61st EAAP, Heraklion – Greece
session 25 – n°3

Nutrition of the hyper-prolific sow during lactation

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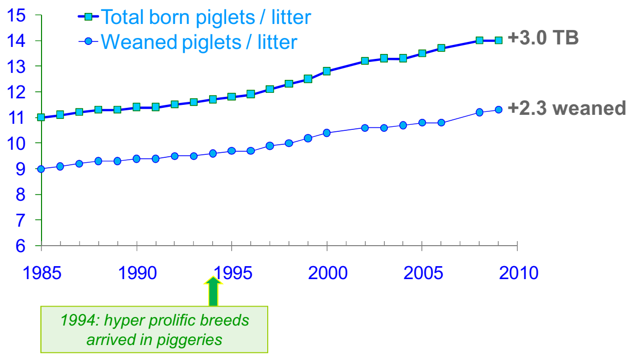
ALIMENTATION
AGRICULTURE

Summary

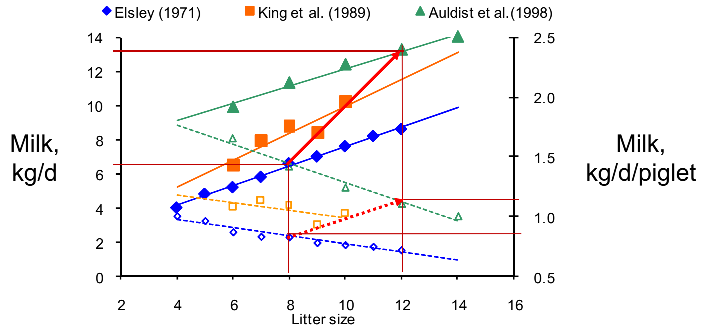
- ✓Introduction
  - ✓A drastic increase in lactation performance of sows
- ✓Nutrient utilisation by lactating sows
  - ✓Energy
  - ✓Amino acids
  - ✓Phosphorus and calcium
- ✓InraPorc a tool for decision making in sow nutrition
  - ✓Description of the model
  - ✓Examples of calculation of requirements & simulations
- ✓Appetite : a key issue for the feeding of lactating sows
  - ✓ Intrinsic factors
  - ✓ Extrinsic factors
- ✓Conclusions & perspectives

Evolution of litter size over the 25 last years in France



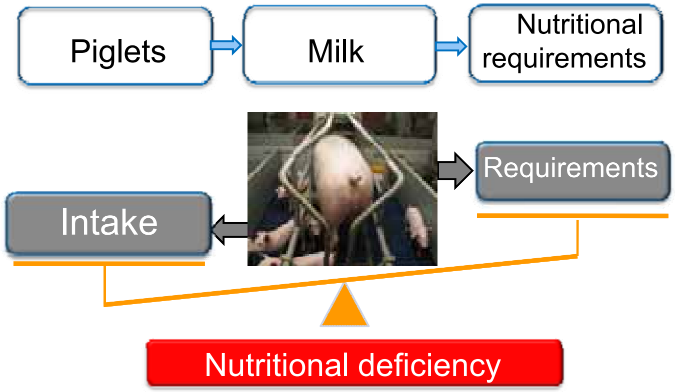
Source IFIP – GTTT (...2010)

Effect of litter size on milk production



as reviewed by Renaudeau (2001)

Prolificacy and nutritional balance



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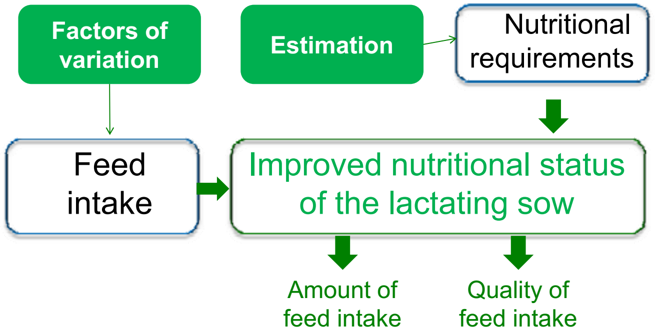
HYPER Prolificacy and nutritional balance



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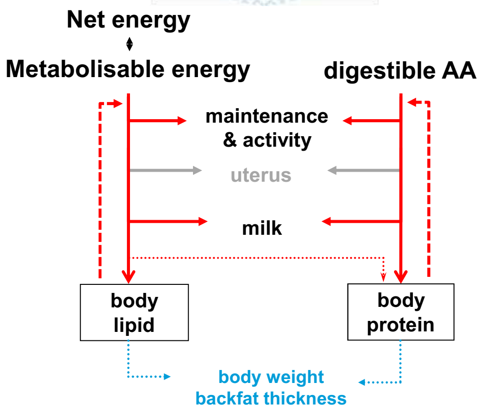
Lactating sows



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Energy utilisation by lactating sows

$$ME = ME_m + E_{milk} / k_m - ER_m/(k_{rm} \times k_m)$$

ME_m: $= 460\ kJ.BW^{-0.75}.d^{-1}$

E_{milk}: energy in milk

$MeanE_{milk} = (20.6 \times ADG_{litter} - 376 \times \text{litter size})$

$DailyE_{milk} = MeanE_{milk} \times (2.76 - 0.014\ d_{lact}).e^{-0.025t}.e^{-e(0.5-0.1t)}$

k_m: efficiency of ME for milk $= 0.72$

k_{rm}: efficiency of body reserves for milk $= 0.87$

ER_m: energy from body reserves

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Noblet and Etienne (1987, 1989)
Dourmad et al. (2008)

Lysine utilisation by lactating sows

Factorial calculation

$Lysine_{dig} = LYSm + LYS_{milk} / k_{Lys}$

$LYSm = 0.036\ BW^{0.75}$

N_{milk}: nitrogen in milk

$MeanN_{milk} = (0.0257 \times ADG_{litter} + 0.42 \times \text{litter size})$

$DailyN_{milk} = MeanN_{milk} \times (2.76 - 0.014\ dlact).e^{-0.025t}.e^{-e(0.5-0.1t)}$

Lys_{milk} = Lysine in milk = $(N_{milk} \times 6.38) \times 7.5$

k_{lys} : Efficiency of lysine for milk = 0.81

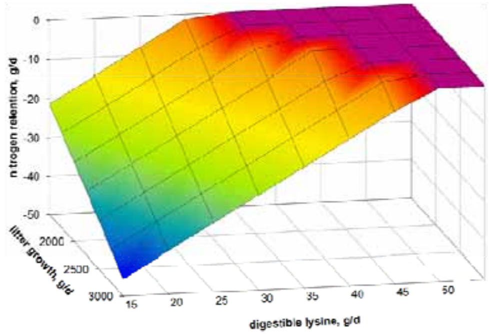
Empirical calculation

$N\ balance = -14.2 + 1.335 \times Lysine_{dig} - 0.629 \times N_{milk}$

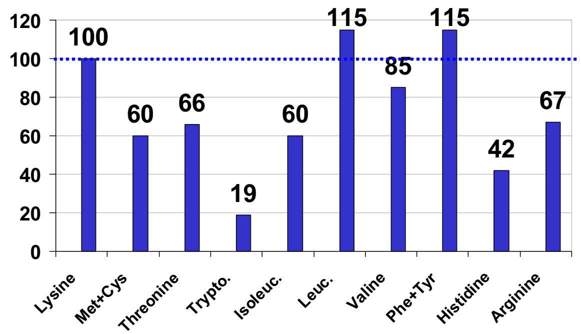
$Lysine_{dig} = (14.2 + 0.629 \times N_{milk}) / 1.335$ (without N mobilisation)

Noblet and Etienne (1987, 1989)
Fuller et al. (1989), Dourmad et al. (2008)

Response curve of N balance according to digestible lysine supply and litter growth rate



Requirement for others amino acids - Ideal protein for lactation -



Dourmad et al. (2008)

P and Ca utilization by lactating sows

$P\ balance = P_{dig.} - 0.01\ BW - P_{milk}$

$P_{dig} = 0.01\ BW + P_{milk}$

$Ca_{tot} = 3.2 \times P_{dig}$

P_{milk}: P in milk

$MeanP_{milk} = (0.0257 \times ADG_{litter} + 0.42 \times \text{litter size}) \times 6.38 \times 1.55 / 50$

$DailyP_{milk} = MeanP_{milk} \times (2.76 - 0.014\ dlact).e^{-0.025t}.e^{-e(0.5-0.1t)}$

Jondreville and Dourmad et al. (2005)

InraPorc®

http://www.rennes.inra.fr/inraporc/
(evaluation, education, commercial)

The objectives of InraPorc

- **Development of a decision support tool for the nutrition of sows** (and growing pigs)
  - **Integrate current knowledge of nutrient utilization by sows** and growing pigs
    - **net energy - SID AA – digestible P**
  - **Predict the response of the animal to nutrient supply**
    - **weight gain – feed efficiency – body composition**
    - **identify the limiting factors and excess in the diet**
  - **Improve the definition of nutritional requirements**
    - **objectives of performance**
    - **account for the dynamic change in requirements**
    - **adapted to the animal profile (genotype**/sex**)**

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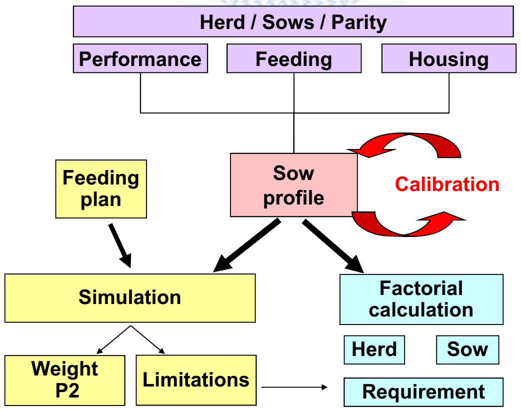
The decision support tool



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Simulation of body composition changes during lactation (high productive sows - parity 1)

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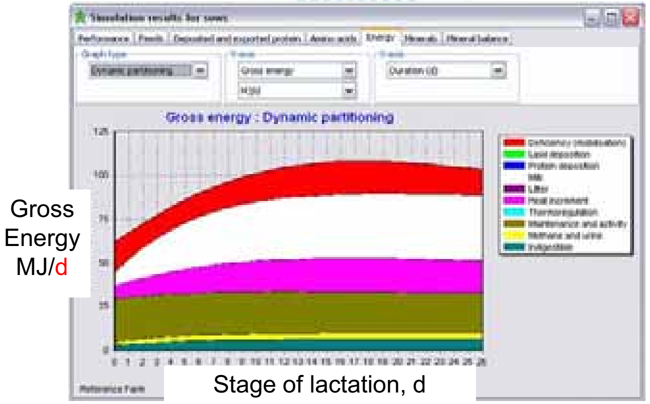
Simulation of energy utilisation (parity 1)



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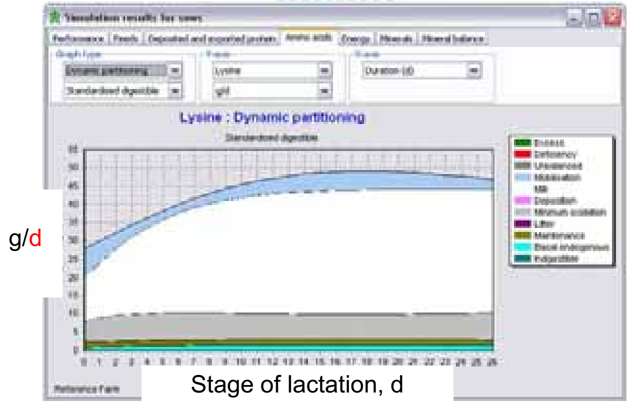
Simulation of digestible lysine utilisation (parity 1)



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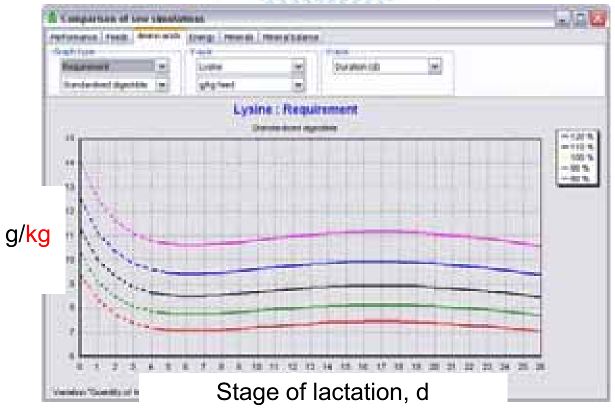
Sensivity of lysine requirement to appetite (Parity 1)



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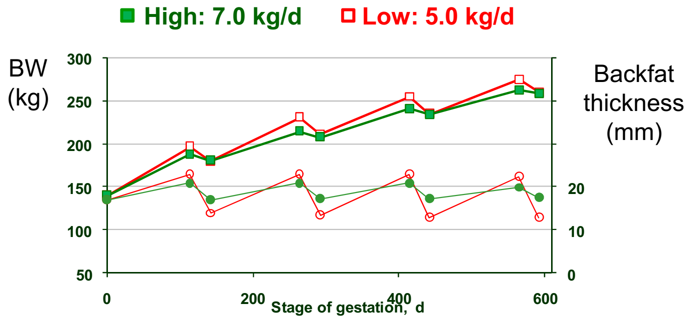
Simulation of long-term feeding strategies
Effect of appetite during lactation



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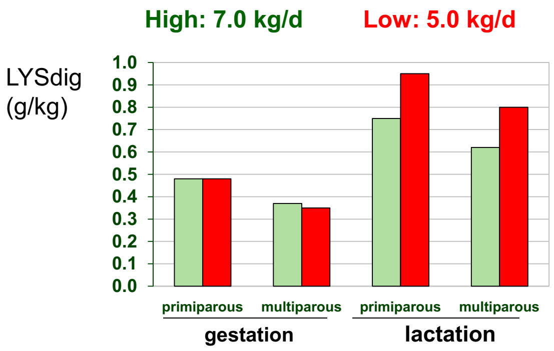

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Variation factors of appetite in lactating sows

Intrinsic factors → The Sow ← Extrinsic factors

The animal
- Genotype
- Litter size
- Stage of lactation
- Parity / body weight
- Health

The Environment
- Ambient temperature

The feed
- [Net energy]
- Thermic effect of feed

The feeding procedure
- Feeding plan during lactation
- Meal frequency

Backfat thickness — Feed allowance during the previous gestation

Previous experience — Feedstuffs used in gestation/lactation diets

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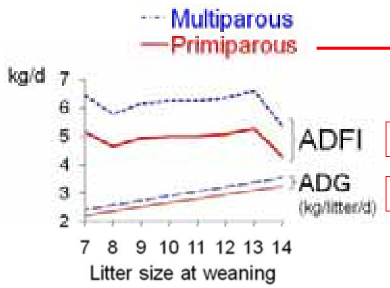
Parity

Intrinsic factors



ADFI: -15 / -20%

milk production: -8 / -10%

Higher risk of nutritionnal inbalance in parity 1

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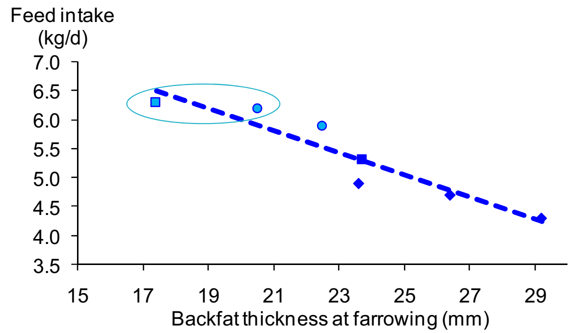
Quiniou (2008)

Backfat thickness at farrowing

In / Ex trinsic

(Feed allowance during the previous gestation)



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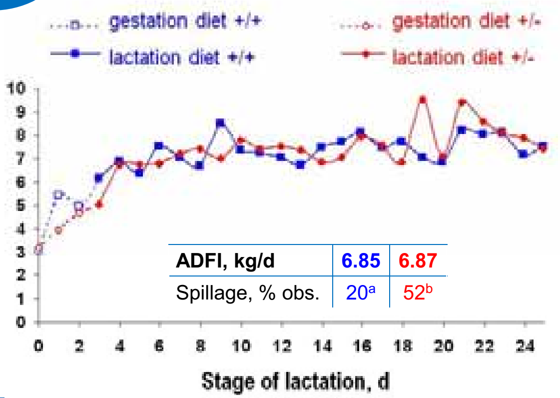
Dourmad et al. (1991)
Primiparous sows

In / Ex trinsic

Previous experience

(Feedstuffs used in gestation/lactation diets)

ADFI, kg/d



ADFI, kg/d	6.85	6.87
Spillage, % obs.	20[a]	52[b]

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Quiniou (2006)
transition performed on the 3rd d post-partum

The ambient temperature

Extrinsic factors

When temperature was kept constant over 24 h/24 h

Temperature	18°C	...	25°C	...	29°C	Stat.
ADFI, kd/d	7.78		6.31		3.50	***
Number of meals / d	6.8		7.2		4.5	
Meal size, g	1372		931		883	
Diurnal feed intake, %	84		79		91	***

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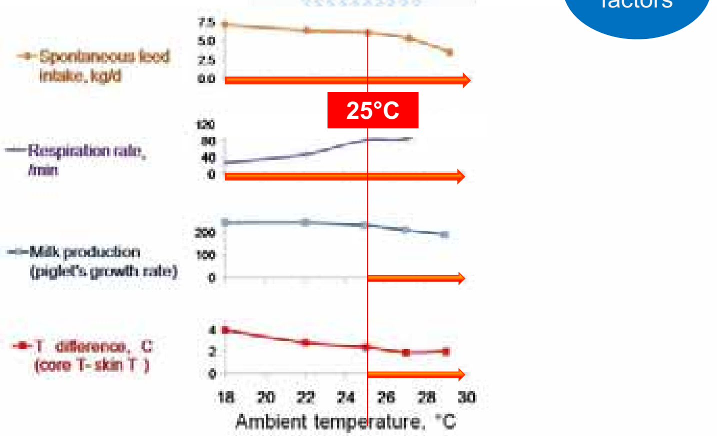
Quiniou et al. (2000)
Renaudeau et al. (2002)

The ambient temperature

Extrinsic factors



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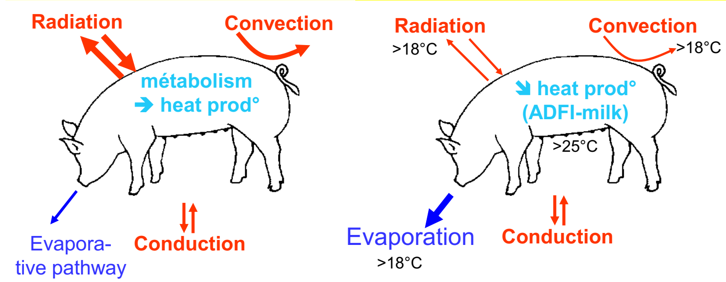
Quiniou and Noblet (1999)
Renaudeau et al. (2001), Quiniou et al. (2000)

Is it possible to adapt dietary characteristics to ambient temperature?

Extrinsic factors

Within the thermo-neural zone Production = exportation	**Under heat stress :** ↘ exportation capacities



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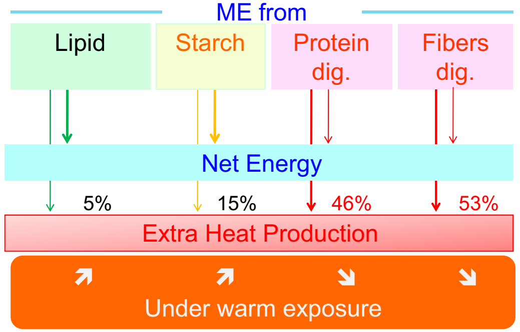
Thermic Effect of Feed and dietary components

Extrinsic factors

Efficiency of ME utilisation from different components



Noblet et al. (1989)

Low TEF diets or increased NE and AA contents and performance

Extrinsic factors

↘ extra heat prod' ↗ net energy (at 29°C) ↘ extra heat prod' (at 29°C) ↘ extra heat prod' ↗ net energy (at 20°C) ↘ extra heat prod' (at 20°C)	Renaudeau et al. (2001)
↗ net energy ↗ amino acid (at 26°C) ↗ net energy ↗ amino acid (at 20°C)	Quiniou et al. (2000)
↗ net energy ↗ amino acid (at 24°C)	Quiniou et al. (2005)
↗ net energy	Quiniou et al. (2008)
↗ electrolytic balance ↘ % crude protein ↘ % crude protein	Quiniou (2004)
↘ % crude protein	Quiniou and Noblet (1999)

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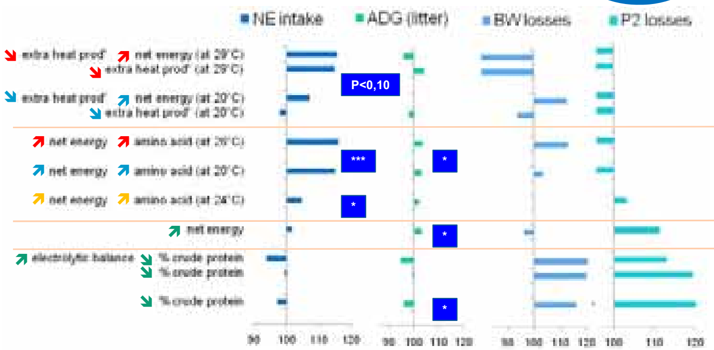
Low TEF diets or increased NE and AA contents and performance

Extrinsic factors



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Meal frequency

Extrinsic factors

Number of meals/day	2	3	4	Ad lib
ADFI, kg	5.9	6.4	6.9	7.4

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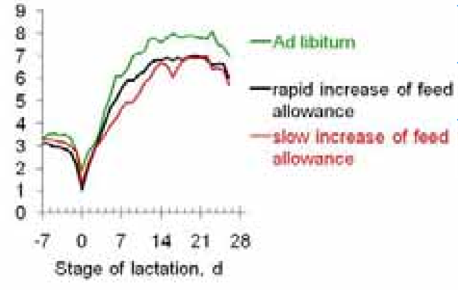
EDE Bretagne (1995)
from a survey performed in piggeries

Feeding plan during lactation

Extrinsic factors

Feed allowance or spontaneous feed intake, kg/d



ADFI (kg)	BW at weaning (kg/piglet)
6.5	8.2
5.9	8.2
5.6	8.0

EDE Bretagne (1995)
from a survey performed in piggeries

Summary

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- ✓InraPorc a tool for decision making in sow nutrition
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  - ✓ Extrinsic factors
- ✓**Conclusions & perspectives**

Conclusions

- ❑Increase in performance of lactating sows over 20 years
  - ❑Prolificacy (+30%) & milking potential (+100%)
  - ❑Little increase in feed intake
    - ❑Increased risk of nutrient deficiency
      - affects milk production
      - affects subsequent reproductive performance
- ❑↗ knowledge on nutrient utilisation in lactating sows over the recent years
  - ❑Energy, amino acid, digestible phosphorus
  - ❑Prediction models are available and allow to address nutrient utilisation in a more dynamic way
- ❑Limited feed intake of lactating sows remains a major problem in practice

Perspectives

- ❑Scientific knowledge
  - ❑Improvement of determination of AA requirements
    - ❑contribution of AA from body reserves...
  - ❑Contribution of body reserves to mineral supply
  - ❑Thermoregulation & appetite
  - ❑Integration of knowledge in more mechanistic models
- ❑Application
  - ❑Feed composition adapted to
    - ❑environmental conditions
    - ❑parity (primiparous / multiparous), feed intake, performance…
  - ❑Precision feeding
    - ❑"Intelligent" feeders with mixing of two diets

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