

## Genetic parameters of feed intake patterns of Duroc sows during gestation and lactation

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### Introduction

Feed intake is a key factor in the economic and sustainable pig industry. However, feed intake of sows during gestation and lactation periods did not received much research attention perhaps because it represents only 15-17% of the total feeding costs which are estimated by 68% the total variable production costs (Solà-Oriol & Gasa, 2016). During gestation and lactation periods, adequate FI levels prevent excessive mobilization of nutrients from body stores (Yoder *et al.*, 2014) which increases sow longevity. FI during gestation is changing according to the stage of gestation which supports the theory of multi-phase feeding strategy during that period (Jackson, 2009, McPherson *et al.*, 2004). Studies have demonstrated considerable genetic variation for FI traits during lactation (Bergsma *et al.*, 2008, Hermes, 2007). However, little is known about the genetic parameters of FI of pregnant sows. Therefore, there is a lack of knowledge about the genetic relationships between FI during gestation and lactation periods. Accordingly, the aim of this study is to estimate the genetic parameters of feed intake patterns during gestation and lactation periods and their relationship with prolificacy traits.

### Material and methods

#### Animals and dataset

Animals used in this study come from a Duroc line (Tibau *et al.*, 1999), which was subjected to selection since 1991 using an index including weight at off test, approximately 180 days (W180), backfat thickness at off test (BF180), number born alive (NBA) and number of functional teats (NT). In this study, a total number of 663 sows belonged to different parity orders were used. Individual feed intake (FI), body weight (BW) and backfat (BF) were recorded during gestation and lactation periods, and the obtained number of born alive (NBA) was also recorded for each sow. Changes in BF ( $\Delta$ BF) was calculated as the difference (mm) between BF just before parturition and BF just after AI.

FI data at early gestation (until approximately 40 days of gestation) and during lactation were manually recorded 3-4 times per weeks. For middle and late lactation FI records were retrieved from the feeding devices used to provide feed to the sows housed in groups. FI data were edited by keeping records during gestation and lactation periods, daily FI records lower than 1.6 kg (about 1% of the data) and outliers were treated as missing values. Also, data recorded after 105 days of gestation were eliminated to avoid the high FI variability resulted by pre-parturition time. Daily FI records until 28 days of lactation were only considered. Daily

FI was predicted for days without record during lactation (FI<sub>lac</sub>) and early gestation (FI<sub>1-40</sub>) using 3<sup>rd</sup> degree Legendre Polynomial function. Late gestation daily FI missing records (FI<sub>41-105</sub>) were predicted using 6<sup>th</sup> degree Legendre Polynomial function. Thereafter this period was divided to calculate two separated daily FI traits: FI<sub>41-80</sub> and FI<sub>81-105</sub>. In addition, a single gestation daily FI trait (FI<sub>1-105</sub>) was defined combining FI throughout all the gestation.

### Statistical Analysis Models

Tri-variate animal repeatability models were used to analyse the indicated traits, in these models FI<sub>lac</sub> and NBA were always considered in the analysis and in addition one daily gestation FI trait was fitted. The model used for NBA and gestation daily FI was:

$$y_{ijklm} = P_i + B_j + S_k + \beta_1 BW + \beta_2 BF + \beta_3 \Delta BF + \beta_4 Age + a_l + p_l + e_{ijklm}$$

where  $Y_{ijklm}$  denotes the value of the trait during the reproductive cycle  $i^{th}$  of animal  $l^{th}$ , in batch  $j^{th}$  and season  $k^{th}$ . The fixed effects were: reproductive cycle ( $P_i$ , 5 levels: 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>-6<sup>th</sup> and > 6<sup>th</sup>); batch ( $B_j$ , 25 levels); season ( $S_k$ , 3 levels) and partial regressions on BW, age, BF and  $\Delta BF$  ( $\beta_1$ ,  $\beta_2$ ,  $\beta_3$  and  $\beta_4$ , respectively). The random part of the model includes the additive genetic and permanent environmental effects of the sow  $l$  ( $a_l$ ,  $p_l$ ). The term  $e_{ijklm}$  is the residual of the model. The model for lactation daily FI was the same as that previously described but in addition it included the effect of the lactation length. Random effects were assumed to be independent, but the same random effect was assumed correlated between traits. The prior distribution of the additive genetic values and permanent effects were  $a|G \sim MVN(0, A \otimes G)$  and  $p|P \sim MVN(0, I \otimes P)$  where  $A$  is the matrix of coefficients of relatedness between individuals,  $\otimes$  denotes the Kronecker product,  $G$  is the 3x3 additive genetic covariance matrix,  $P$  is the corresponding 3x3 covariance matrix and  $I$  is the appropriate identity matrix. For all analyses, statistics of the marginal posterior distributions of all unknown parameters were obtained using the Gibbs Sampling algorithm. The software used for Gibbs Sampling was gibbs2f90 (Misztal *et al.*, 2002). Chains of 200,000 samples were run and the first 20,000 iterations were discarded, one out 100 iterations was retained.

### Results and discussion

Descriptive statistics are presented in Table 1. During gestation period the variability of FI was high during early gestation, decreased to nearly null values in mid gestation, and increased again in late gestation. The same trend was also observed for FI averages as it was 2.29 kg/d/sow in FI<sub>1-40</sub>, then decreased about 20% during FI<sub>41-80</sub>, and reached 2.73 kg/d/sow in FI<sub>81-105</sub> period. These patterns are compatible with the feed restriction the sows are subject to. The average daily lactation FI was 5.87 kg/d/sow.

Table 1. Mean, SD, minimum, maximum and number of records (N) for traits and covariates.

Trait/Covari	Mean	SD	Minimum	Maximum	N
FI <sub>1-40</sub>	2.29	0.24	1.62	2.91	1094
FI <sub>41-80</sub>	1.84	0.04	1.6	1.94	1062
FI <sub>81-105</sub>	2.73	0.11	1.81	3	1062
FI <sub>41-105</sub>	2.18	0.06	1.69	2.35	1062
FI <sub>1-105</sub>	2.23	0.12	1.77	2.51	1097
FI <sub>lac</sub>	5.87	0.52	3.55	7.21	948
NBA	11.34	3.06	1	19	1092

BW	222.3	23.7	148.5	358.5	1081
Age	652	254	251	1433	1097
BF	16.36	3.71	7	31	1098
$\Delta$ BF	3.07	2.92	-12	18	992

Heritability estimates for all traits are presented in Table 2. Heritability estimates for daily FI during gestation are nearly null. Lactation daily FI was also low but slight higher (0.117). Low lactation FI heritability (0.14) was also reported in pigs (Bergsma *et al.*, 2008). Hermesch (2007) reported similar  $h^2$  estimates, and they also observed an increasing trend with the lactation time. Moderate heritability (0.21) was estimated for NBA, similar  $h^2$  (0.15) was reported by Abell *et al.* (2012). Low positive genetic correlation (0.09) was found between NBA and daily lactation FI (not reported in tables). Hermesch *et al.* (2008) reported positive genetic correlation between daily lactation FI and NBA.

Table 2. Posterior means (SD) of genetic parameters for the different traits.

Trait	$h^2$ (SD)	$P^2$ (SD)	Residual (SD)
FI <sub>1-40</sub>	0.025 (0.019)	0.024 (0.022)	0.0269 (0.0001)
FI <sub>41-80</sub>	0.054 (0.030)	0.031 (0.033)	0.0004 (0.00002)
FI <sub>81-105</sub>	0.069 (0.036)	0.064 (0.053)	0.0051 (0.0004)
FI <sub>41-105</sub>	0.061 (0.032)	0.056 (0.056)	0.0015 (0.0001)
FI <sub>1-105</sub>	0.040 (0.024)	0.040 (0.025)	0.0045 (0.0002)
FI <sub>lac</sub>	0.117 (0.046)	0.196 (0.058)	0.1091 (0.0083)
NBA	0.211 (0.050)	0.093 (0.042)	6.1608 (0.3949)

Genetic, permanent and residual correlations between gestation daily FI traits are presented in Table 3. High positive genetic correlations were observed between gestation daily FI traits and NBA, particularly when considering FI at early gestation, or the whole gestation period. Positive genetic correlations were obtained between FI<sub>lac</sub> and daily middle (FI<sub>41-80</sub>) or late (FI<sub>81-105</sub>) gestation FI, this correlation with early gestation daily FI was null. When the whole gestation was considered (FI<sub>1-105</sub>), the correlation with FI<sub>lac</sub> cannot be discarded to actually be positive, although the posterior mean is negative. Weldon *et al.* (1994) reported a negative phenotypic relationship between daily FI during gestation and lactation. Permanent correlations had large errors and the only ones that can be said to be different from zero are FI<sub>lac</sub>-FI<sub>1-40</sub> and FI<sub>lac</sub>-FI<sub>1-105</sub>, in both cases negative. In spite of these results it has to be noted that given the low variability and heritability of gestation daily FI traits the aforementioned estimates of genetic correlations do not have much relevance. In fact our major conclusion is that gestation FI data are of limited interest to genetically modify efficiency of the sows, being much more promising to consider lactation FI data as well as backfat thickness and body weight evolution.

Table 3. Posterior means (SD) of genetic, permanent and residual correlations.

	Genetic		Permanent		Residual	
	FI <sub>lac</sub>	NBA	FI <sub>lac</sub>	NBA	FI <sub>lac</sub>	NBA
FI <sub>1-40</sub>	0.14(0.27)	0.99(0.0.1)*	-0.78(0.27)*	0.37(0.49)	-0.03(0.05)	-0.02(0.04)
FI <sub>41-80</sub>	0.63(0.31)*	0.64(0.31)*	-0.26(0.59)	0.11(0.61)	-0.02(0.06)	-0.04(0.05)
FI <sub>81-105</sub>	0.82(0.25)*	0.45(0.30)	-0.31(0.51)	0.39(0.58)	-0.01(0.06)	-0.06(0.05)
FI <sub>41-105</sub>	0.81(0.27)*	0.45(0.31)	-0.10(0.42)	0.50(0.63)	-0.02(0.06)	-0.06(0.05)
FI <sub>1-105</sub>	-0.35(0.54)	0.68(0.26)*	-0.74(0.31)*	0.27(0.53)	0.04(0.05)	0.01(0.04)

\* Probability of being greater than 0 > 0.95 or < 0.05.

## Acknowledgements

This study has been funded by the Spanish research project RTA2014-00015-C02-01 Feed-a-Gene Project, funded from the European Union's H2020 Programme under grant agreement no 633531.

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