



*Genotype **plus** Environment*
Integration for a more sustainable dairy production system

How fast can we change resilience and efficiency through breeding and management?

N. Gengler¹, M. Hostens² & GplusE Consortium³

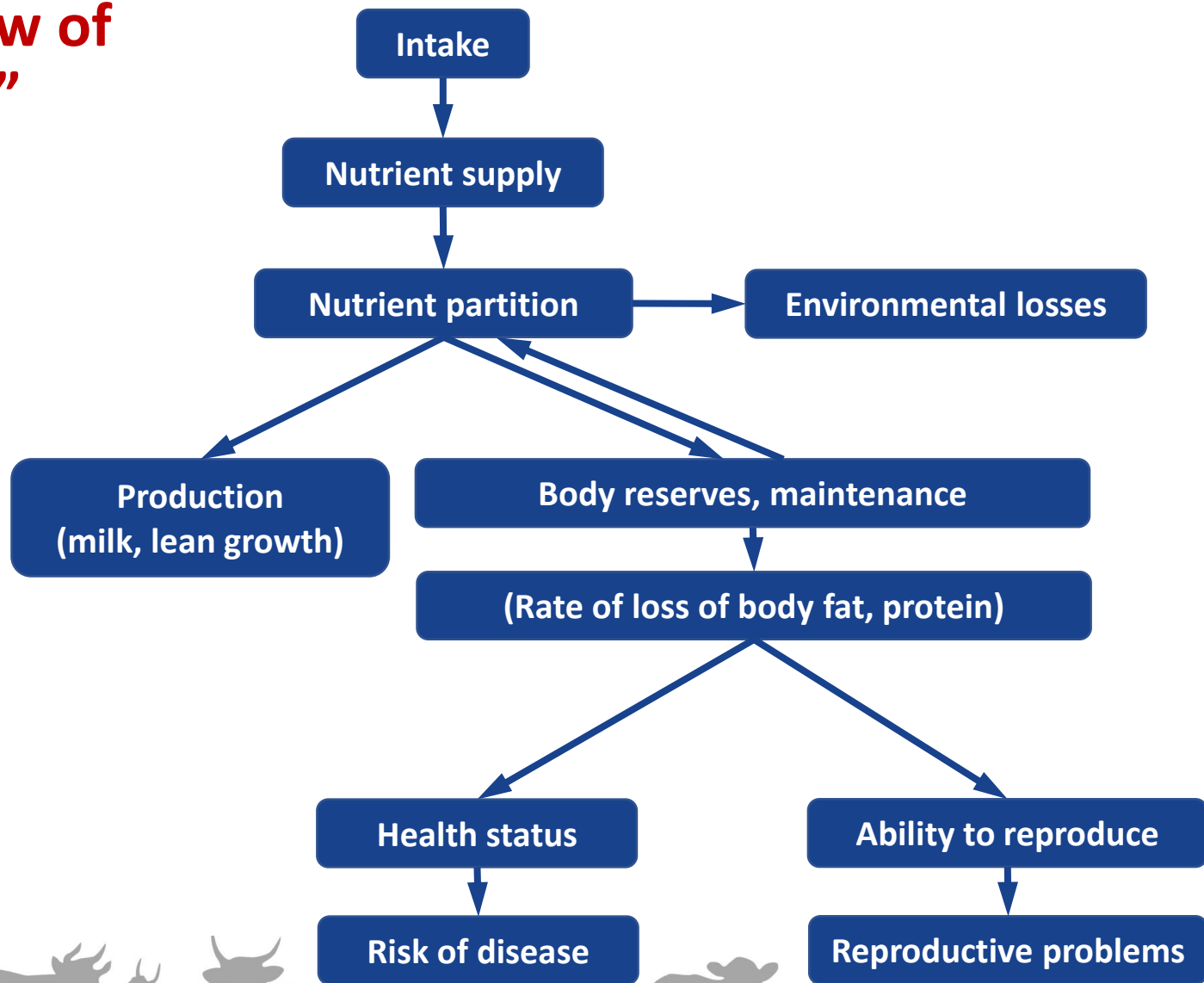
¹ *ULiège-GxABT, Belgium (nicolas.gengler@uliege.be)*

² *UGent, Belgium (miel.hostens@ugent.be)*

³ *<http://www.gpluse.eu> (mark.crowe@ucd.ie)*

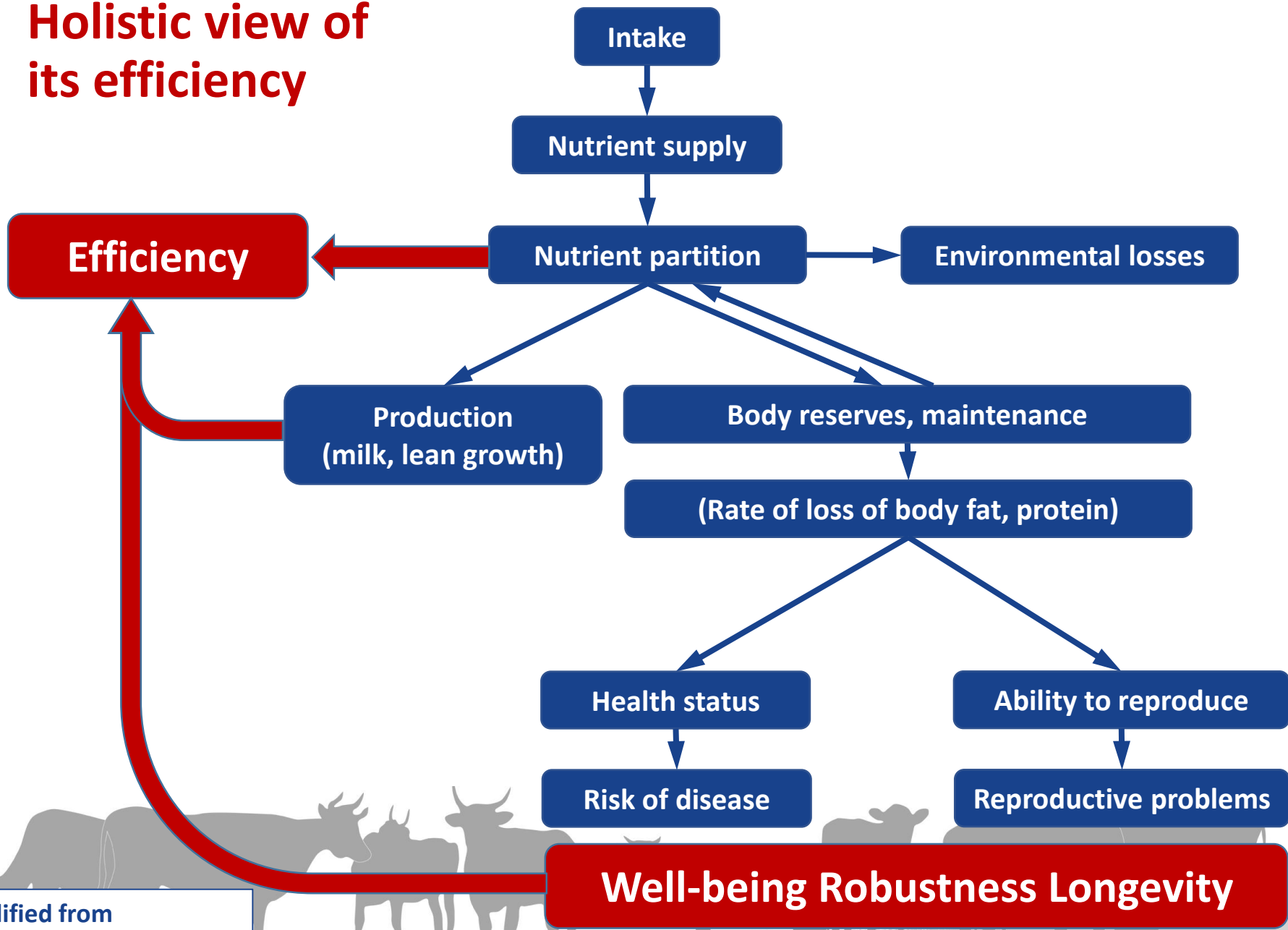


Holistic view of an “animal”



Modified from
Friggens et al., BSAS 2018

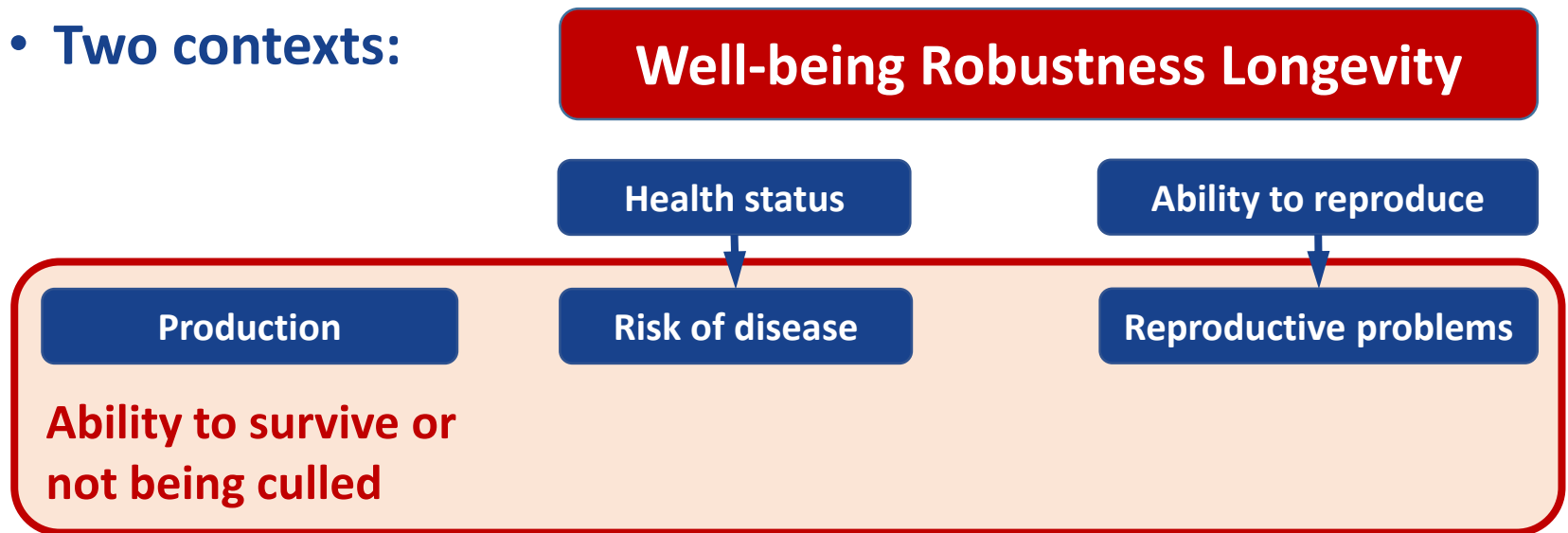
Holistic view of its efficiency



Modified from
Friggens et al., BSAS 2018

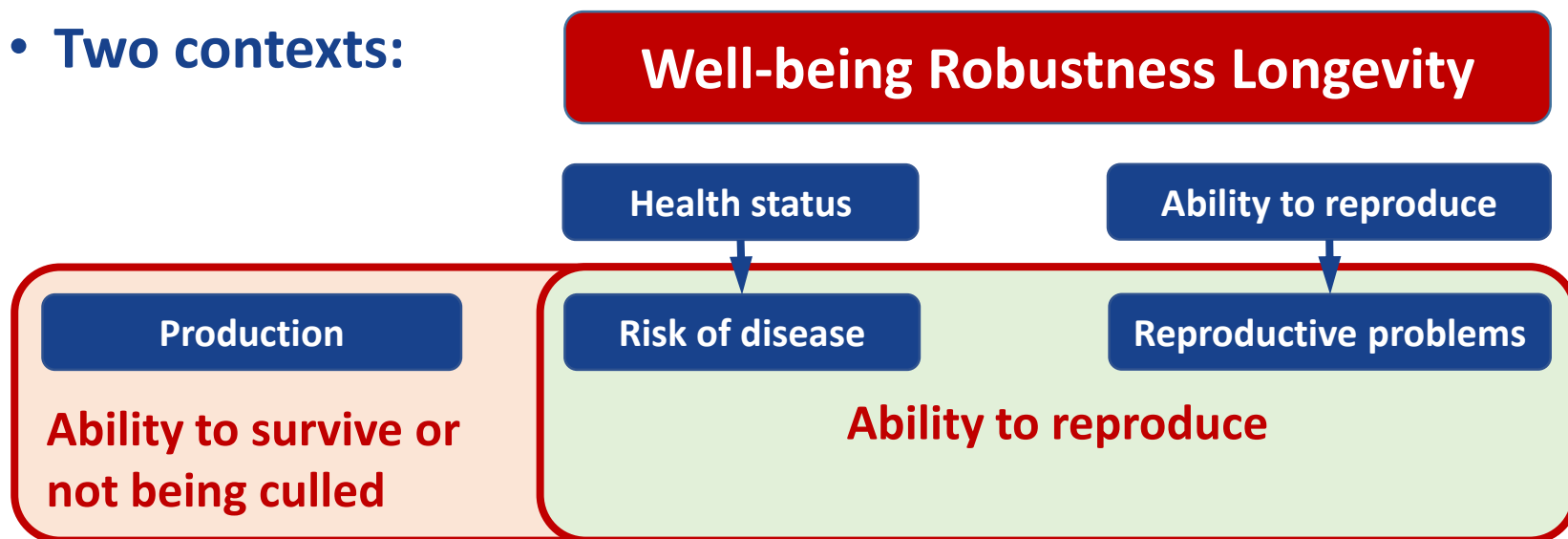
Resilience

- Capacity to respond to perturbations
- More precisely: “individual” capacity to resist perturbations
- Two contexts:



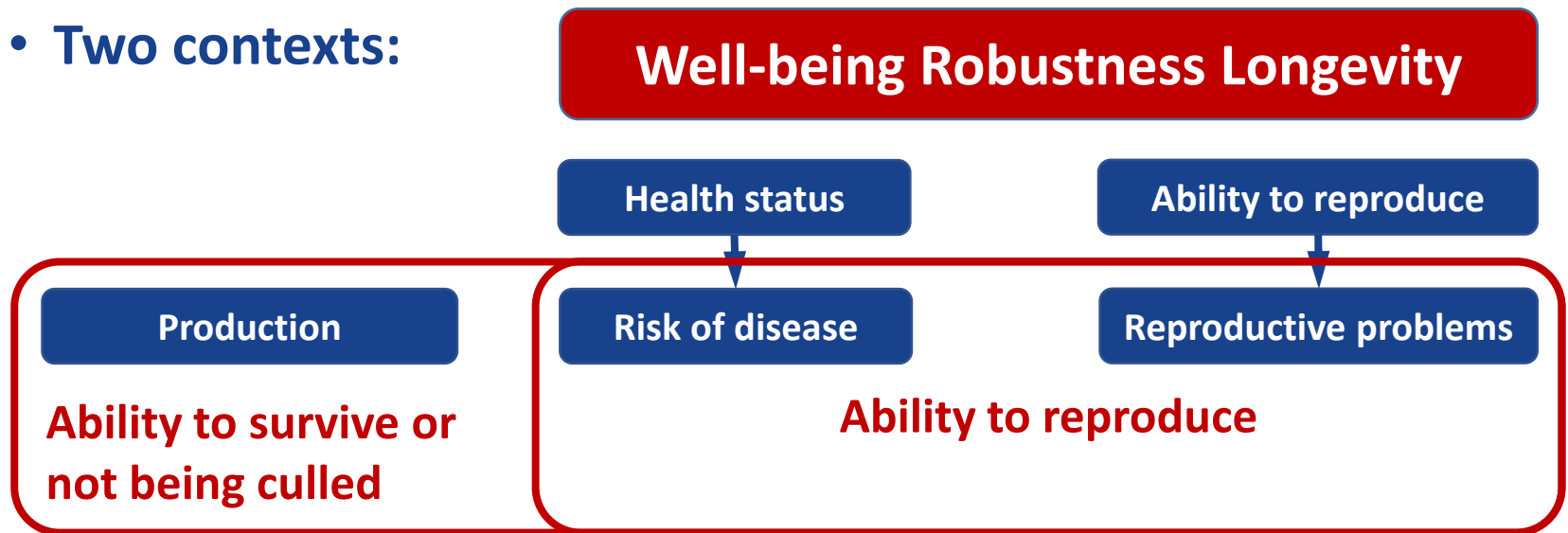
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Resilience

- Capacity to respond to perturbations
- More precisely: “individual” capacity to resist perturbations
- Two contexts:



➔ BOTH needed to perpetuate genes of a given “individual”



Changing environments ↔ Changing animals ?

- **Old question:**

- Do we change the environment?
- Do we change the animals?

- **Changing resilience and efficiency:**

- Through breeding and management or **both**?

→ **Innovative objectives of the FP7 Project GplusE:**

1. **Genotype AND Environment** contributing to sustainability of dairy cow production systems
2. **By optimal integration of genomic selection and novel management protocols**
3. **Through the development and exploitation of genomic data and supporting novel phenotyping approaches**



How fast can we change resilience and efficiency through breeding and management?

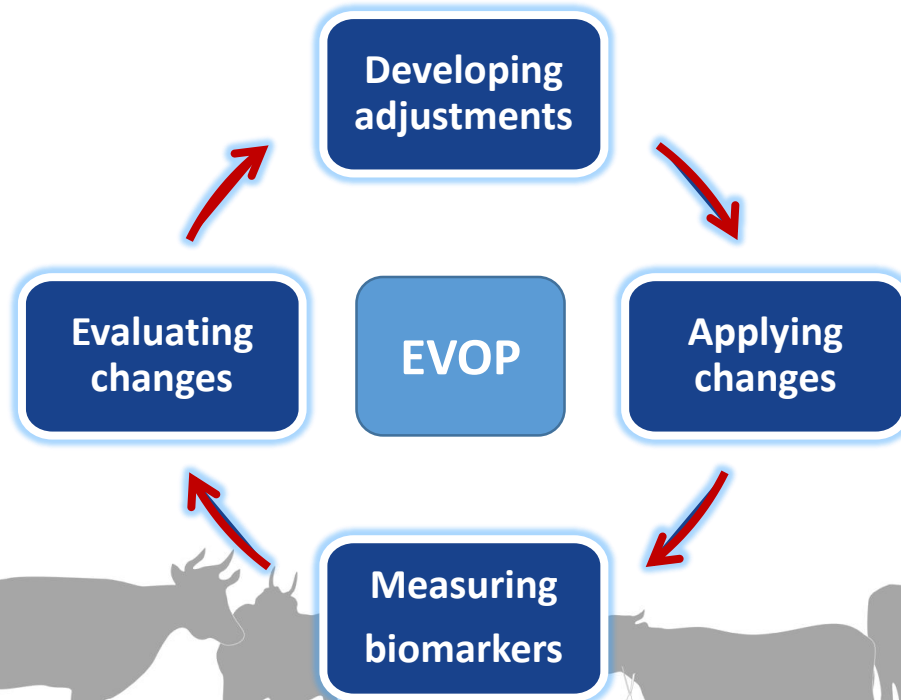


**How fast can we change resilience and efficiency through breeding and management,
and where should we put our eggs?**



GplusE Project: Innovations in management

- **GplusE → innovative methods to optimize management**
 - Hazard Analysis Critical Control Point (HACCP)
 - preventative approach
 - Evolutionary Operation (EVOP)
 - continuous process of optimization



GplusE Project: Innovations in management

- **GplusE → innovative methods to optimize management**
 - Hazard Analysis Critical Control Point (HACCP)
 - preventative approach
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 - continuous process of optimization
- **Optimize dairy cow management**
 - in given production circumstances
- **Continuous process of cumulative optimization**
- **Analogous to genetic (genomic) selection**
 - Another important research topic of the GplusE project



Bottleneck: phenotypes for efficiency and resilience

- Needed for G and E:

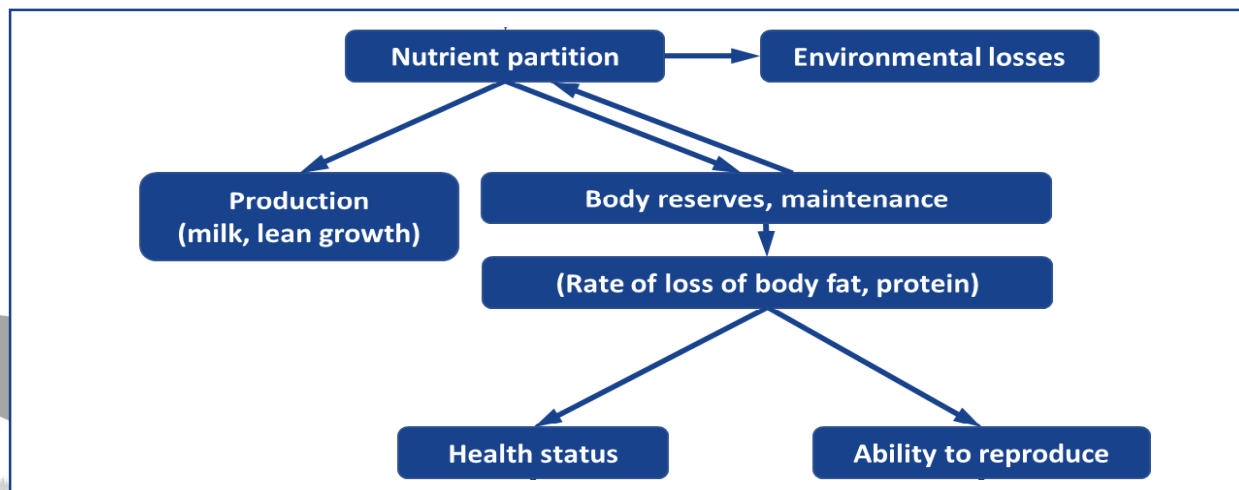
- Development of appropriate response variables describing efficiency and resilience

→ Phenotypes ← Biomarkers

- Many challenges and opportunities

- Example developed in this presentation:

- Negative energy balance and associated metabolic imbalance



GplusE: Phenotypes

- **Objective:**

- To develop and validate new, easily-measured phenotypes
- That can supplement or correlate with and replace traditional phenotypes as milk yield and composition, traditional functional traits,

- **Main focus of GplusE**

- Metabolites and enzymes in blood and milk
- Glycan profiles
- Mid-infrared (MIR) spectra
 - ➔ predicting “traditional” and “novel” (metabolites and enzymes)



GplusE: Individual blood biomarkers ← MIR predicted

- | Blood biomarkers | n | R^2_{cv} | RPD_{cv} |
|------------------|-----|------------|------------|
| Glucose | 380 | 0.44 | 1.33 |
| IGF-I | 387 | 0.61 | 1.59 |
| NEFA | 234 | 0.39 | 1.28 |
| BHB | 205 | 0.70 | 1.81 |

Grelet et al., animal 2018

<https://doi.org/10.1017/S1751731118001751>

- MIR records → milk MIR based predictions** (older equations)

- 144,623 records (closest to DIM25)
- From 73,378 cows in Walloon region of Belgium

- Model: single-trait, multi-lactation (1, 2, 3+)**

- Variance components computed using EM-REML**

- h^2 ranging from **0.12** to **0.27**, high correlations among lactations

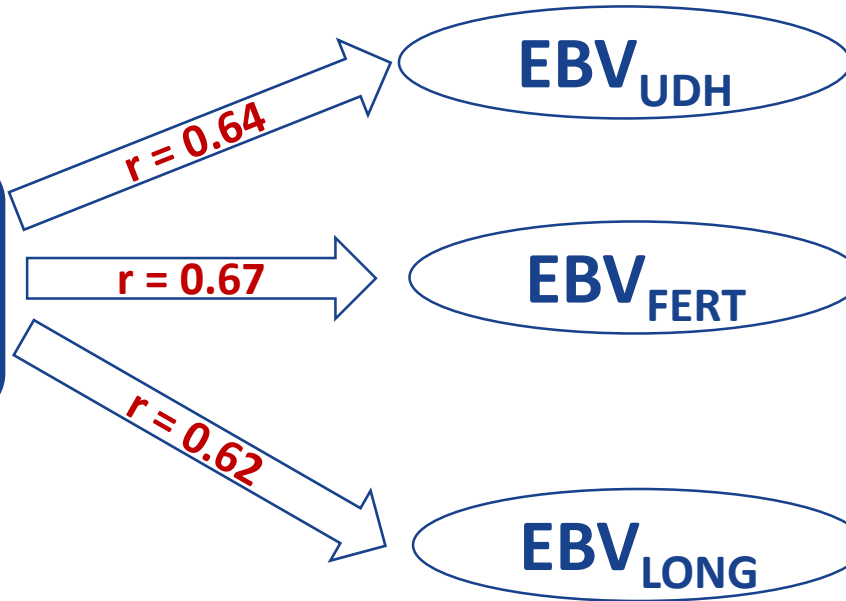
Gengler et al., ICAR 2018

<https://www.icar.org/wp-content/uploads/2018/07/ICAR-Technical-Series-23-Auckland-2018-Proceedings.pdf>



Useful?

MIR predicted
blood biomarker
EBV



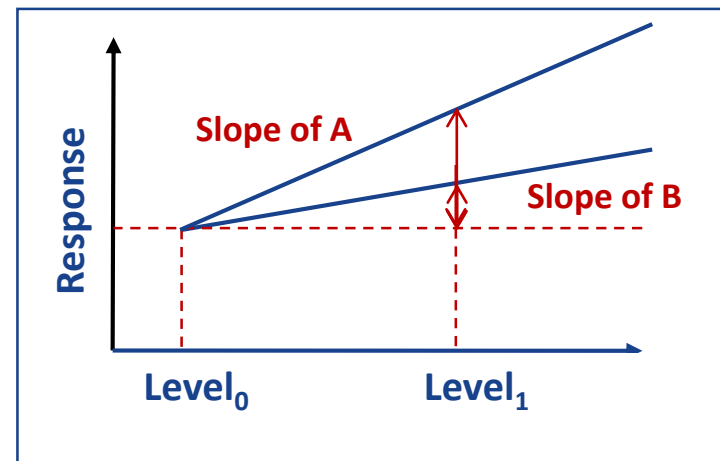
Gengler et al., ICAR 2018
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1. Predicting robustness and resilience traits from earlier available biomarker based MIR traits

2. Association between slope of MIR predicted blood biomarkers on heat stress with resilience and robustness traits

- Based on reaction norms →
- First results

Mineur et al., ICAR 2018
<https://www.icar.org/wp-content/uploads/2018/07/ICAR-Technical-Series-23-Auckland-2018-Proceedings.pdf>



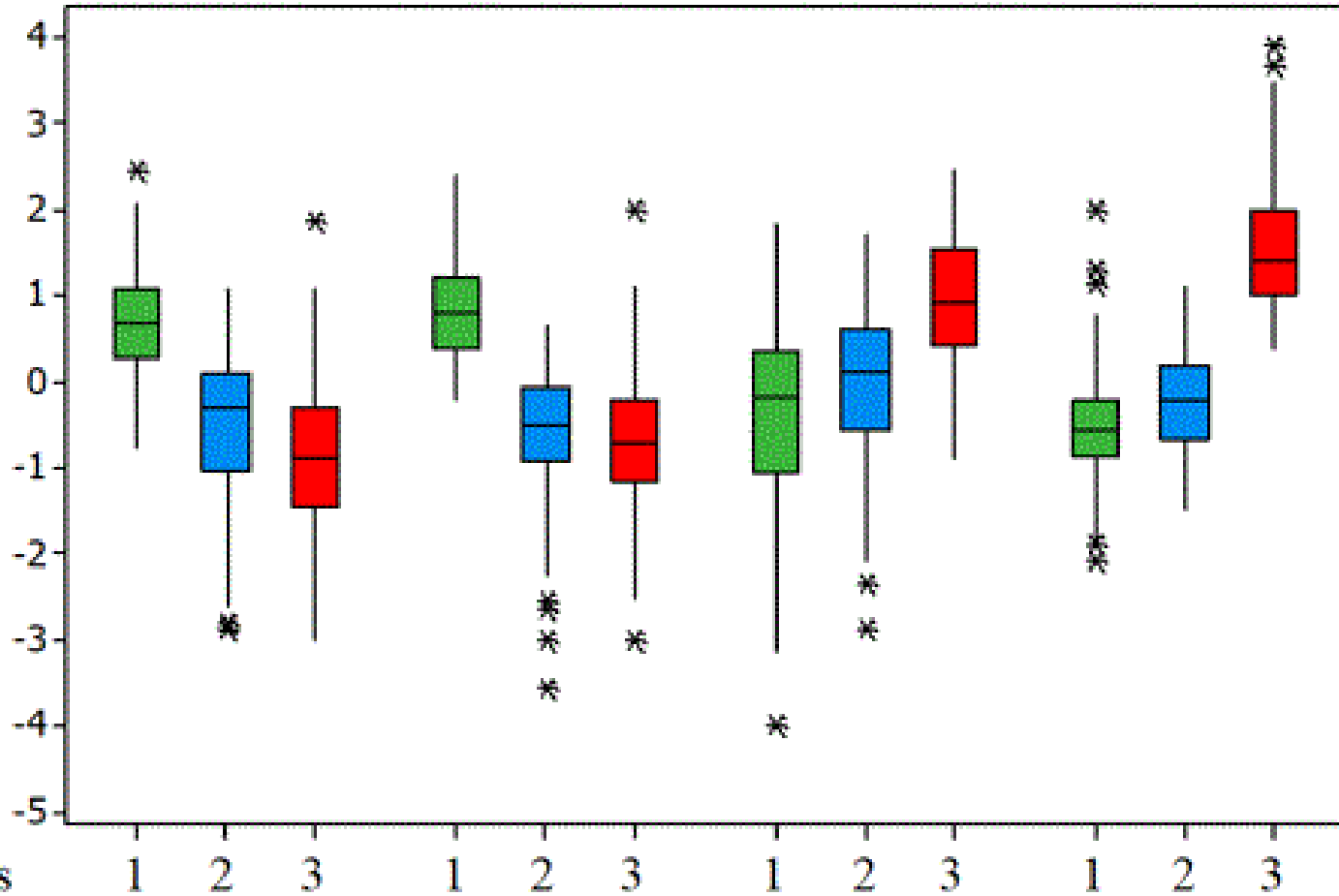
Negative energy balance and associated metabolic imbalance

- **Danger of mixing-up issues here**
 - Negative energy balance not the same as metabolic imbalance
- **Biomarkers for negative energy balance (NEB)**
 - Biomarkers in milk: BHB, acetone, C18:1 cis-9....
 - Better biomarkers in blood: BHB, glucose ...
- **But issue not detecting “healthy” animal that is in NEB but:**
NEB → metabolic imbalance
- **Innovative phenotypes ← metabolic cluster**
 - Definition – ongoing process see
 - Grelet et al., animal 2018 <https://doi.org/10.1017/S1751731118001751>
 - De Koster et al., JDS 2018 (submitted)



Metabolic clusters

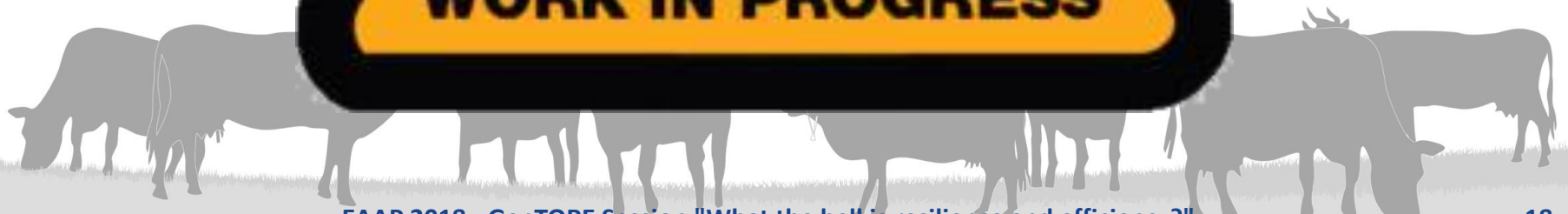
Clusters with ALL parities (n=372)



Clusters

Grelet et al., animal 2018
<https://doi.org/10.1017/S1751731118001751>

Genetics of metabolic clusters



Conclusions

- **How fast can we change resilience and efficiency through breeding and management, and where should we put our eggs?**
 - Not an easy question to answer !
- **Depends on replies to these questions:**
 - How do we define resilience and efficiency?
 - How do we measure resilience and efficiency?
 - Which tools do we have at our disposal to improve them?
 - How effective are these tools?
- **Breeding and management → advantages and disadvantages**
- **Bottleneck → phenotyping resilience and efficiency**
 - GplusE: metabolites, glycans, MIR + innovative modeling



Acknowledgments and Disclaimer

- **Support of the whole GplusE team, in particular:**
 - Clément Grelet CRA-W (for the ongoing calibration effort)
 - Hédi Hammami ULiège-GxABT (for the genetic computations)



This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement n° 613689

The views expressed in this publication are the sole responsibility of the author(s) and do not necessarily reflect the views of the European Commission.

- **Support by:**
 - Walloon Breeding Association (awé) providing access to MIR data used in the reported studies and European Milk Recording (EMR) providing access to the MIR data standardization

