lactation

More body reserves → Better reproduction
More body reserves → Better longevity

$$\textbf{Long-term efficiency} = \frac{\sum E_{\text{lactation}}}{\sum E_{\text{intake}}} \quad \textbf{lifespan}$$

Conclusion

- So what ?
  - Proof of concept → animal model with acquisition & allocation as inputs
  - Different drivers of short & long-term efficiencies
    - Different management & selection effects

- What's next ?
  - G correlations in acquisition and allocation parameters
    - Structural mass and basal acquisition
  - Acquisition and allocation in a limiting environment
    - G x E

Thanks for your attention

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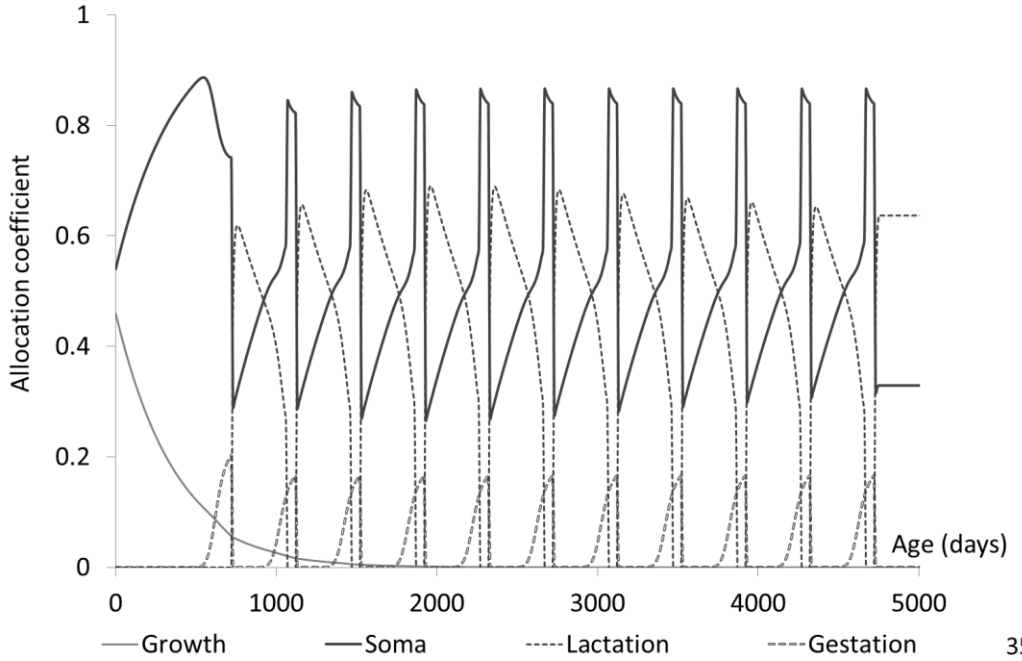
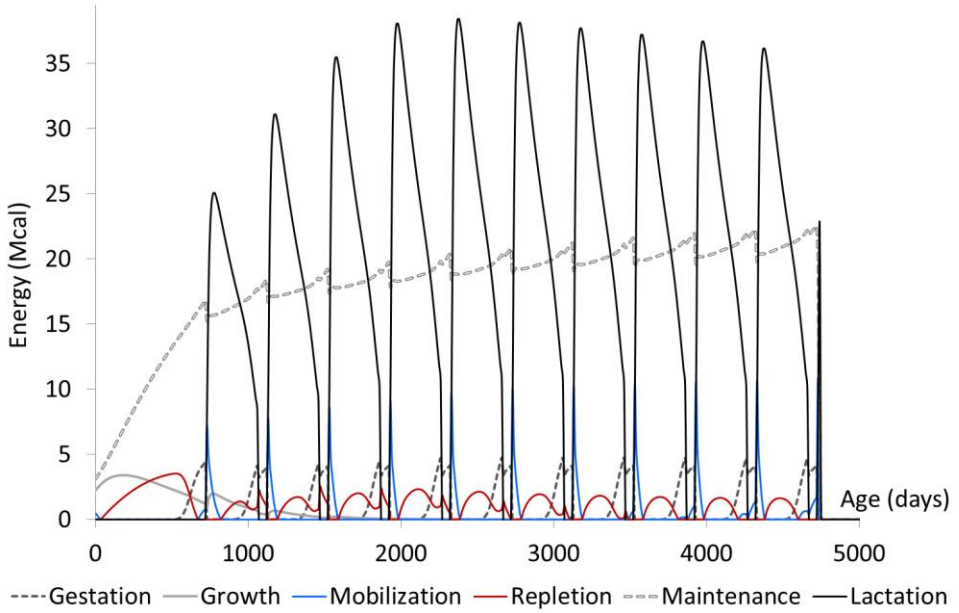
Model description: outputs

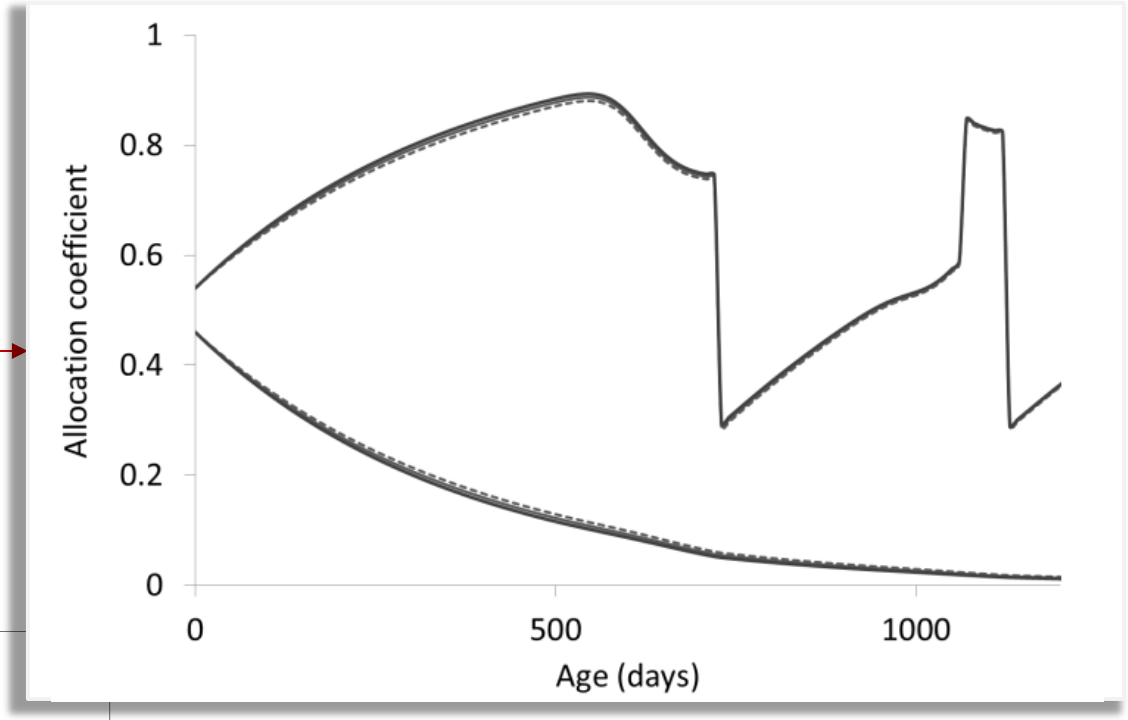


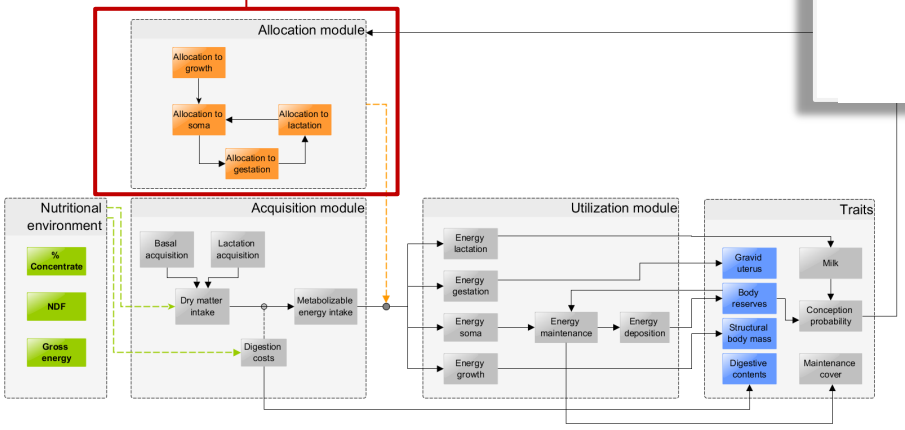


Simulations: design of experiments

- 4 parameters x 3 levels | 20 replications | *n* = *1620*

Parameter 1:
allocation to growth





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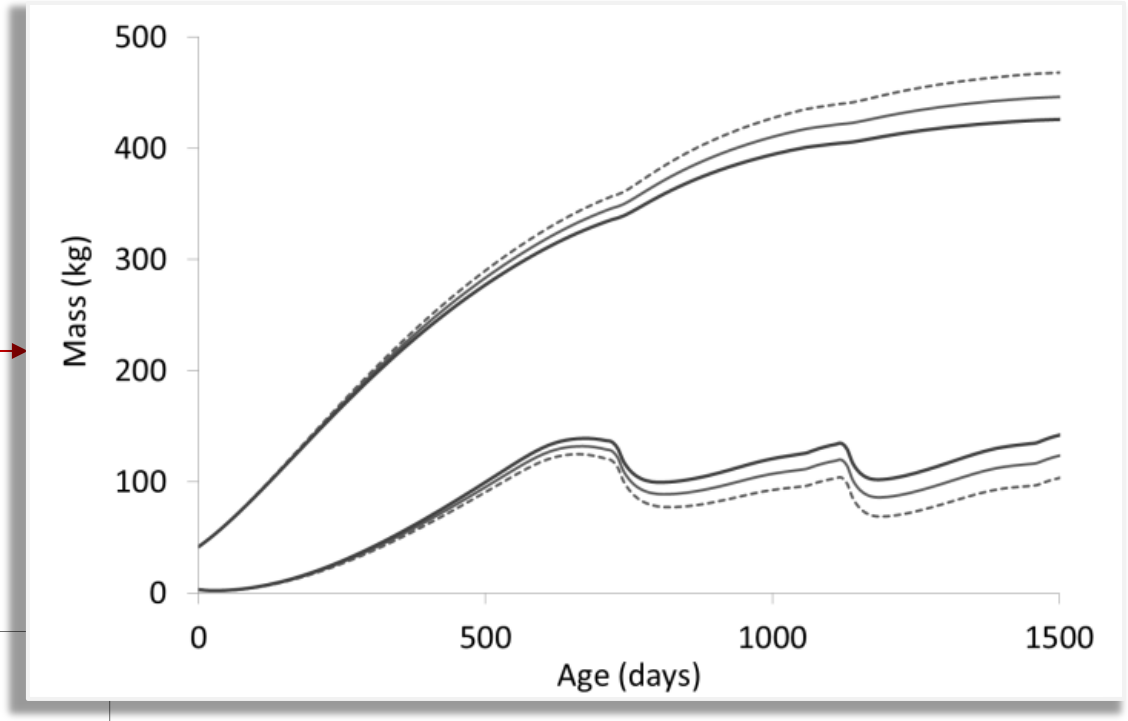
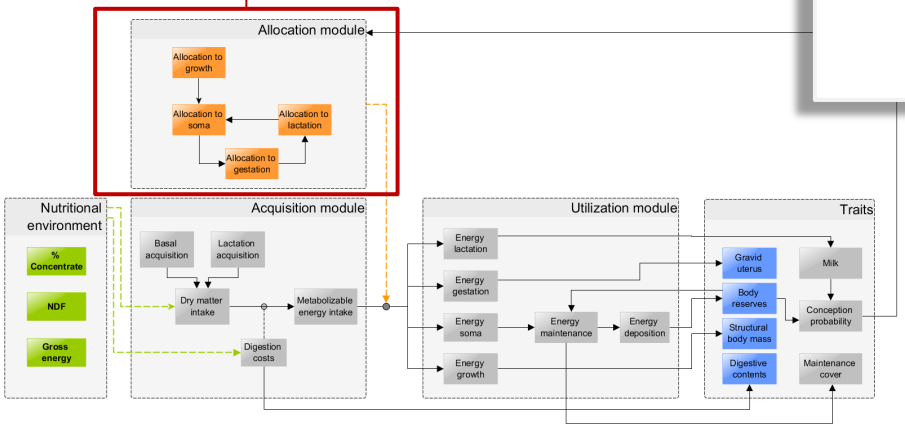
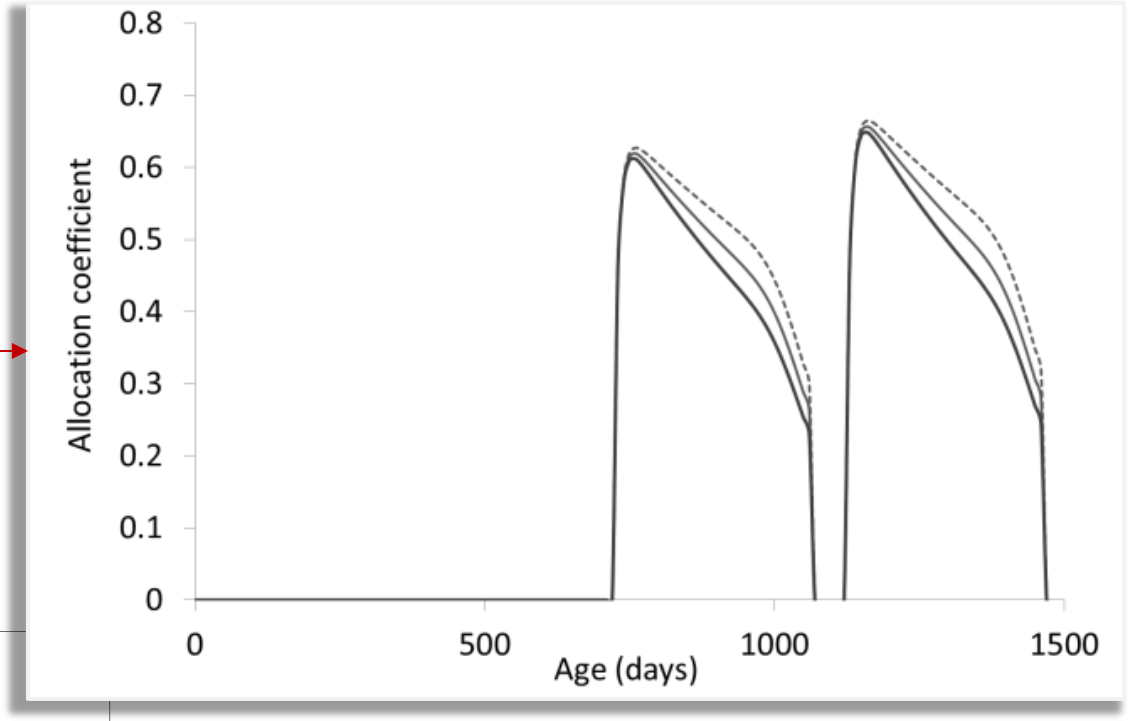


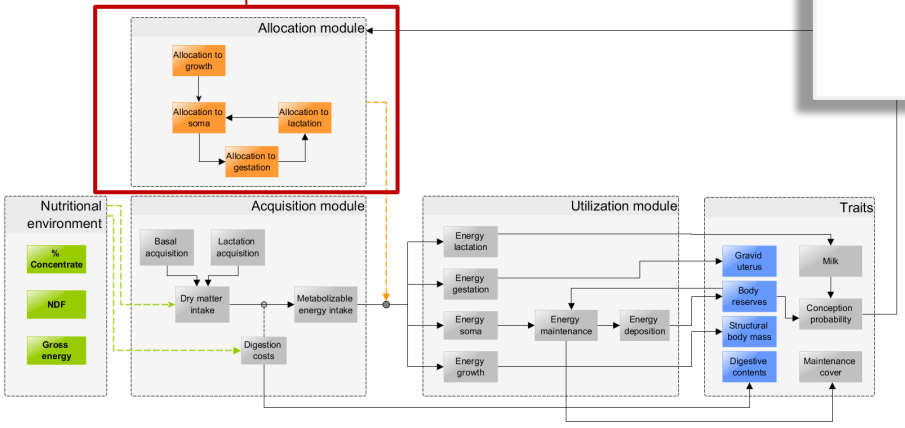


Simulations: design of experiments

- 4 parameters x 3 levels | 20 replications | *n = 1620*

Parameter 2:
allocation to lactation





Simulations: design of experiments

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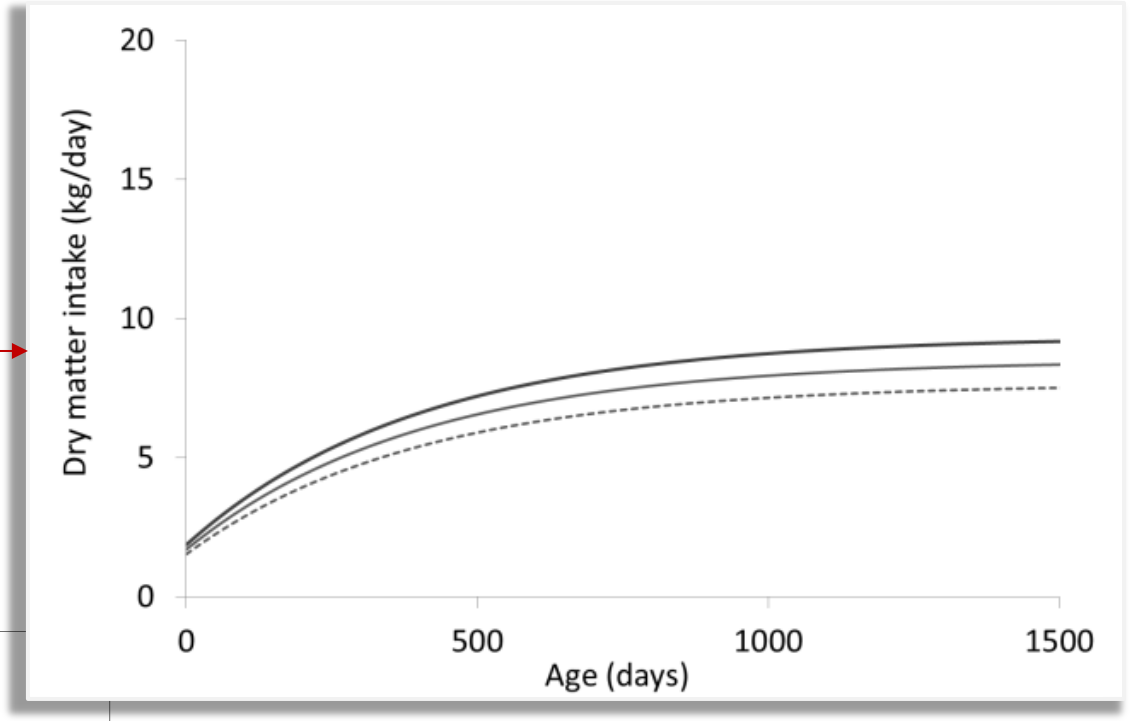
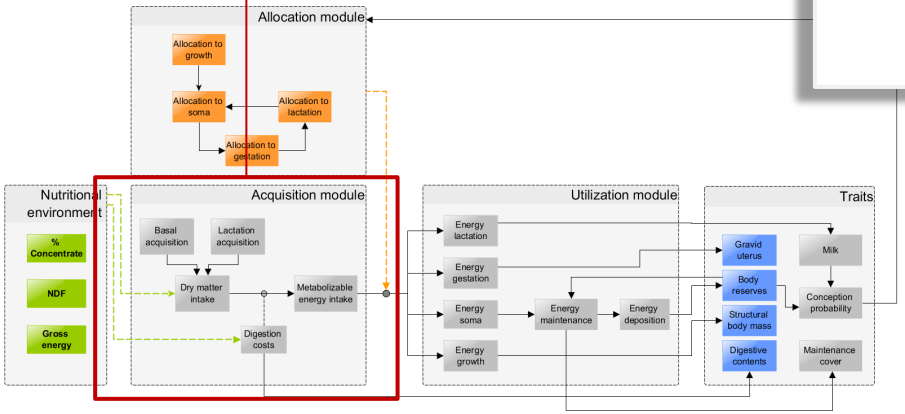
Parameter 3:
basal acquisition





Simulations: design of experiments

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Parameter 4:
lactation acquisition