Economic and environmental optimization of feed sequence plans in pig fattening unit

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Major importance/contribution of feed production, and of the fattening unit
To optimize feeding sequences on economic and environmental criteria.

Economy | environment

- Δ P excreted
- Δ Feed cost

Pomar et al. 2007

Least-cost formulation of feeds

To adjust quantity and quality of nutrient supply

SID lysine, g/MJ EN

LW (kg)

Requirements | 2 phases | Multiphase

0% 5% 10% 15% 20% 25%
To develop an optimization model: PigOptim

Optimisation algorithm

Feeding sequence to be tested

Growth model (InraPorc®)

SID Lysine requirements

FCR, lean%,...

Economic evaluation

Life Cycle Assessment

Market situation and impacts of feed ingredients

Objective function

Optimal feeding sequence

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Decision variables: what is optimized?

\[ S = (LW_1, l_1, \bar{x}_1; \ldots; LW_n, l_n, \bar{x}_n) \]

- \( l_n \) from 70% to 130% of the population SID lysine requirement formulation with:
  - min/max for nutrient contents
  - min/max for incorporation rates of feed ingredients
Growth model from InraPorc®

Responses to the level of lysine from simulations of one population of 192 pigs

(Brossard et al. 2009)

Total Feed consumption, ADG, Lean %

= f( SID Lys, number of phases)
Economic evaluation and LCA → objective function

\[
\text{GrossMargin} = (\text{SellingPrice} \times \text{CarcassWeight} - \text{FeedingCost} - \text{CareCost} - \text{PigletPrice} - \text{LabourCost}) \times N_{\text{pigs}}
\]

\[
Z = \alpha \times \text{GrossMargin} \ - \beta \times \text{ClimateChangeImpact}
\]

(Dourmad et al. 2014; Garcia-Launay et al. 2014)
Behaviour of the model when fixing LYS level (1)

\[ Z = \alpha \times \text{GrossMargin} - \beta \times \text{ClimateChangeImpact} \]

% LYS fixed

(70 → 130% of the population requirement)

Economic optimization

\[ \alpha = 1 ; \beta = 0 \]

70LYS ... 130LYS

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Behaviour of the model when fixing LYS level (2)

Feed conversion ratio (kg/kg)

Climate Change (kg CO$_2$e/kg LW)
Trade-off between economy and environment (1)

\[ Z = \alpha \times \text{GrossMargin} - \beta \times \text{ClimateChangeImpact} \]

% LYS optimized
(70 → 130% of the population requirement)

Economic or both environmental and economic optimization

\[ \alpha = 1 \; ; \beta = 0, 1, \ldots, 4 \]

ENV0, ENV1, ..., ENV4
Climate change and energy demand reduced but eutrophication and land occupation increased.
Trade-off between economy and environment (3)

**Optimized LYS varies according to number of phases**

- **Optimal LYS ↑ when number of phases ↑ to compensate for restriction in LYS at the beginning of each phase**

- **Optimal LYS ↓ when number of phases ↑**
  - → No more impact of low LYS supply (70%) for the 8th to 10th phase.

Number of feeding phases

SID lysine feed content (% of the average population requirement)
Conclusions

- First attempt of an optimization model → appropriate behaviour | level of SID lysine

- Interaction between SID lysine level and number of feeding phases → performance, impacts, gross margin

- Technical optimum ≠ Economic optimum ≠ Environment optimum
Perspectives

- First attempt of an optimization model | next steps
  - link with InraPorc® to simulate the behaviour of any population
  - optimizing the number of feeding phases
  - optimizing feed restriction

- To include various impacts in the objective function

- Necessary to test sensitivity to market situation
Thank you for your attention!