EFFICIENT & ECOLOGICALLY-FRIENDLY PIG AND POULTRY PRODUCTION.

A WHOLE-SYSTEMS APPROACH TO OPTIMISING FEED EFFICIENCY AND REDUCING THE ECOLOGICAL FOOTPRINT OF MONOGASTRICS.

BASIC DATA

Funding: EU-FP7
(€ 6 million)

Start date: 1 February 2013

Duration: 48 months
(2013 to 2016)
Proper modelling of feed efficiency in breeding programs
revealed through novel Bayesian response to selection methodology:
RFI vs FCR

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FCR occupies large proportion of breeding objectives in pig breeding programs

The MAXGRO™ terminal line

The Danish Duroc terminal line

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Measures of feed efficiency

**FCR: gross measure**

- **FCR**
- **ADFI** (input)
- **ADG** (output)

FCR = Less Efficiency

FCR = High Efficiency

**RFI: partial measure**

- **RFI =** Observed ADFI – Expected ADFI
- **RFI =** ADFI - b₁ ADG – b₂ LMP

RFI = Less Efficiency

RFI = High Efficiency
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• Traits
  • ADFI: 2.61 (0.39) kg/d
  • ADG: 1.12 (0.15) kg/d
  • LMP: 62.7 (1.97) percent

The MAXGRO™ terminal line
Statistical model: Bayesian analysis

\[ y_{ijkl}^{ADFI} = \text{Gender}_{ij} + \text{Parity}_{ik} + YS_{il} + b^{ADFI}(SBW_i) + a_i^{ADFI} + p e_i^{ADFI} + e_{ijkl}^{ADFI} \]

\[ y_{ijkl}^{ADG} = \text{Gender}_{ij} + \text{Parity}_{ik} + YS_{il} + b^{ADG}(SBW_i) + a_i^{ADG} + p e_i^{ADG} + e_{ijkl}^{ADG} \]

\[ y_{ijkl}^{LMP} = \text{Gender}_{ij} + \text{Parity}_{ik} + YS_{il} + b^{LMP}(EBW_i) + a_i^{LMP} + p e_i^{LMP} + e_{ijkl}^{LMP} \]
Modelling residual feed intake (RFI)

RFI = ADFI – E(ADFI)

Genetic RFI ($RF_{ig}$)

$$a_{RFI_{ig}} = a_{i}^{ADFI} - b_{g.1} a_{i}^{ADG} - b_{g.2} a_{i}^{LMP}$$

Phenotypic RFI ($RF_{ip}$)

$$a_{RFI_{ip}} = a_{i}^{ADFI} - b_{p.1} a_{i}^{ADG} - b_{p.2} \hat{a}_{i}^{LMP}$$

$$\begin{bmatrix}
G_{RFI} \\
G_{p,RFI_{ig}} \\
P_{RFI} \\
P_{p,RFI}
\end{bmatrix}
= B G B'$$

$$\begin{bmatrix}
G_{RFI,p} \\
G_{p} \\
P_{RFI,p} \\
P_{p}
\end{bmatrix}
= B P B'$$

$$B = \begin{bmatrix}
I_{fi} & -b_{fi} \\
0 & I_{p}
\end{bmatrix}$$

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Feed conversion ratio (FCR) estimation

\[
a_i^{FCR} = \frac{\mu_{ADFI}}{\mu_{ADG}} + \frac{\hat{a}_i^{ADFI}}{\hat{a}_i^{ADG}} - \frac{\mu_{ADFI}}{\mu_{ADG}}
\]
One use of heritability is to determine how a population will respond to selection.

26.45% with 5.58 PSD of the genetic variation in ADFI is explained by $\text{RFI}_g$. 

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**RFI\_g** is independent of production traits
Selection for RFI results in reduction of ADFI without altering the production traits. Selection for FCR results in disproportional selection on its component traits.
Selection for FCR results in disproportional selection pressure on its component traits and also LMP

RFI\(_g\) allows

1) selection on the proportion of feed intake that is independent of production; and

2) easier and better selection index weights for the traits in the breeding programs

Selection for improved feed efficiency is likely best achieved through multiple-trait selection on RFI\(_g\) and production traits

Joint selection for feed intake and production traits can also result in genetic improvement of feed efficiency
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