Feed-a-Gene

Adapting the feed, the animal and the feeding techniques to improve the efficiency and sustainability of monogastric livestock production systems

Results from Feed-a-Gene on socially affected traits

Social genetic effects interact with feeding regime in growing rabbits

Piles *et al*. 2017, GSE 49

6264 rabbits

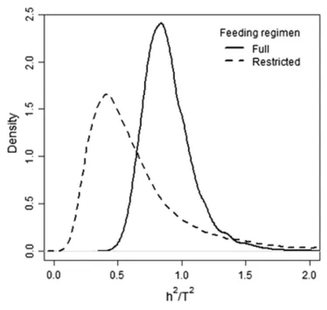
In collective cages of 8

Measure: average daily gain

Analysis: social model in interaction with feeding regime

Parameter[1]	Restricted feeding mean	Restricted feeding MCE	Full feeding mean	Full feeding MCE
TBV	3.616	0.07878	7.484	0.08072
h^2	0.033	0.00029	0.082	0.00041
T^2	0.064	0.00138	0.095	0.00101
s^2	0,0017	2.9^{e-5}	0.0003	5.7^{e-5}
$\rho_{d,s}$	-0.505	0.01059	-0.030	0.01286

Tab1: genetic parameters



- The contribution of social genetic effects to the heritable variance was higher for animals on restricted feeding than on full feeding.
- Feeding regime affects the magnitude of the correlation between social and direct genetic effects
- When social genetic effects were taken into account, the correlation between ETBV for animals on F and R was null, indicating a strong interaction between genotype and FR.

Social genetic effects are important when animals are fed on restricted feeding. Ignoring them in a breeding program for body weight gain at fattening could have negative consequences on the response to selection

Social genetic effects change with time

David *et al*. 2018, GSE 50

3096 rabbits

In collective cages of 8 under restricted feeding regime

Measure: 5 weekly average daily gain

Analysis: social model in interaction with time

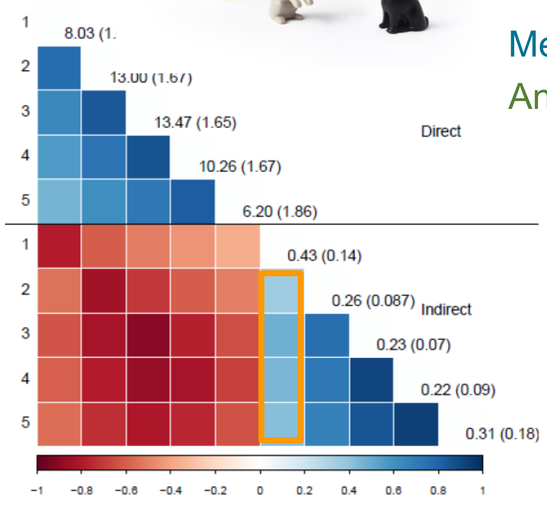


Fig1: Genetic variance and correlations

Week	Direct heritability	Indirect heritability	Total heritability
1	0.17 (0.03)	0.44 (0.13)	0.19 (0.10)
2	0.24 (0.03)	0.23 (0.07)	0.09 (0.06)
3	0.22 (0.02)	0.18 (0.06)	0.05 (0.04)
4	0.15 (0.02)	0.16 (0.06)	0.06 (0.04)
5	0.08 (0.02)	0.18 (0.11)	0.12 (0.10)

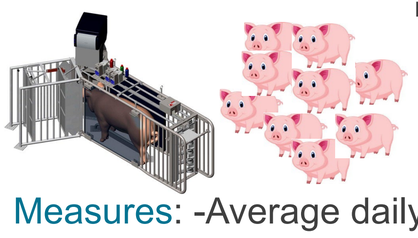
Tab1: heritabilities

- Higher social effects just after mixing
- Social effect after mixing is a different trait than social effect expressed later
- Genetic antagonism between direct and social effects

Growth of animals under a restricted feeding regime could be improved and the delay of their growth curve shortened by reducing the negative impact of social effects, especially during the first week after mixing.

Measure of pair-mate specific degree of interaction improves social model

Ragab *et al*. 2018, animal 13, 231-239



663 pigs in collective cages of 10 to 14

Equiped with electronic self-feeder

Measures: -Average daily gain

-Feeding behavior variables: feeding rate (FR), feeding frequency (FF); time between consecutive visits (Fint) and occupation time (OT)

Analysis: -Define degree of interaction between each pair of individuals using feeding behavioral records ➔matrix $\boldsymbol{C}_s$

-Analyse ADG using :

- Classical animal model (AM)
- Social model (AM_IGE)
- Social model taking into account $\boldsymbol{C}_s$ ($AM\_IGE_{behavior}$)

	AM	AM-IGE	$AM\text{-}IGE_{FR}$	$AM\text{-}IGE_{FF}$	$AM\text{-}IGE_{Fint}$	$AM\text{-}IGE_{OT}$	$AM\text{-}IGE_{ALL}$
DIC	1402.07	1348.69	1376.08	1338.59	1330.77	1304.74	1321.54
$r_{y,\hat{y}}$	0.52 (0.12)	0.53 (0.16)	0.55 (0.09)	0.52 (0.07)	0.54 (0.05)	0.56 (0.05)	0.58 (0.04)

Tab1: Model comparison by deviance information criteria (DIC) and the correlation between observed and predicted average daily gain

	EBV_{animal}	TBV_{CONST}	TBV_{FR}	TBV_{FF}	TBV_{Fint}	TBV_{OT}	TBV_{ALL}
EBV_{animal}	–	0.70	0.79	0.89	0.76	0.44	0.52
TBV_{CONST}	0.89	–	0.68	0.68	0.58	0.41	0.52
TBV_{FR}	0.94	0.85	–	0.83	0.79	0.39	0.59
TBV_{FF}	0.98	0.86	0.95	–	0.83	0.41	0.62
TBV_{Fint}	0.91	0.80	0.92	0.93	–	0.44	0.65
TBV_{OT}	0.61	0.59	0.61	0.61	0.63	–	0.48
TBV_{ALL}	0.69	0.69	0.79	0.79	0.82	0.71	–

Tab2: Percentage of coincidence between top 10% animals (above diagonal) and rank correlations between genetic rankings (below diagonal)

- Better fit to the data and better predictive ability when considering degree of interaction
- Best model: $AM\text{-}IGE_{OT}$, that define the degree of interactions between pen mates on the basis of the occupation time

Considering feeding behavior variables to define differential interaction degree across pairs of mates helps to improve the performance of models fitting IGEs for genetic evaluation

Demonstration of the use of social effects to improve selection for feed efficiency

One generation of divergent selection based on GEBV (social) for ADG

High GEBV-IGE — 165

Low GEBV-IGE — 174

		High	Low
(G)EBV's	CB-GEBV-IGE_{ADG} (g/d)	+2,6	-2,6
	GEBV-IGE_{ADG} (g/d)	+1,1	-1,1
	GEBV-DGE_{ADG} (g/d)	-3,6	+3,6
Weights	Birth weight (g)	1450	1440
	Weaning weight (kg)	7,4	7,2
	On-test weight (kg)	22,0	22,3
	Off-test weight (kg)	129,2	132,9
Production traits	ADG (g/d)	939	978
	DFI (g/d)	2174	2296
	FCR (g/g)	2,33	2,35
	BF-carcass (mm)	12,4	13,5
	LD-carcass (mm)	68,4	69,6
	Meat percentage (%)	60,2	59,5
	Dressing percentage	76,2	75,9
Behavior	Meals (#/d)	27,6	26,7
	Visits (#/d)	30,2	28,8
	Eating time (h/d)	0,793	0,852
	Feeding rate (g/min)	164	170
	Meal size (g)	79	83

Tab 1: Uncorrected means

Preliminary results suggest that animals with a high GEBV for the Indirect Genetic Effect (on growth) show a lower feed intake and have a lower feeding rate. Previous analysis showed that these are characteristics of (feed) efficient animals. However, differences in FCR are small.
Data collection is not yet finalized.
Final data set will be expanded with Microbiota- and Metabolite-data.

Topigs Norsvin

INRAE la science pour la vie, l'humain, la terre

IRTA

Feed-a-Gene

Feed-a-Gene is a European H2020 project involving 23 partners which aims to adapt feeds, animals and feeding techniques to improve the efficiency and sustainability of pig, poultry and rabbit production systems. It is coordinated by INRAE (France), started in March 2015 and will last 5 years. The project aims to reduce the environmental impact of monogastric livestock production by improving and diversifying animal diets and feed technologies and by integrating new selection criteria for these animals. The Feed-a-gene project further aims to develop new management systems for precision feeding and precision farming and to evaluate the overall sustainability of the different management solutions proposed in the project.

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