Nutrition and animal management as part of a global strategy for reducing the environmental impact of pig production

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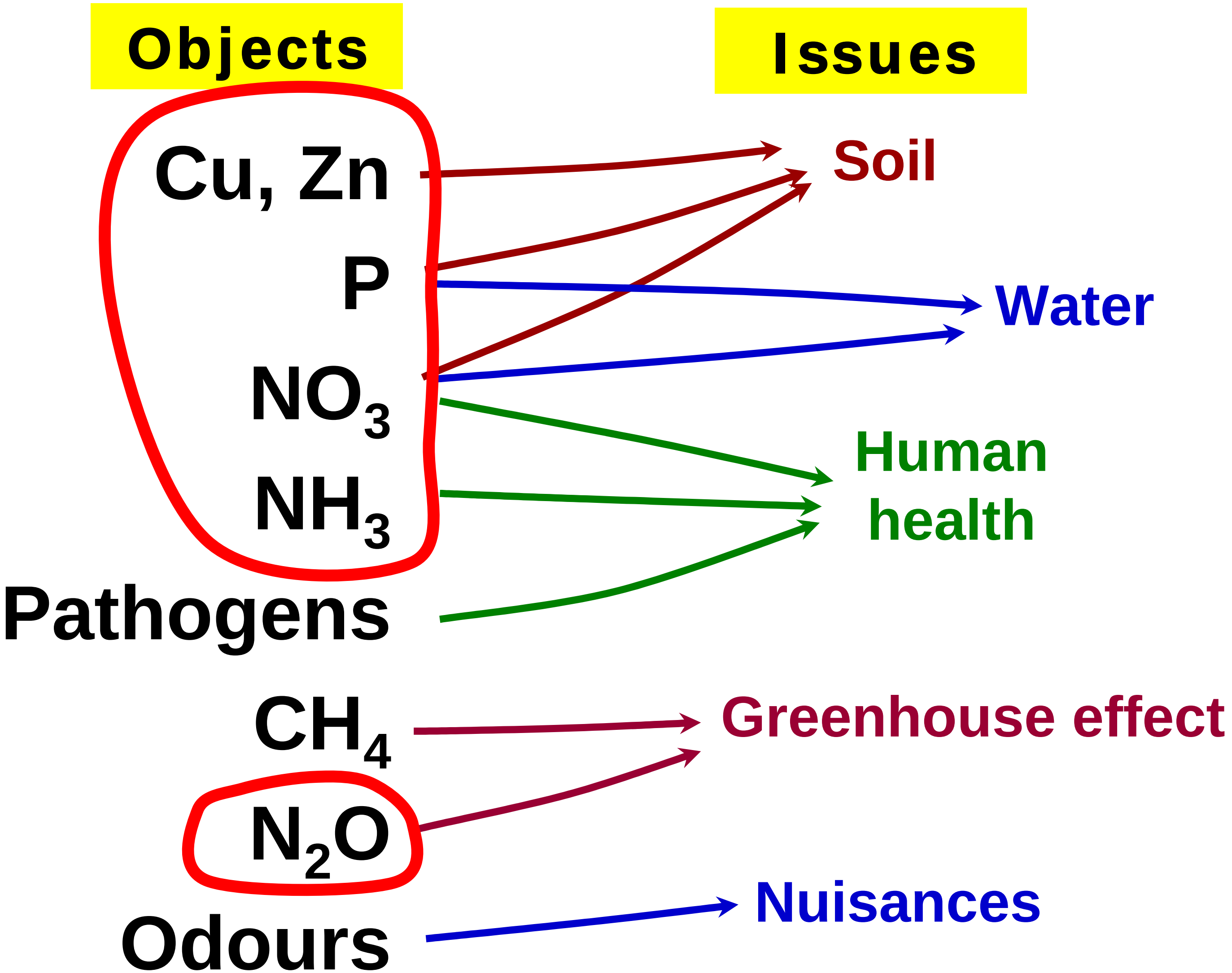
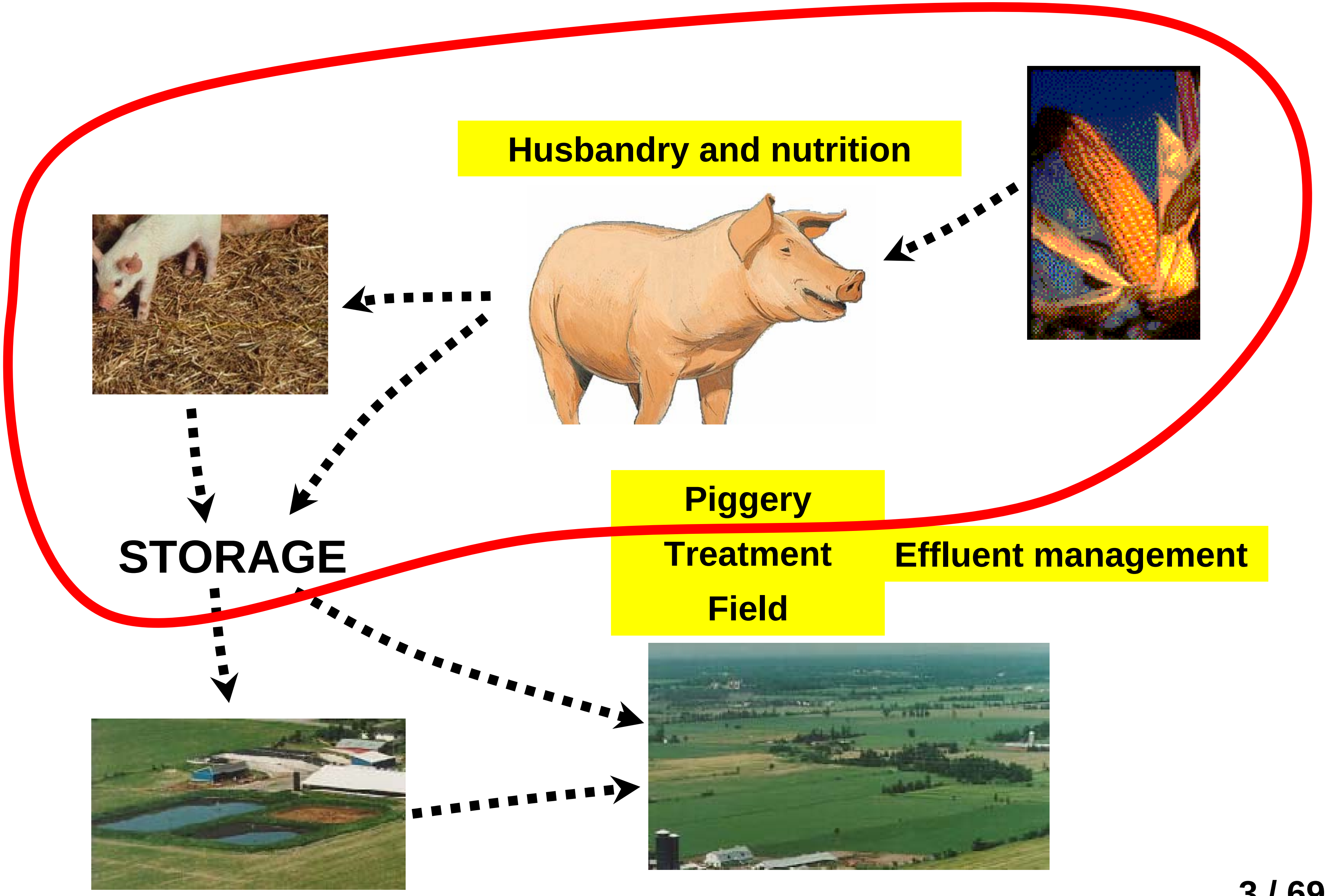
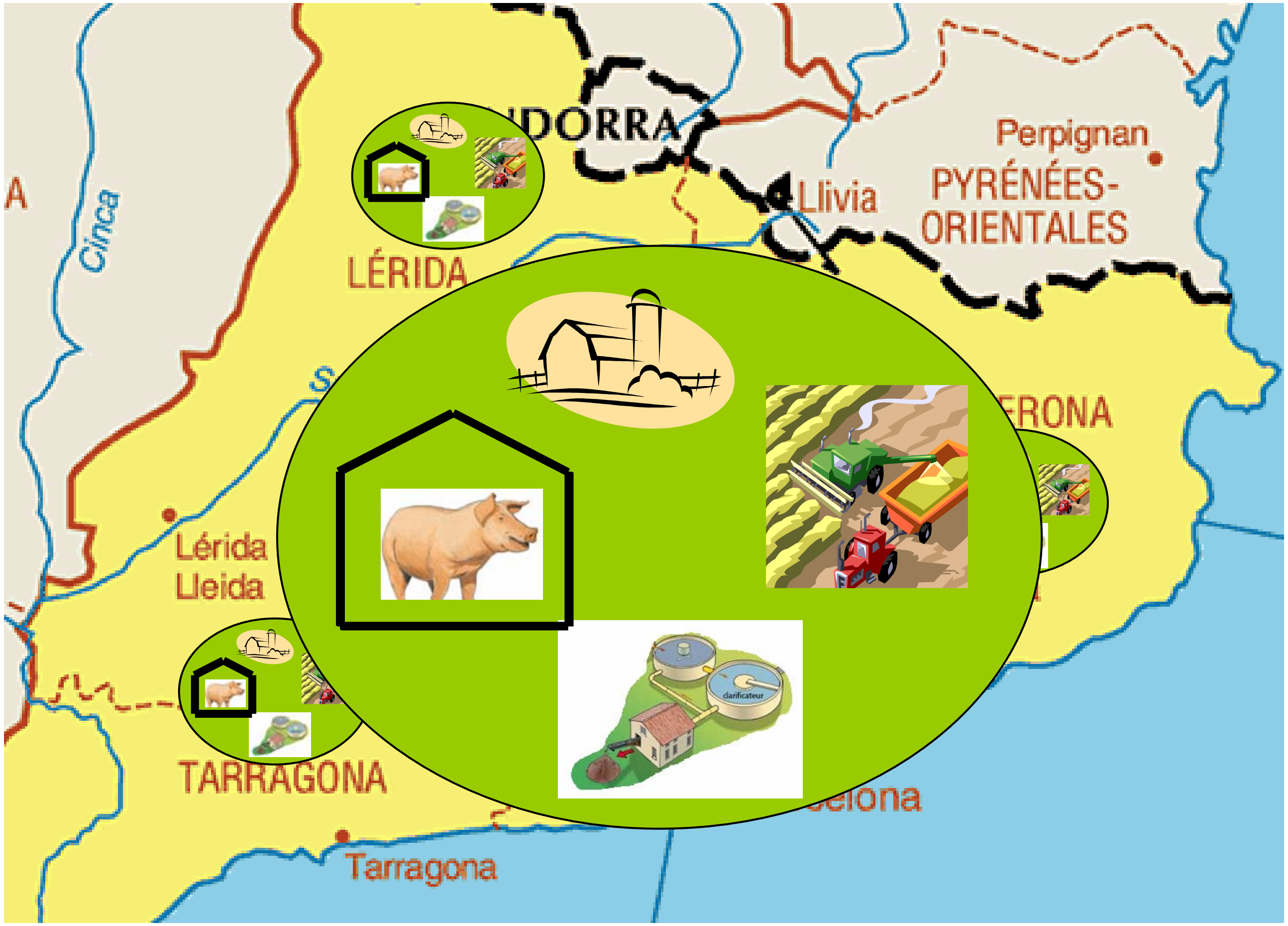
Environmental impact of pig production




Husbandry and nutrition
STORAGE
Piggery
Treatment
Field
Effluent management



ANDORRA
Perpignan
PYRÉNÉES-ORIENTALES
Llivia
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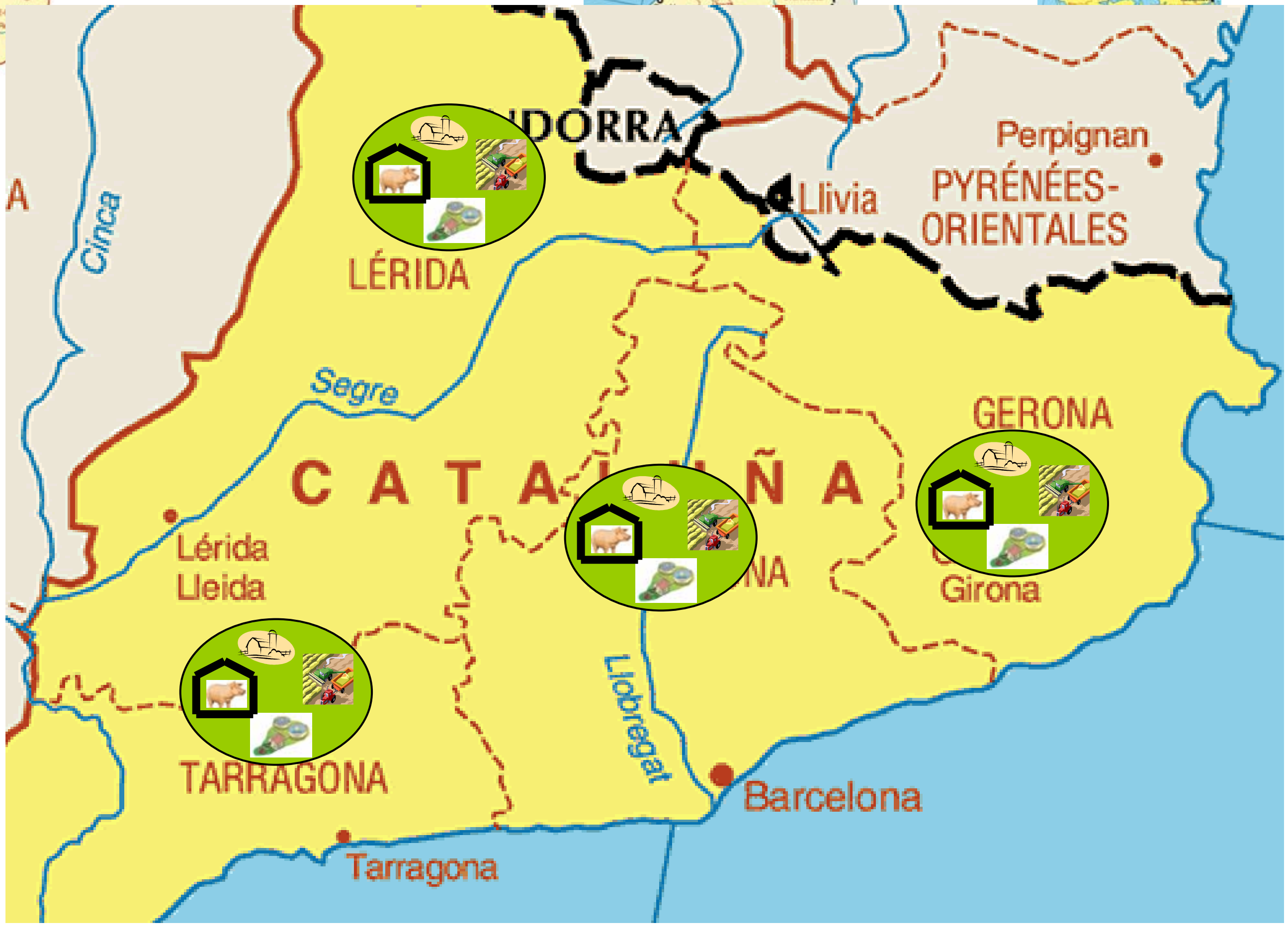
TARRAGONA
Tarragona
clarificateur

The Global Planet



Nutrition and animal management as part of a global strategy for reducing the environmental impact of pig production

- Reducing the output of nitrogen and phosphorus from the animals
- Management of nitrogen output via housing conditions and the use of litter
- Reducing the output of trace elements from the animals
- Optimizing manure management at farm level
- Optimizing manure management at regional level
- Scenarios for environment-friendly pork production

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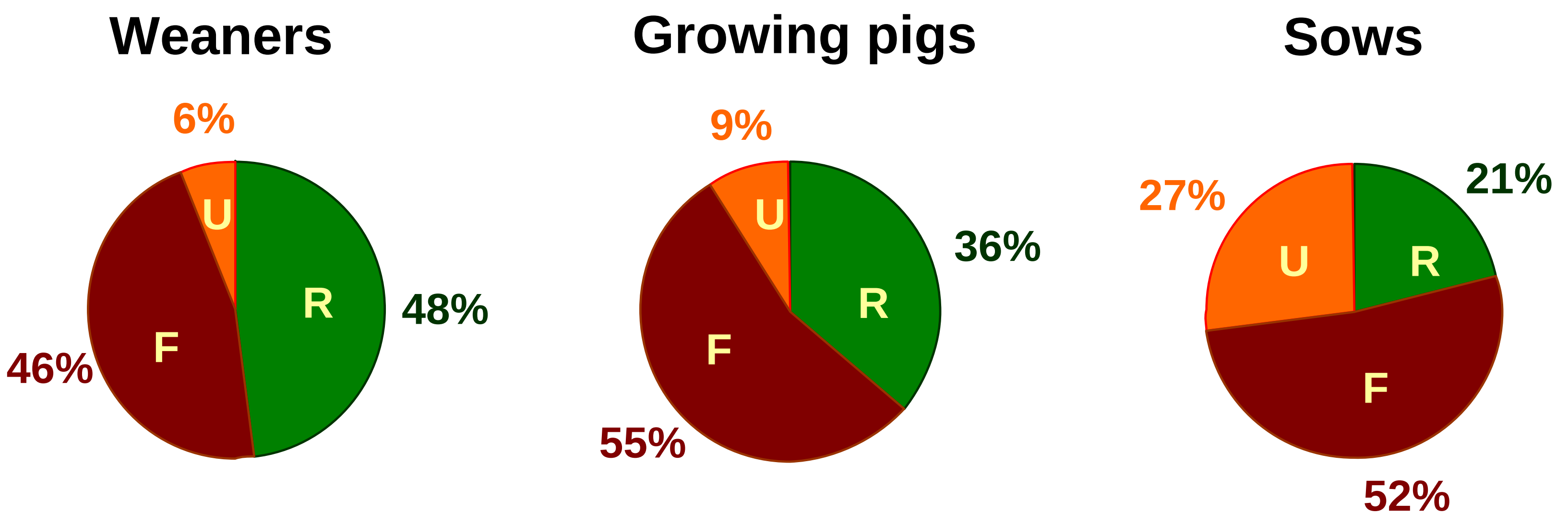
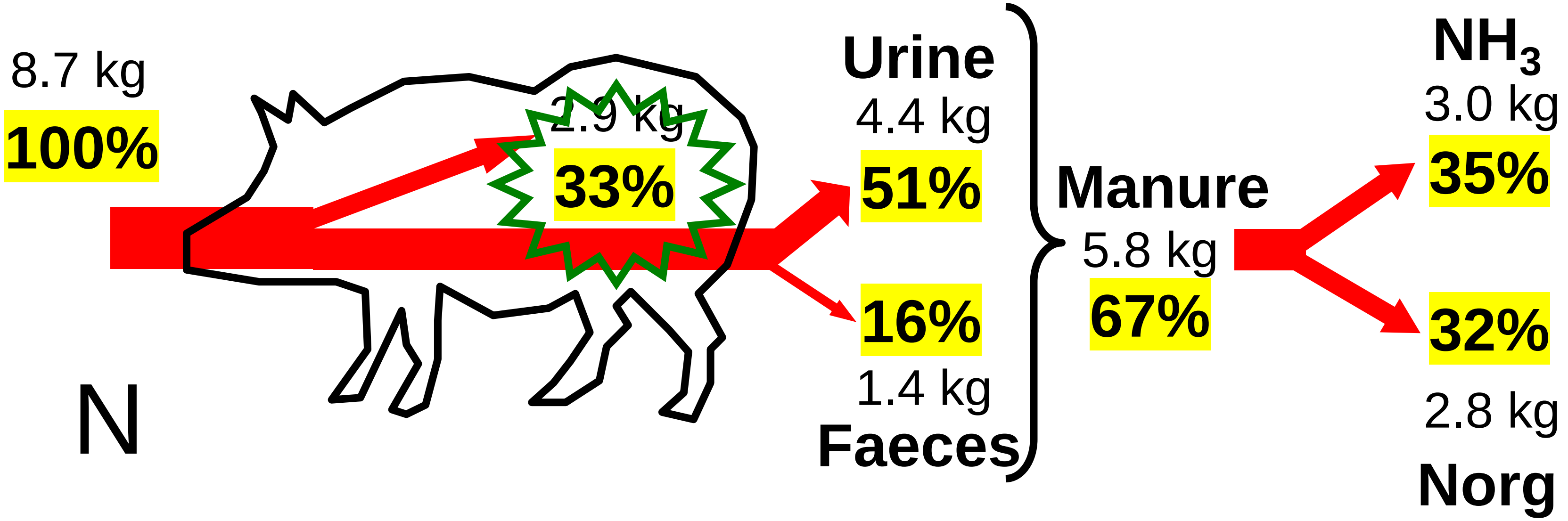
Reducing the output of nitrogen and phosphorus from the animals



P retention is low

Poulsen et al. (1999)

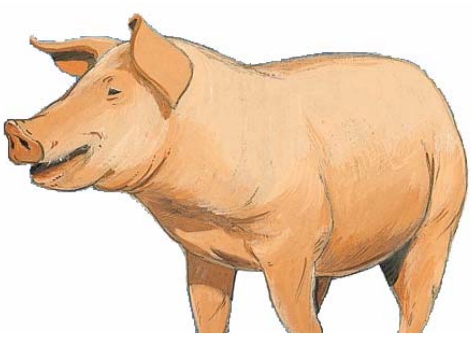
N retention is low



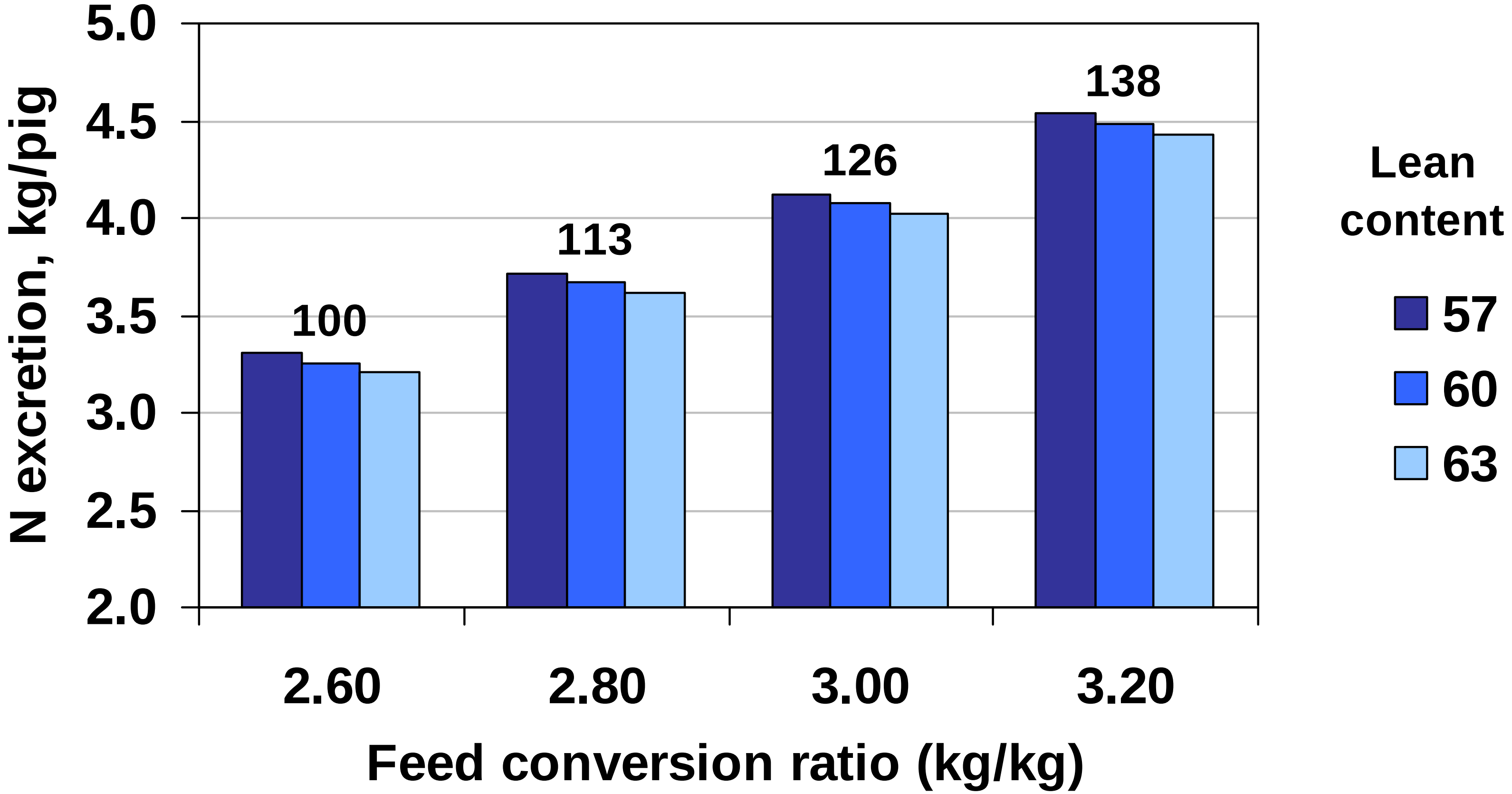
Utilise feed in a more efficient way for the deposition of carcass tissue

Utilise feed in a more efficient way for the deposition of carcass tissue

- Select leaner, faster growing pig
- Improve the availability of nutrients in the feed
- Better fit nutrient allowances to animal requirements

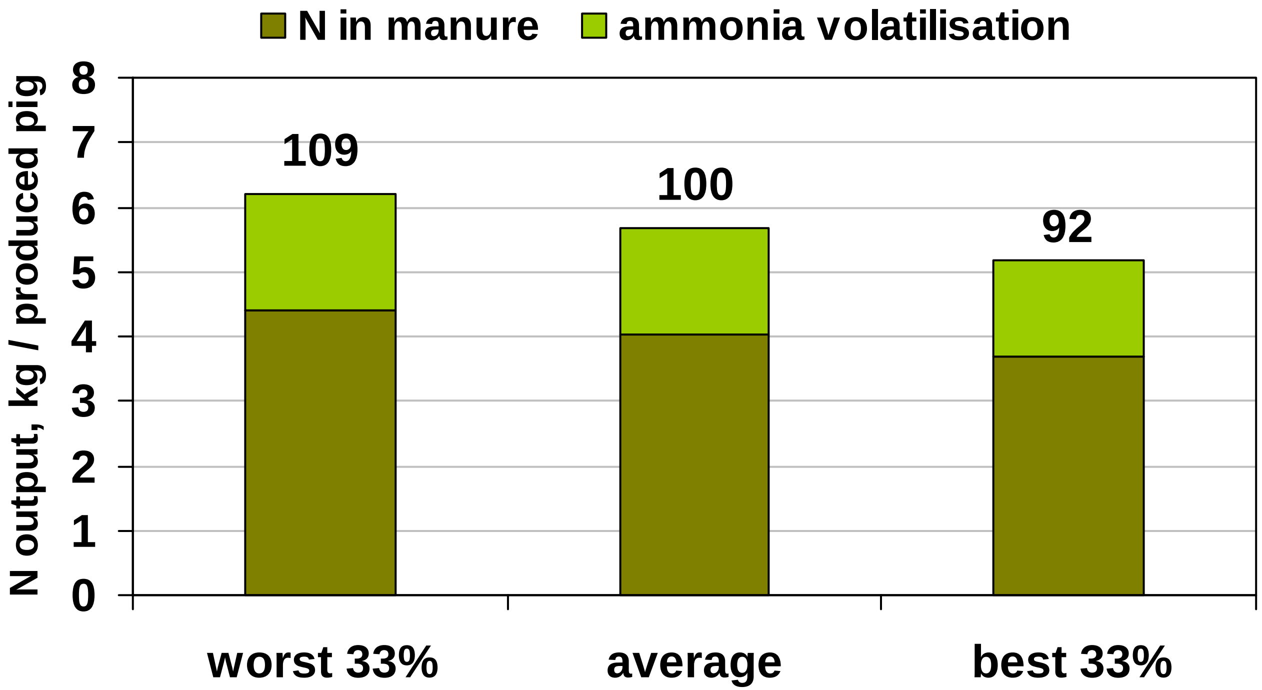


Effect of carcass lean content and FCR on N excretion in growing pigs (30-112 kg)



CORPEN, 2003

Effect of performance* on N output per slaughter pig (farrow to finish unit)



FCR (fattening)	**3.20**	**2.93**	**2.75**
Pigs / sow / year	**18.0**	**20.0**	**22.0**

*** farms are grouped according to gross margin / sow / year**

Dourmad et al. (1999)

Improving efficiency of N utilization : a better fitting of protein supply to the requirements

✓ Improvement of amino acid balance

- Adequate choice of feed ingredients
- Use of industrial amino acids

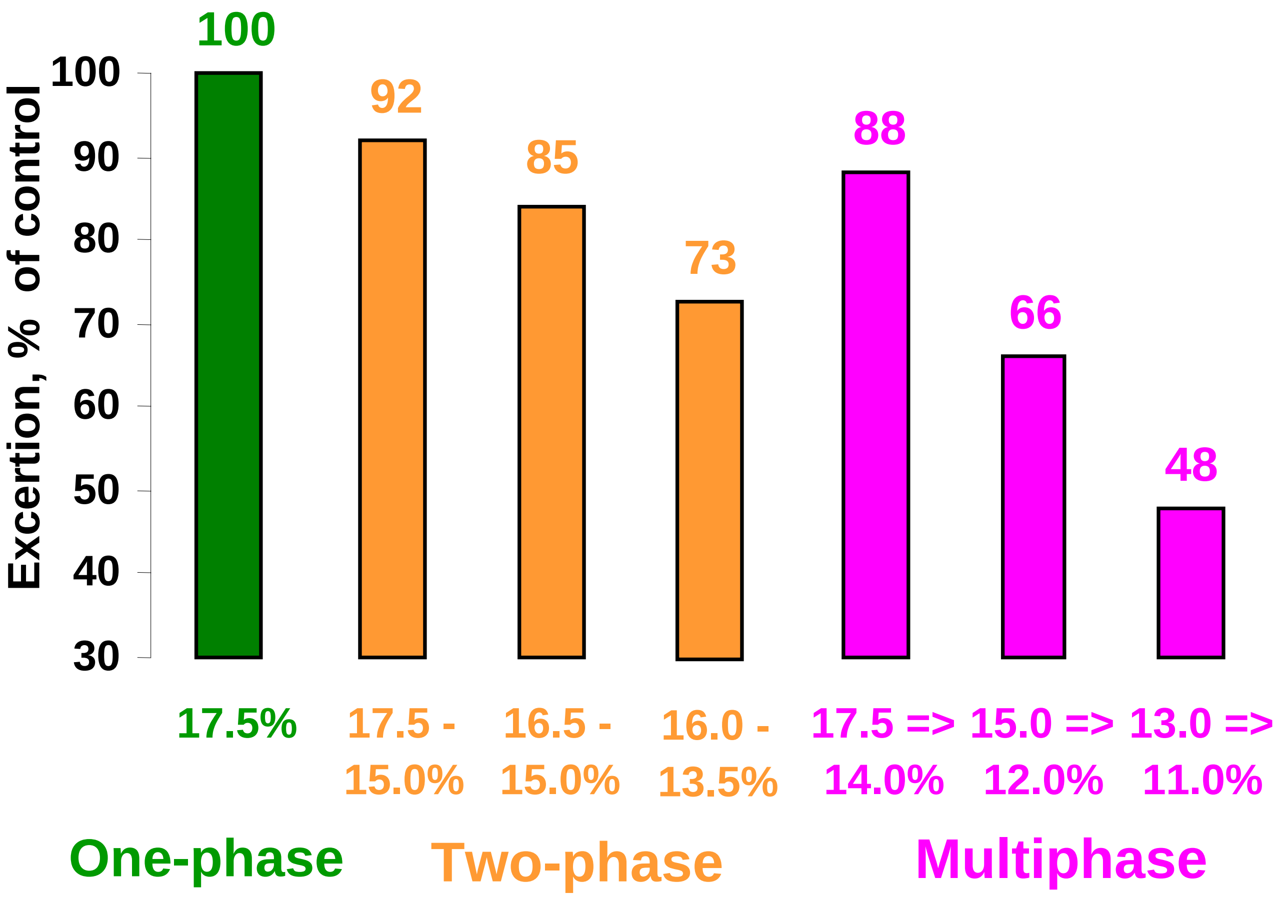
⇒ Requires a precise knowledge of ideal amino acid profile in the protein requirement

✓ Improvement of the feeding strategy

- Change the composition of the diet according to growing stage or physiological status

⇒ Requires a precise knowledge of changes in amino acid requirements over time

Effect of phase feeding and protein quality on N excretion by fattening pigs



Bourdon et al. (1997)

Effect of CP on slurry characteristics and ammonia volatilisation in fattening pigs

	Dietary crude protein content		
	20%	16%	12%
N balance ($g.pig^{-1}.d^{-1}$)			
N Retention	23.2	23.5	21.9
N Excretion	40.7	27.6	15.0
Ammonia volatilis.	17.4	13.8	6.4
N in Soil	23.3	13.8	8.6

Portejoie et al., 2005

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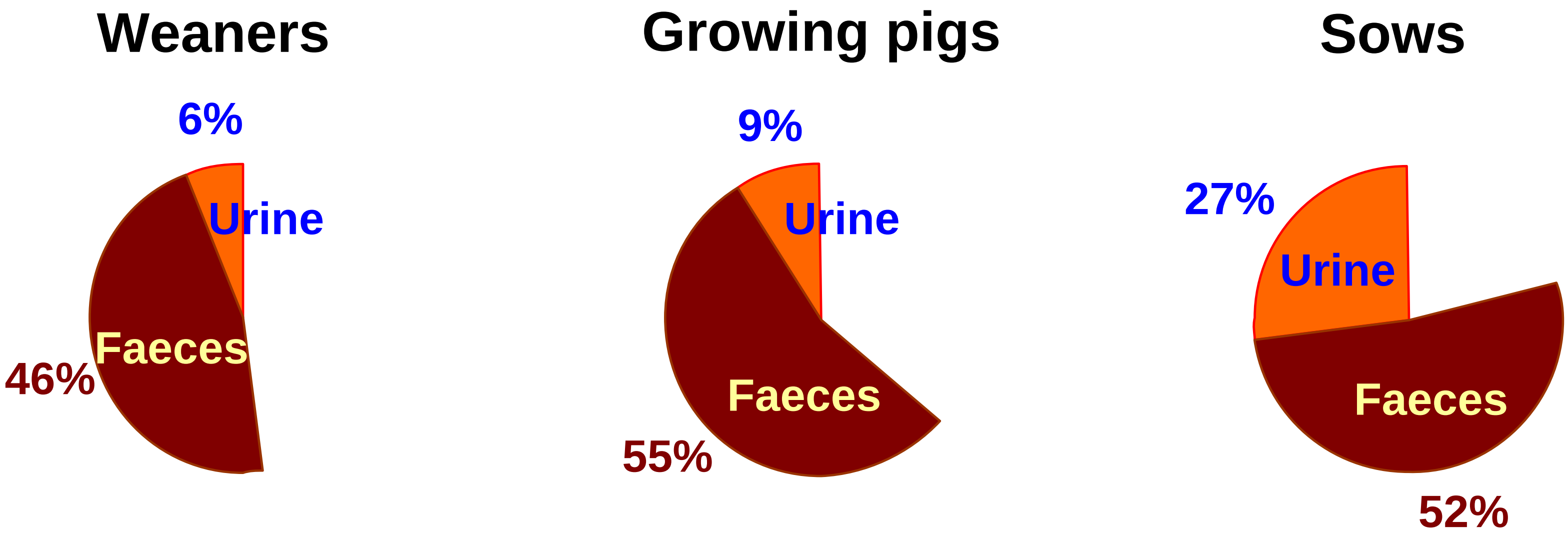
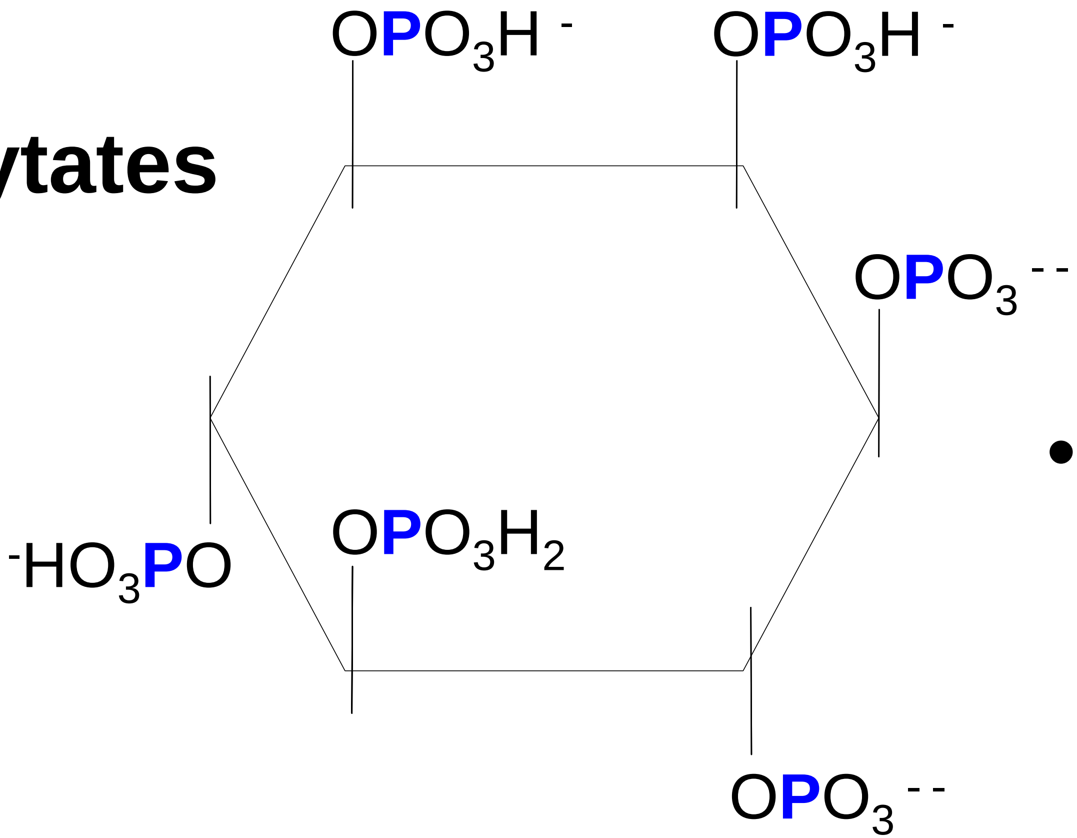


The digestibility of P is low

Digestibility of P in plants is generally low

- **Phytates**



- **Mineral P is added to the diet**

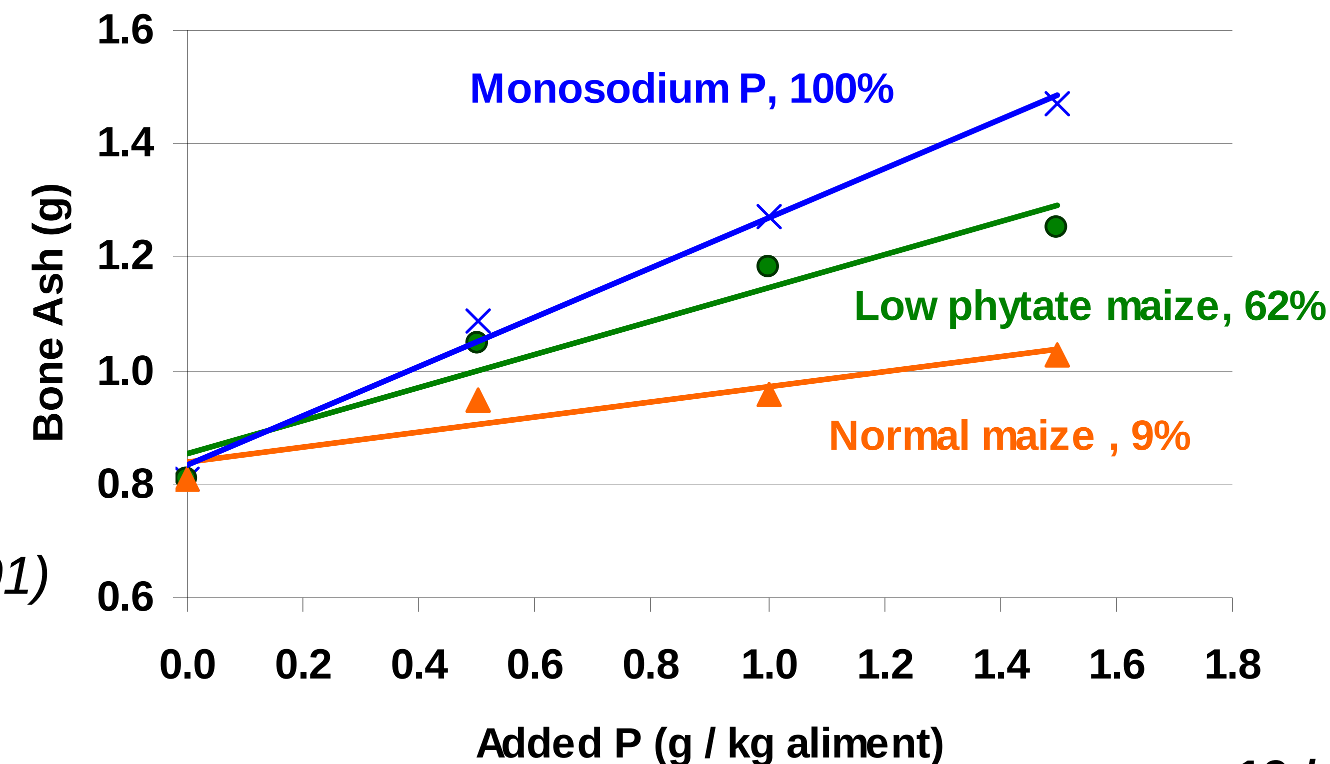
Improving P digestibility

- **Use of highly digestible phosphates**
- **Improve phytic P digestibility**
  - **Pigs expressing salivary phytase :**
    Phytic P almost totally digested
  - **Low phytate cultivars (maize, barley)**
  - **Microbial phytase**

Improving P digestibility :

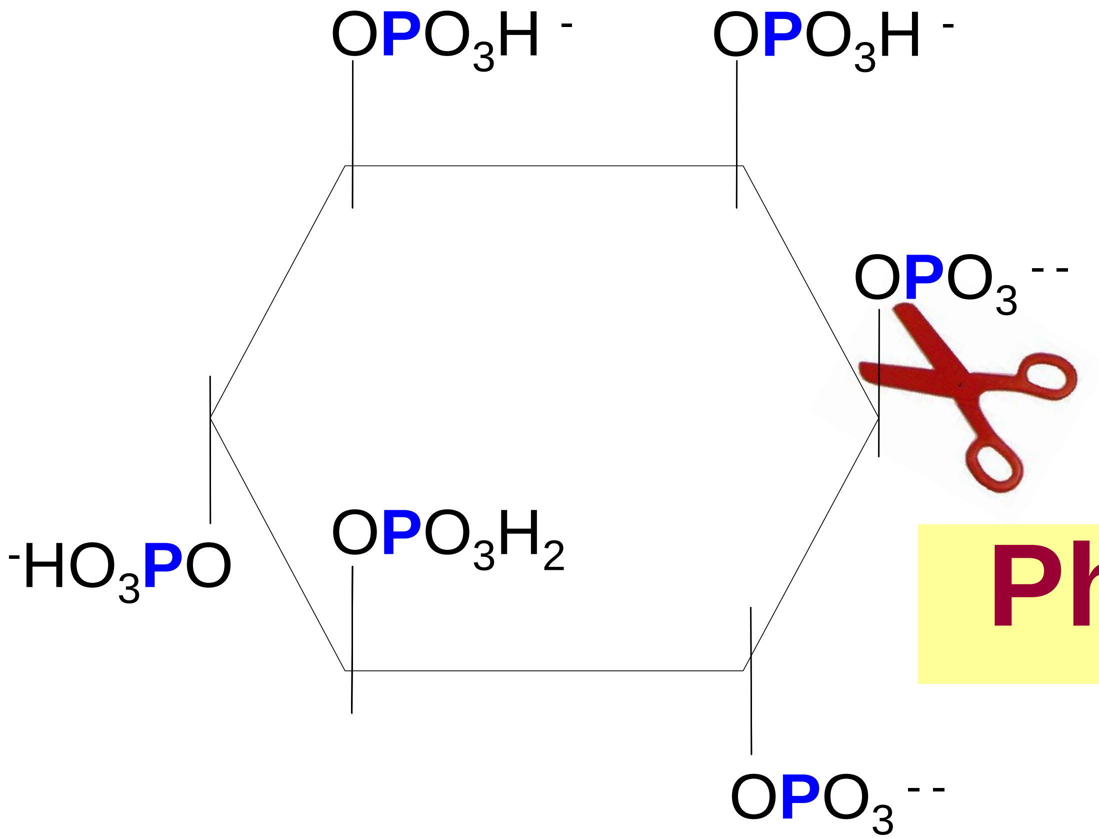
Low phytate cultivars

Maize	Normal	« low phyt. »
Total P (g / kg)	2.5	2.8
Phytic P (% total P)	80	36



Spencer et al. (2001)
weaned piglets

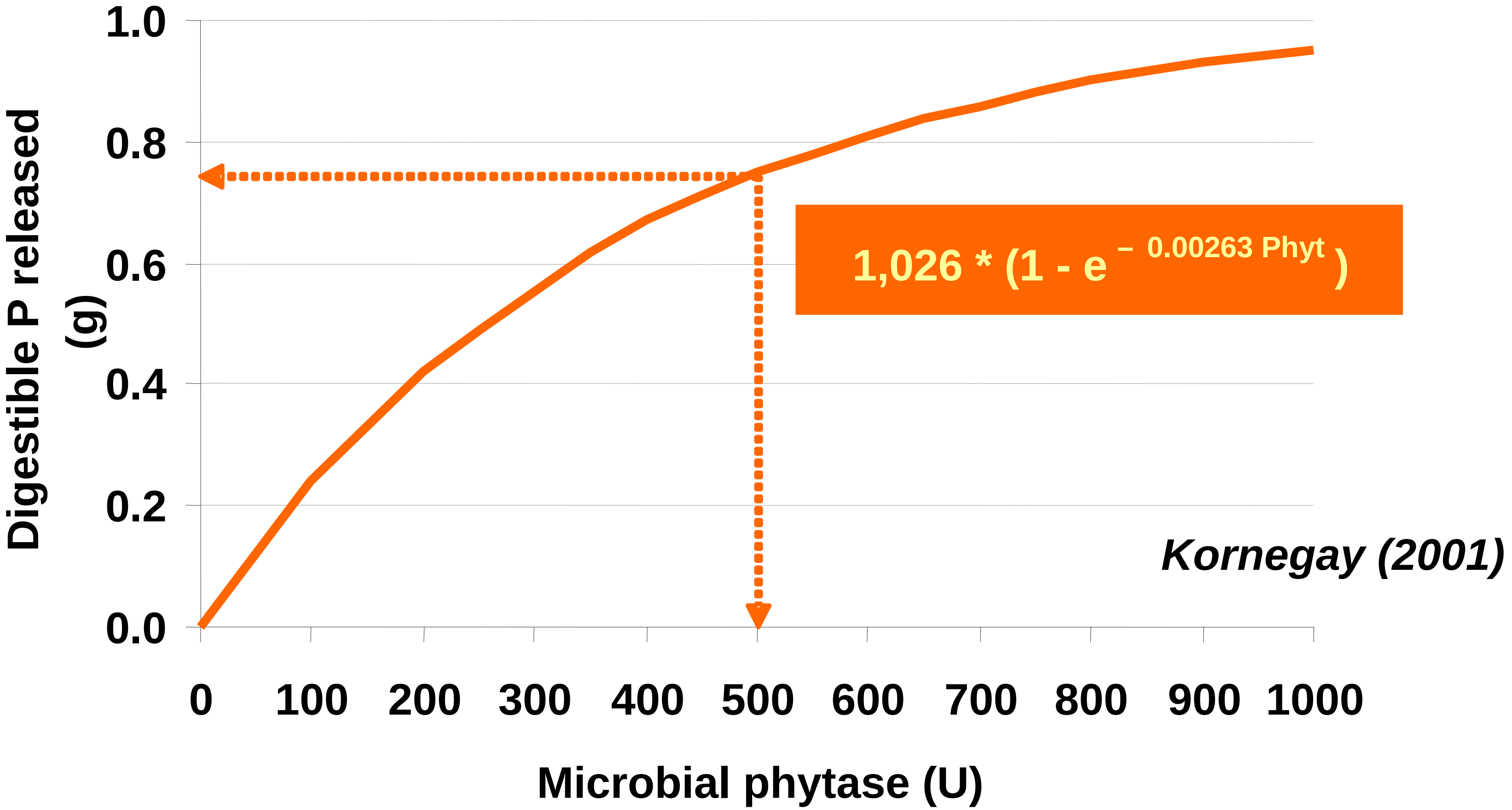
Improving P digestibility : microbial phytase



Phytase

Improving P digestibility :

Microbial phytase



500 U ≈ 0.65 to 0.75 g dP

Effect of three strategies for phosphorus feeding on growth performance and P excretion in growing-finishing pigs

	Basal	Min.P	Phytase
P content, g/kg	3.9	5.2	3.7
Phytase activity (FTU/kg)	210	205	735
Average daily gain, g	764[a]	805[b]	795[b]
Feed conversion ratio	2.73	2.65	2.66
Bone breaking strength, N/m[1]	11.9[a]	13.7[b]	14.3[b]
Volume of slurry, l/pig	358	337	331
P in slurry, kg/pig	0.36	0.50	0.26

Latimier et al., 1994

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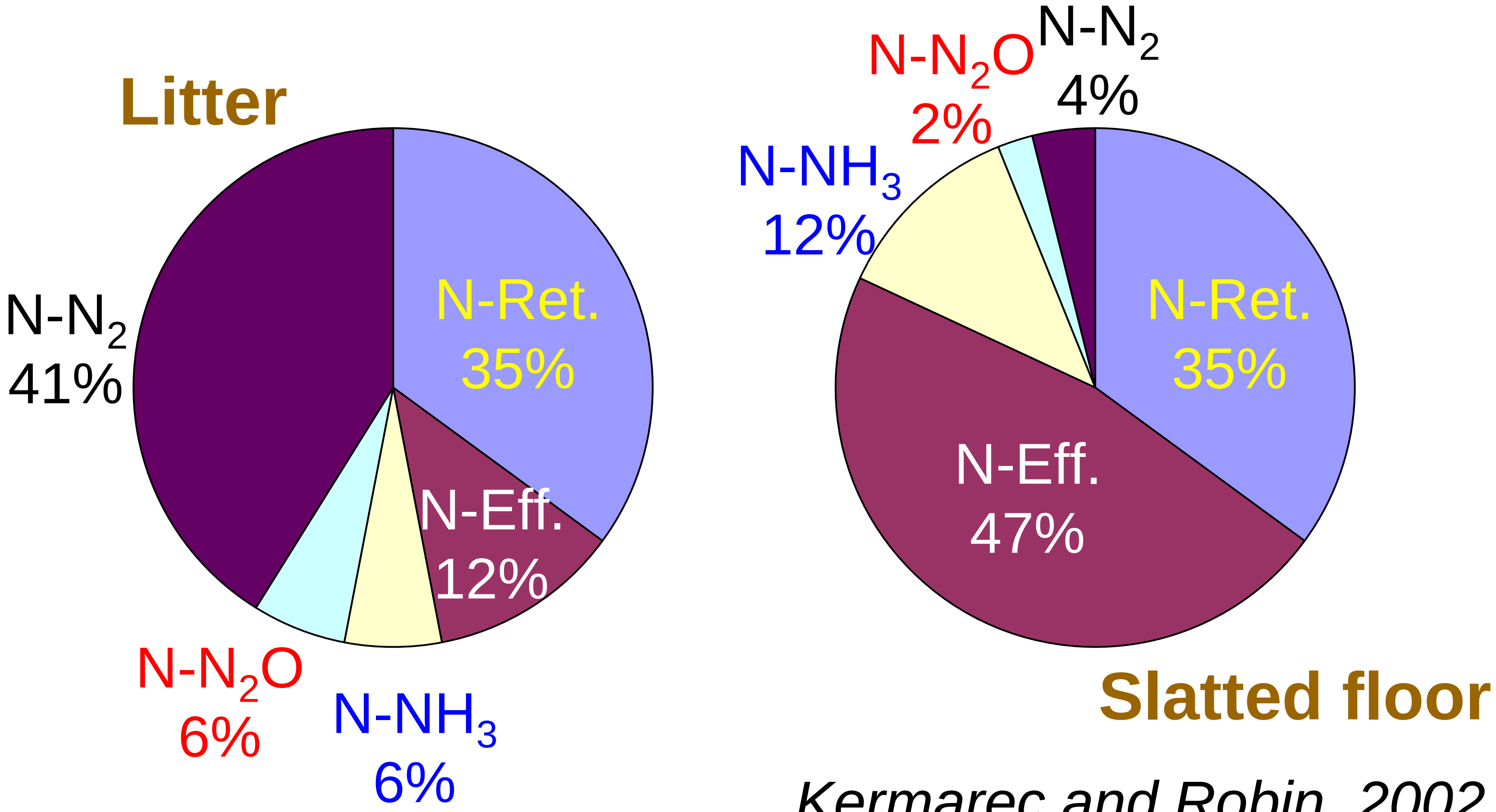
Nitrogen : Litter vs Slatted floor



Kermarec and Robin, 2002

Experimental facilities

Nitrogen : Litter vs Slatted floor

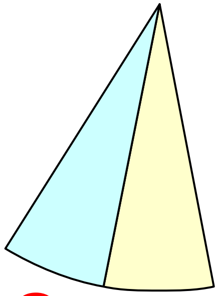
Litter

$N-N_2O$
1-8%

$N-NH_3$
10-16%

Commercial farms

Hassouna et al., 2005



$N-N_2O$
6%

$N-NH_3$
6%

Experimental facilities

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Trace elements:

Copper and Zinc

- ☑**Cu and Zn oversupplied in pig feeding**
  - **To avoid digestive pathology**
  - **Environmental pollution**
    (accumulation in soils)

Animal requirements and maximal incorporation rate of Cu and Zn in diets for piglets and growing-finishing pigs

	Recommendations			
	NRC (1998)	INRA (1989)	BSAS[a] (2003)	EU regulation (2004)
Copper (ppm)				
piglets(8-28 kg)	6.0-5.0	10	6	<170
growing pigs(28-60 kg)	4.0	10	6	<25
finishing pigs(60-110 kg)	3.5	10	6	<25
Zinc (ppm)				
piglets(8-28 kg)	100-80	100	100	<150
growing pigs(28-60 kg)	60	100	100	<150
finishing pigs(60-110 kg)	50	100	100	<150

[a]*to be added to the diet*

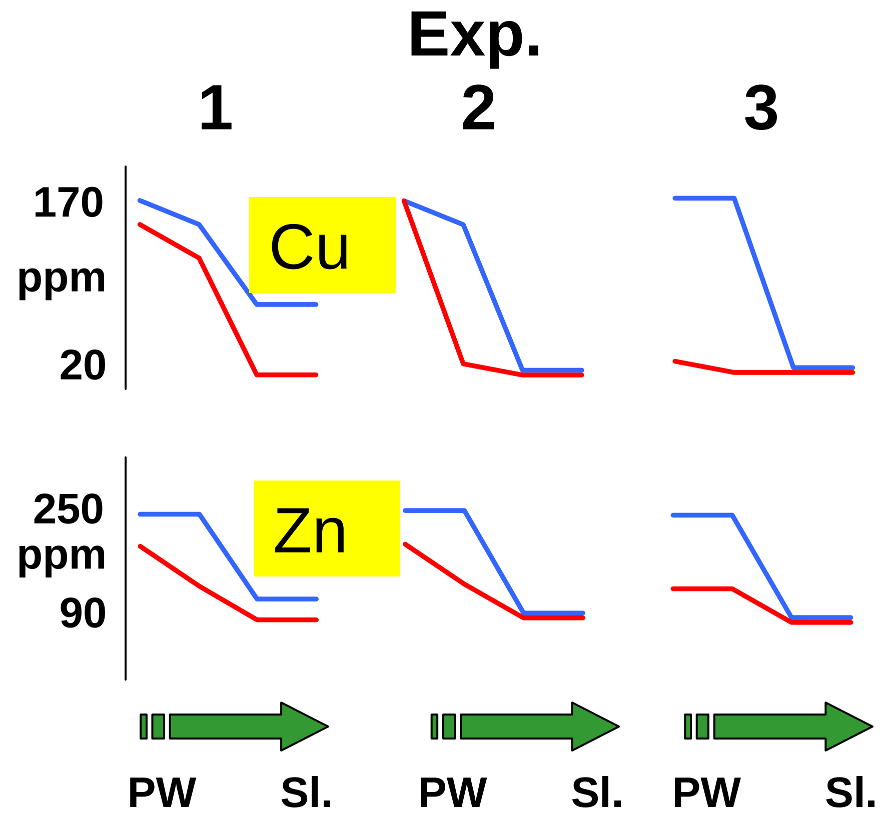
Reducing the output of trace elements

- **Better knowledge of requirements**
  - ✓ Deposition ? **Low**
  - ✓ Overall health status / immunity ?
  - ✓ Prevention of digestive disorders ? **High**
- **Improvement of availability to pigs**

Excretion in slurry g / pig

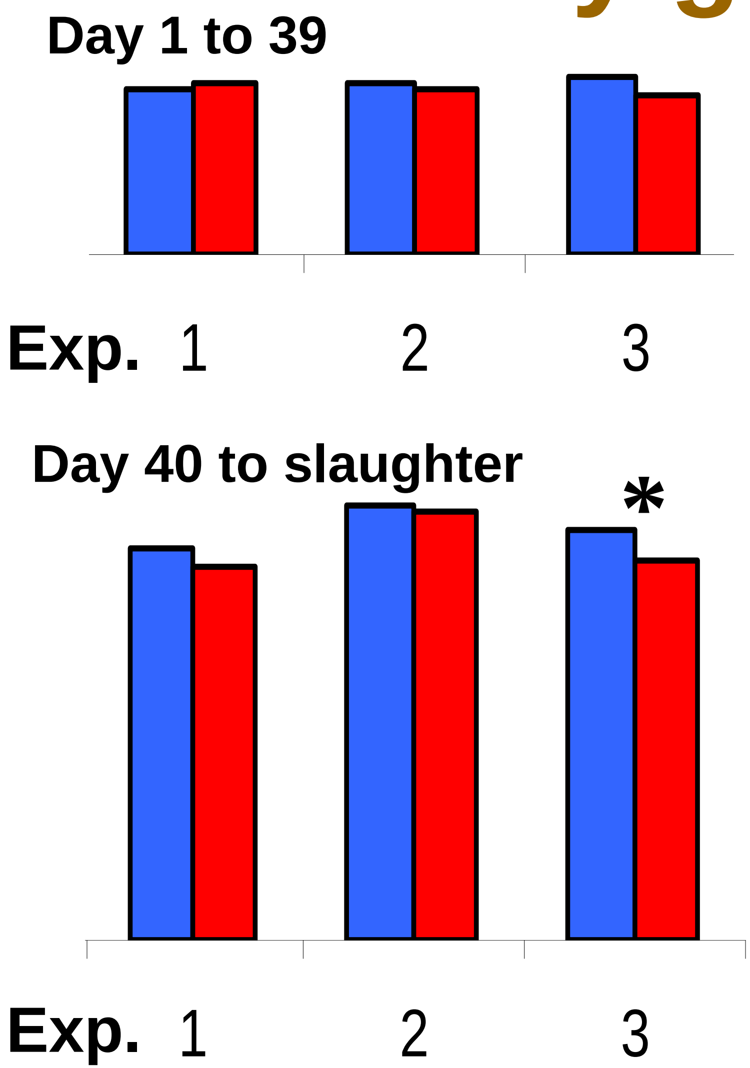
Cu	Exp. 1	Exp. 2	Exp. 3
Ctrl	17	7	7
Low	7	5	4

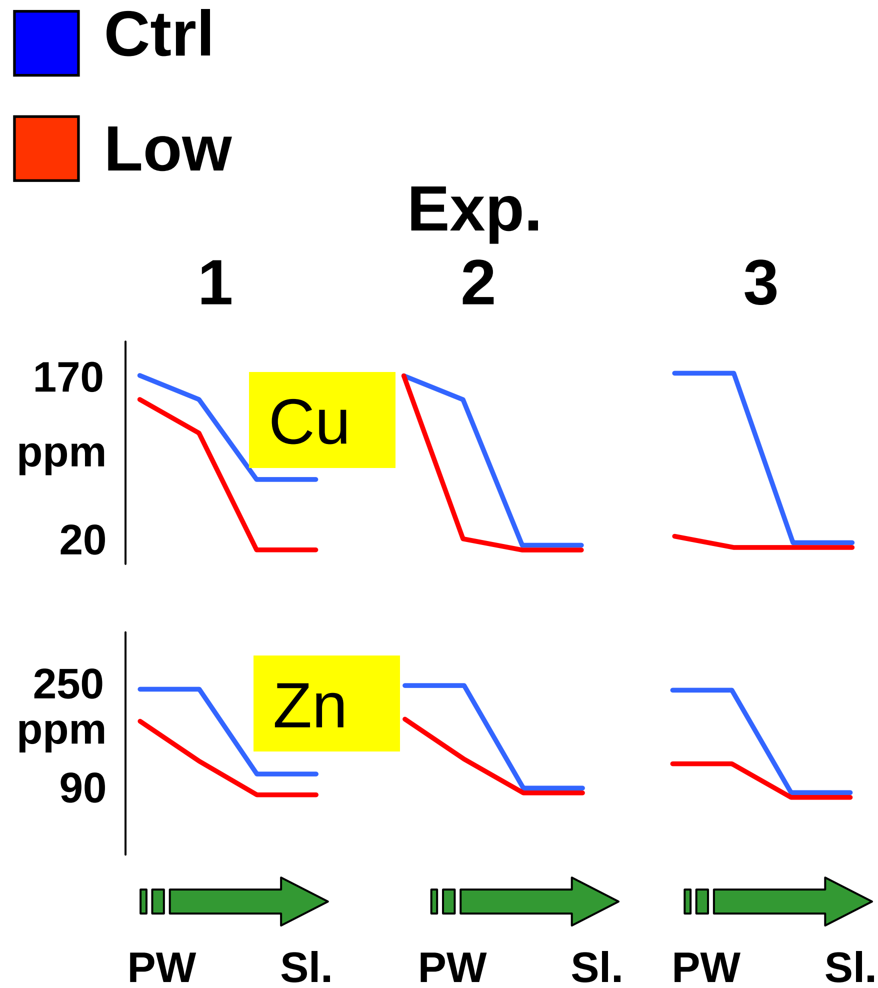
Zn	Exp. 1	Exp. 2	Exp. 3
Ctrl	25	20	23
Low	21	18	19



Paboeuf et al., 2005

Daily gain

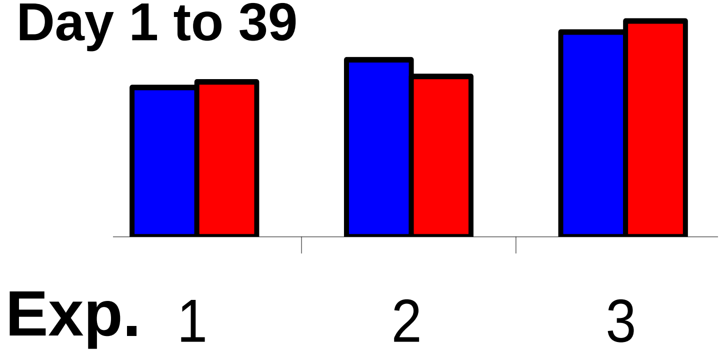




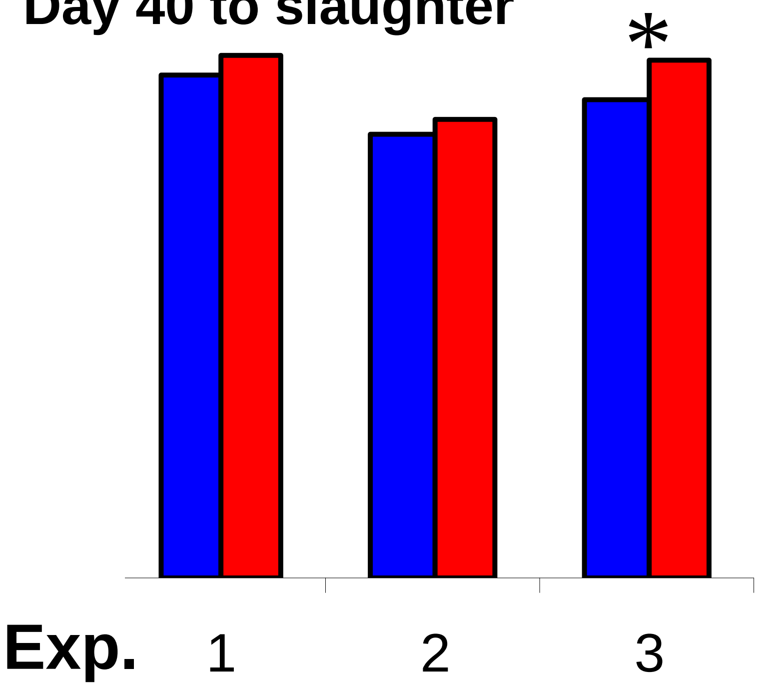
Paboeuf et al., 2005

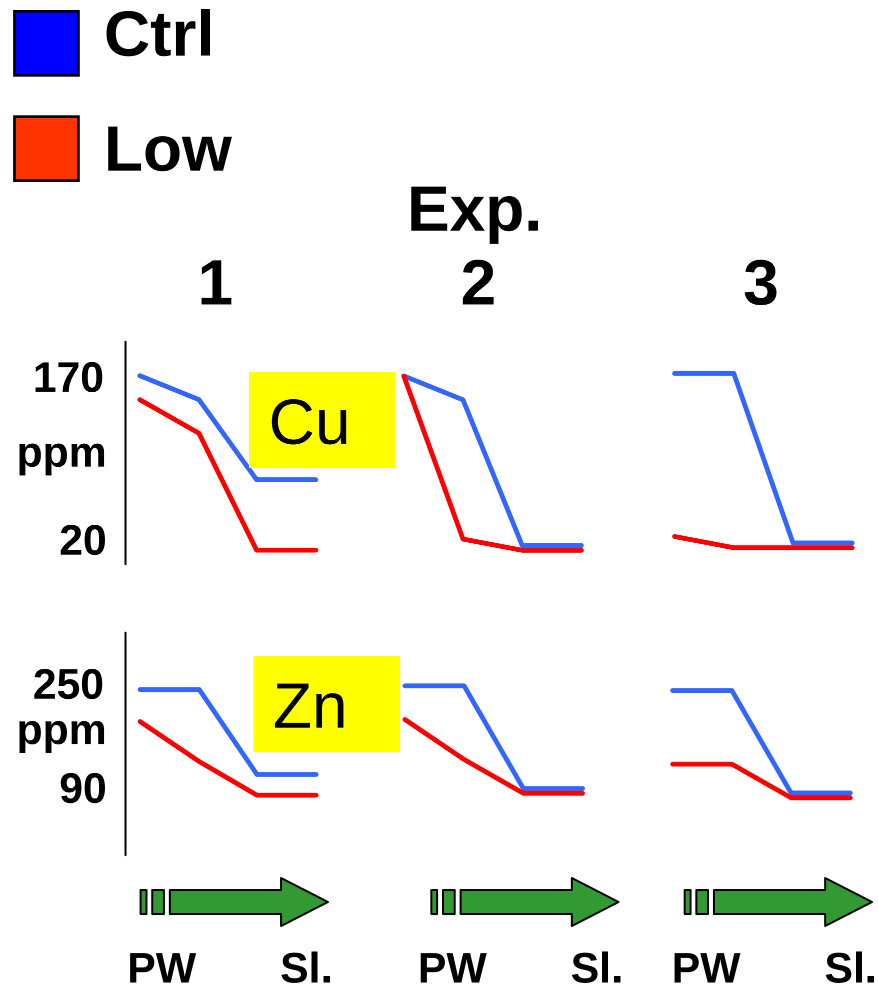
Feed conversion ratio

Day 1 to 39



Day 40 to slaughter

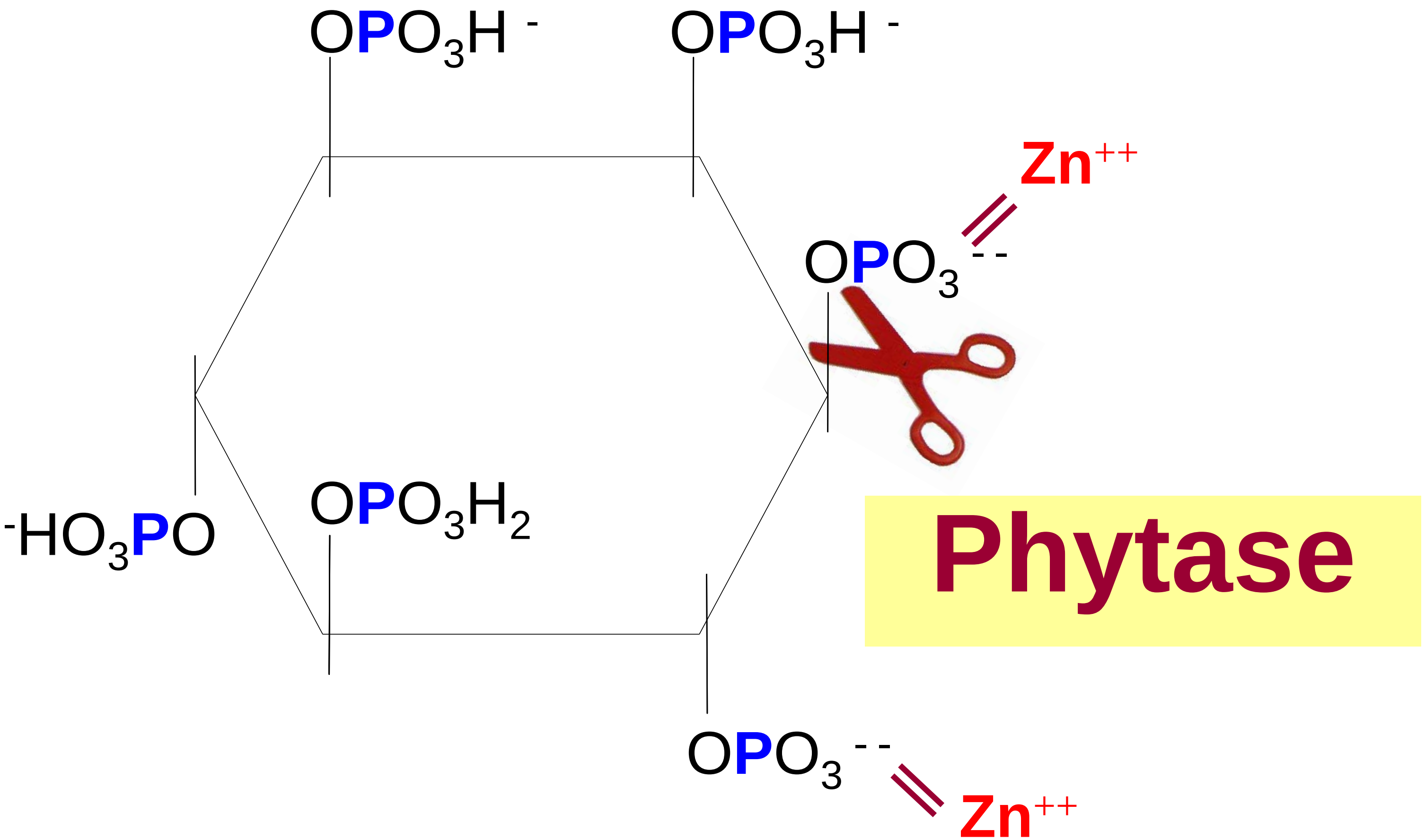




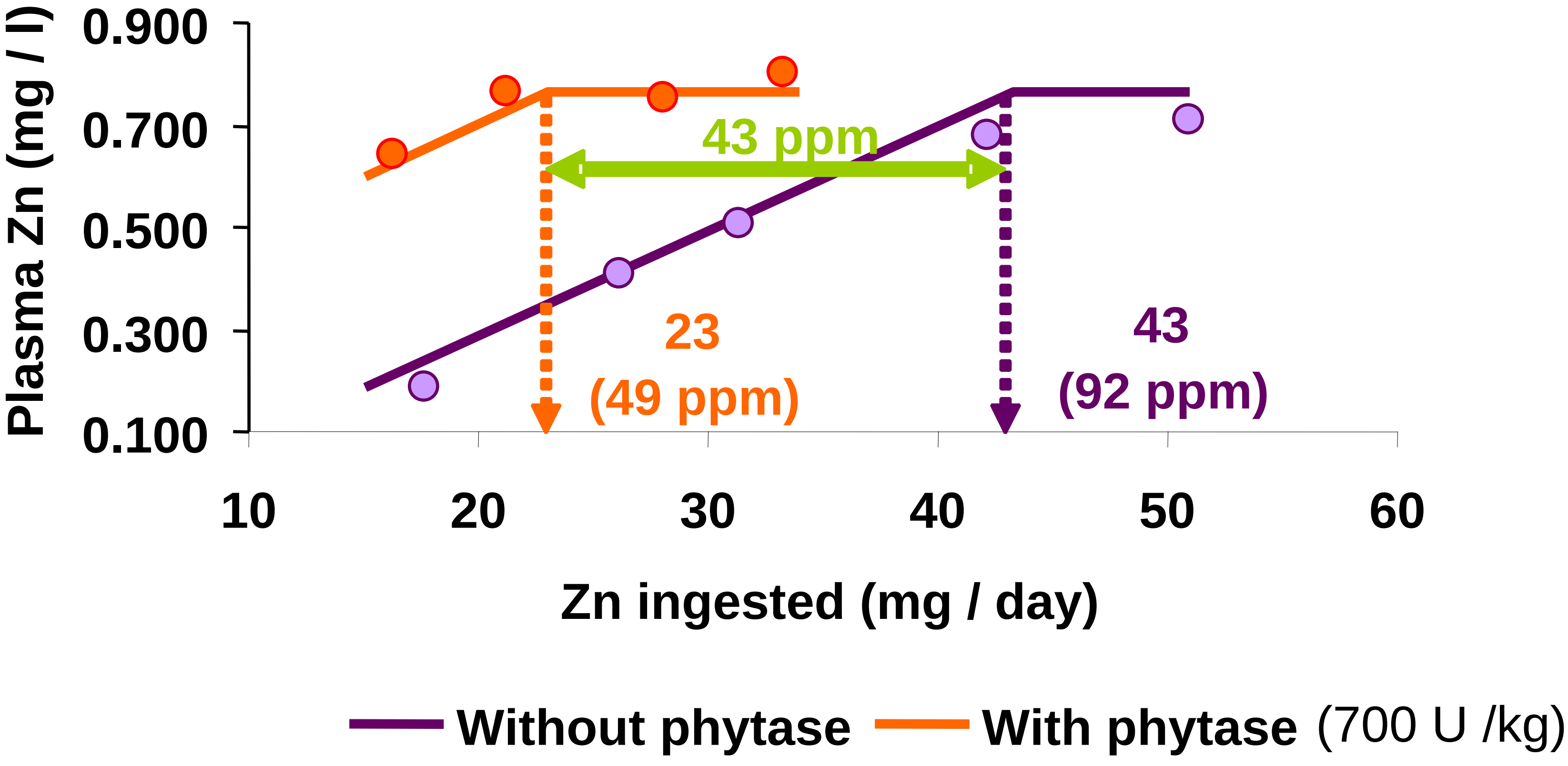
Paboeuf et al., 2005

Improving Zn availability

- **Phytates**



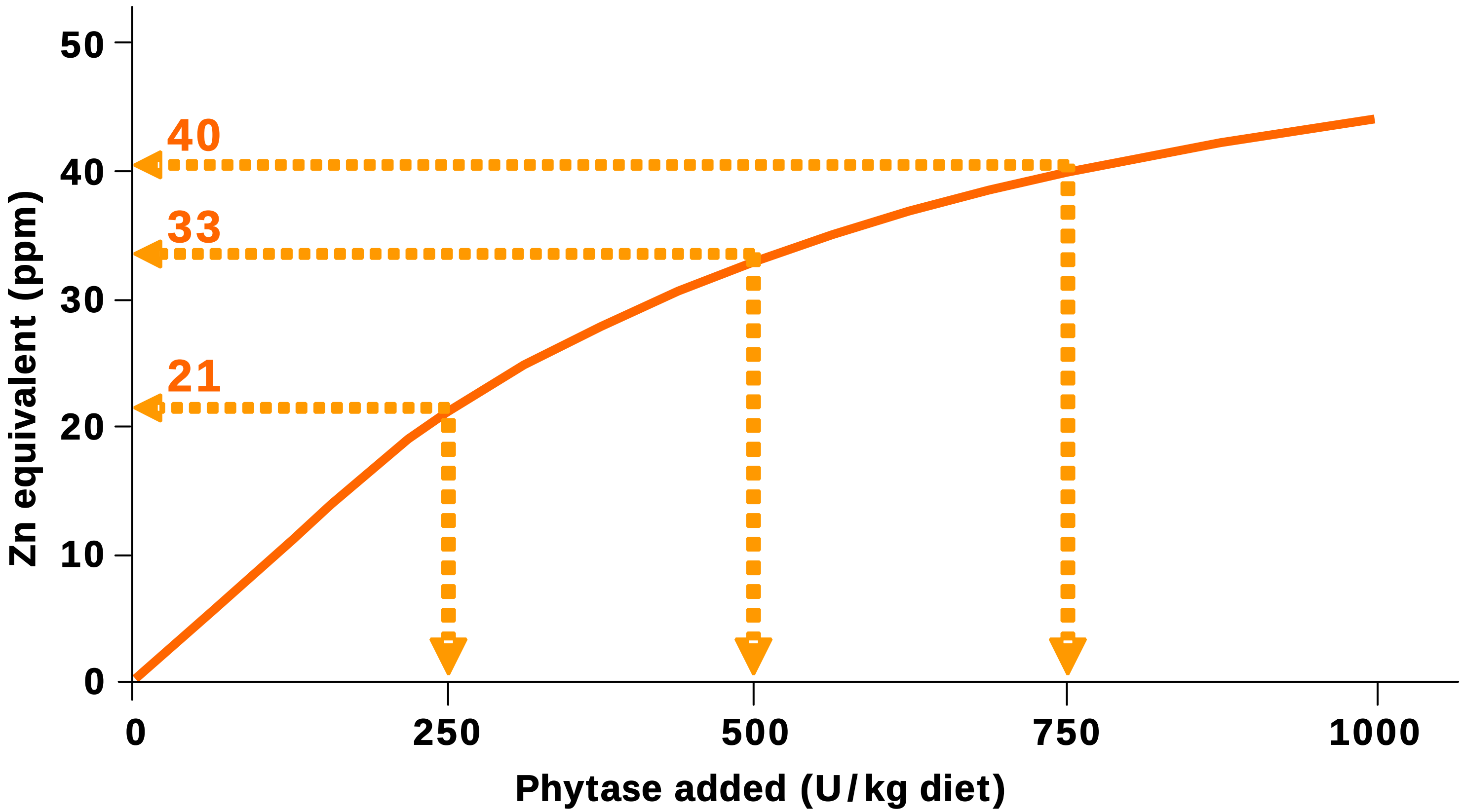
Phytase in piglet diet



Jondreville et al., 2005

Zn equivalency for phytase

(weaned piglets fed maize-soybean meal based diets)



500 U ≈ 30 mg Zn as sulphate

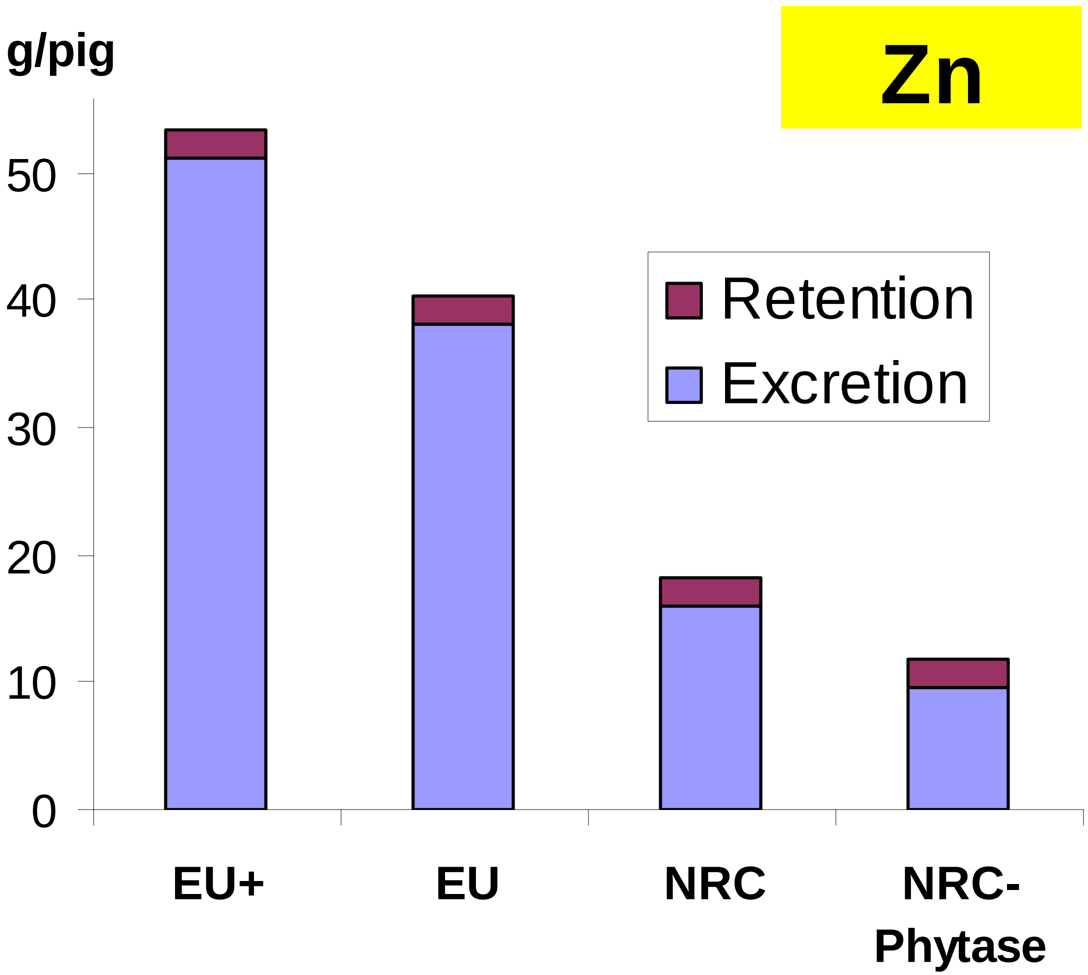
From data by Revy et al. 2003, 2004 and Jondreville et al. 2005

Different scenarios of Zn supply

	Dietary content (ppm)			
	EU+	EU	NRC	NRC Phytase
Piglet 1 (8-13 kg)	2000	150	100	70
Piglet 2 (13-30 kg)	150	150	80	50
Growing (30-60 kg)	150	150	60	30
Finishing (60-110 kg)	150	150	50	30

Jondreville et al., 2005

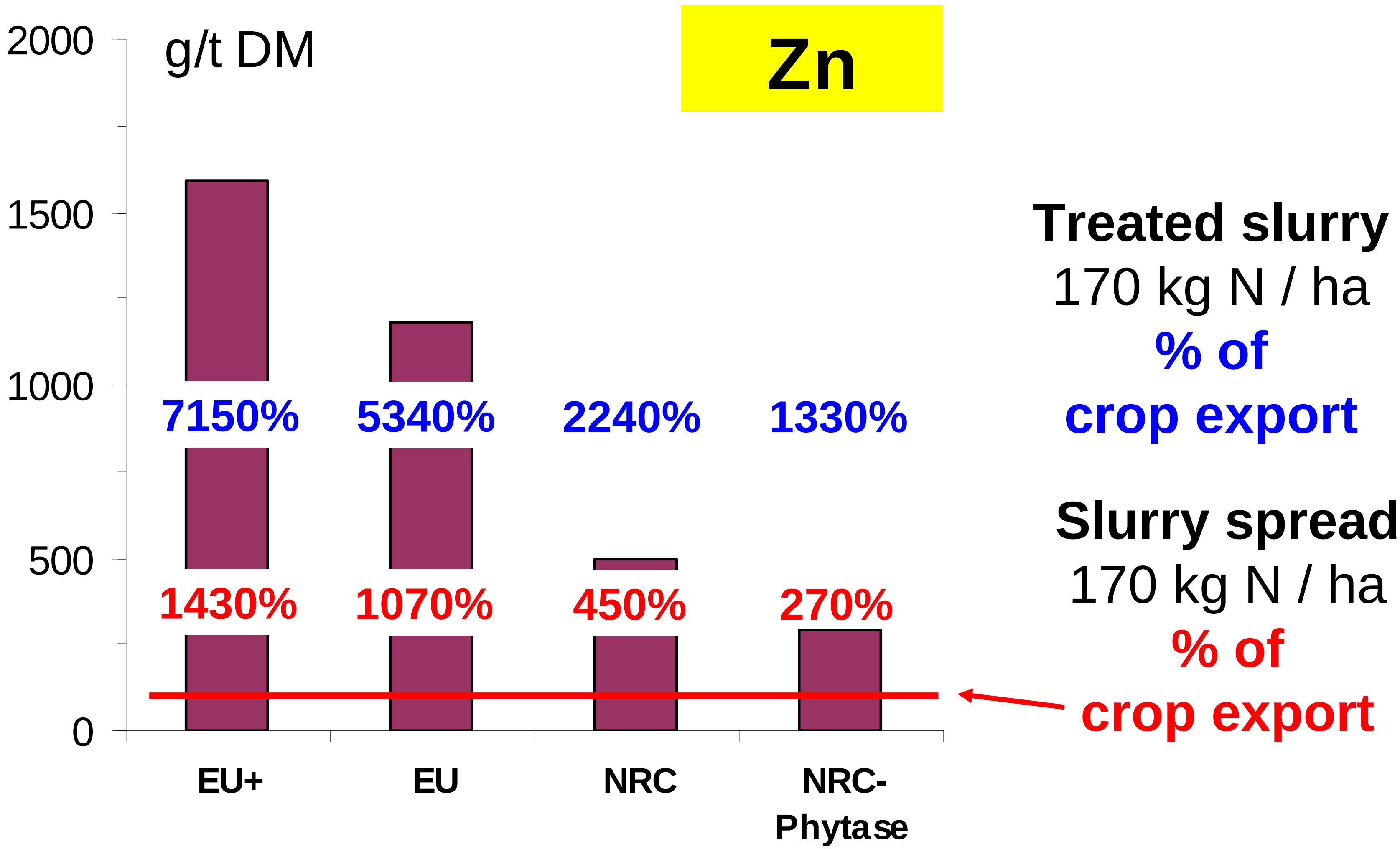
Different scenarios of Zn supply



Jondreville et al., 2005

Jondreville et al., 2005

Different scenarios of Zn supply



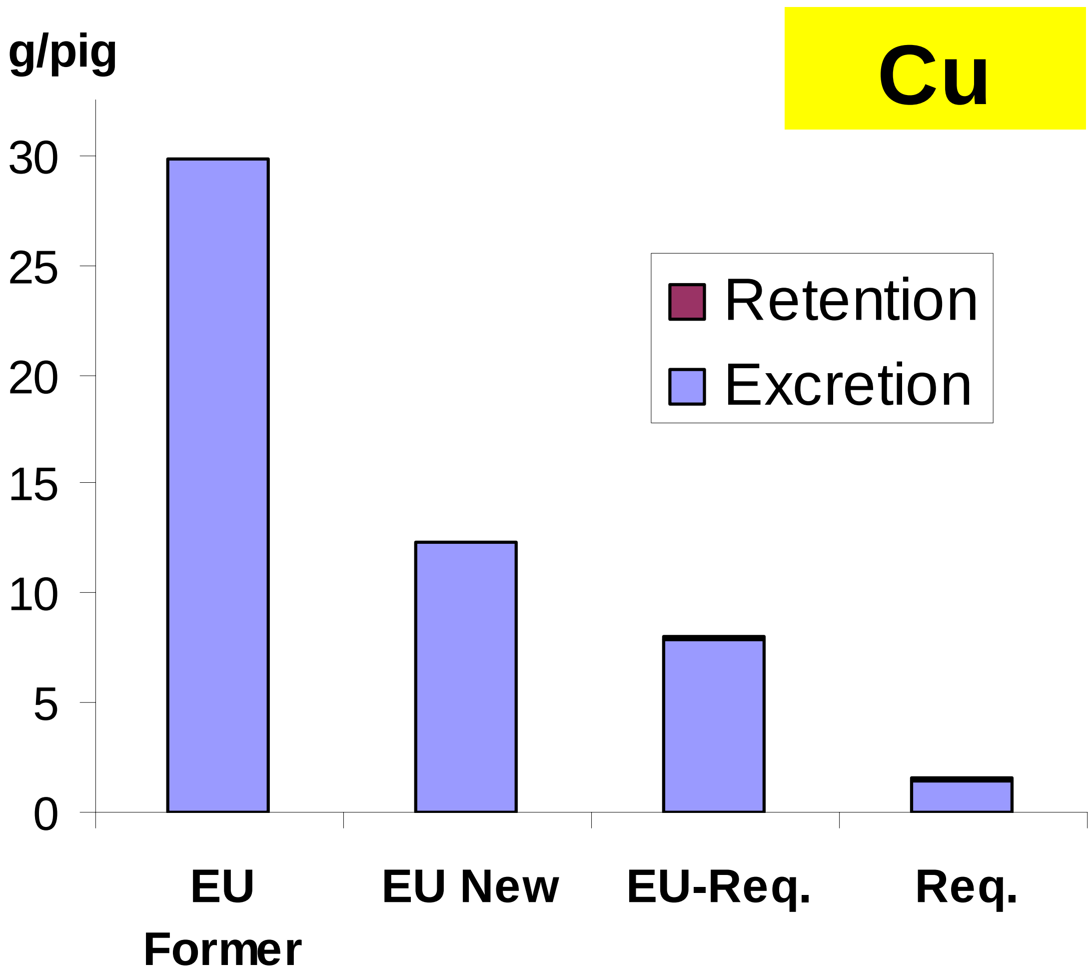
Jondreville et al., 2005

Different scenarios of Cu supply

	Dietary content (ppm)			
	EU+ Former	EU New	EU➔ Req.	Requirement
Piglet 1 (8-13 kg)	175	170	170	6
Piglet 2 (13-30 kg)	175	170	170	6
Growing (30-60 kg)	100	25	6	6
Finishing (60-110 kg)	100	25	6	6

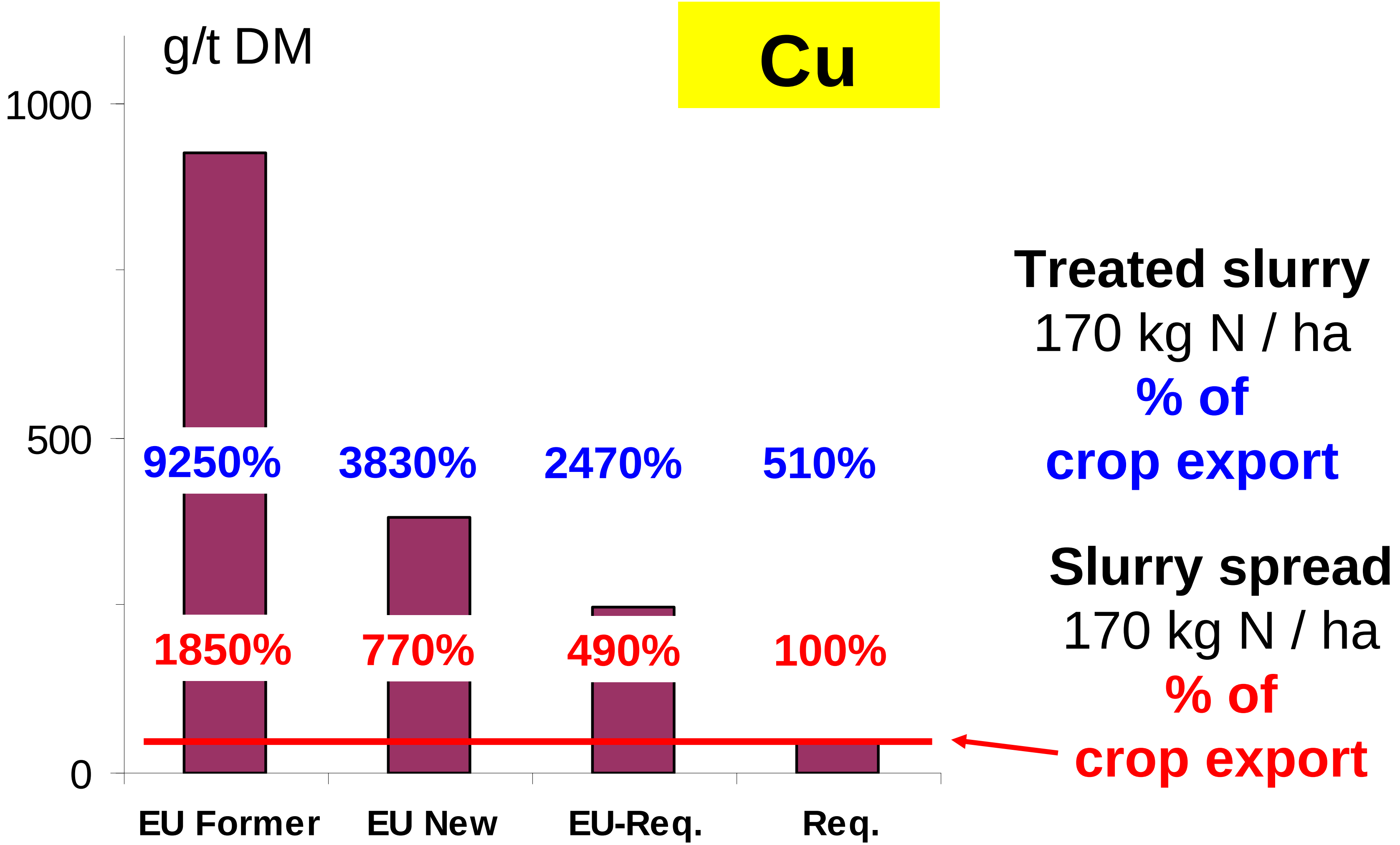
Jondreville et al., 2005

Different scenarios of Cu supply



Jondreville et al., 2005

Different scenarios of Cu supply



Jondreville et al., 2005

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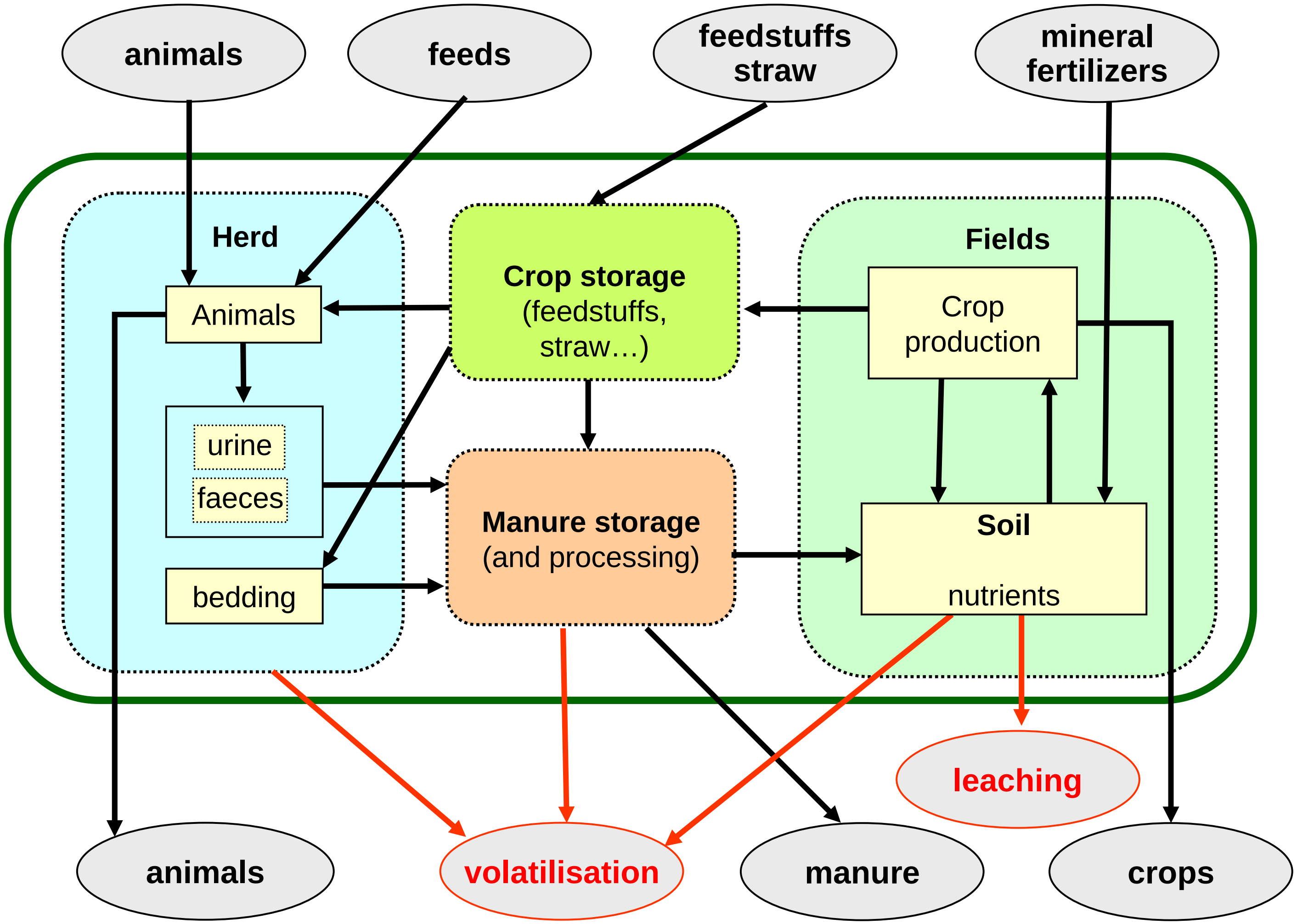
Optimisation at farm level

- Build a model of a farm associating crop and pig productions
- Use this model for the optimisation of different production systems in different contexts of manure utilization
- Maximisation of the gross margin under environmental constraints (N & P)

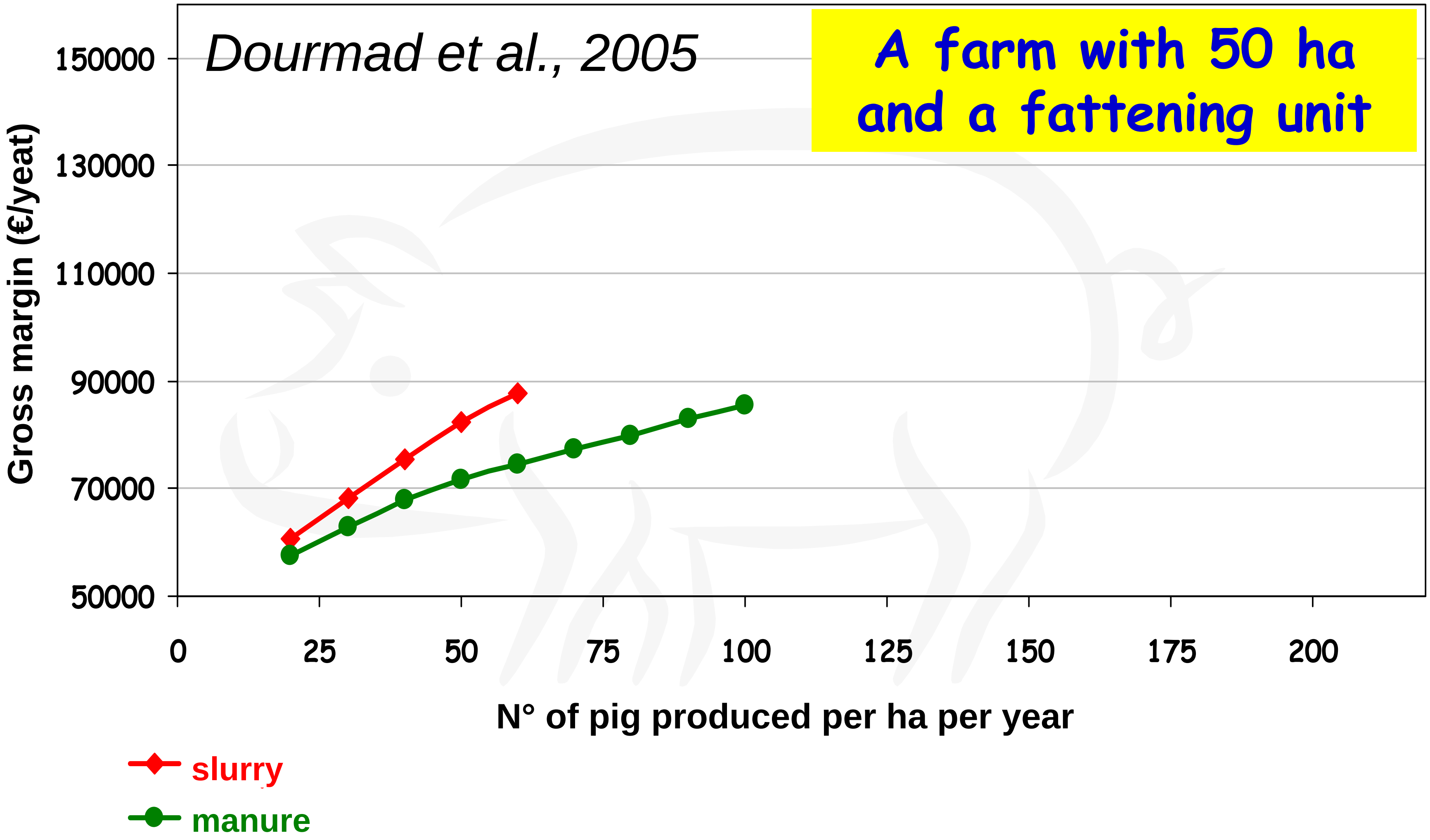
Dourmad et al., 2005

Modelling N fluxes in a farm



Dourmad et al., 2005

Effect of manure management and intensity of pig production on gross margin



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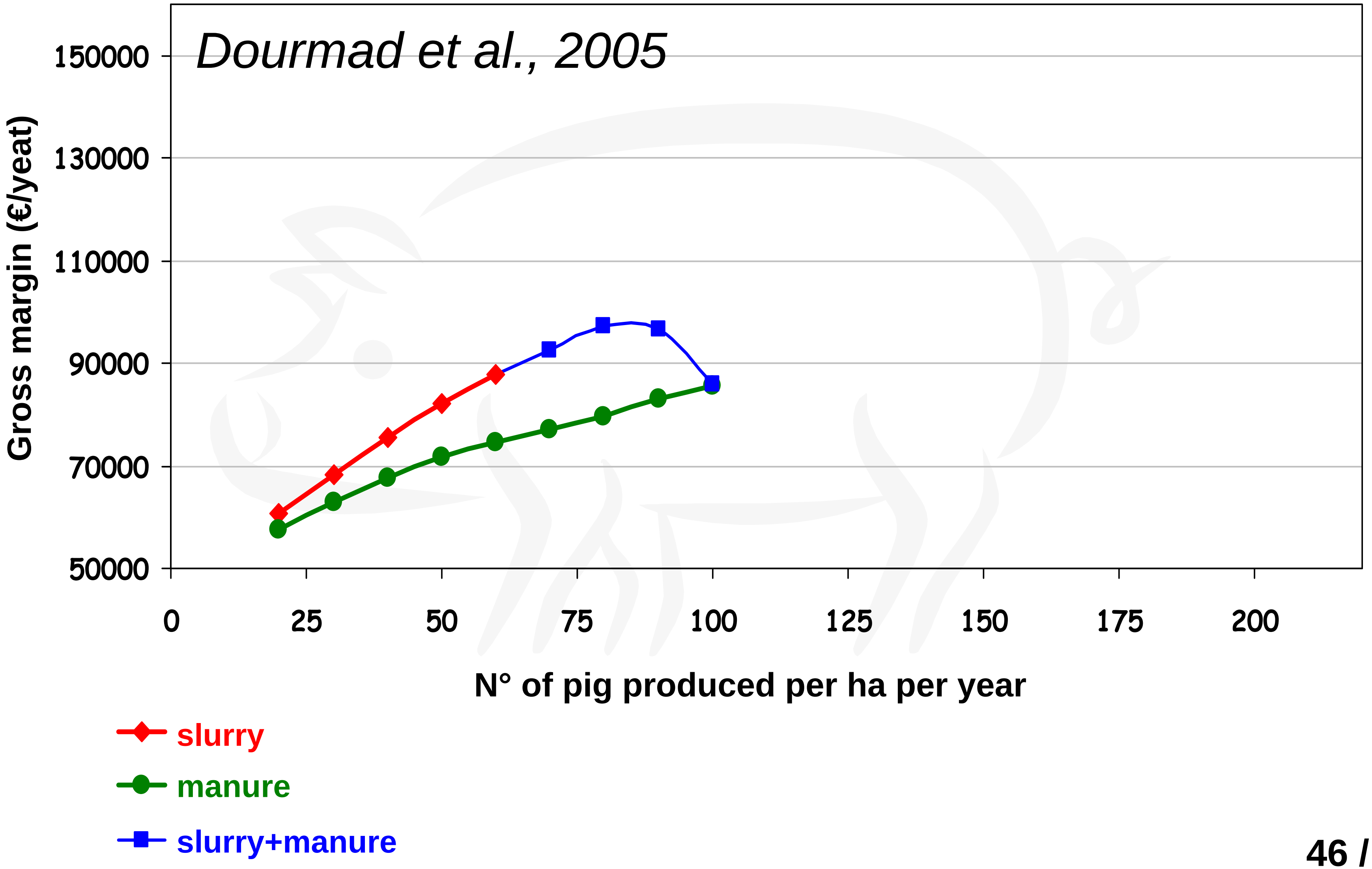

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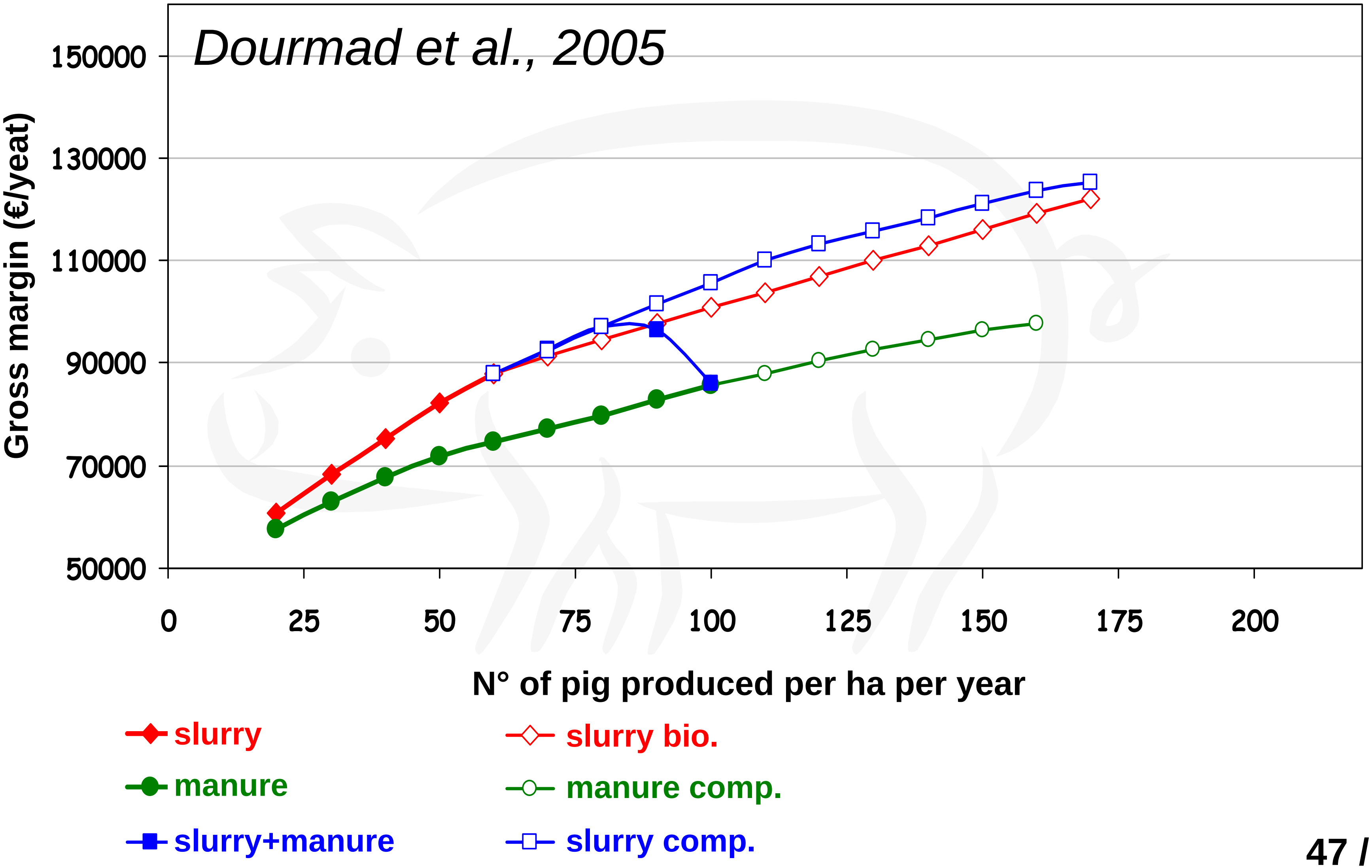

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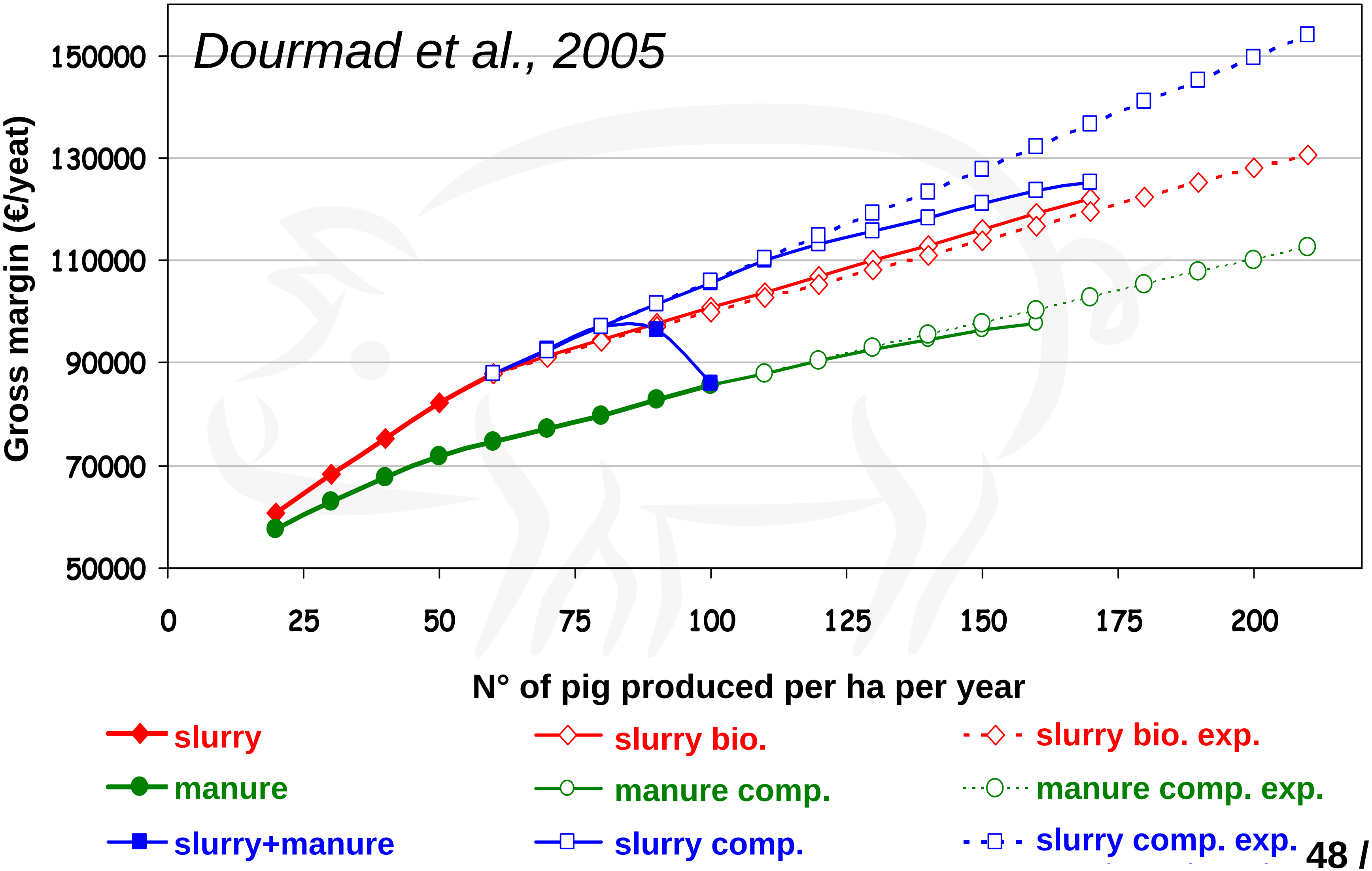
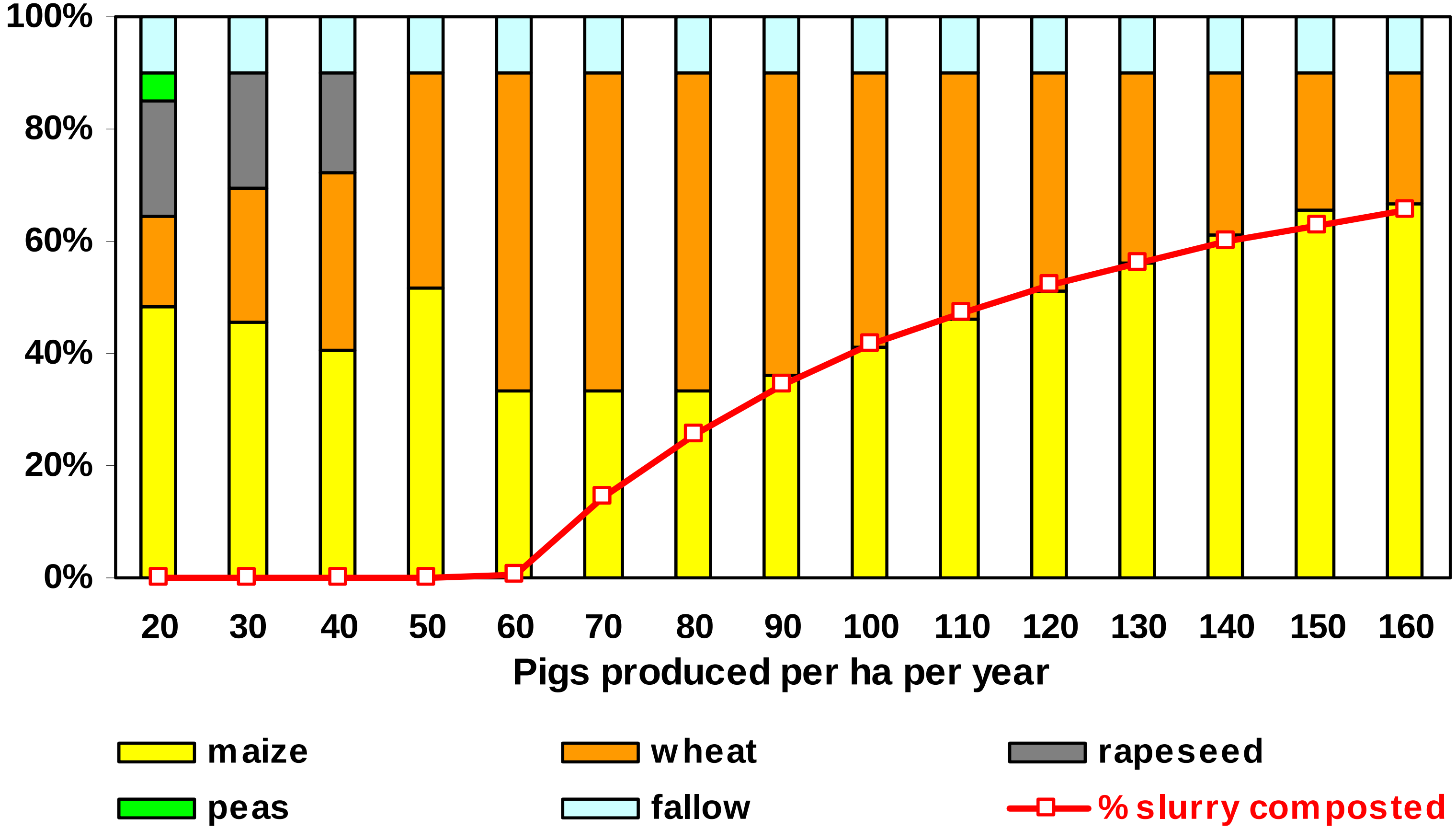


Evolution of crop rotation with intensity of pig production (20-160 fattening pigs / ha / year)

liquid slurry + compostation with straw



Dourmad et al., 2005

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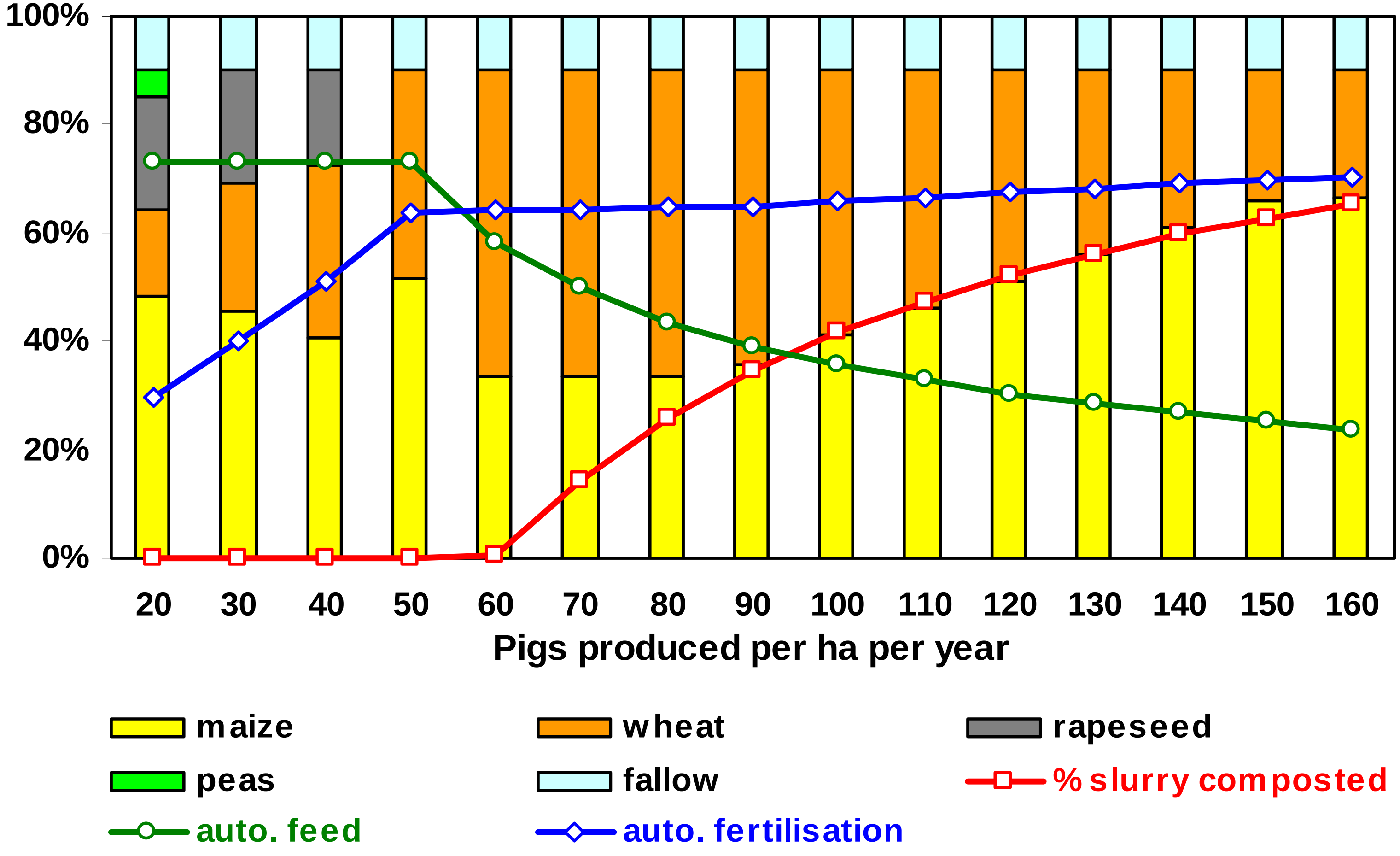

Dourmad et al., 2005

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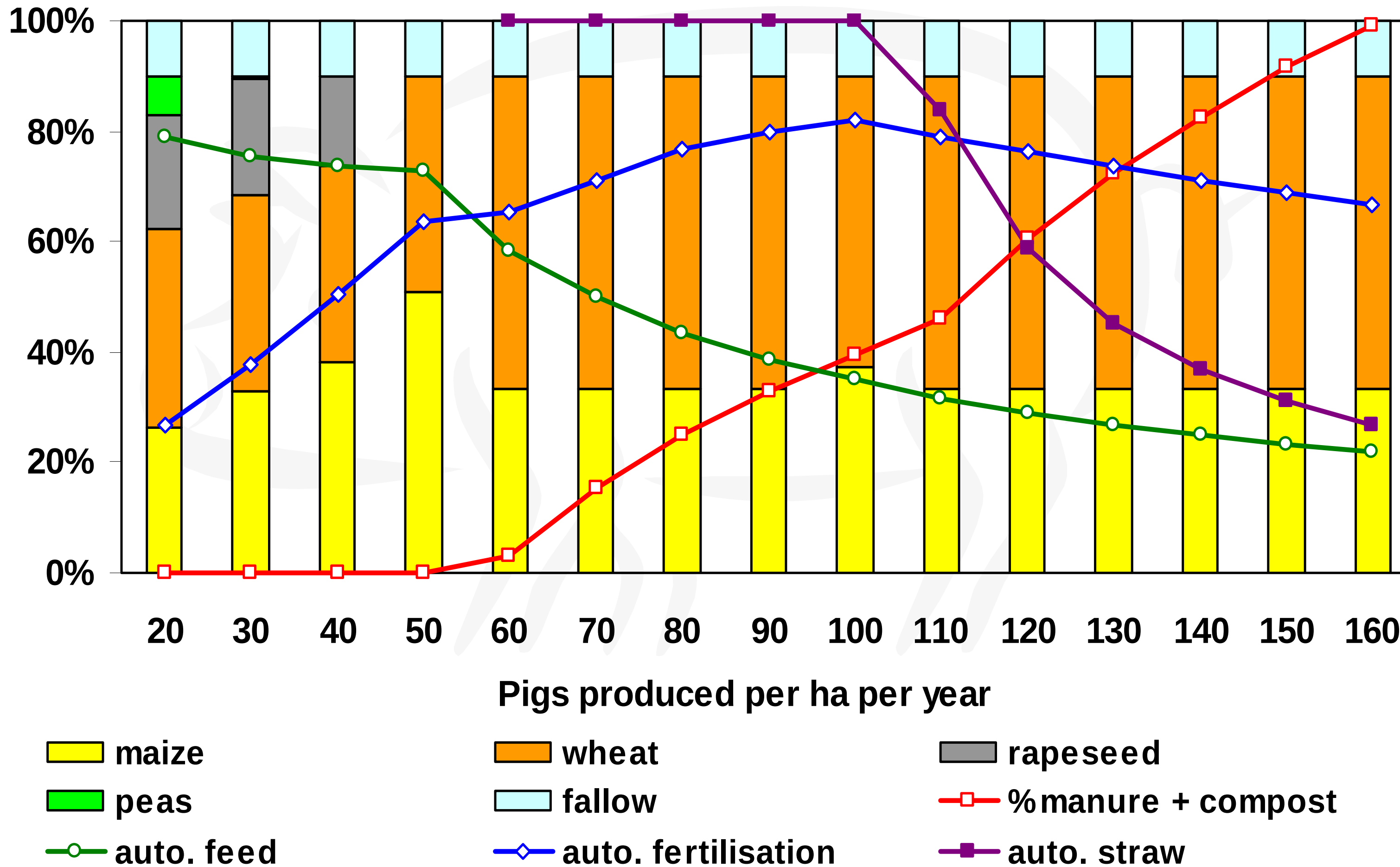
slurry + manure + compostation



Dourmad et al., 2005

Optimisation of gross margin per activity

- Pig production (€/pig)
  Optimum: 50-60 pigs/ha/year.
  above => increased cost of manure management
- Crop production (€/ha)
  Optimum: 60-70 pigs/ha/year
  below => increased cost of fertilisation
  above => constraints on crop rotation

Dourmad et al., 2005

Optimizing manure management at farm level

- Strong links between animal and crop productions
  => interest for a simultaneous optimization
- Crop rotation depends on both the strategy of slurry management and N loading per ha
- Systems with intermediate intensity of pig production are more sustainable (*high autonomy for feeding & fertilization*)
- Association on the same farm of liquid and solid manure appears an interesting solution.
- Optimal economical efficiency for about 60-70 fattening pigs produced / ha / year

Dourmad et al., 2005

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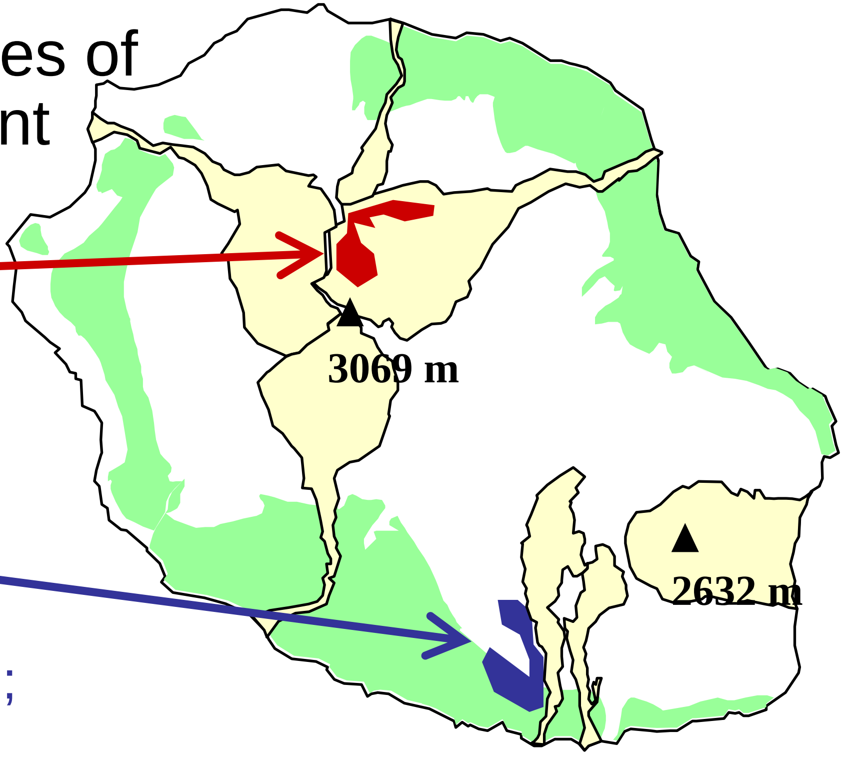
Optimizing manure management at regional level

Réunion Island

Goal : to elaborate regional strategies of manure management in 2 different contexts of Reunion island

- «Grand-Îlet » :
  - no spreading areas for slurry produced by pig and poultry farms
    ➔ slurry processing
- « Plaine des Grègues » :
  - Pig and cattle farms
    = organic matter (OM) producers ;
  - Vegetables or sugar-cane farms
    = OM consumers

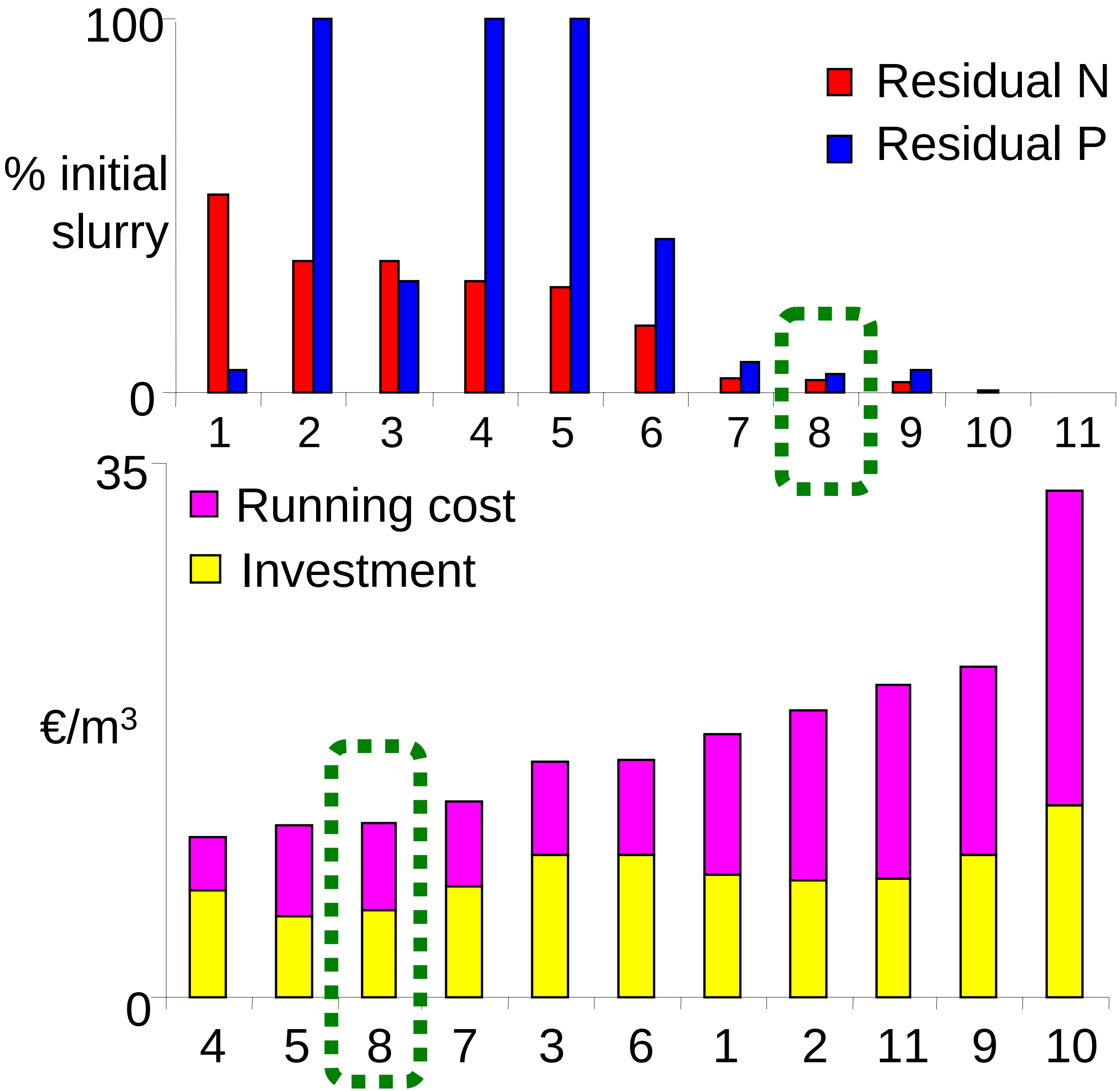


➔ **Need to organize OM exchanges**

Modeling according to 3 steps

1. **What kind of treatment ? (*Macsizut*)**
2. **Where to locate the treatment unit and how to feed it ? (*Approzut*)**
3. **Optimise the use of organic matter (slurry or treatment outputs) (*Biomas*)**

Step 1: Macsizut



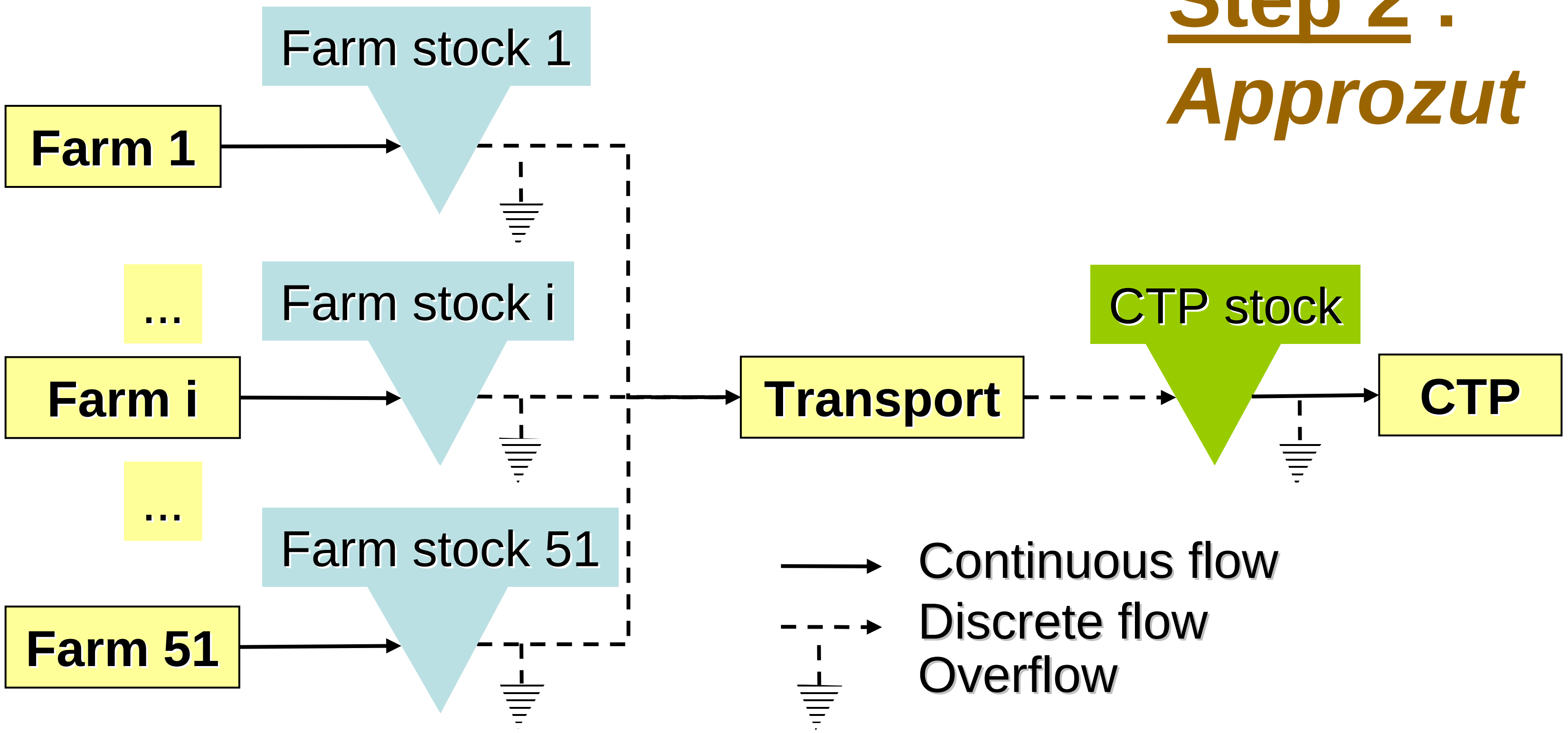
Most cost-effective: **8**

centrifugation + nitrification-denitrification

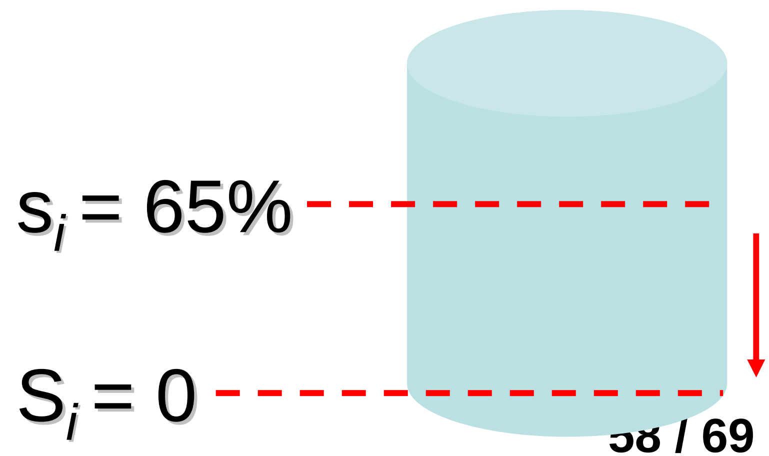
Médoc et al., 2005

Médoc et al., 2005

Step 2 : *Approzut*

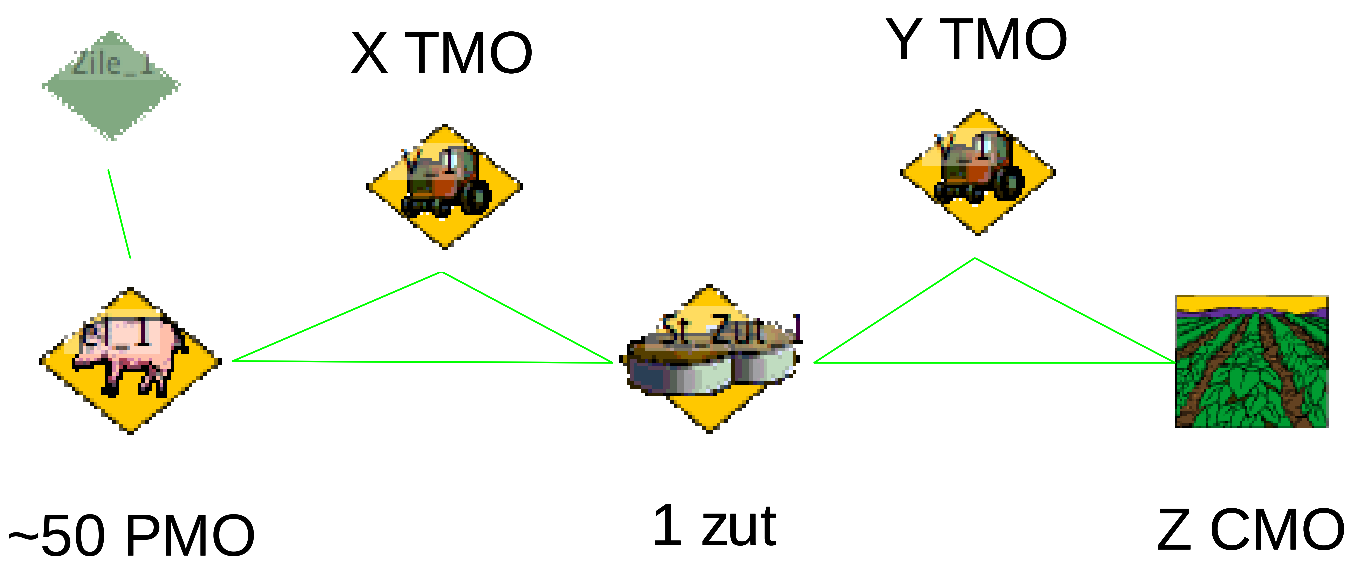


- **Farm policy :**
  driven by farm stocks
- **CTP policy :**
  driven by treatment plant stock
- **Plan**



<u>Step 3</u> : *Biomass*

A multi-actors model to simulate organic matter exchanges at the regional scale



- To optimize the utilization of solid phase coming from the treatment plant
- To organize exchanges of raw organic matter between producers (PMO) and consumers (CMO), taking into account the carriers (TMO)

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The Life Cycle Analysis approach

- **Classic approach: one location, one pollutant**
  - **e.g. pig farm, nitrates**
- **May lead to problem shifting**
  - **e.g. solve one problem (nitrate), but create/enhance two new problems (P, N_2O)**
  - **emissions on farm versus emissions off farm**

➔Multi-impact systems approach, such as LCA

The Life Cycle Analysis approach

- LCA applied to agriculture:
  - takes into account a large number of pollutant emissions and non-renewable resources,
  - both on the farm (direct effects) and associated with its inputs (indirect effects):
    - fertiliser, machines, diesel oil,
  - may include transformation and use (consumption) of farm products

Three scenarios

- **1. Good Agricultural Practice (GAP)**
- **2. Organic pig (Org)**
- **3. Quality pig Label Rouge (Qua)**

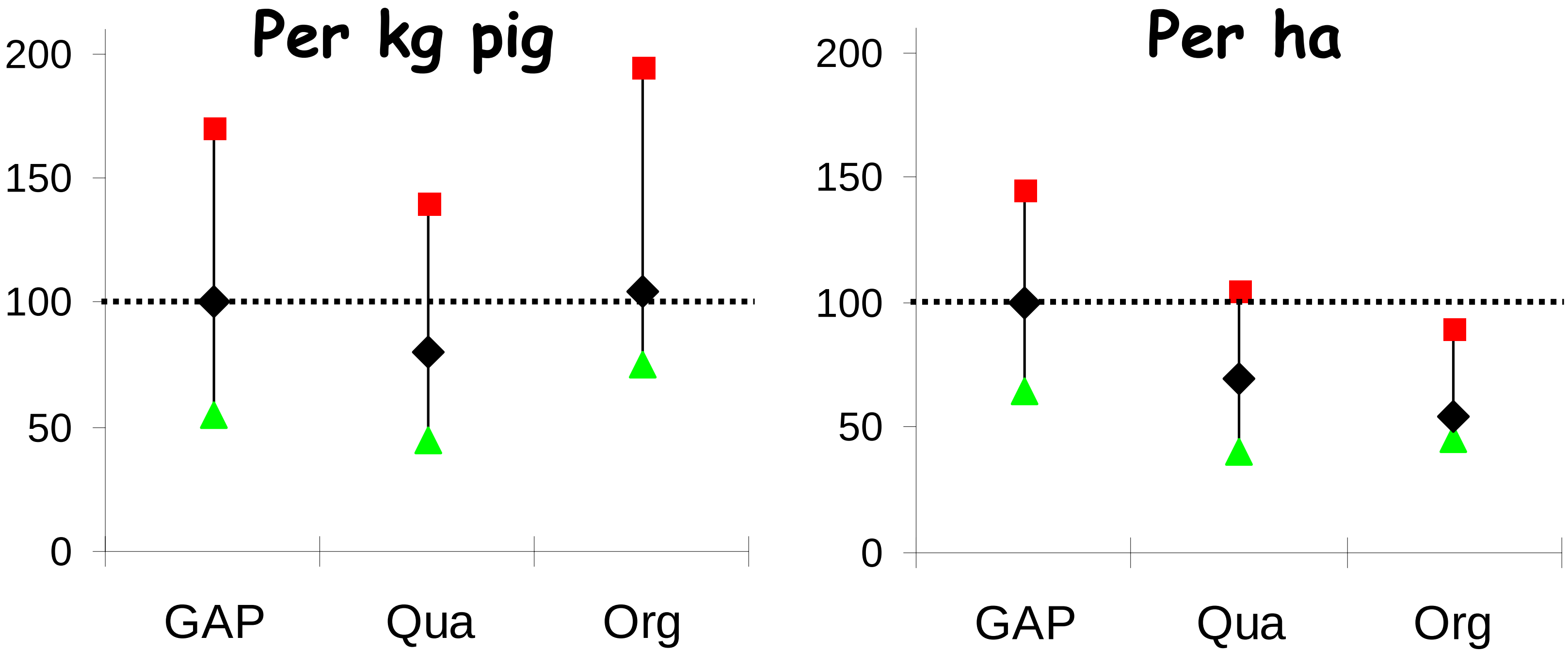
Basset et al., 2005

The GAP, Qua and Org pig production systems

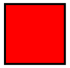
	GAP	Qua	Org
Piglet production			
Housing	Slatted floor	Outdoor	Outdoor
Weaned piglets	25.5	22.6	20.3
Weaning age, d	25.7	28	42
Surface per sow, m^2	<4	1000	1000
Feed per sow, kg/y	1313	1490	1695
Weaning to slaughtering			
Housing	Slatted floor	Straw litter	Straw litter
Surface per pig, m^2	0.85	2.6	2.3
Feed : gain ratio	2.7	2.9	3.2
Slaughter age, d	175	190	195
Slaughter weight, kg	113	115	120

Basset et al., 2005

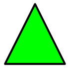
LCA results

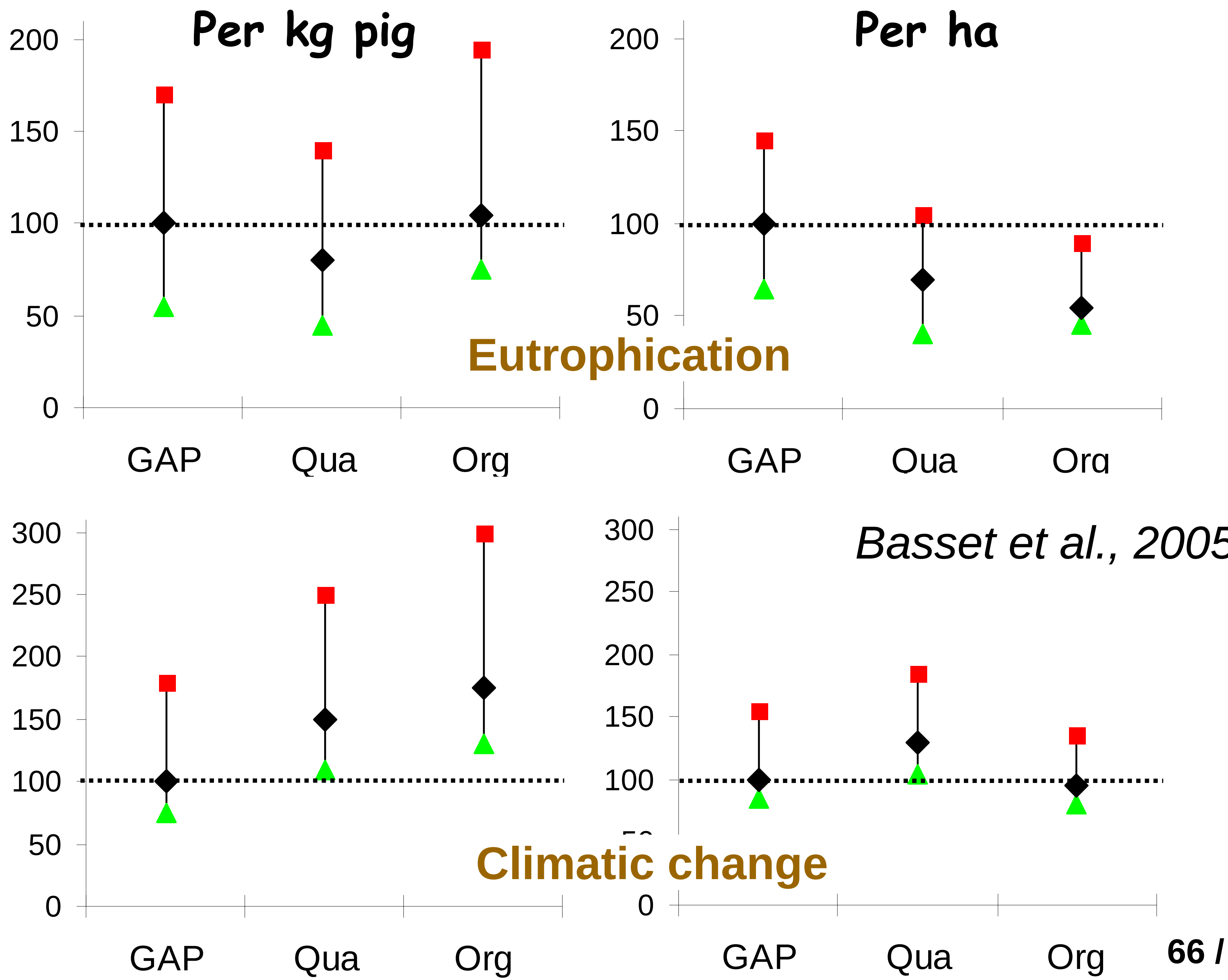


Basset et al., 2005

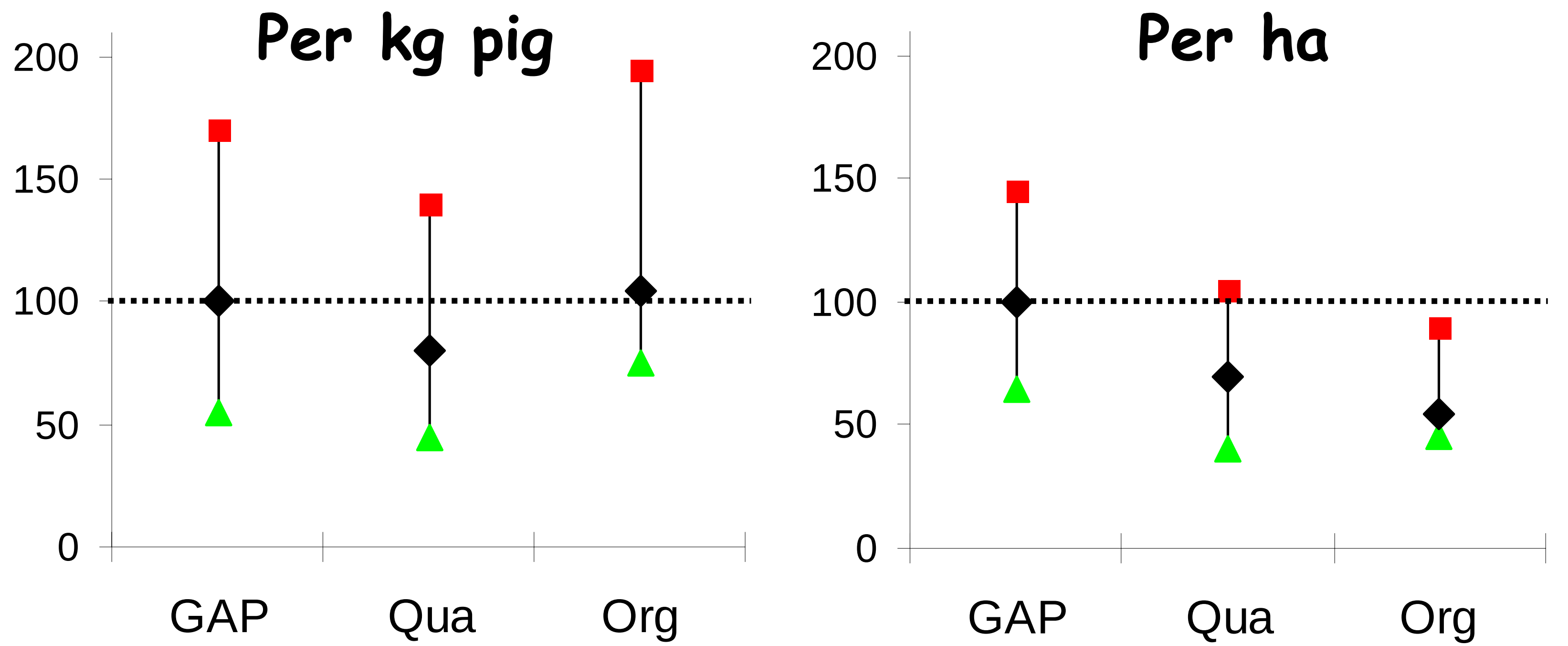

Most unfavourable conditions


Reference conditions


Most favourable conditions

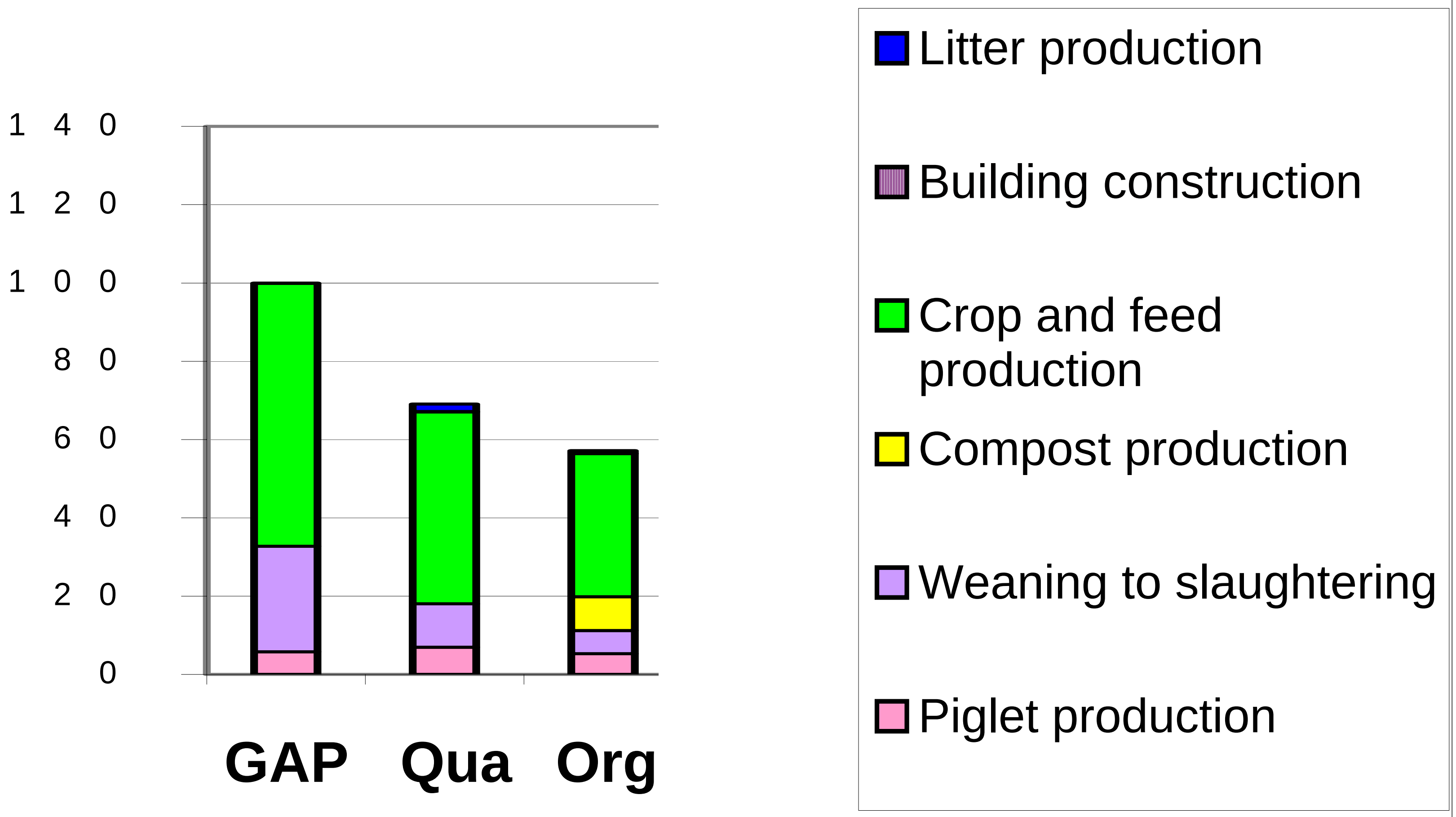

Per kg pig
Per ha
Eutrophication
Climatic change
Basset et al., 2005
0
50
100
150
200
250
300
GAP
Qua
Org

LCA results



Basset et al., 2005

- **The scenarios differ**
- **The results depend on the unit**
- **There is more variation within scenarios than between scenarios**



Contribution of life cycle stages to eutrophication, per ha

Identify where progress can be made

Thank you for your attention