

Adapting the feed, the animal and the feeding techniques to improve the efficiency and sustainability of monogastric livestock production systems

# An update on the Feed-a-Gene research project

Jaap van Milgen



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#### Efficiency = gain-over-feed?



They do not want to grow; they eat so that they can play music ... and they are poor musicians as well



#### The issue of feed efficiency and competition for resources is not new

The Efficiency of the Animal Compared with the Steam Engine. It is of interest in studying the efficiency of the animal as a converter of energy in work and food production to compare it with a mechanical energy converter such as the steam engine. We have recently been confronted with the phenomenon of the burning of corn for fuel in place of the usual use as a food for animals or man. The economy of this substitute conversion might help solve the question of the ethics of such a substitution.





#### Variation among individuals is natural, essential, and very well controlled







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#### Variation among individuals is natural, essential, and very well controlled









### Variation among individuals is natural, essential, and very well controlled

Item	Energy
Maintenance energy requirement	2580 kcal/d
0.5% imbalance	13 kcal/d
Deposited as lipid	1.3 g/d
Per year	481 g/yr
Between 20 and 60 years of age	19 kg of lipid



EU funded Research project



€10 M Budget



Adapting the **feed**, the **animal** and the **feeding techniques** to improve the efficiency and sustainability of monogastric livestock production systems (www.feed-a-gene.eu)



**15** Industry

**8** Academic



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#### The Feed-a-Gene consortium







## Objectives of the Feed-a-Gene project



- Develop new local feed resources that are not/less in competition with food
- Improve the nutritional value of feed resources



- Gene:
- Use of novel traits indicative for feed efficiency and robustness that can be used as selection criteria
- "Do better with feeds that may be worse"



- Traits, models, and feeding techniques:
  - Appreciate variation among animals
  - Develop precision feeding techniques
  - Evaluate the overall sustainability



### It is all about variation

Observe variation in feeds, animals, and the environment



# <u>Predict</u> using data-driven models and quantify interactions and variation





<u>Understand</u> the underlying mechanisms of variation

<u>**Control**</u> through livestock management (e.g., feeding, breeding)





#### Protein production from green biomass







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#### Protein production from green biomass







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### Upgrading rapeseed meal by feed processing technologies







#### Protein-rich fraction





## New animal traits for innovative feeding and breeding strategies

#### behavior and welfare



image analysis serotonin, cortisol

#### individual feed intake



feed intake patterns feeding behavior

#### digestive efficiency



digestibility markers gut health microbiota

#### metabolic efficiency



#### metabolomics





#### Microbiota as a trait to differentiate





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#### Residual feed intake can be used to study feed efficiency





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#### Microbiota as a trait to differentiate



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MDS1



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#### Modeling biological functions



Liver Stomach Small Intest

Nutritional growth models such as InraPorc use digestible nutrients as model inputs ...



traits of a single animal in a





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### Modeling digestion in pigs and poultry







#### Feed intake patterns can be variable





#### Feed intake patterns can be variable







#### Feed intake patterns can be variable































#### Modeling the effect of a perturbation







#### Managing variation among individuals through precision livestock feeding





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#### Precision livestock feeding is about observing, predicting, and control





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### Management systems for precision livestock feeding







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#### Management systems for precision livestock feeding





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System prototypes are now being tested

## Growing pigs

Restricted feeding

Ad-libitum feeding





Sows
Gestation





Lactation



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## Sustainability evaluation





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## Sustainability evaluation



Identification of sustainability indicators

- Life Cycle Assessment of some of the proposed management systems
- Cost-benefit analysis
- Evaluation of consumer and farmer attitudes
- Overall sustainability appraisal





## Conclusions

- Livestock production and animal-derived products are part of a sustainable food supply
- There is a potential to increase the efficiency and robustness of livestock production systems
- There is no "one-size-fits-all".
  - Variation (among animals and systems), differentiation (of products), and segmentation (of markets) are essential
- Information-based technologies (e.g., precision livestock farming) have a great potential and are inevitable. Are we ready for it?



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