The Feed-a-Gene Project has received funding from the European Union's H2020 Programme under grant agreement no 633531

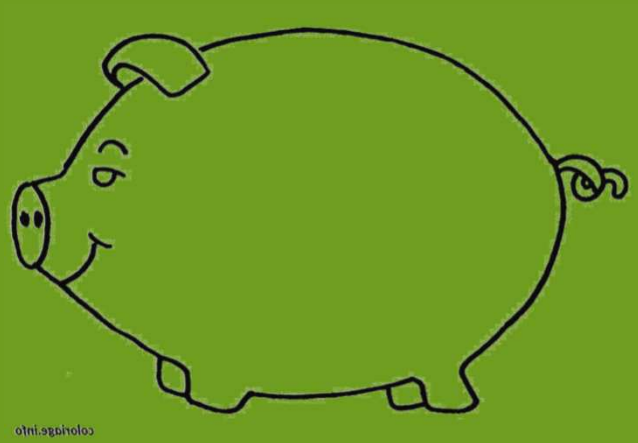
OPERATIONAL MEASURES OF EFFICIENCY: MAKE THEM MEASUREABLE ON LARGE SCALE

Session "What the hell is resilience and efficiency?"

Hélène Gilbert – Egbert F. Knol

The Feed-a-Gene Project has received funding from the European Union's H2020 Programme under grant agreement no 633531

Feed-a-Gene



INRA SCIENCE & IMPACT

OPERATIONAL MEASURES OF EFFICIENCY: MAKE THEM MEASUREABLE ON LARGE SCALE

Session "What the hell is resilience and efficiency?"

Hélène Gilbert – Egbert F. Knol

Topigs Norsvin PROGRESS IN PIGS

Efficiency: what is the objective?

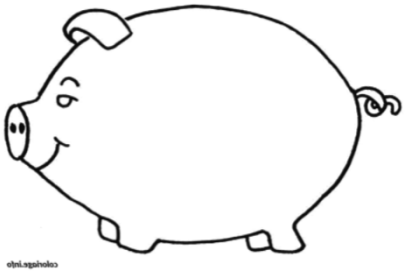
Pig Farm final product = meat

Consumer starting product = Meat?
Human edible proteins?

What is the farmer object?

The pig

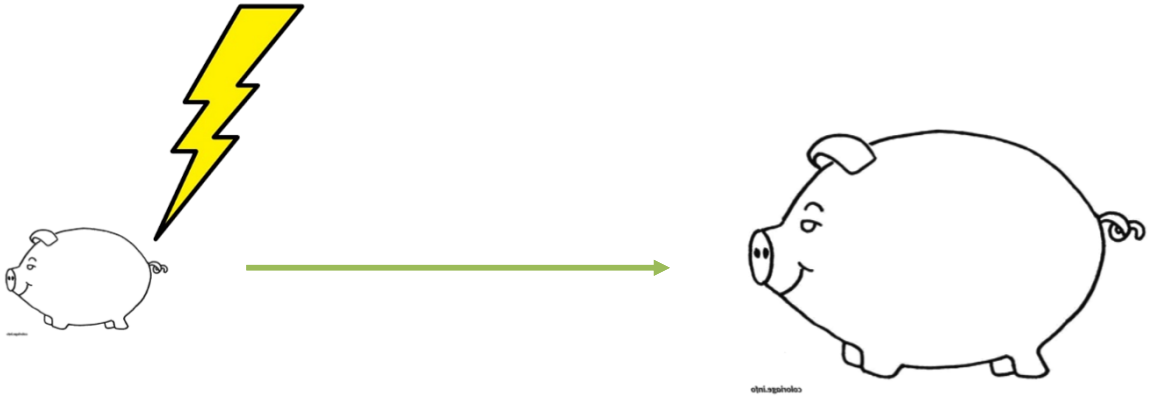
Pig Farm final product = meat



What is the farmer object?

The pig, using sun to grow

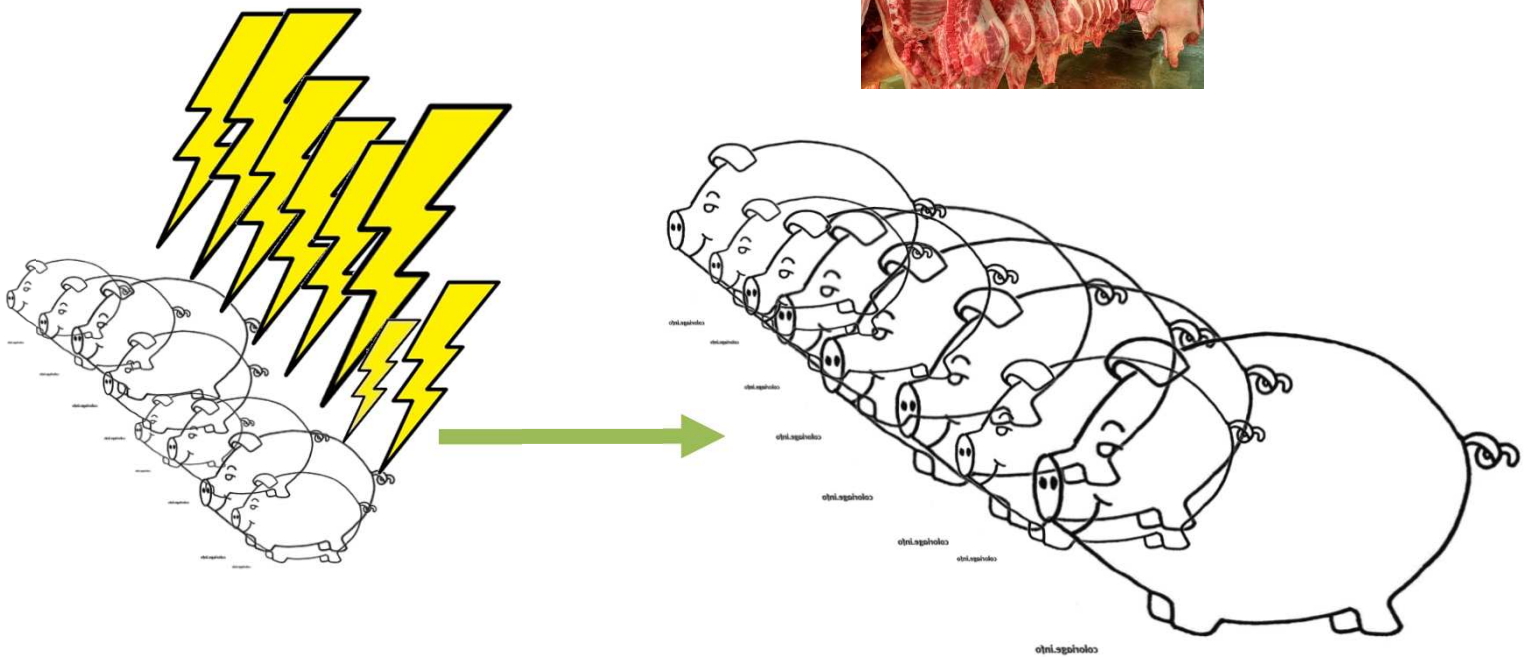
Pig Farm final product = meat



What is the farmer object?

The pig, using sun to grow, raised from a litter

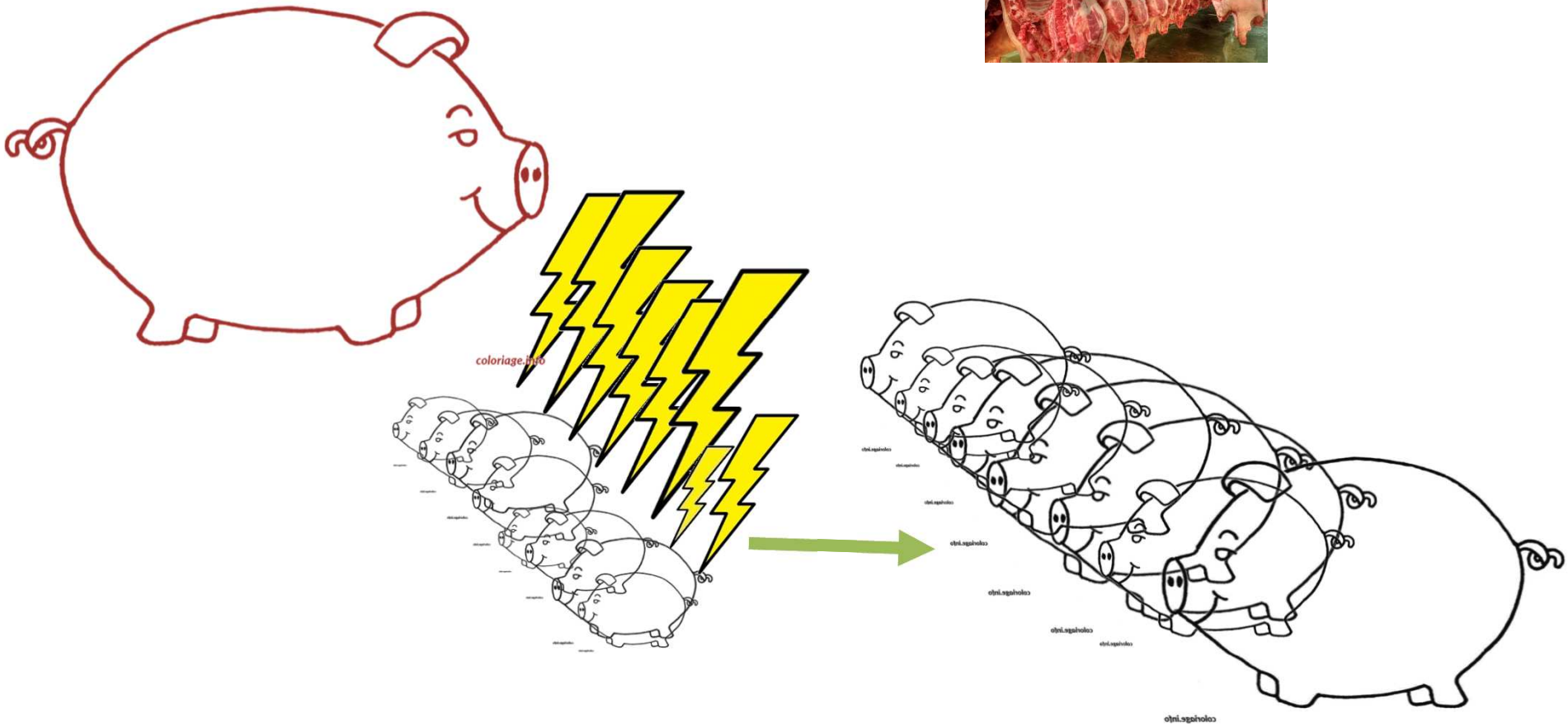
Pig Farm final product = meat



What is the farmer object?

The pig, using sun to grow, raised from a litter, born from a sow

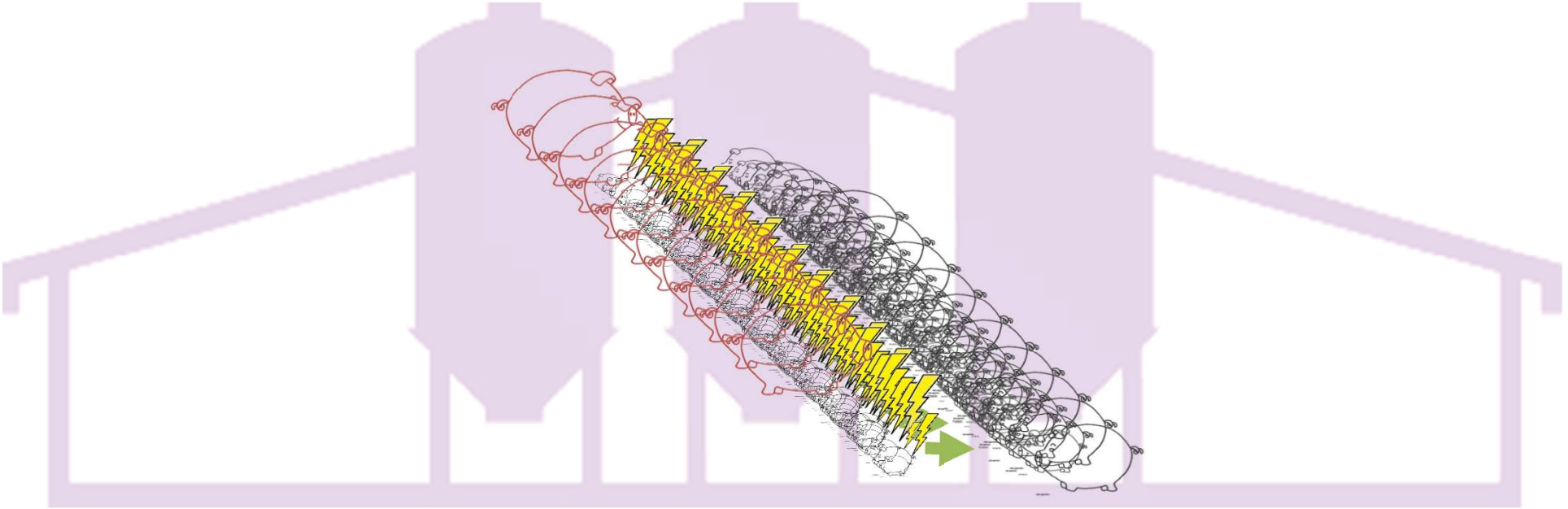
Pig Farm final product = meat



What is the farmer object?

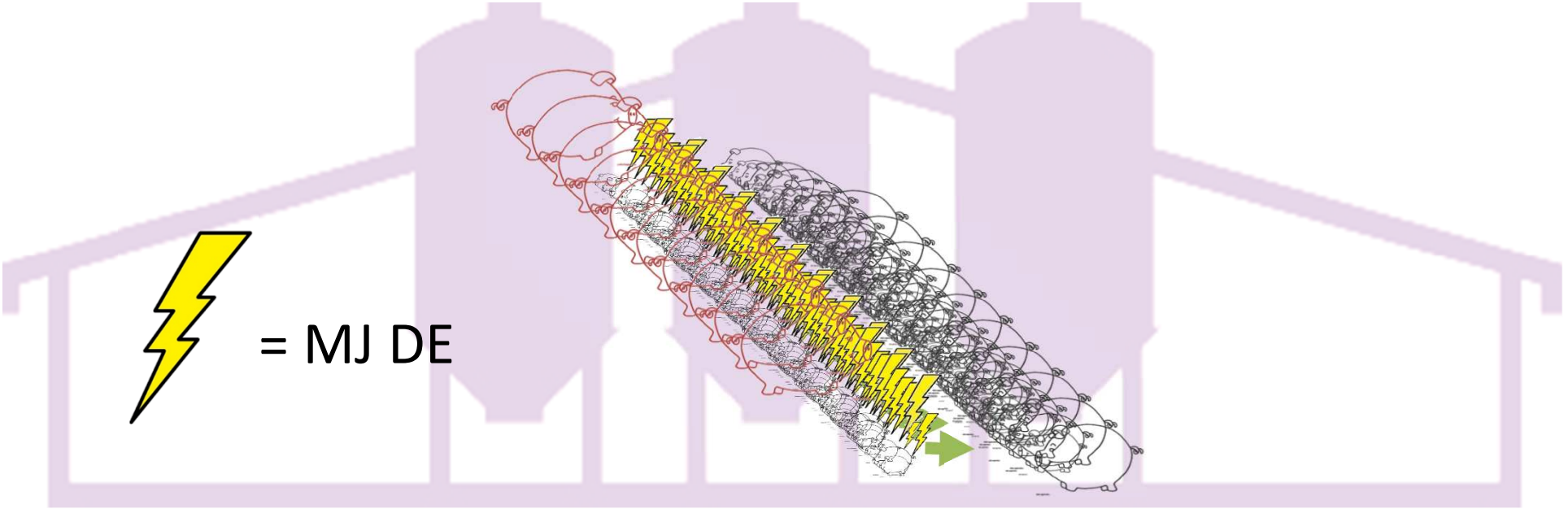
The pig, using sun to grow, raised from a litter, born from a sow, among multiple sows raised in a farm

Pig Farm final product = meat



What is the fuel?

Pig Farm final product = meat



Kilo or energy or cost per kg gain

Which unit to consider?

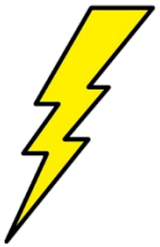
Table 1. Effect of diet dilution from 35-49d of age on broiler performance.

Diet ME (kcal/kg)	Diet CP (%)	49d body wt (g)	Feed intake 35-49d (g)	Feed:gain 35-49d	Energy efficiency (Mcal/kg gain)
3200	18	2950	2580	2.34	7.43
2900	16	2920	2760	2.49	7.19
2600	14	2880	2900	2.72	6.97
2300	13	2910	3270	2.99	6.70
1900	11	2910	3670	3.31	6.37
1600	9	2890	4300	4.01	6.41

Adapted from Leeson et al. (1996)

Is efficiency only energy?

Which unit to consider?



= MJ DE

What about

Protein efficiency?

AA?

Minerals?

Vitamins?

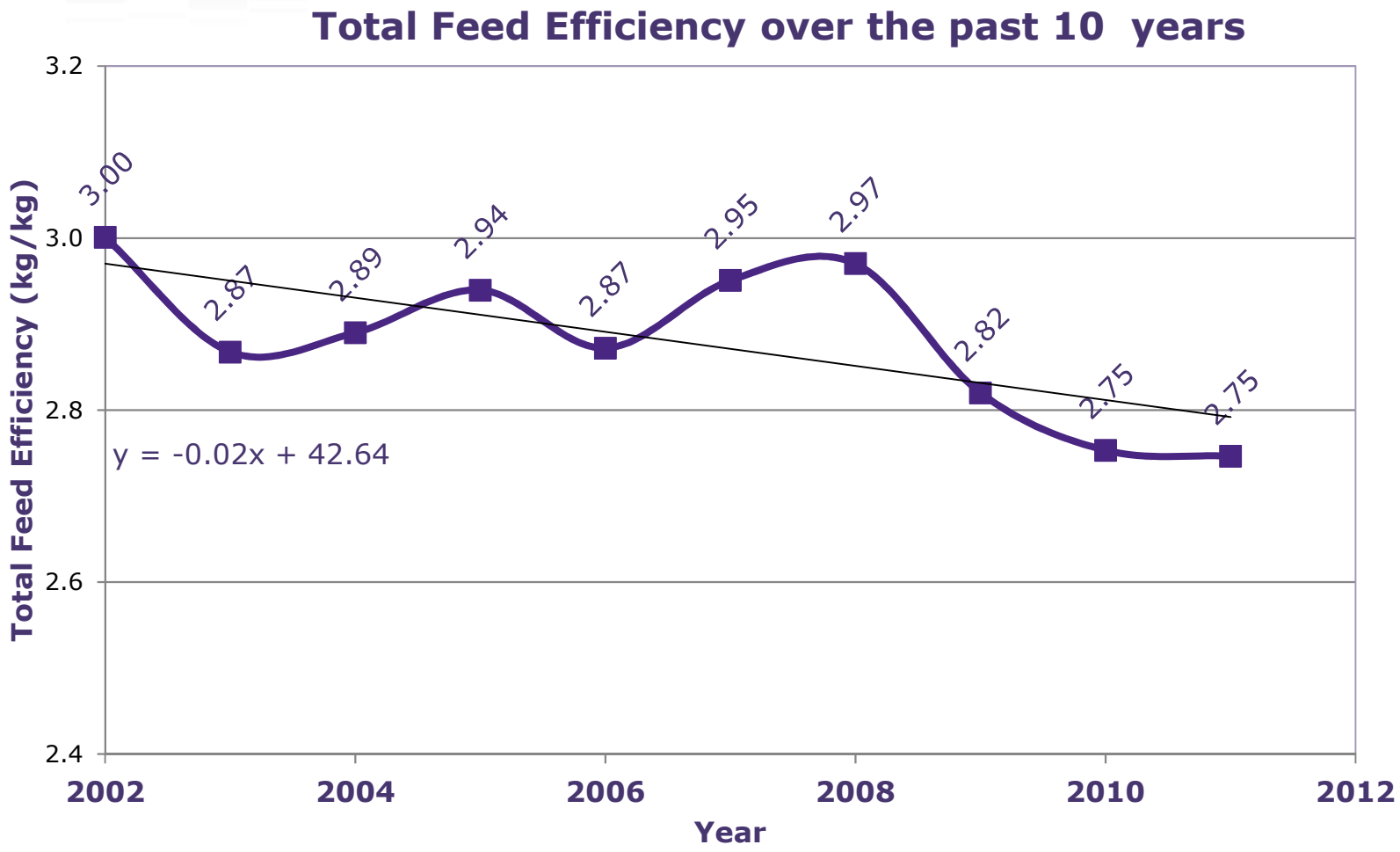
Farmer approach

Total feed efficiency =

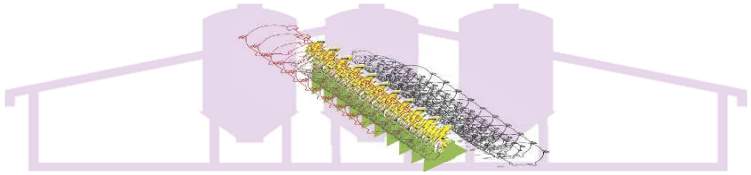
$$\frac{\text{Pork farm out}}{\text{Feed farm in}}$$

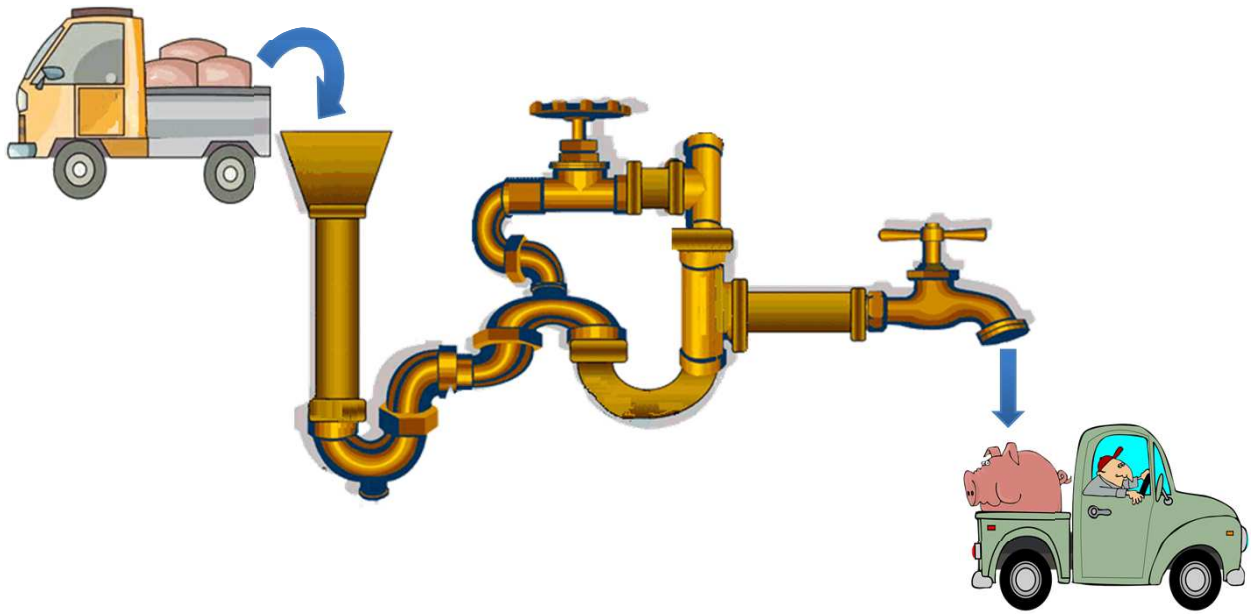
Total feed efficiency (TFE)

TFE TOPIGS Research farm Beilen



Efficiency of the production system

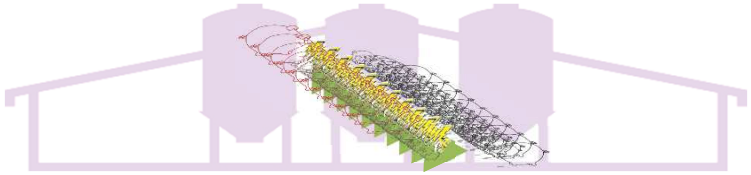




~ Knol 2010

Losses

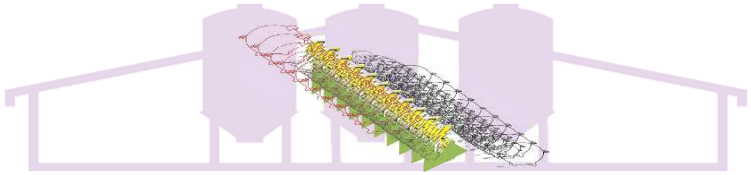
Efficiency of the production system



~ Knol 2010

Losses

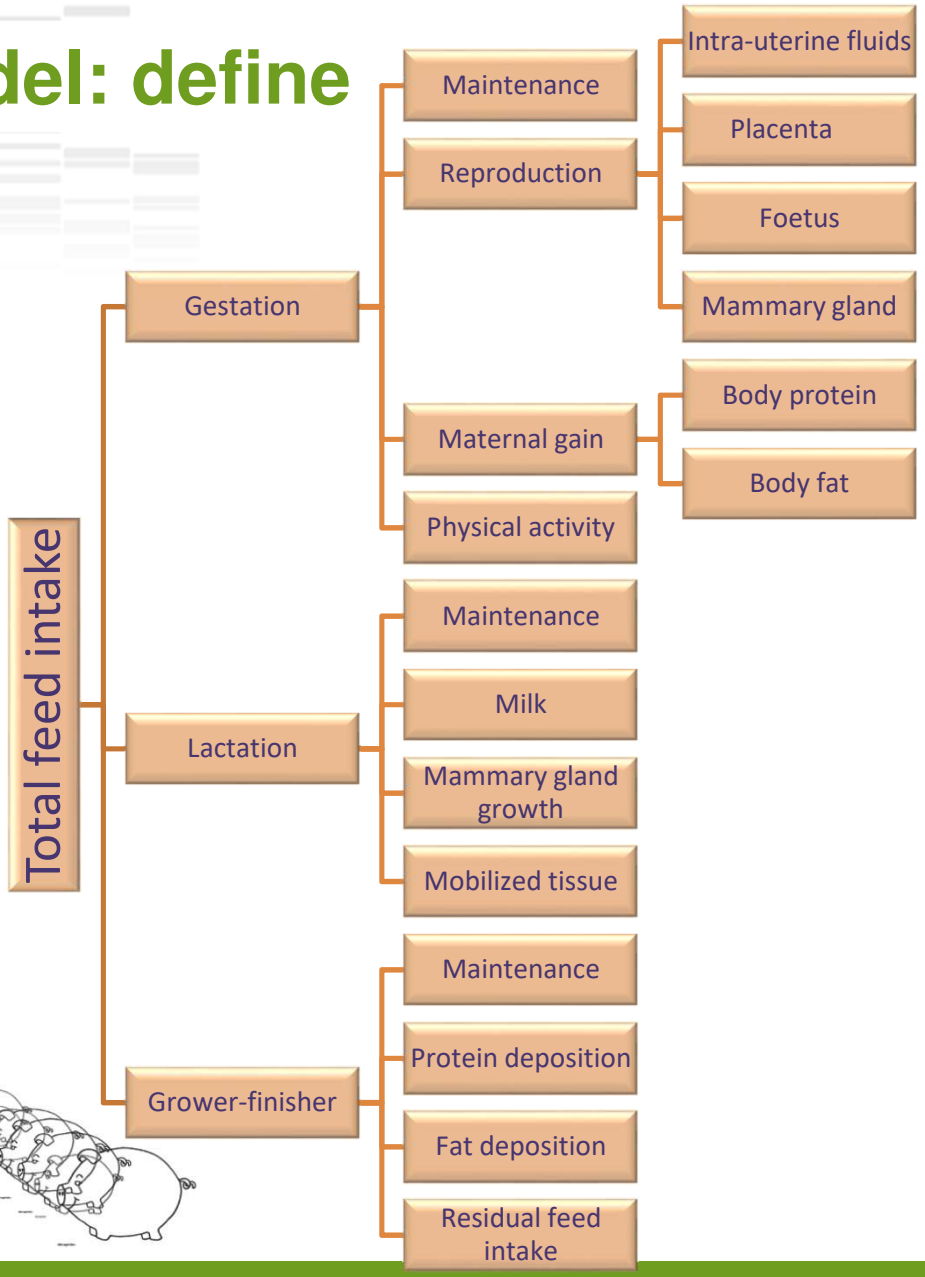
Efficiency of the production system

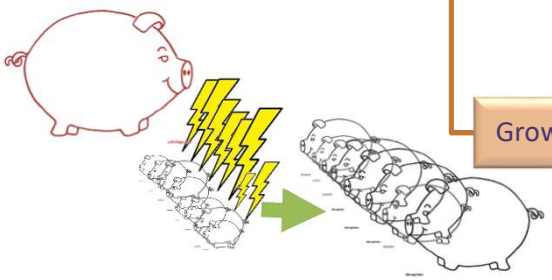


~ Knol 2010

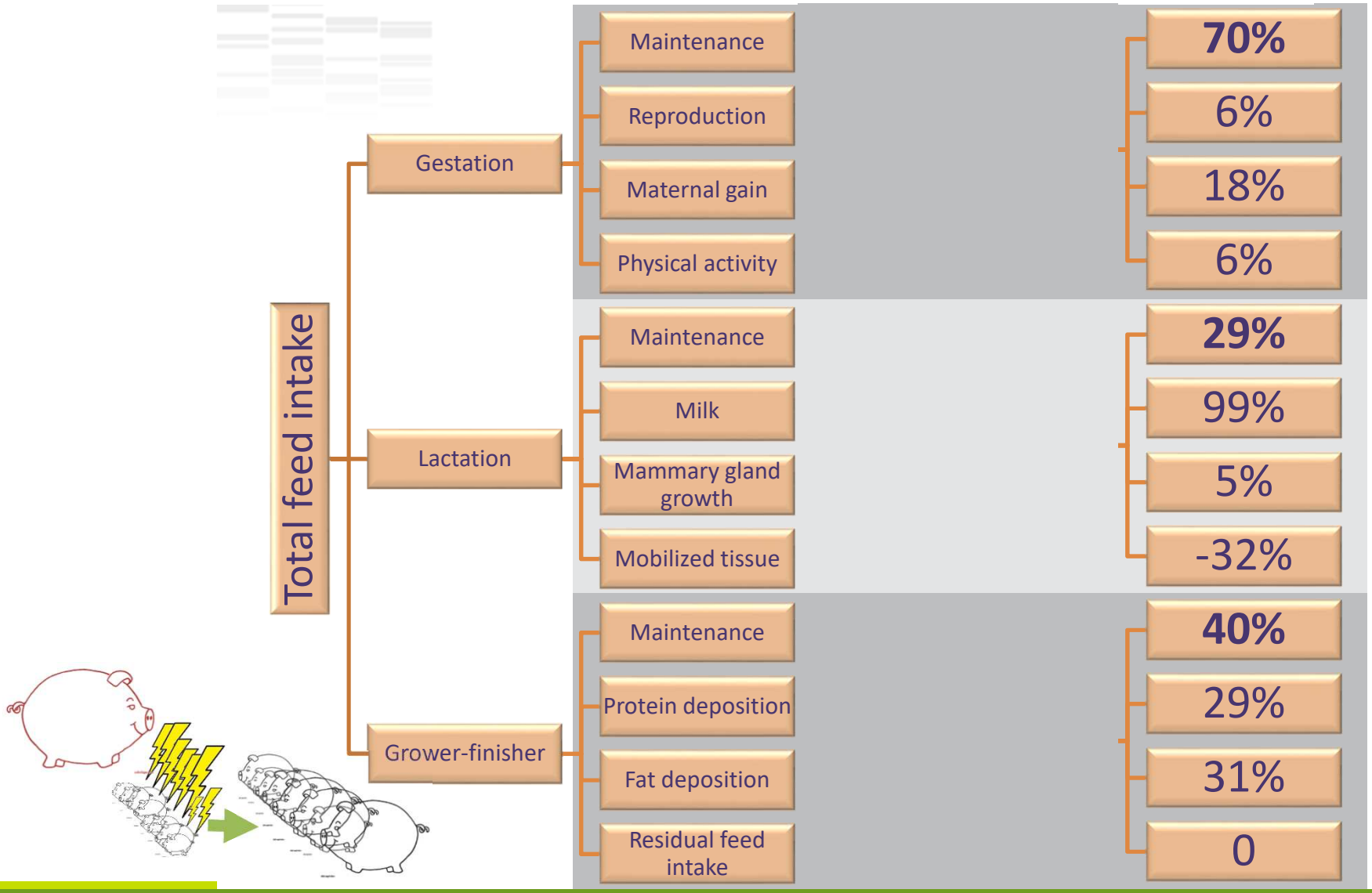
➔ Need models and measures

Model: define

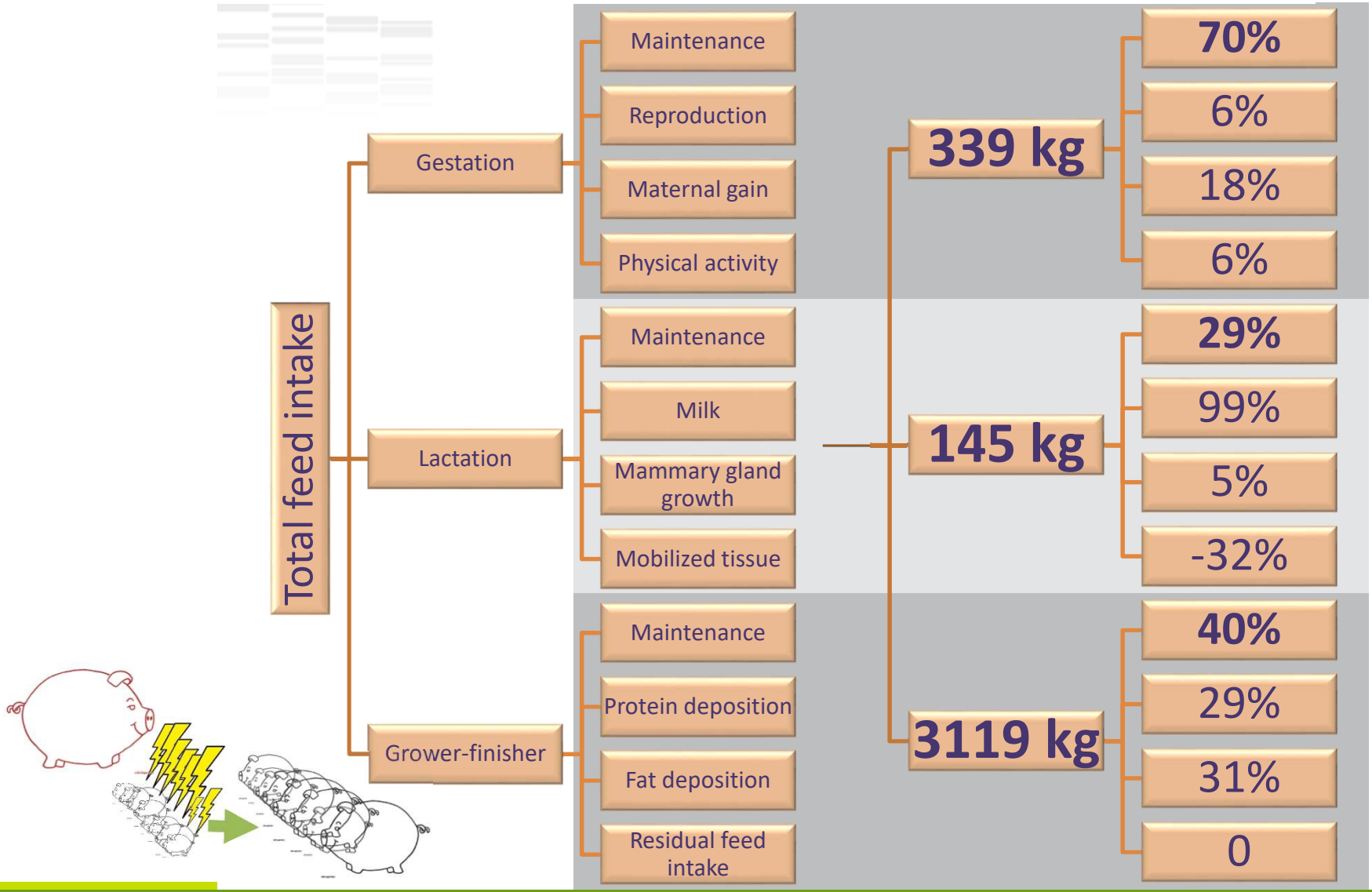




Model: quantify



Model: quantify



Model: quantify

	Model Prediction
Feed intake during gestation (kg)	339
Feed intake during lactation (kg)	145
Feed intake during nursery (kg)	
Feed intake during growing-finishing (kg)	
Sum of FI of grower-finishers (kg)	3119
Total feed intake per litter (kg)	**3602**
No animals slaughtered per litter	12.6
Slaughter weight (kg)	116.3
Live weight sold per litter (kg)	**1463**
TFE	**2.461**

Model: validate

	Model Prediction	Observed in Beilen
Feed intake during gestation (kg)	339	321
Feed intake during lactation (kg)	145	140
Feed intake during nursery (kg)		28
Feed intake during growing-finishing (kg)		218
Sum of FI of grower-finishers (kg)	3119	
Total feed intake per litter (kg)	**3602**	3586
No animals slaughtered per litter	12.6	
Slaughter weight (kg)	116.3	
Live weight sold per litter (kg)	**1463**	
TFE	**2.461**	**2.450**

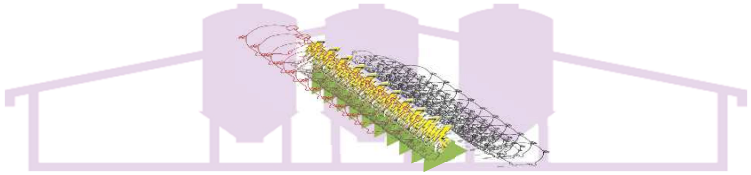
➔ Overestimation model less than 0.5%

Model: evaluate, test sensitivity

	Normal value	+1 std dev	TFE	change in TFE	%	abs%
Baseline, 20 traits			**2.461**			
1 HGP-BF (mm)	15.3	18.3	2.583	0.121	**4.9**	**4.9**
2 Average daily gain (g/d)	730	807	2.380	-0.082	**-3.3**	**3.3**
3 Litter size at farrowing	15.1	18.2	2.406	-0.056	**-2.3**	**2.3**
4 Litter mortality during lactation %	10%	22%	2.497	0.036	**1.4**	**1.4**
5 Body weight at start lactation (kg)	219	253	2.497	0.035	**1.4**	**1.4**
6 Slaughter weight (kg)	116.3	123.8	2.494	0.033	**1.3**	**1.3**
..						
..						
19 Killing out %	78%	80%	2.462	-0.00013	**-0.005**	**0.005**
20 Number of mammary glands	15.1	16.1	2.462	0.00001	**0.000**	**0.000**

Losses

Efficiency of the production system

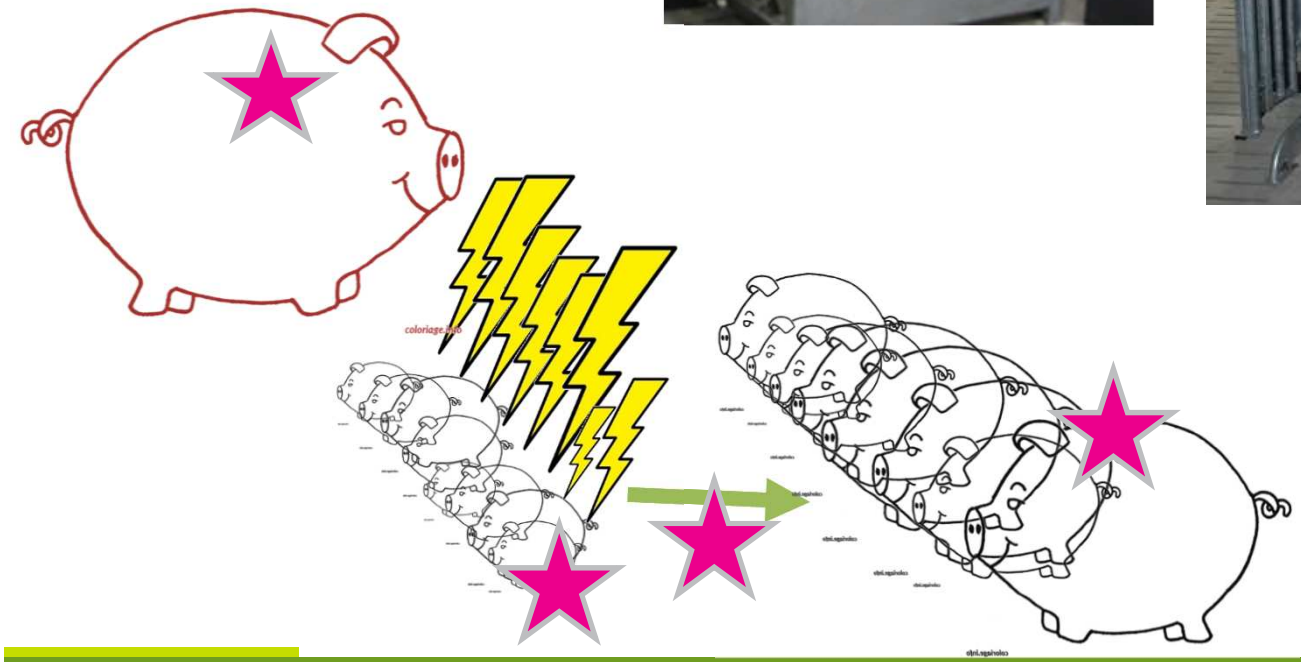


~ Knol 2010

➔ Need models and **measures**

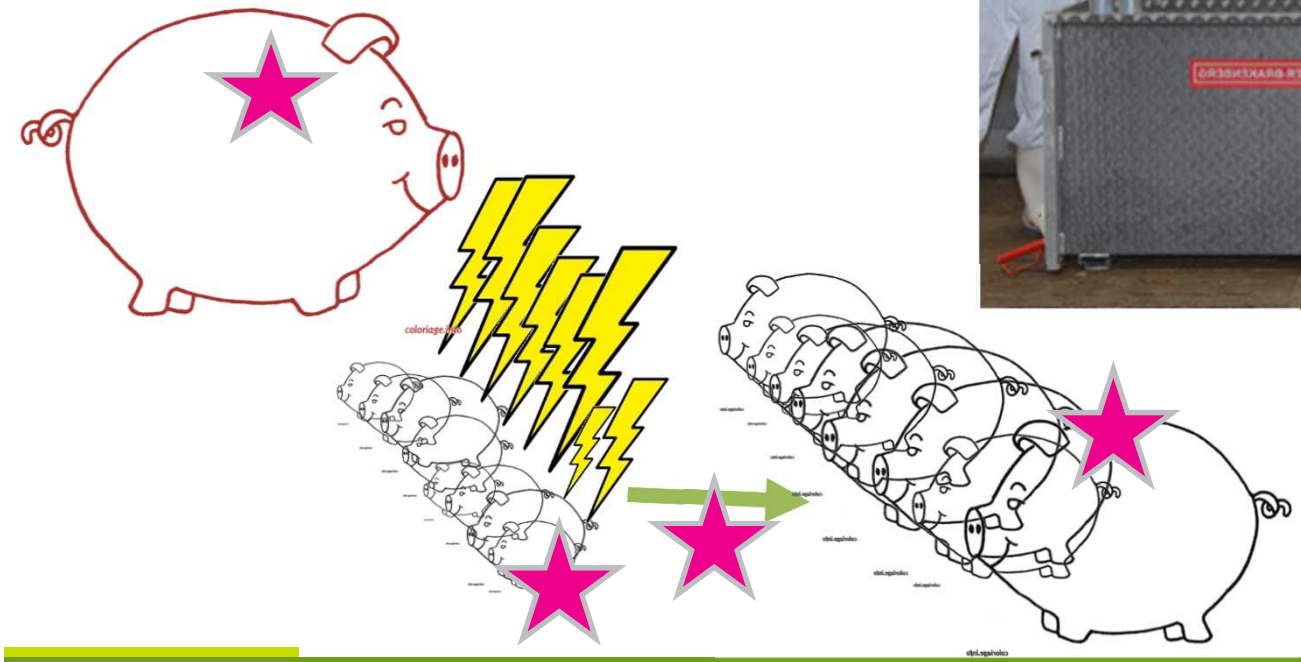
Measures

Animal(s)



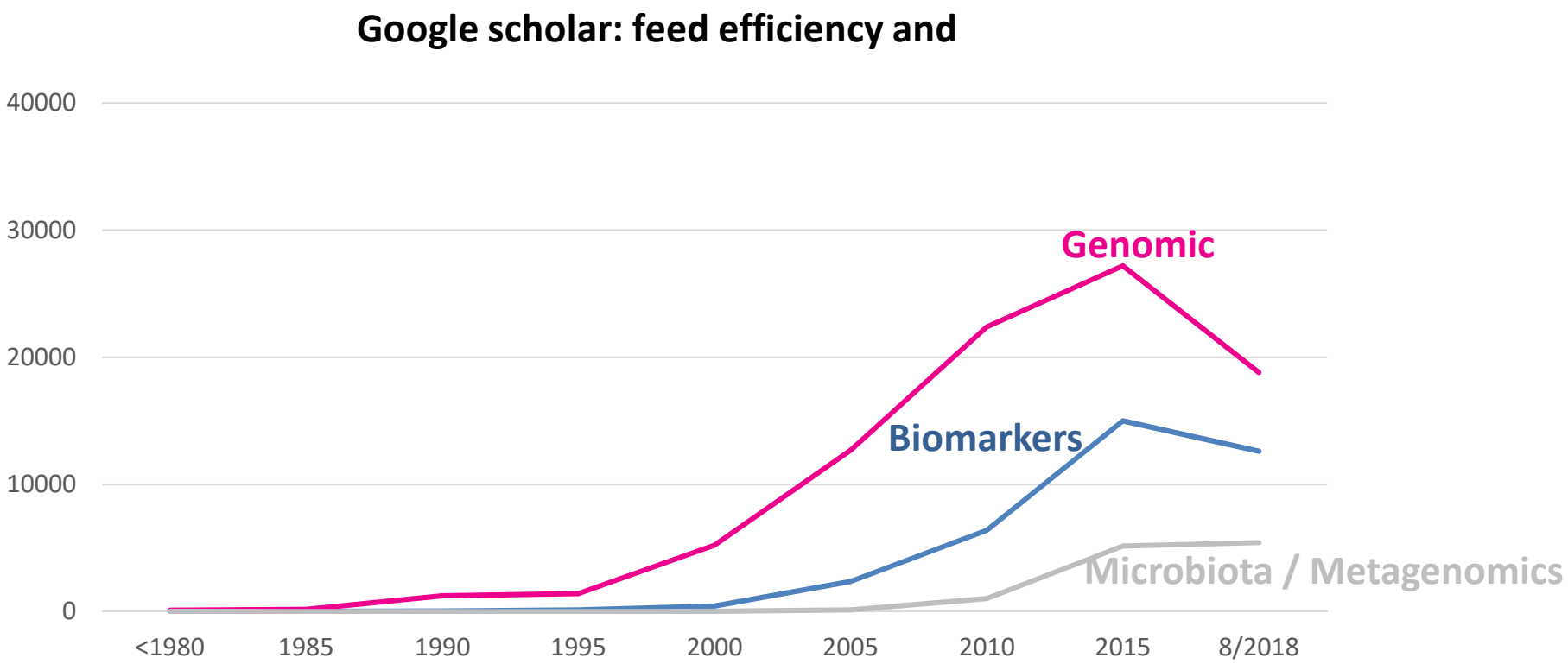
Measures

Animal(s)



Measures or proxy?

Animal(s)



Measures or proxy?

Thousands of biomarkes discovered, how many used in practice?
The biomarker case

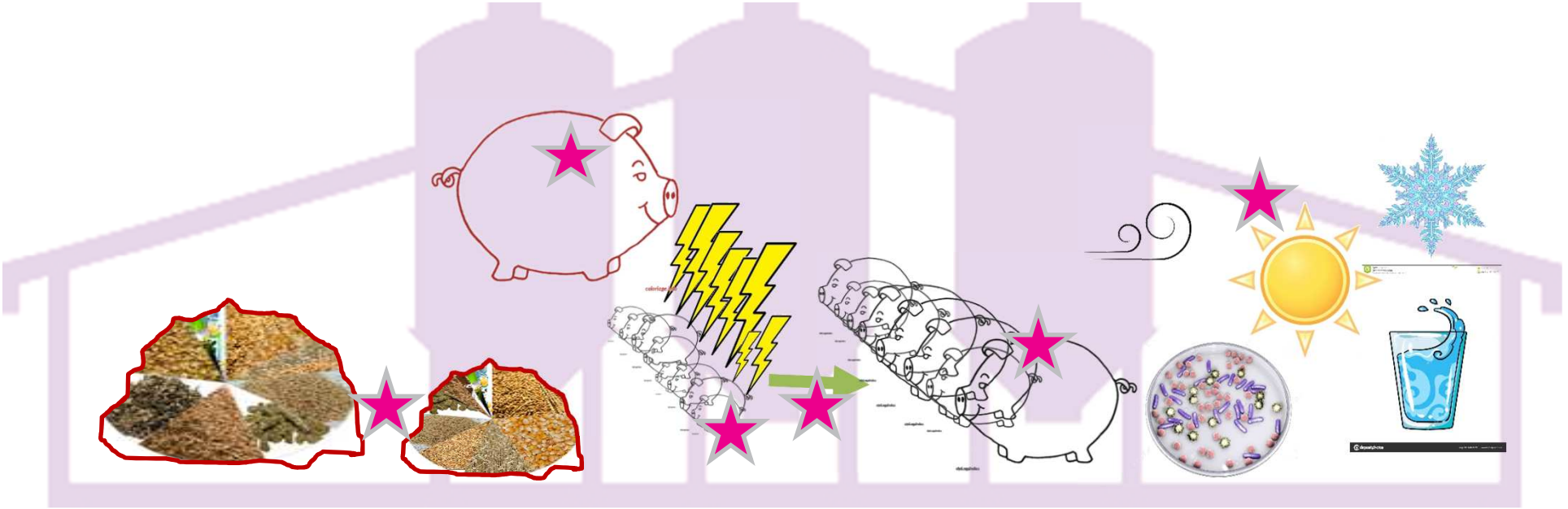
From discovery to use on-farm

Lack of generality in the discovery process?
Lack of decision tools?
Difficulty to quantify potential side effects?

➔ Should/Can we discover on farm?

Measures

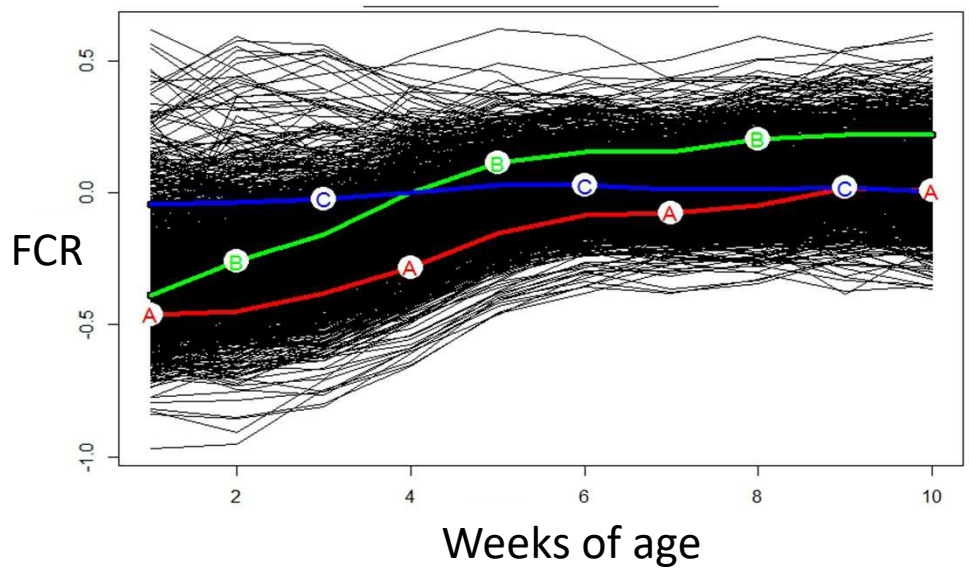
Animal(s) AND environment



Measures and records

Animal(s) AND environments

Time ➔ dynamics of the responses



Huynh Tran et al, 2017

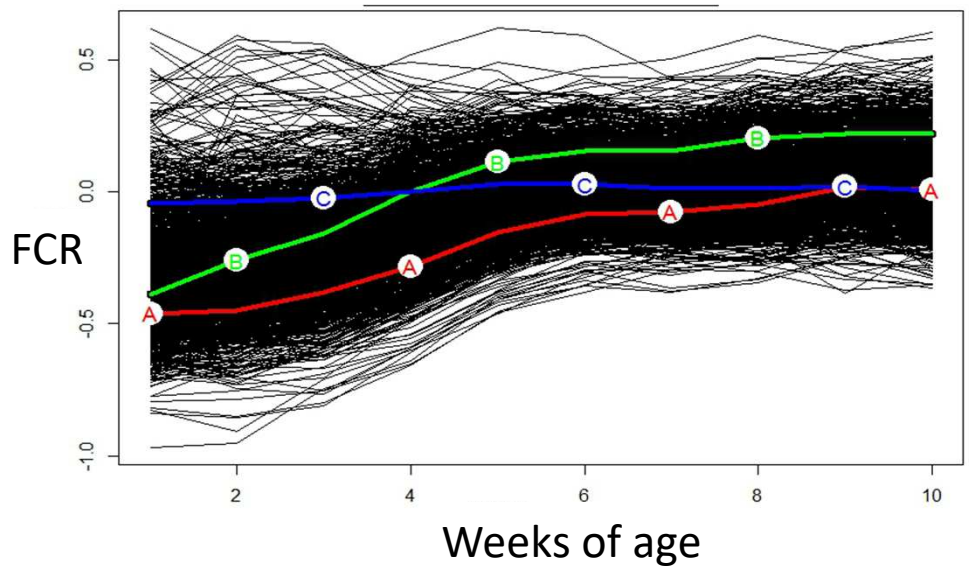
Measures and records

Animal(s) AND environments

Group composition

➔ variability of the group

➔ competition / stimulation interactions

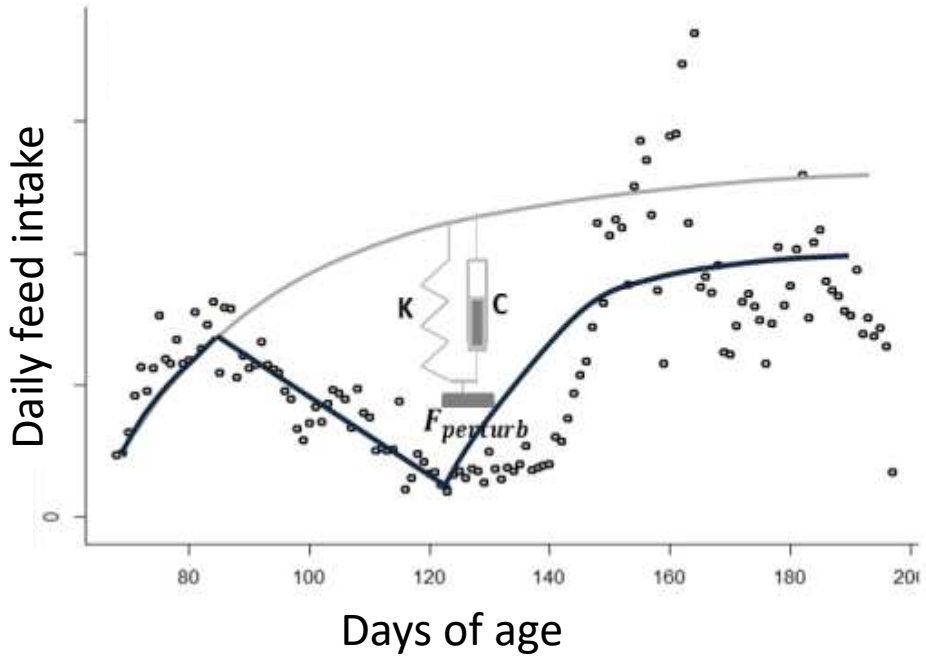


Huynh Tran et al, 2017

Measures and records

Animal(s) AND environments

Treatments / events / changes of environment and management…



Dynamics + individual variability + external events

→ Resilience!

Taghipoor et al, 2017

Why measuring?

- Detect health issues
- Feed according to the requirements – Precision feeding
- Improve the population performance – in multiple E
  - ✓ decision tools needed

Message from pig breeders

- Choose your objective: precision management, health improvement, selection?
- Choose your unit of:
  - Interest: farm, pen, or animal (suggestion: farm)
  - Input: MJ/Kcal; ME/DE; feed/euros/sun
  - Output: kg milk, kg fat+protein

- Choose your measurements, plan the validation and decision tools (biomarkers, image analyses, microbiome…)
    - Choose your efficiency
- Think dynamics and groups
    - Choose your resilience

Message from pig breeders

- Find your system losses: management + animal
- Quantify maintenance requirements and keep them under control
- Quantify the relevance of the production parameters (and cull the lowest 5%, regardless)

- Record, record, record