Topigs Norsvin

“The value of social interactions and crossbred information in selection to improve feed efficiency”

12-Dec-2019 | Rob Bergsma | Wageningen

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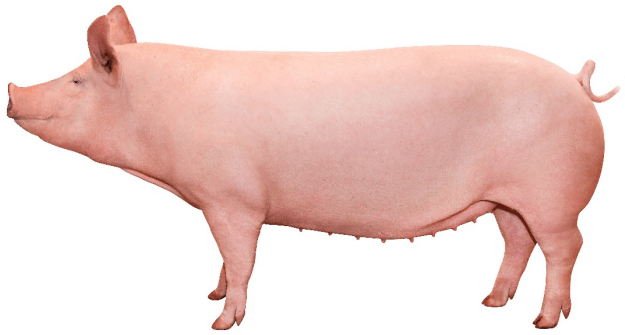

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Content

- Purebred – crossbred interaction
- Indirect Genetic Effects (IGE)
- Understanding the nature of IGE
- High / Low experiment

“How to breed for maximum performance on commercial level”

Feed-a-Gene

5 YEAR RESEARCH FOR BREEDING
TOWARDS IMPROVED FEED EFFICIENCY

Review of the estimated purebred-crossbred correlation (r_{pc}) in pigs

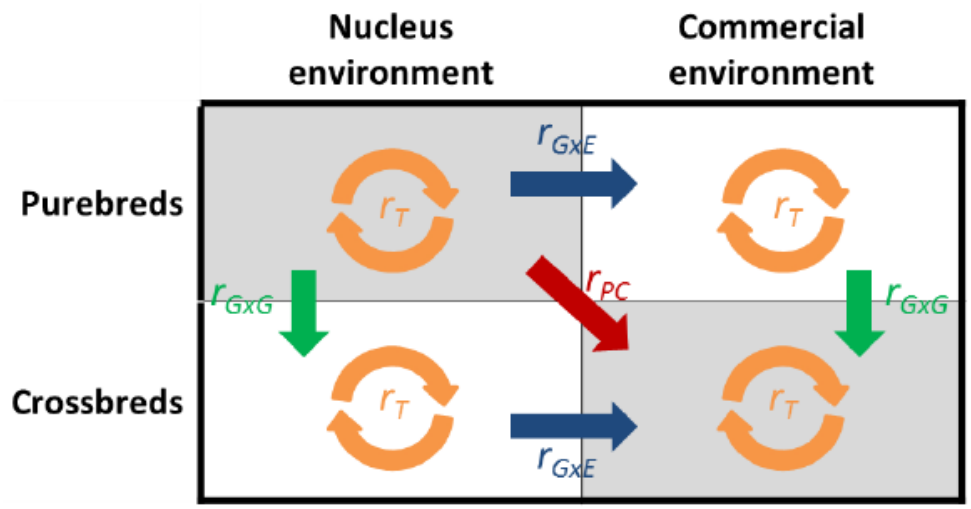
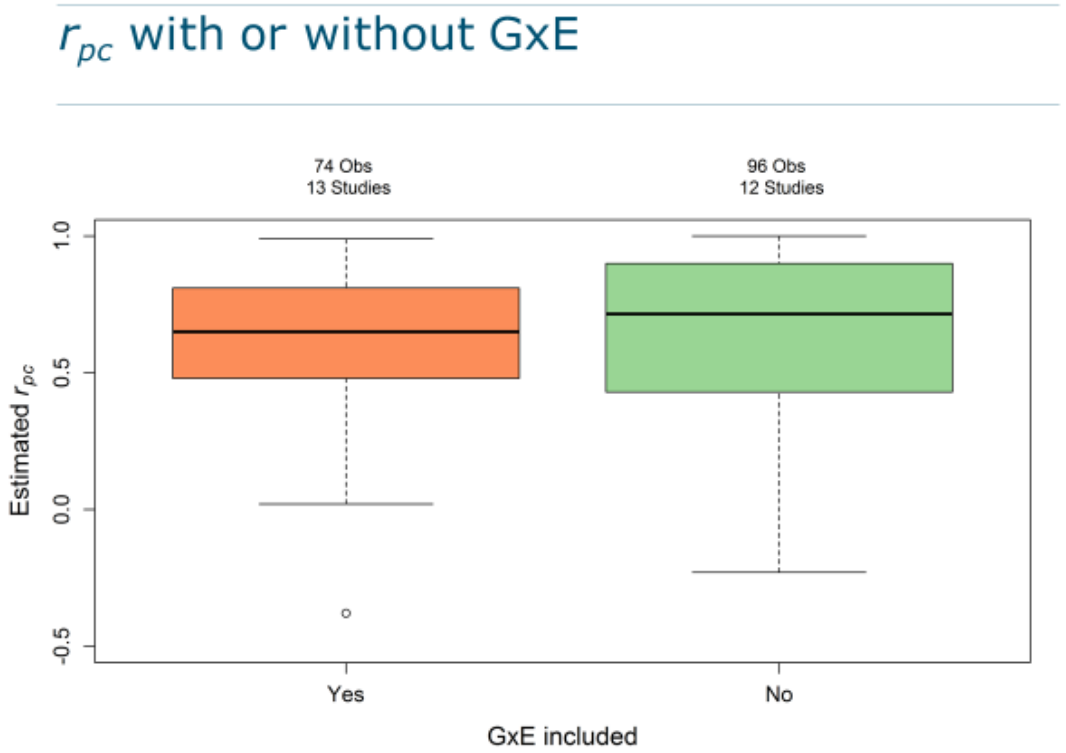


Figure 8 – Experimental design to disentangle the effect of the different components on r_{pc}. Currently, data is collected only in the grey boxes using one method to measure the trait. The arrows within the boxes indicate the correlation due to trait measurements (r_T) when measurements are done using two different methods. The different arrows between the boxes indicate genotype by genotype interactions (r_{GxG}), genotype by environment interactions (r_{GxE}), and the total purebred-crossbred correlation (r_{pc}).



Wientjes and Calus, 2017. BOARD INVITED REVIEW: The purebred-crossbred correlation in pigs: A review of theory, estimates, and implications. *J.Anim.Sci. 95:*3467–3478

Genetic correlations between purebred and crossbred traits

	ADG	DFI	Backfat	Loindepth	FCR	RFI
r_{PC}	0.61 ± 0.06	0.65 ± 0.15	0.82 ± 0.03	0.75 ± 0.04	0.67 ± 0.18	0.62 ± 0.18

Rule of thumb: $r_{PC} < 0.8$ => different traits
$r_{PC} \geq 0.8$ => same trait

Godinho et al., 2018. Genetic correlations between feed efficiency traits, and growth performance and carcass traits in purebred and crossbred pigs. J.Anim.Sci. 96:817-829

Is r_{PC} a GxG- or a GxE-interaction?

USA

~ 85 % Corn/Soy

~ 10% By-products

EU

~ 50 % Wheat/Barley

~ 45 % By-products

	ADG	DFI	FCR	RFI
r_{PC}	1.00 ± 0.19	1.00 ± 0.22	1.00 ± 0.14	0.89 ± 0.16

Godinho et al., 2018. *Genotype by feed* interaction for feed efficiency and growth performance traits in pigs. J.Anim.Sci. 96:4125-4135

Prediction accuracy for crossbred performance

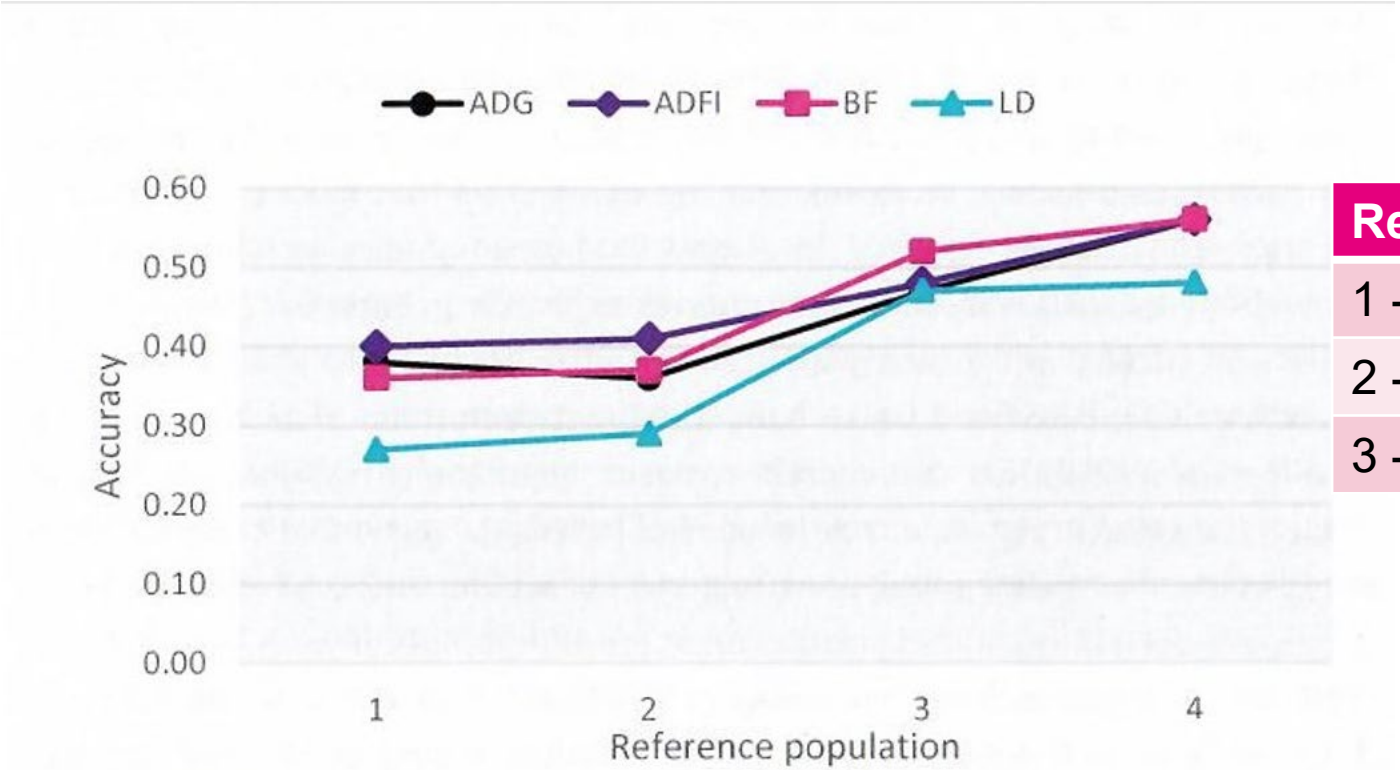


Figure 6.2. Predicted accuracy of the EBV of purebred animals for crossbred performance of average daily gain (ADG), average daily feed intake (ADFI), back fat thickness (BF), and loin depth (LD), using different reference populations: 1) purebred phenotypes, 2) purebred and crossbred phenotypes, 3) purebred phenotypes, genotypes, and crossbred phenotypes, and 4) purebred and crossbred phenotypes and genotypes.

Reference population	Δ accuracy
1 -> 2	-5% - 7%
2 -> 3	31% - 62%
3 -> 4	2% - 19%

Claudia A. Sevillano, 2018. Genomic evaluation considering the mosaic genome of the crossbred pig, PhD thesis. Wageningen University & Research

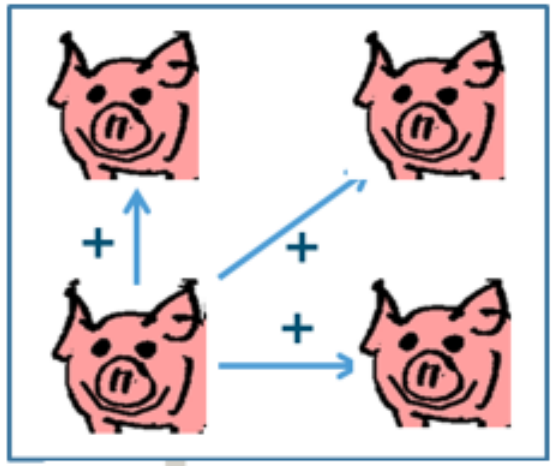
Additional remarks & conclusions

- It's difficult to disentangle purebred-crossbred interaction from Genotype by environment interaction
- It's likely that there is a substantial purebred-crossbred (GxG) interaction
- Genetic evaluation should treat purebred and crossbred traits as different traits (except perhaps for carcass-quality traits)
  - Rule of thumb: $r_{PC} < 0.8$ => different traits

    $r_{PC} \geq 0.8$ => same trait
- Therefore, it's expected that genotyping crossbreds has added value
- But it's difficult to disentangle the effect of purebred-crossbred interaction or increased reference population
- Nevertheless, first results show added value of genotyping crossbreds ☺

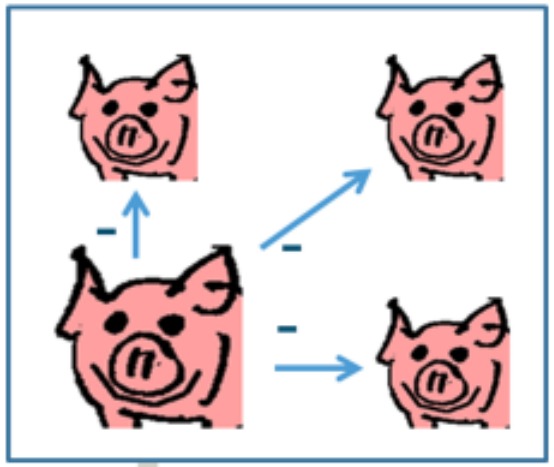
Part 2: Indirect Genetic Effects (IGE)

- Variance components
- Validation
- Behavior
- Genetic evaluation
- High/Low experiment



Positive influence on growth pen mates

' High Indirect Genetic Effect' (on growth)



Negative influence on growth pen mates

' Low Indirect Genetic Effect' (on growth)

Variance components Indirect Genetic Effects (IGE)

What	Z	Z
var(A_D)	3181	3059
var(A_I)		32
covar(A_{DI})		69
r_g		0.22
var(group)	1020	620
var(bar)	1053	830
var(litter)	565	554
var(e)	4211	4321
h^2/T^2	0.32	0.70
var(P)	10030	9669
Var(TBV)		6804
LogL	-1729	-1697
difference		32

Average Daily Gain (ADG)
1 (sow-) line only

Green = IGE model
Blue = classical model

group size Z = 9.82

Bergsma et al., 2008 The contribution of social effects to heritable variation in finishing traits of domestic pigs (Sus scrofa). Genetics, 178(3), 1559-1570.

Validation Indirect Genetic Effect

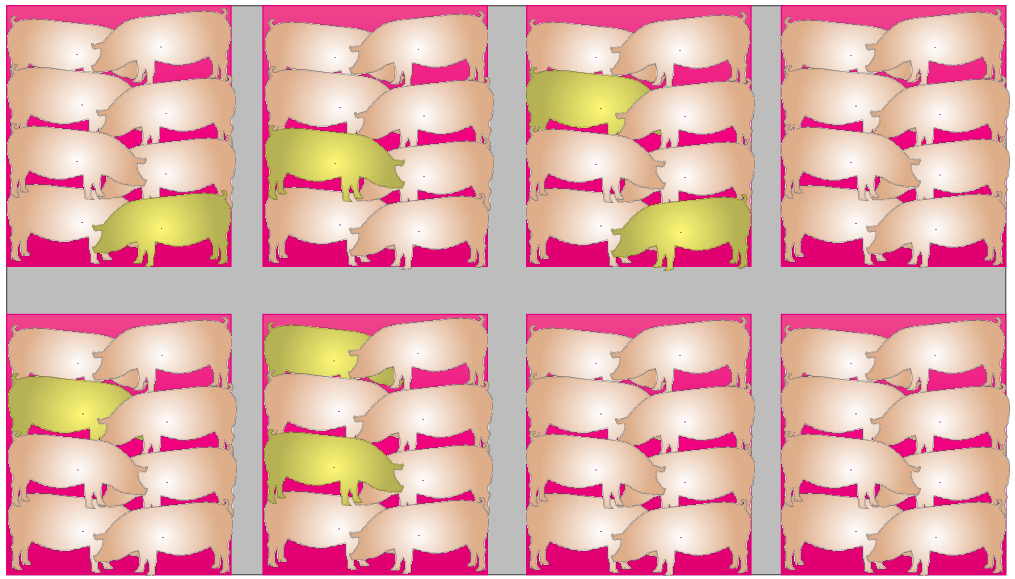
SIRE

OFFSPRING

pred. ~ 20%

Correlate with corrected phenotype

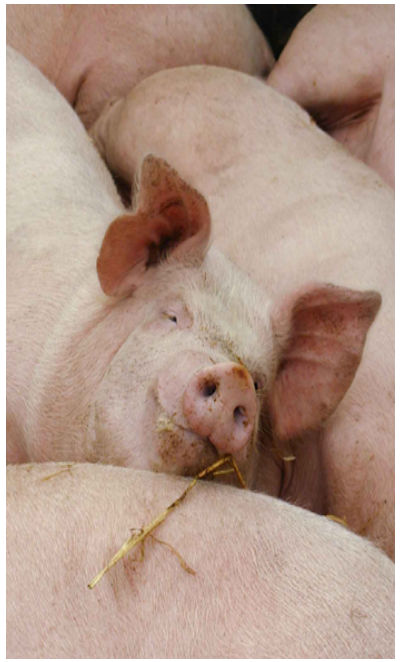
Blind phenotypes of complete
FARM – COMPARTMENT – CONTEMPORARY GROUP
Cut off dataset at that point



General correlations with corrected phenotype

Pred phen	Correlation
CBV	0.328
DBV	0.327
IBV	0.219
DIBV	0.352

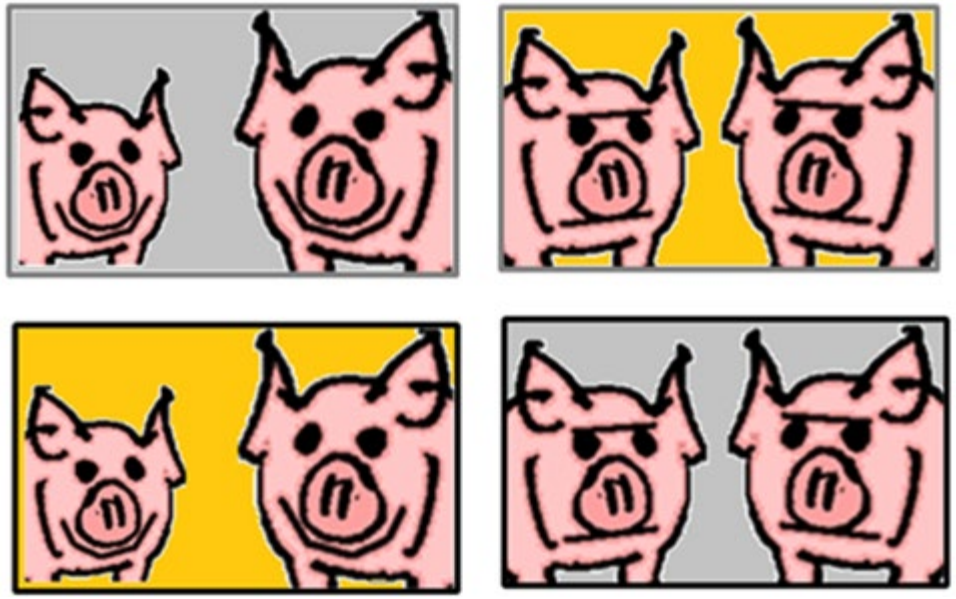
CBV Classical Breeding Values
DBV Direct Breeding Values
IBV Indirect Breeding Values
DIBV both Direct- and Indirect Breeding Values



Naomi Duijvesteijn, 2014. *Sociable Swine:* prospects of indirect genetic effects for the improvement of productivity, welfare and quality, PhD thesis. Wageningen University & Research

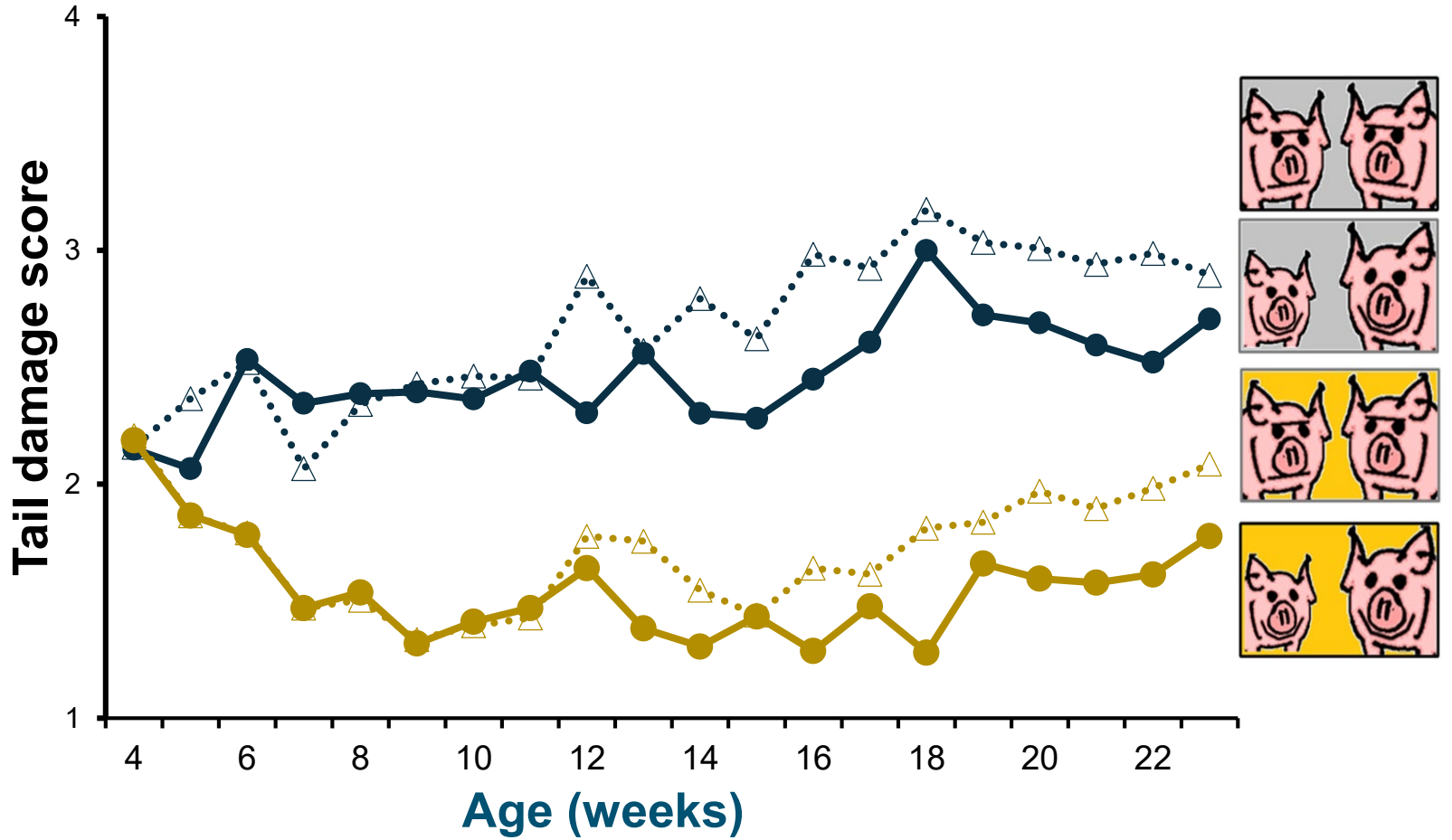
Study WUR

- Large experiment WUR (N=480)
- High and low EBV's Indirect Genetic Effect for ADG
- Barren or straw enriched pens



Irene Camerlink, 2014. *Sociable Swine:* Indirect genetic effects on growth rate and their effect on behaviour and production of pigs in different environments , PhD thesis. Wageningen University & Research

Tail damage: IGE_g and effect housing



Camerlink et al. 2014

Indirect Genetic Effect for skin damage

	Symbol	Excluding IGE	Including IGE
Direct genetic variance	$\sigma^2_{A_D}$	29.72	28.78
Indirect genetic variance	$\sigma^2_{A_I}$	-	1.37
Direct-indirect covariance	$\sigma_{A_{DI}}$	-	-1.09
Group variance	σ^2_{group}	112.6	98.35
Residual variance	σ^2_e	397.08	395.08
Total genetic variance	$\sigma^2_{A_T}$	29.72	128.24
Total phenotypic variance	σ^2_P	539.4	535.02
T^2 or h^2	T^2 or h^2	0.06	0.24
Genetic correlation	$r_{A_{DI}}$	-	-0.17
AIC		-29166.79	-29180.09
Relative likelihood		0.0013	1

Kanibalismus

Data steffi

TN70 gilt rearing

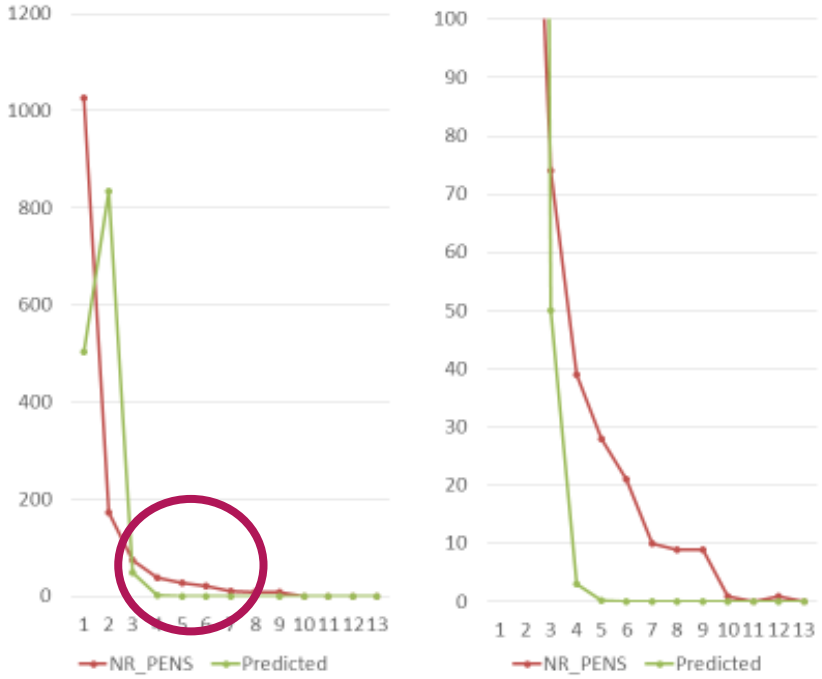
16,000 animals in pens of 12

Culled because of damaging: 6%

Green: random chance of 6%

Red: realized

Conclusion: some families bite



Conclusions (2) and follow up

- Indirect Genetic Effects exist for Average Daily Gain and Feed Intake; unexpectedly we were not able to estimate an Indirect Genetic Effect for FCR
- Indirect Genetic Effects are not an artifact
- Still phenomenon not fully understood
- Initial idea:
  - 24/7 video recording
  - Link animal ID to video
  - Develop algorithms to process video's
- Replaced video analyses by behavioral analyses in feeding stations

Mean values (± SD) for feed intake behaviour traits for high, middle and low ranked animals according to Blom's rank index.

	20% high	Ranking 60% middle	20% low
Number of animals	3222	9518	3151
Number of wins	472	375	264
Number of losses	354	383	371
Number of visits ± SD	22.4 ± *14.0*	20.2 ± *13.8*	18.3 ± *12.4*
Feed intake per meal ± SD (g)	232 ± 117	252 ± *122*	269 ± *130*
Time per meal ± SD	4.63 ± *2.77*	5.18 ± *2.99*	5.52 ± *3.06*
Feeding rate ± SD (g/min/d)	56.8 ± *25.7*	54.8 ± 24.1	54.8 ± *26.7*
Feed conversion ratio ± SD	2.29 ± *0.39*	2.25 ± *0.38*	2.24 ± *0.38*
Average daily gain ± SD (g)	1039 ± 145	1028 ± 144	1016 ± 140

Genetic correlation for Blom's rank index (±SE).

	Daily feed intake	Number of visits	Feed intake per meal	Feed intake time per meal	Feeding rate	Feed conversion ratio	Average daily gain
Rank Blom-score	0.39 ± *0.08*	-0.15 ± *0.08*	0.20 ± *0.07*	0.21 ± *0.08*	0.13 ± *0.10*	0.26 ± *0.09*	0.43 ± *0.08*

Genetic evaluation

- Phenotyping and genotyping crossbreds is part of the Feed-a-Gene work package
- Almost all genotyped crossbreds with phenotype on FE
- The routine genetic evaluation has been expanded with crossbred genomics
- Training dataset ± 5,000 genotyped and phenotyped crossbreds

- GEBV's are used in a High / Low experiment to:
  - Provide a proof of principal
  - Try to understand the mechanisms behind IGE

Feed-a-Gene

- Purebred – crossbred interaction for Indirect Genetic Effect might be as low as 0.40 (personal communication Michael Aldridge)
- IGE for purebreds and crossbreds should be treated as different traits (as thus DGE)

High / Low experiment

- Data until ~2019 used as reference population

- Farrowing batch 48 litters
- 10 highest and 10 lowest litters (before farrowing) are assigned
- All piglets of assigned litters are genotyped (>250)
- 48 highest and 48 lowest based on GEBV are put on test

High / low results

		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)	1415	1411
	Weaning weight (kg)	7,1	7,5
	On-test weight (kg)	24,1	23,4
	Off-test weight (kg)	122,1	121,8
Production traits	ADG (g/d)	947	953
	DFI (g/d)	2195	2199
	FCR (g/g)	2,33	2,31
	BF-carcass (mm)	12,6	12,1
	LD-carcass (mm)	66,7	66,8
Behavior	Visits (#/d)	24,6	27,0
	Eating time (h/d)	0,843	0,813
Microbiota			
Metabolites			

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