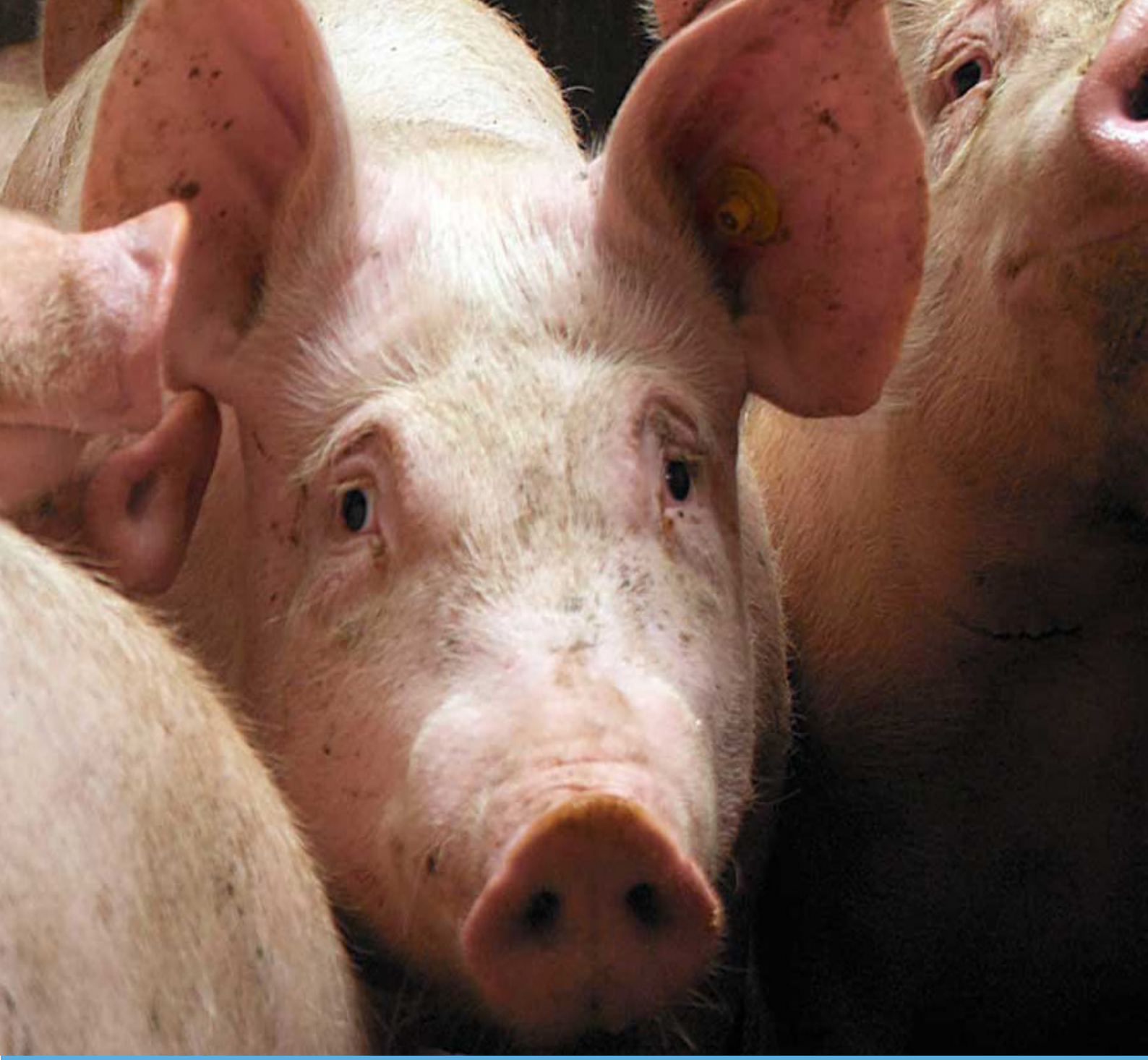

Lysine requirement of growing-finishing pigs: a dose-response study

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Lysine requirement of growing-finishing pigs: a dose-response study

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Foreword

The research “Lysine requirement of growing-finishing pigs: a dose-response study” was conducted by Wageningen Livestock Research and private partners Agrifirm and ForFarmers as part of the Public Private Partnership “Feed4Foodure”, and was funded by Vereniging Diervoederonderzoek Nederland (VDN) and the Ministry of Agriculture, Nature and Food Quality (LNV). The authors thank VDN and LNV for their support, and the members of the Cluster “Swine” of VDN for their valuable and inspiring contribution to the research. The skilful and devoted contribution of staff of the two facilities at which the research was conducted, and of colleagues involved at Agrifirm and ForFarmers is highly appreciated!

Carola van der Peet-Schwering and Paul Bikker

Summary

Recently, Van der Peet-Schwering and Bikker (2018) updated the recommendations for standardized ileal digestible (SID) essential amino acids (AA) in starter, grower and finisher diets for current and future growing and finishing (GF) boars, gilts and barrows. The SID lysine requirement was determined using the pig model InraPorc (Van Milgen et al., 2008). The updated SID lysine requirements for current pigs were validated in a dose-response study described in the present report. The study was performed on two farms (Farm A and Farm B) both with GF gilts and boars. The pigs of each sex were assigned to one of four SID lysine levels: 80, 95, 110 or 125% of the recommended level for current boars and gilts in the starter, grower and finisher phase (Van der Peet-Schwering and Bikker, 2018). These levels were fed during the whole GF period. The SID lysine (in g/EW_{2015}) at the 100% level was sex specific and hence differed between boars and gilts. Recommended SID levels (100%) in starter, grower and finisher diets for current GF boars were 8.7, 7.6 and 6.8 g/EW_{2015}, respectively. Recommended SID levels (100%) in starter, grower and finisher diets for current GF gilts were 8.3, 7.1 and 6.1 g/EW_{2015}, respectively. The GF boars and gilts pigs were fed a starter diet during the first five weeks, a grower diet for the subsequent four weeks and a finisher diet until delivery to the slaughterhouse. At Farm A, feed was supplied ad libitum in a dry feed hopper with one feeding place and one drinking nipple per pen. At Farm B, feed was supplied ad libitum in a dry feed hopper with two feeding places and two drinking nipples per pen. On both farms, the feed was provided as pellets via a computerized automatic system, which registered the amount of feed (in kg) supplied per pen per day. In each of the three phases, regression analyses with a broken line model with average daily gain (ADG) and feed conversion ratio (FCR) as response variables and SID lysine (g//EW_{2015}) as independent variable was used to determine the required dietary SID lysine content for maximum ADG and minimum FCR.

The study was conducted without major problems. The mean growth performance was at a high level. Mean results on high lysine diets on Farm A was for feed intake 2.2/2.3 kg/d, ADG 1080/990 g/d and FCR 2.1/2.3 for boars and gilts, respectively. For Farm B, mean results were for feed intake 2.1/2.2 kg/d, ADG 900/840 g/d and FCR 2.3/2.6 for boars and gilts, respectively.

Based on the results of this study, the following conclusions were drawn:

- In general, the approach adopted by Van der Peet-Schwering and Bikker (2018) to define the growth performance based on ADG and FCR and derive the SID lysine requirements using InraPorc was confirmed by the present study. Adequate farm specific typing of growth performance of the pigs is crucial. The growth curve on a farm may deviate from that used for the current GF pigs in Van der Peet-Schwering and Bikker (2018).
- The recommended SID levels in starter diets of 8.7 and 8.3 g/EW_{2015} for current boars and gilts, respectively, were too low for the farms in this study. For maximizing ADG and minimizing FCR, the recommended SID levels in starter diets for boars and gilts were 10.6 and 9.5 g/EW_{2015}, respectively, on Farm A and 9.8 and 9.0 g/EW_{2015}, respectively, on Farm B.
- The recommended SID levels in grower diets of 7.6 and 7.1 g/EW_{2015} for current boars and gilts, respectively, are in accordance with the SID lysine requirement of boars and gilts during the grower phase on Farm A and Farm B.
- The recommended SID level in finisher diets of 6.8 g/EW_{2015} for current boars might be too low for boars on Farm A (for minimizing FCR, not for maximizing ADG) but too high for boars on Farm B. The recommended SID level in finisher diets of 6.1 g/EW_{2015} for current gilts might be too low for gilts on Farm A (for minimizing FCR, not for maximizing ADG) but is in accordance with the SID lysine requirement of gilts during the finisher phase on Farm B. For maximizing ADG and minimizing FCR, the recommended SID levels in finisher diets for boars and gilts were 8.0 and 6.5 g/EW_{2015}, respectively, on Farm A and 6.0 and 6.0 g/EW_{2015}, respectively, on Farm B.
- The difference in estimated requirements on Farm A and Farm B compared to recommendations for current pigs was largely explained by FCR realised in each phase on the two farms, relative to the FCR of current pigs.

1 Introduction

Recently, Van der Peet-Schwering and Bikker (2018) updated the recommendations for standardized ileal digestible (SID) essential amino acids (AA) in starter, grower and finisher diets for current and future growing and finishing (GF) boars, gilts and barrows. The SID lysine requirement was predicted with help of the pig model InraPorc (Van Milgen et al., 2008). The SID requirements of the other essential AA, relative to lysine, were estimated based on literature data of the last 10 years. The performance of the current GF pigs was based on the performance of GF boars, gilts and barrows in the control group as published by Van der Peet-Schwering et al. (2012). These performance data were about 5% better than the mean performance of the GF pigs in the Netherlands as published in the Kengetallenspiegel 2016 (Agrovision, 2017). The daily gain of the future GF pigs was assumed to be 10% higher than the daily gain of the current GF pigs and was realized by a 10% higher feed intake or a 10% improved feed conversion ratio. In Table 1, the performance and the updated recommendations for SID lysine (in g per EW_{2015}) in starter, grower and finisher pig diets for the average current and future GF boar, gilt and barrow (Van der Peet-Schwering and Bikker, 2018) as predicted with InraPorc (Van Milgen et al., 2008) are presented.

Table 1 *Performance and updated recommendations for standardized ileal digestible (SID) lysine in starter, grower and finisher pig diets (in g per EW_{2015}) for the average current and future[1] growing and finishing pig (Van der Peet-Schwering and Bikker, 2018) as predicted with InraPorc (Van Milgen et al., 2008).*

	Current growing and Finishing pigs			Future growing and finishing pigs: 10% higher feed intake			Future growing and finishing pigs: 10% improved feed conversion ratio		
	Boar	Gilt	Barrow	Boar	Gilt	Barrow	Boar	Gilt	Barrow
Performance (25-120 kg):									
ADG[2] (g/d)	869	841	826	957	929	906	956	929	905
ADFI[2] (kg/d)	1.99	2.08	2.11	2.19	2.29	2.32	1.99	2.09	2.11
FCR[2]	2.29	2.47	2.56	2.29	2.46	2.57	2.09	2.25	2.33
Mean PD[2] (g/d)	145	136	132	157	148	142	163	156	149
SID lysine (g/EW_{2015}):									
Starter diet (25-50 kg)	8.7	8.3	8.3	9.1	8.7	8.7	9.6	8.7	8.9
Grower diet (50-80 kg)	7.6	7.1	7.1	7.8	7.3	7.1	8.5	8.0	7.8
Finisher diet (80-120 kg)	6.8	6.1	5.8	6.8	6.1	5.8	7.6	7.2	6.8

[1] The daily gain of the future growing and finishing pigs is 10% higher than the daily gain of the current growing and finishing pigs and is realized by a 10% higher feed intake or a 10% improved feed conversion ratio; [2] ADG = average daily gain; ADFI = average daily feed intake; FCR = feed conversion ratio; PD = protein deposition.

The goal of this experiment was to validate the updated SID lysine recommendations for current growing and finishing pigs (Van der Peet-Schwering and Bikker, 2018) in a dose-response study. The study was performed on two farms both with GF gilts and boars.

2 Material and methods

2.1 Animals

The trial was conducted at two farms:

- Farm A: pig research facility Laverdonk of Agrifirm;
- Farm B: pig farm of ForFarmers.

On Farm A, the trial was conducted with in total 520 GF pigs (Tempo boar x T20 sow and Tempo boar x TN70 sow). At an age of nine weeks, 260 GF boars and 260 GF gilts were assigned to the experiment in four batches with each three weeks in between. On Farm B, the trial was conducted with in total 1408 GF pigs (Triton boar x TN70 sow). At an age of nine weeks, 704 GF boars and 704 GF gilts were assigned to the experiment in four batches with each one week in between. On both farms, pigs were followed till delivery to the slaughterhouse. Pigs in all pens were delivered to the slaughterhouse in two or three deliveries with about two weeks in between. The heaviest pigs in a pen were first delivered to the slaughterhouse and then the remainder of the pigs. The trial was conducted from January till July 2019.

2.2 Experimental treatments

The GF boars and gilts were assigned to one of four SID lysine levels: 80, 95, 110 or 125% of the recommended level for current boars and gilts (Van der Peet-Schwering and Bikker, 2018). These levels were fed during the whole GF period. The content of SID lysine (in g/kg) at the 100% level differed between boars and gilts. The content of SID lysine (in g/kg) in the starter, grower and finisher diet at the four SID lysine levels is presented in Table 2 (see chapter 2.5) for both the GF boars and gilts. Boars and gilts were housed separately.

2.3 Experimental design

Farm A

On Farm A, pigs were blocked for BW. Each block contained four pens (the four dietary treatments) with boars or four pens with gilts. Two blocks (one block with boars and one block with gilts) with a similar BW were assigned to rooms with eight pens each. The four pens in each block were randomly allotted to the four dietary treatments. In total 64 pens (4 dietary treatments x 2 sexes x 8 replicates) were assigned to the experiment.

Farm B

On Farm B, pigs were not blocked for BW. In every batch, three rooms (one room with only boars, one room with only gilts and one room with boars and gilts (separately housed)) with each 12 pens were assigned to the experiment. Two pens of each 11 pigs were fed by one feed valve. Therefore, the feed intake was not available per pen but per two pens. Six feeding valves (12 pens) per room were randomly assigned to the dietary treatments. In the room with only boars, four feeding valves (8 pens) were assigned to the four dietary treatments. In total 128 pens (64 feeding valves) (4 dietary treatments x 2 sexes x 8 replicates) were assigned to the experiment.

2.4 Housing and climate

Farm A
The GF pigs were housed in eight rooms (three rooms in batch 1, two rooms in batch 2, two rooms in batch 3 and one room in batch 4) with eight pens each. The number of pigs per pen was 7 in three rooms, 8 in two rooms, 9 in two rooms and 10 in one room. The pens with 7 pigs per pen were 1.75 x 3.30 m and had 40% concrete solid floor and 60% slats. The pens with 8, 9 or 10 pigs were 2.65 x 3.20 m and had 40% concrete solid floor and 60% slats. In all rooms, the climate was controlled by computer and an automatic curve (room temperature: 25^0C at day 1 and gradually decreasing to 21^0C at day 100). From 7.30 till 16.30 h artificial light was on in the rooms (automatically by a timer). A control lamp was on from 7.00 till 20.00 h (automatically by a timer). A chain with a toy was supplied in every pen as pen enrichment. Boars and gilts were housed separately.

Farm B
The GF pigs were housed in 12 rooms (three rooms per batch) with 12 pens each. In every pen, 11 pigs were housed. All pens were 2.20 x 4.00 m and had 40% concrete solid floor and 60% slats. Two pens of 11 pigs were fed by one feed valve. In all rooms, the climate was controlled by computer and an automatic curve (room temperature: 25^0C at day 1 and gradually decreasing to 21^0C at day 100). From 7.30 till 16.30 h artificial light was on in the rooms (manually operated). A control lamp was on from 7.00 till 20.00 h (automatically by a timer). A chain with a toy was supplied in every pen as pen enrichment. Boars and gilts were housed separately.

2.5 Feeding and water supply

The GF boars and gilts pigs were fed a starter diet during the first five weeks, then a grower diet for four weeks and then a finisher diet till delivery to the slaughterhouse. At Farm A, feed was supplied ad libitum in a dry feed hopper with one feeding place and one drinking nipple per pen. At Farm B, feed was supplied ad libitum in a dry feed hopper with two feeding places and two drinking nipples per pen. At Farm B, two pens of each 11 pigs were fed by one feed valve. On both farms, the feed was provided as pellets via a computerized automatic system, which registered the amount of feed (in kg) supplied per pen per day. Water was supplied ad libitum.

From the starter, grower and finisher diet only the diets with the highest SID lysine level (125% for the GF boars) and the lowest SID lysine level (80% for the GF gilts) were produced. The other diets were obtained by mixing the diets with the highest and lowest SID level on pen level with the computerized feeding system on the farms. The SID lysine content (in g/kg and in g/EW_{2015}) in the starter, grower and finisher diet supplied to the GF boars and gilts at the four SID lysine levels and the ratio between the diets with the highest and the lowest SID lysine level is presented in Table 2. The SID lysine levels in the starter diet 125% for boars and 80% for gilts were 12.00 and 7.28 g/kg, respectively. The SID lysine levels in the grower diet 125% for boars and 80% for gilts were 10.50 and 6.24 g/kg, respectively. The SID lysine levels in the finisher diet 125% for boars and 80% for gilts were 9.38 and 5.36 g/kg, respectively. All diets had an EW=1.10 (= 9.68 MJ NE). The levels of SID methionine + cysteine, threonine, tryptophan, isoleucine and valine were at least 5% higher than the updated recommendations in Van der Peet-Schwering and Bikker (2018) to be sure that there was no shortage of these amino acids. The ingredient and nutrient composition of the diets is shown in Appendix 1.

Table 2 *Standardized ileal digestible (SID) lysine content (in g/kg and g/EW_{2015}) in the starter, grower and finisher diet supplied to the growing and finishing (GF) boars and gilts at the four SID lysine levels (80, 95, 110 and 125%) and the ratio between the diets with the highest (125% for boars) and the lowest (80% for gilts) SID lysine level*

	Starter diet				Grower diet				Finisher diet			
SID level	SID lysine (g/kg)	SID lysine (g/EW_{2015})	80%	125%	SID lysine (g/kg)	SID lysine (g/EW_{2015})	80%	125%	SID lysine (g/kg)	SID lysine (g/EW_{2015})	80%	125%
Boars:												
80%	7.66	6.96	92	8	6.67	6.06	90	10	5.96	5.42	85	15
95%	9.07	8.25	62	38	7.94	7.22	60	40	7.13	6.48	56	44
110%	10.54	9.58	31	69	9.22	8.38	30	70	8.25	7.50	28	72
125%	12.00	10.91	0	100	10.50	9.55	0	100	9.38	8.53	0	100
Gilts:												
80%	7.28	6.62	100	0	6.24	5.67	100	0	5.36	4.87	100	0
95%	8.65	7.86	71	29	7.43	6.75	72	28	6.37	5.79	75	25
110%	10.07	9.15	41	59	8.63	7.85	44	56	7.37	6.70	50	50
125%	11.44	10.40	12	88	9.82	8.93	16	84	8.42	7.65	24	76

2.6 Measurements

Body weight, feed intake and slaughter data

The pigs were weighed individually on Farm A and at pen level on Farm B at the start of the trial, at day 35 (day of transition from starter diet to grower diet), at day 63 (day of transition from grower to finisher diet), one day prior to first delivery to the slaughterhouse, remaining pigs at second or third delivery (only Farm A) and in case of culling. On Farm B, the remaining pigs after first delivery were not weighed when they were delivered to the slaughterhouse. Therefore, the BW at slaughter of all delivered pigs was calculated from the slaughter weight with the following equation (Uniformeringsafspraken Varkenshouderij, 2012):

- Boars: calculated BW at slaughter = 5 + (slaughter weight x 1.22)
- Gilts: calculated BW at slaughter = 5 + (slaughter weight x 1.20)

Total feed intake per pen (feed supply – remainder of feed) was measured at every weighing of pigs and in case of culling of a pig. At every weighing of pigs, the remainders of the diet per pen were collected and weighed to determine the feed intake per pen. Feed intake included intake of starter diet, grower diet and finisher diet. At slaughter the following data were collected of each individual pig: slaughter weight, lean meat percentage, backfat thickness and muscle thickness.

Culling, veterinary treatments and faecal scores

The number of culled pigs and the number of pigs treated with antibiotics were recorded including date and reason of culling and veterinary treatment. Feed intake was registered on the day of culling to correct for the feed intake of the lost animal. Faecal scores were performed once a week during the starter phase (week 1-5). On Farm A, in each pen the number of GF pigs with normal faeces (score = 0), soft faeces (score = 1) and watery faeces (score = 2) was scored visually by the same person across the treatment groups. On Farm B, the faeces of the pigs was scored on pen level with normal faeces (score = 0), little bit soft faeces (score = 0.5), soft faeces (score = 1) and watery faeces (score = 2) by the same person.

Diets

For Farm A, the starter, grower and finisher diets were produced in six, six and four (finisher diet 125%) or five (finisher diet 80%) batches, respectively. For Farm B, the starter, grower and finisher diets were produced in four, five and eleven batches, respectively. Before the diets were delivered to the farms, they were analysed on the contents of crude protein, moisture, ash, crude fibre, crude fat, starch and sugar with Near-Infrared Spectroscopy (NIR). When the difference between calculated and analysed crude protein content was greater than 6 g/kg, the diet was produced again. The mean results of the NIR analyses per diet per farm are presented in Appendix 2. In all diets, the calculated and analysed nutrients were very similar.

Subsamples from every batch per diet per farm were pooled and analysed for dry matter, ash, nitrogen (N), crude fat, starch, sugar and AA composition. Dry matter was analysed by drying at 103

°C (ISO 6496), ash by combustion to a constant weight at 550 °C (ISO, 5984), N by using the Dumas method (ISO 16634-1) and crude fat after hydrolysis (ISO, 6492). Starch was enzymatically determined (ISO 15914). Determination of sugars was based on the method described by Van Vuuren et al. (1993). Amino acid composition was analysed by acid hydrolysis at 110°C for 23 h and ion-exchange chromatography with postcolumn derivatisation with ninhydrin (ISO13903; ISO, 2005a) and tryptophan by alkaline hydrolysis at 110°C for 20 h ion-exchange chromatography with fluorescence detection (MOD.0094 version G; ISO 13904; ISO, 2005c). The analysed nutrient composition is presented in Appendix 3.

2.7 Statistical analysis

2.7.1 Analysis of variance

The data were statistically analysed by means of F-tests using ANOVA (GenStat, 2018) using pen as the experimental unit on Farm A and using feed valve (two pens were fed by one feed valve) as experimental unit on Farm B. Results were considered significant at a $P \leq 0.05$ and considered a trend at $P \leq 0.10$.

The performance data (daily gain, daily feed intake, daily SID lysine intake and feed conversion ratio) and slaughter data (slaughter weight, lean meat percentage, backfat thickness, muscle thickness and dressing percentage) were analysed with a split-plot model. Sex was tested on block level and SID lysine on pen level. The level of SID lysine was included as a second degree polynomial in the analysis so that linear and quadratic effects of the SID lysine level and the influence of sex on this could be determined.

Y = μ + Batch + Block(Batch) + Sex + SID lysine linear + SID lysine quadratic + Sex x SID lysine linear + Sex x SID lysine quadratic + residual error

in which:
Y = dependent variable
Batch = batch effect (1-4)
Block = block effect within batch (1-16)
Sex = boar vs gilt
SID lysine = 4 levels: 80, 95, 110 and 125%

This model allows the determination of linear and quadratic effects of SID lysine and determination of sex effects on the overall level of the response parameter, the linear component and the quadratic component of the SID lysine effect. In the analysis of lean meat percentage, backfat thickness, muscle thickness and dressing percentage, slaughter weight was added to the model as a covariate.

The number of culled and veterinary treated piglets were analysed using the Chi-square test.

The percentage of GF pigs within a pen with soft or watery faeces (score 1 and 2) (Farm A) and the mean faecal score on pig level (Farm A) or pen level (Farm B) were analysed with the same model as used for the performance data.

2.7.2 Estimate of lysine requirements

In each of the three phases, regression analyses with a broken line model with ADG and FCR as response (y) variables and SID lysine ($g//EW_{2015}$) as independent (x) variables was used to determine the required dietary SID lysine content for maximum ADG and minimum FCR. These analyses were conducted using a broken stick procedure in GenStat (2018) based on the RCYCLE and FIT directive. The model was described by three parameters:

- a plateau, representing the maximum AGD or the minimum FCR at adequate dietary SID lysine;
- a breakpoint, representing the SID lysine level (g/EW_{2015}) to reach the maximum ADG or the minimum FCR;

- a slope, representing the increase in ADG or decrease in FCR per g increase of SID lysine/EW_{2015} from the lowest inclusion level until the breakpoint was reached.

The minimum model (0) included three common parameters for boars and gilts, indicating that none of these parameters differed between the sexes. The maximum model (7) included six parameters, with each of the three parameters separately estimated for the two sexes. The other models included one or two parameters combined for the two sexes and the other separate for boars and gilts: model (1) separate plateau, model (2) separate breakpoint, model (3) separate slope, model (4) separate plateau and breakpoint, model (5) separate plateau and slope, model (6) separate breakpoint and slope. Starting with the minimum model, stepwise forward and backward selection procedures were used to determine the contribution of the inclusion of a sex effect on the three different parameters, based on the additional sums of squares and to determine the optimal model with the highest explained variance (highest adjusted R^2, lowest Root Mean Square Error, RMSE) containing only significant parameters. This implies that separate parameters for boars and gilts for one of the three parameters would only be included in the final model if this significantly improve the model. Secondly, the stepwise approach implied that first sex specific estimates were included for one of the three parameters, based on the highest addition in model sums of squares. Subsequently, it was determined whether an additional sex effect on one of the remaining two parameters gave a significant contribution. In the results, only the final model with significantly different parameters was included. Inclusion of one parameter estimate for boars and gilts combined implies absence of statistical proof of a sex effect on this parameter.

For Farm A, we conducted an additional analyses using the relative ADG and FCR within a room as response parameters. These relative values were calculated by dividing the ADG and FCR of each pen by the mean of all eight pens for boars and gilts within a room. This approach allows accounting for the room effect, largely caused by the body weight block allocated to the rooms. As a result, the residual variation (error) is reduced, allowing for a sharper test of treatment effects. The results of this additional analyses was included in the response table of Farm A (see Table 13). Farm B did not use this blocking on the basis of body weight within rooms.

3 Results

3.1 Diets

The analysed nutrient composition (dry matter, ash, crude protein, crude fat, crude fibre, starch and sugar) of the diets and the analysed content of AA and of free AA in the diets are presented in Appendix 3. In all diets, the analysed contents of ash, crude protein, crude fat, crude fibre, sugar, AA and free AA were as expected. The analysed contents of starch were 20 to 30 g/kg lower than the calculated contents.

3.2 Performance

The performance of the GF pigs from the start till the day of first delivery to the slaughter house and from the start till slaughter is presented in Table 3 (Farm A) and Table 4 (Farm B).

Table 3 *Performance[1] from the start till the day of first delivery to the slaughterhouse and from the start till slaughter of growing-finishing pigs (boars and gilts) (Farm A) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars[2] and gilts[3] (Van der Peet-Schwering and Bikker, 2018)).*

		SID level				SEM[4]	P-value				
	Sex	80%	95%	110%	125%	lysine	lys L[5]	lys Q[6]	sex	sex x lys L	sex x lys Q
BW (kg):											
Start	Boar	23.7^{a}	23.7^{a}	23.7^{a}	23.7^{a}	0.03	0.99	0.76	0.96	0.40	0.68
	Gilt	23.8^{a}	23.8^{a}	23.8^{a}	23.8^{a}						
First delivery	Boar	102.3^{a}	111.4^{cdef}	114.6^{defg}	116.8^{eg}	1.21	<0.001	0.001	0.11	0.071	0.53
	Gilt	99.2^{a}	105.5^{bc}	107.7^{bcd}	109.3^{bde}						
Slaughter	Boar	119.9^{ab}	122.2^{bc}	125.0^{c}	124.6^{c}	0.78	<0.001	0.04	0.08	0.94	0.66
	Gilt	116.6^{a}	121.7^{bc}	121.4^{bc}	122.5^{bc}						
Start till first delivery (D86):											
ADG (g/d)	Boar	911^{ab}	1016de	1052^{ef}	1078^{f}	9.5	<0.001	0.001	0.01	0.07	0.51
	Gilt	874^{a}	946^{bc}	972^{cd}	990^{d}						
ADFI (kg/d)	Boar	2.08^{a}	2.14^{abc}	2.15^{abc}	2.15^{abc}	0.020	0.02	0.09	0.75	0.93	0.86
	Gilt	2.09^{ab}	2.18^{ac}	2.15^{abc}	2.17^{ac}						
SID lysine intake (g/d)	Boar	13.99^{a}	17.07^{b}	20.04^{d}	22.75^{f}	0.176	<0.001	0.23	0.04	0.22	0.89
	Gilt	13.15^{a}	16.27^{b}	18.77^{c}	21.41^{e}						
FCR	Boar	2.28^{e}	2.11^{c}	2.05^{b}	2.00^{a}	0.012	<0.001	<0.001	<0.001	0.04	0.17
	Gilt	2.39^{f}	2.31^{e}	2.22^{d}	2.19^{d}						
Start till slaughter:											
No of days	Boar	103.4	96.1	96.1	93.8						
	Gilt	105.3	103.0	100.5	100.5						
ADG (g/d)	Boar	932^{ab}	1026^{cd}	1054de	1077^{e}	8.5	<0.001	<0.001	0.006	0.08	0.73
	Gilt	884^{a}	953^{b}	974^{bc}	985^{bc}						
ADFI (kg/d)	Boar	2.21^{a}	2.24^{abc}	2.23^{abc}	2.22^{a}	0.020	0.54	0.17	0.26	0.74	0.60
	Gilt	2.23^{ab}	2.32^{ac}	2.27^{abc}	2.28^{abc}						
SID lysine intake (g/d)	Boar	14.54^{a}	17.61^{b}	20.49^{d}	23.23^{f}	0.170	<0.001	0.23	0.02	0.32	0.78
	Gilt	13.59^{a}	16.80^{b}	19.23^{c}	21.92^{e}						
FCR	Boar	2.38^{de}	2.18^{c}	2.12^{b}	2.07^{a}	0.013	<0.001	<0.001	<0.001	0.04	0.25
	Gilt	2.53^{f}	2.44^{e}	2.33^{d}	2.32^{d}						

[1] Data are based on 8 pens (65 pigs) per treatment per sex; [2] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing boars are 8.7, 7.6 and 6.8 g/EW_{2015}, respectively; [3] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing gilts are 8.3, 7.1 and 6.1 g/EW_{2015}, respectively; [4] SEM = pooled SEM. Means are presented as least squares means; [5] lys L = linear effect of SID lysine level; [6] lys Q = quadratic effect of SID lysine level.

Table 3 shows that from start till first delivery and from start till slaughter, boars grew faster and had a higher SID lysine intake and a lower FCR than gilts. ADFI was similar in boars and gilts. In both boars and gilts, ADG was highest at the 125% SID lysine level and lowest at the 80% SID lysine level. ADG at the 125% SID lysine level did not differ significantly from ADG at the 110% SID lysine level. FCR was lowest at the 125% SID lysine level and highest at the 80% SID lysine level in both boars and gilts. In gilts, FCR was similar at the 110 and 125% SID lysine level. SID lysine intake (g/d) increased with increasing SID lysine level in the diet.

Table 4 *Performance[1] from the start till the day of first delivery to the slaughterhouse and from the start till slaughter of growing-finishing pigs (boars and gilts) (Farm B) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars[2] and gilts[3] (Van der Peet-Schwering and Bikker, 2018)).*

		SID level				SEM[4]	P-value				
	Sex	80%	95%	110%	125%	lysine	lys L[5]	lys Q[6]	sex	sex x lys L	sex x lys Q
BW (kg):											
Start	Boar	25.7	25.5	25.2	25.5	0.24	0.54	0.86	0.08	0.96	0.40
	Gilt	26.0	26.4	25.9	26.0						
First delivery	Boar	107.7^{b}	115.1^{e}	116.4^{e}	117.2^{e}	0.66	<0.001	<0.001	<0.001	0.68	0.89
	Gilt	101.6^{a}	109.0^{bc}	111.3^{cd}	111.7^{d}						
Slaughter	Boar	119.8^{b}	124.7^{cd}	125.3^{d}	125.0^{d}	0.38	<0.001	<0.001	0.13	0.03	0.83
	Gilt	117.8^{a}	123.0^{c}	124.7^{d}	125.1^{d}						
Start till first delivery (D100):											
ADG (g/d)	Boar	820^{b}	896^{d}	912^{d}	917^{d}	6.0	<0.001	<0.001	<0.001	0.67	0.85
	Gilt	756^{a}	826^{b}	854^{c}	857^{c}						
ADFI (kg/d)	Boar	2.04^{ab}	2.07^{abc}	2.07^{abc}	2.09^{c}	0.012	0.001	0.04	0.44	0.60	0.08
	Gilt	2.02^{a}	2.09^{bc}	2.11^{c}	2.09^{bc}						
SID lysine intake (g/d)	Boar	13.43^{b}	16.23^{d}	18.85^{f}	21.67^{h}	0.096	<0.001	0.14	<0.001	0.08	0.12
	Gilt	12.39^{a}	15.22^{c}	17.85^{e}	20.10^{g}						
FCR	Boar	2.49^{c}	2.30^{a}	2.27^{a}	2.28^{a}	0.011	<0.001	<0.001	<0.001	0.23	0.07
	Gilt	2.68^{e}	2.53^{d}	2.48^{bc}	2.44^{b}						
Start till slaughter:											
No of days	Boar	115.4	111.5	110.5	110.1						
	Gilt	121.1	118.2	118.1	117.8						
ADG (g/d)	Boar	816^{b}	890^{d}	906^{d}	904^{d}	5.5	<0.001	<0.001	<0.001	0.91	0.36
	Gilt	757^{a}	817^{b}	837^{bc}	842^{c}						
ADFI (kg/d)	Boar	2.12^{a}	2.12^{a}	2.10^{a}	2.12^{a}	0.010	0.06	0.11	0.004	0.03	0.02
	Gilt	2.12^{a}	2.17^{b}	2.20^{b}	2.17^{b}						
SID lysine intake (g/d)	Boar	13.74^{b}	16.43^{d}	18.95^{f}	21.74^{h}	0.087	<0.001	0.21	<0.001	0.57	0.07
	Gilt	12.62^{a}	15.47^{c}	18.13^{e}	20.43^{g}						
FCR	Boar	2.59^{c}	2.38^{b}	2.32^{a}	2.34^{ab}	0.013	<0.001	<0.001	<0.001	0.27	0.007
	Gilt	2.80^{e}	2.66^{d}	2.63^{cd}	2.58^{c}						

[1] Data are based on 8 pens (176 pigs) per treatment per sex; [2] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing boars are 8.7, 7.6 and 6.8 g/EW_{2015}, respectively; [3] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing gilts are 8.3, 7.1 and 6.1 g/EW_{2015}, respectively; [4] SEM = pooled SEM. Means are presented as least squares means; [5] lys L = linear effect of SID lysine level; [6] lys Q = quadratic effect of SID lysine level.

Table 4 shows that from start till first delivery and from start till slaughter, boars grew faster and had a higher SID lysine intake and a lower FCR than gilts. From start till first delivery, ADFI was similar in boars and gilts whereas from start till slaughter, ADFI was higher in gilts than in boars. In both boars and gilts, ADG was highest at the 125% SID lysine level and lowest at the 80% SID lysine level. ADG was similar at the 110 and 125% SID lysine level. FCR was lowest at the 125% SID lysine level in gilts and at the 110% SID lysine level in boars and highest at the 80% SID lysine level. FCR was similar at the 110 and 125% SID lysine level in both boars and gilts. SID lysine intake (g/d) increased with increasing SID lysine level in the diet.

The performance of the GF pigs from the start till day 35, day 35-63, day 63 till first delivery to the slaughterhouse and day 63 till slaughter is presented in Table 5 (Farm A) and Table 6 (Farm B). The average daily gain and feed conversion ratio from the start till day 35, day 35-63, day 63 till first delivery to the slaughterhouse and day 63 till slaughter are also presented in Figures 1-8 (Farm A) and Figures 9-16 (Farm B).

Table 5 and Figures 1 and 2 show that from start till day 35 (the starter phase), ADG, ADFI and SID lysine intake were similar in boars and gilts. FCR was lower in boars. In boars, ADG was highest and FCR was lowest at the 125% SID lysine level. In gilts, ADG was highest at the 110% SID lysine level and FCR was lowest at the 125% SID lysine level. FCR, however, was similar at the 110 and 125% SID lysine level. SID lysine intake (g/d) increased with increasing SID lysine level in the diet.

Table 5 and Figures 3 and 4 show that from day 35-63 (the grower phase), boars grew faster and had a higher SID lysine intake and a lower FCR than gilts. ADFI was similar in boars and gilts. In boars, ADG was highest and FCR was lowest at the 110% SID lysine level. ADG and FCR, however, were similar in boars at the 95, 110 and 125% SID lysine level. In gilts, ADG was highest and FCR was lowest at the 125% SID lysine level. ADG and FCR, however, were similar in gilts at the 95, 110 and 125% SID lysine level. SID lysine intake (g/d) increased with increasing SID lysine level in the diet.

Table 5 and Figures 5 and 6 show that from day 63 till first delivery at day 86, boars grew faster and had a higher ADFI, a higher SID lysine intake and a lower FCR than gilts. In boars, ADG was highest and FCR was lowest at the 125% SID lysine level. ADG and FCR, however, were similar at the 110 and 125% SID lysine level. In gilts, ADG was highest and FCR was lowest at the 125% SID lysine level. ADG and FCR, however, were similar at the 95, 110 and 125% SID lysine level. SID lysine intake (g/d) increased with increasing SID lysine level in the diet.

Table 5 and Figures 7 and 8 show that from day 63 till slaughter, boars grew faster and had a higher SID lysine intake and a lower FCR than gilts. ADFI was similar in boars and gilts. In boars, ADG was highest and FCR was lowest at the 125% SID lysine level. ADG, however, was similar at the 95, 110 and 125% whereas FCR was similar at the 110 and 125% SID lysine level. In gilts, ADG was highest at the 125% SID lysine level and FCR was lowest at the 110% SID lysine level. ADG and FCR, however, were similar at the 95, 110 and 125% SID lysine level. SID lysine intake (g/d) increased with increasing SID lysine level in the diet.

Table 6 and Figures 9 and 10 show that from start till day 35 (the starter phase), ADG and SID lysine intake were similar in boars and gilts. ADFI and FCR were lower in boars. In both boars and gilts, ADG was highest and FCR was lowest at the 125% SID lysine level. ADG and FCR, however, were similar at the 110 and 125% SID lysine level. SID lysine intake (g/d) increased with increasing SID lysine level in the diet.

Table 6 and Figures 11 and 12 show that from day 35-63 (the grower phase), boars grew faster and had a higher SID lysine intake and a lower FCR than gilts. ADFI was similar in boars and gilts. In boars, ADG was highest at the 125% SID lysine level and FCR was lowest at the 110% SID lysine level. ADG and FCR, however, were similar in boars at the 95, 110 and 125% SID lysine level. In gilts, ADG was highest at the 110% SID lysine level and FCR was lowest at the 125% SID lysine level. ADG, however, was similar at the 110 and 125% SID lysine level. FCR was similar at the 95, 110 and 125% SID lysine level. SID lysine intake (g/d) increased with increasing SID lysine level in the diet.

Table 6 and Figures 13-16 show that from day 63 till first delivery at day 100 and from day 63 till slaughter, boars grew faster and had a higher SID lysine intake and a lower FCR than gilts. ADFI was similar in boars and gilts. In boars, ADG was highest and FCR was lowest at the 95% SID lysine level. ADG and FCR at the 80 and 125% SID lysine level were worse than ADG and FCR at the 95% SID lysine level. In gilts, ADG was highest at the 125% SID lysine level. ADG, however, was similar at the 95, 110 and 125% SID lysine level. FCR was not affected by SID lysine level in the diet and was similar at the 80, 95, 110 and 125% SID lysine level. SID lysine intake (g/d) increased with increasing SID lysine level in the diet.

Table 5 *Performance[1] from the start till day 35, day 35-63, day 63 till first delivery to the slaughterhouse and day 63 till slaughter of growing-finishing pigs (boars and gilts) (Farm A) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars[2] and gilts[3] (Van der Peet-Schwering and Bikker, 2018)).*

		SID level				SEM[4]	P-value				
	Sex	80%	95%	110%	125%	lysine	lys L[5]	lys Q[6]	sex	sex x lys L	sex x lys Q
BW (kg):											
Start	Boar	23.7^{a}	23.7^{a}	23.7^{a}	23.7^{a}	0.03	0.99	0.76	0.96	0.40	0.68
	Gilt	23.8^{a}	23.8^{a}	23.8^{a}	23.8^{a}						
Day 35	Boar	50.7^{a}	53.6^{bc}	55.8^{bde}	57.4^{bdf}	0.40	<0.001	0.06	0.98	0.025	0.69
	Gilt	52.1^{ab}	53.7^{abcd}	56.2^{acef}	55.9^{acef}						
Day 63	Boar	78.9^{ab}	85.1^{acd}	87.6^{cde}	89.2^{ce}	0.73	0.005	0.77	0.52	0.19	0.85
	Gilt	78.3^{a}	82.6^{bc}	85.3^{bcde}	85.6^{bde}						
First delivery	Boar	102.3^{a}	111.4^{cdef}	114.6^{defg}	116.8^{eg}	1.21	<0.001	0.001	0.11	0.071	0.53
	Gilt	99.2^{a}	105.5^{bc}	107.7^{bcd}	109.3^{bde}						
Slaughter	Boar	119.9^{ab}	122.2^{bc}	125.0^{c}	124.6^{c}	0.78	<0.001	0.04	0.08	0.94	0.66
	Gilt	116.6^{a}	121.7^{bc}	121.4^{bc}	122.5^{bc}						
Start till day 35:											
ADG (g/d)	Boar	773^{a}	853^{bcd}	917^{d}	963^{e}	11.1	<0.001	0.06	0.99	0.03	0.71
	Gilt	808^{ab}	853^{bc}	926de	919de						
ADFI (kg/d)	Boar	1.55^{a}	1.58^{a}	1.61^{a}	1.61^{a}	0.019	0.15	0.18	0.22	0.43	0.56
	Gilt	1.66^{a}	1.68^{a}	1.71^{a}	1.66^{a}						
SID lysine intake (g/d)	Boar	11.92^{a}	14.32^{b}	17.01^{c}	19.30^{d}	0.205	<0.001	0.33	0.89	0.50	0.48
	Gilt	12.08^{a}	14.54^{b}	17.27^{c}	19.03^{d}						
FCR	Boar	2.01^{de}	1.85^{c}	1.76^{b}	1.67^{a}	0.012	<0.001	0.04	<0.001	0.01	0.46
	Gilt	2.05^{e}	1.97^{d}	1.85^{c}	1.81^{bc}						
Day 35-63:											
ADG (g/d)	Boar	1007^{ab}	1127^{cd}	1136^{d}	1136^{d}	16.8	<0.001	0.005	0.02	0.90	0.53
	Gilt	936^{a}	1033^{b}	1041^{bc}	1060^{bcd}						
ADFI (kg/d)	Boar	2.31^{ab}	2.38^{ab}	2.37^{ab}	2.40^{ab}	0.031	0.04	0.16	0.72	0.76	0.48
	Gilt	2.29^{a}	2.45^{b}	2.40^{ab}	2.42^{b}						
SID lysine intake (g/d)	Boar	15.37^{a}	18.84^{b}	21.90^{c}	25.16^{d}	0.259	<0.001	0.33	0.09	0.57	0.56
	Gilt	14.30^{a}	18.15^{b}	20.78^{c}	23.80^{d}						
FCR	Boar	2.30^{b}	2.11^{a}	2.09^{a}	2.11^{a}	0.023	<0.001	0.004	<0.001	0.96	0.10
	Gilt	2.46^{c}	2.37^{bc}	2.31^{b}	2.29^{b}						
Day 63 till first delivery (D86):											
ADG (g/d)	Boar	1002^{bc}	1127^{d}	1155^{d}	1183^{d}	14.6	<0.001	0.04	<0.001	0.09	0.23
	Gilt	895^{a}	982^{bc}	959^{b}	1018^{c}						
ADFI (kg/d)	Boar	2.60^{abc}	2.69^{c}	2.71^{c}	2.68^{c}	0.028	0.03	0.24	0.072	0.85	0.28
	Gilt	2.50^{a}	2.62^{bc}	2.52^{ab}	2.64^{c}						
SID lysine intake (g/d)	Boar	15.47^{b}	19.16^{d}	22.38^{e}	25.13^{f}	0.215	<0.001	0.47	<0.001	0.05	0.15
	Gilt	13.42^{a}	16.68^{c}	18.64^{d}	22.22^{e}						
FCR	Boar	2.60^{c}	2.41^{b}	2.35^{ab}	2.27^{a}	0.029	<0.001	0.10	<0.001	0.11	0.81
	Gilt	2.80^{d}	2.68^{c}	2.64^{c}	2.60^{c}						
Day 63 till slaughter:											
No of days	Boar	40.4	33.1	33.1	30.8						
	Gilt	42.3	40.0	37.5	37.5						
ADG (g/d)	Boar	1013^{b}	1117^{c}	1125^{c}	1154^{c}	12.0	<0.001	0.01	<0.001	0.07	0.58
	Gilt	904^{a}	979^{b}	959^{b}	986^{b}						
ADFI (kg/d)	Boar	2.72^{ab}	2.81^{ab}	2.77^{ab}	2.77^{ab}	0.029	0.38	0.19	0.39	0.99	0.79
	Gilt	2.66^{a}	2.80^{b}	2.67^{a}	2.74^{ab}						
SID lysine intake (g/d)	Boar	16.19^{b}	19.97^{d}	22.88^{e}	25.97^{f}	0.211	<0.001	0.33	<0.001	0.05	0.52
	Gilt	14.28^{a}	17.77^{c}	19.73^{d}	23.09^{e}						
FCR	Boar	2.69^{c}	2.53^{b}	2.47^{ab}	2.41^{a}	0.022	<0.001	0.04	<0.001	0.07	0.88
	Gilt	2.95^{e}	2.86^{de}	2.79^{d}	2.79^{d}						

[1] Data are based on 8 pens (65 pigs) per treatment per sex; [2] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing boars are 8.7, 7.6 and 6.8 g/EW_{2015}, respectively; [3] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing gilts are 8.3, 7.1 and 6.1 g/EW_{2015}, respectively; [4] SEM = pooled SEM. Means are presented as least squares means; [5] lys L = linear effect of SID lysine level; [6] lys Q = quadratic effect of SID lysine level.

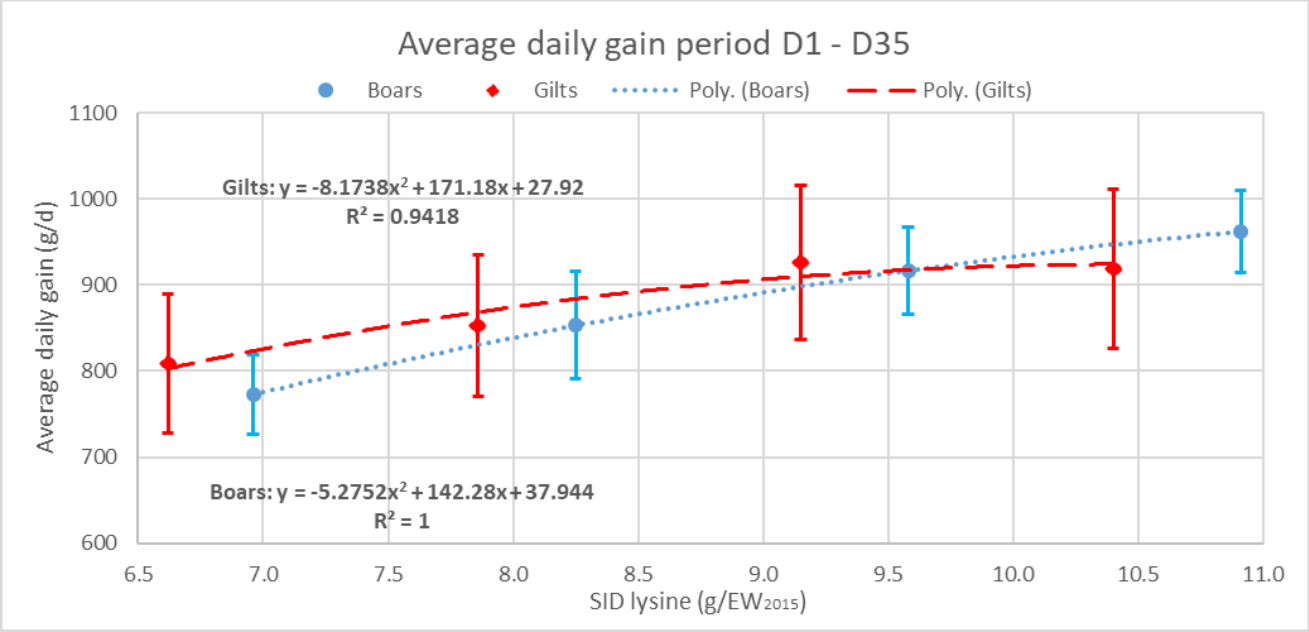

Figure 1 *Average daily gain from the start till day 35 of growing-finishing pigs (boars and gilts) (Farm A) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars and gilts (Van der Peet-Schwering and Bikker, 2018)). Recommended SID levels (100%) in starter diets for current growing-finishing boars and gilts are 8.7 and 8.3 g/EW$_{2015}$, respectively.*

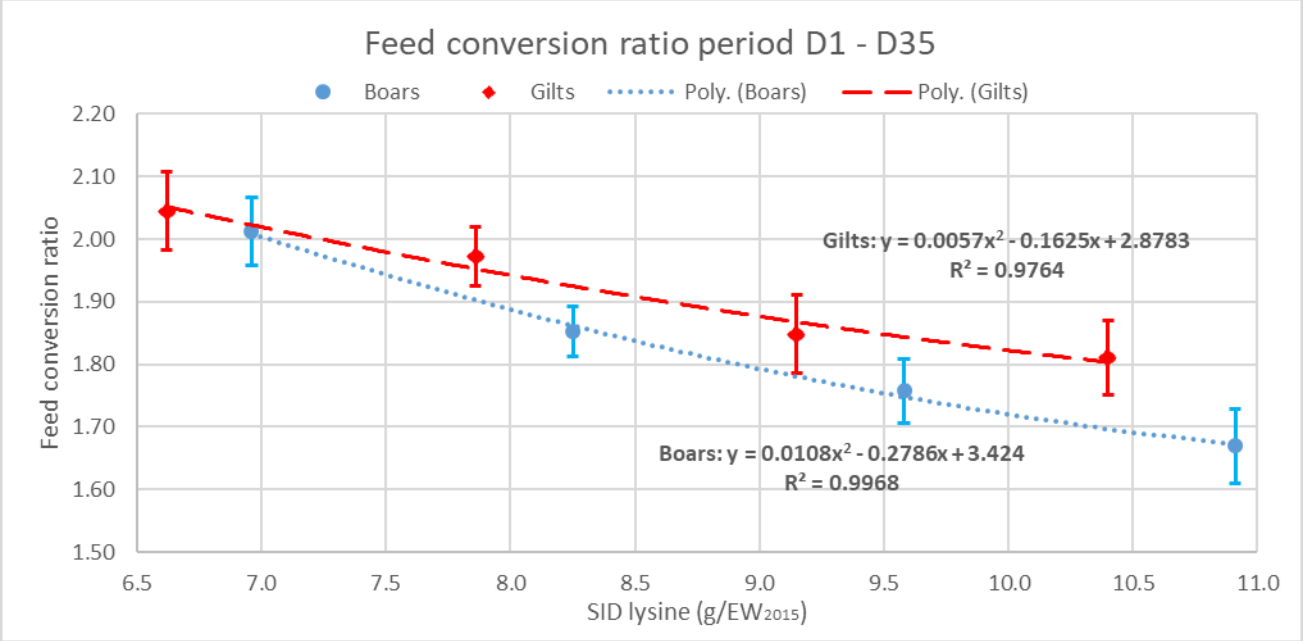

Figure 2 *Feed conversion ratio from the start till day 35 of growing-finishing pigs (boars and gilts) (Farm A) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars and gilts (Van der Peet-Schwering and Bikker, 2018)). Recommended SID levels (100%) in starter diets for current growing-finishing boars and gilts are 8.7 and 8.3 g/EW$_{2015}$, respectively.*

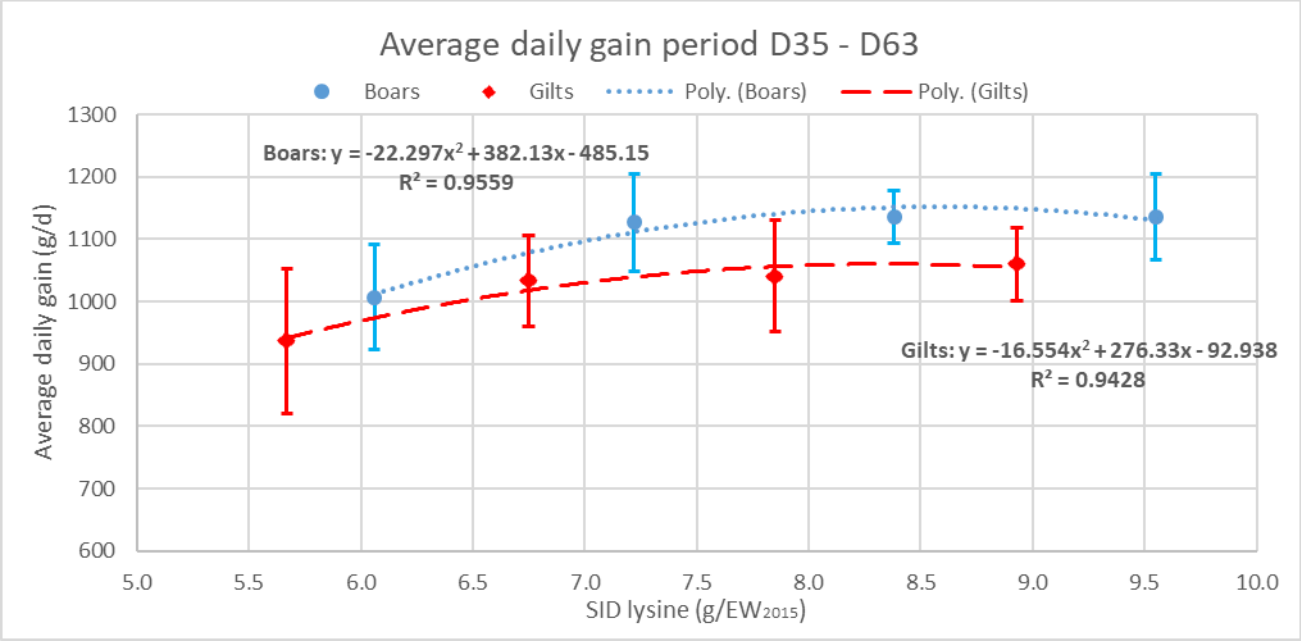

Figure 3 *Average daily gain from day 35 till day 63 of growing-finishing pigs (boars and gilts) (Farm A) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars and gilts (Van der Peet-Schwering and Bikker, 2018)). Recommended SID levels (100%) in grower diets for current growing-finishing boars and gilts are 7.6 and 7.1 g/EW$_{2015}$, respectively.*

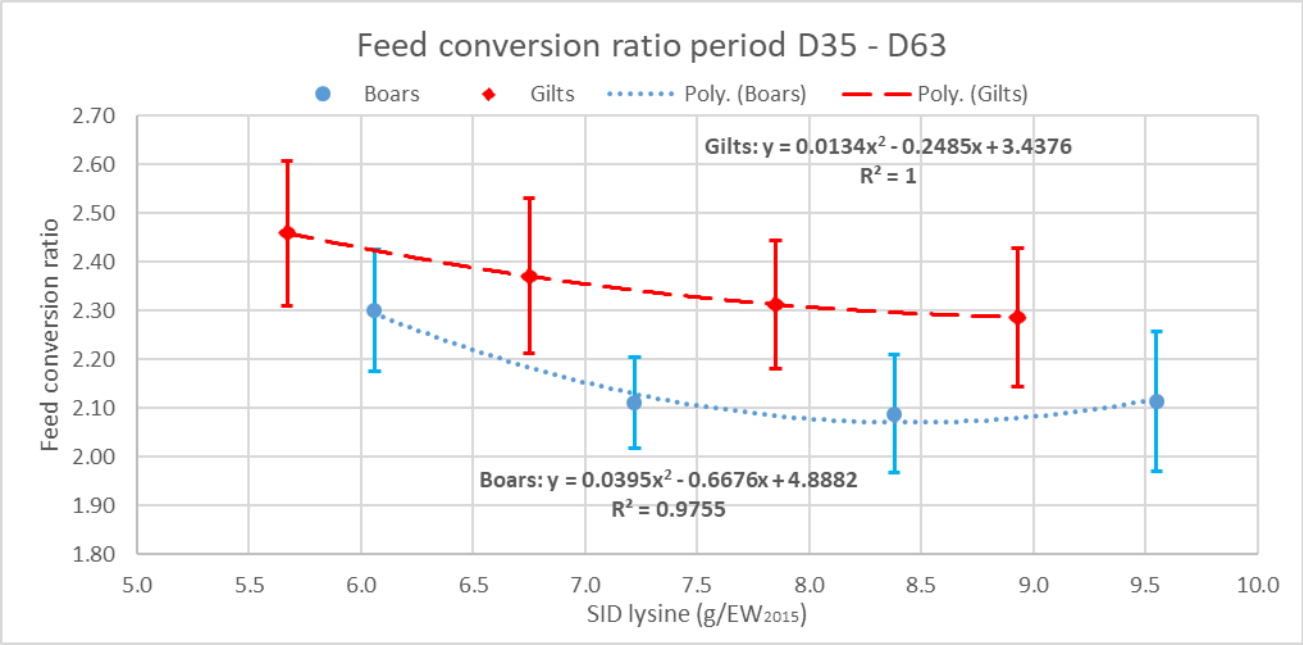

Figure 4 *Feed conversion ratio from day 35 till day 63 of growing-finishing pigs (boars and gilts) (Farm A) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars and gilts (Van der Peet-Schwering and Bikker, 2018)). Recommended SID levels (100%) in grower diets for current growing-finishing boars and gilts are 7.6 and 7.1 g/EW$_{2015}$, respectively.*

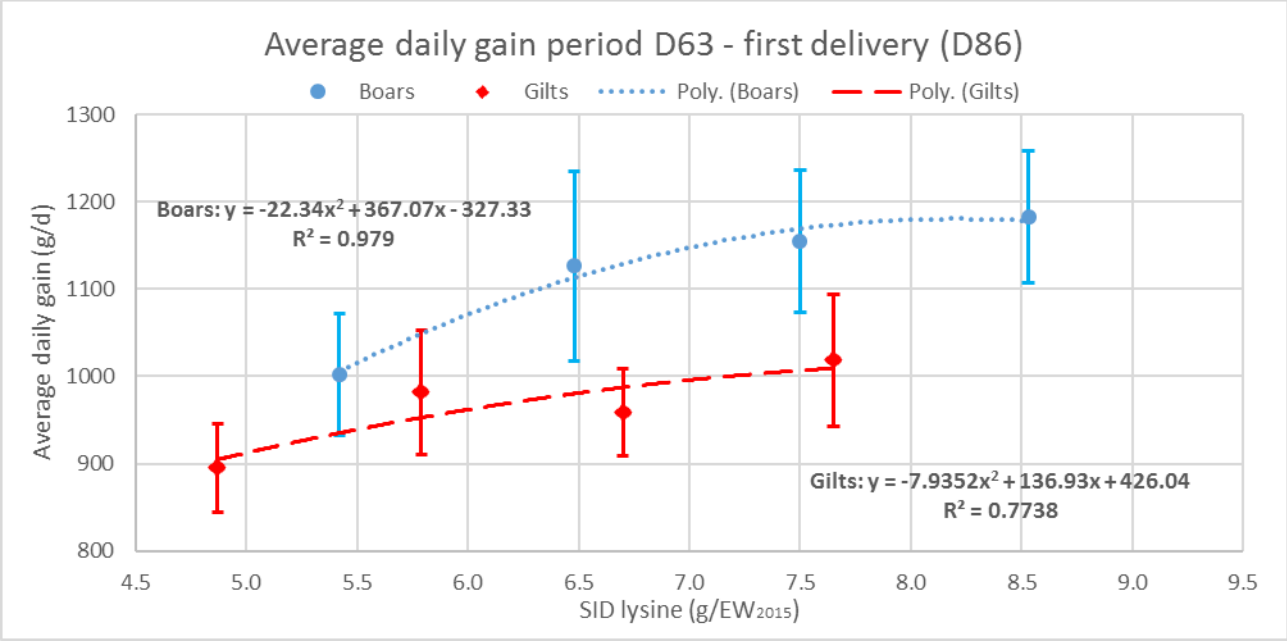

Figure 5 *Average daily gain from day 63 till first delivery of growing-finishing pigs (boars and gilts) (Farm A) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars and gilts (Van der Peet-Schwering and Bikker, 2018)). Recommended SID levels (100%) in finisher diets for current growing-finishing boars and gilts are 6.8 and 6.1 g/EW$_{2015}$, respectively.*

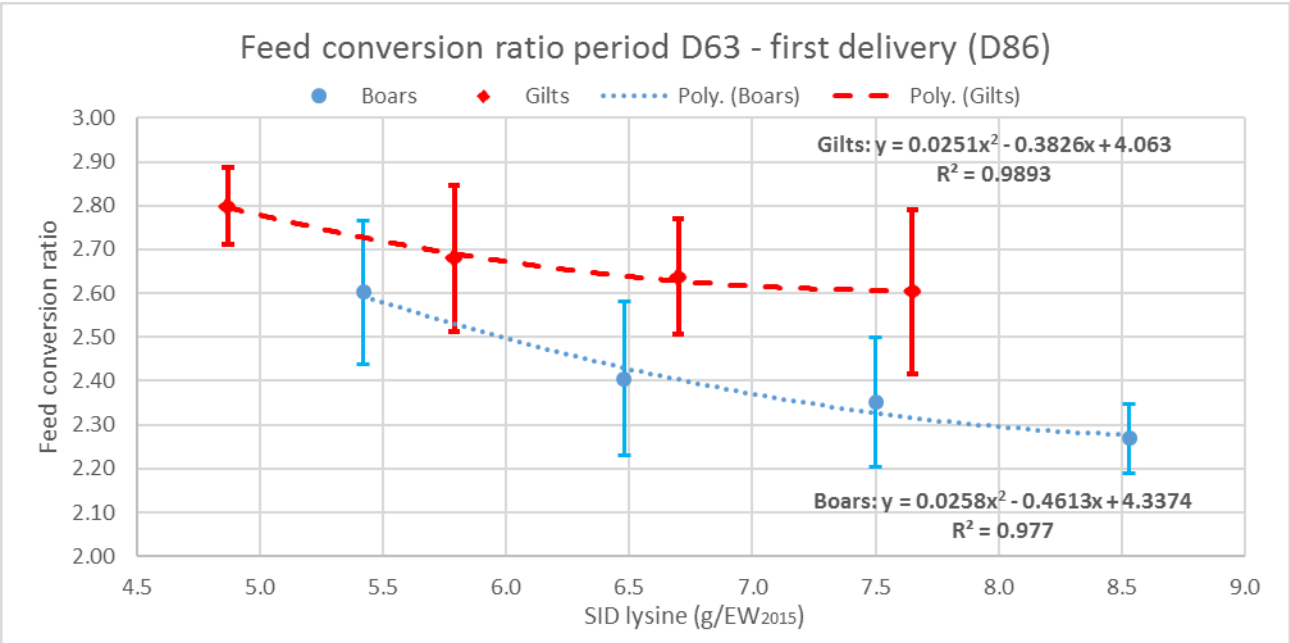

Figure 6 *Feed conversion ratio from day 63 till first delivery of growing-finishing pigs (boars and gilts) (Farm A) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars and gilts (Van der Peet-Schwering and Bikker, 2018)). Recommended SID levels (100%) in finisher diets for current growing-finishing boars and gilts are 6.8 and 6.1 g/EW$_{2015}$, respectively.*

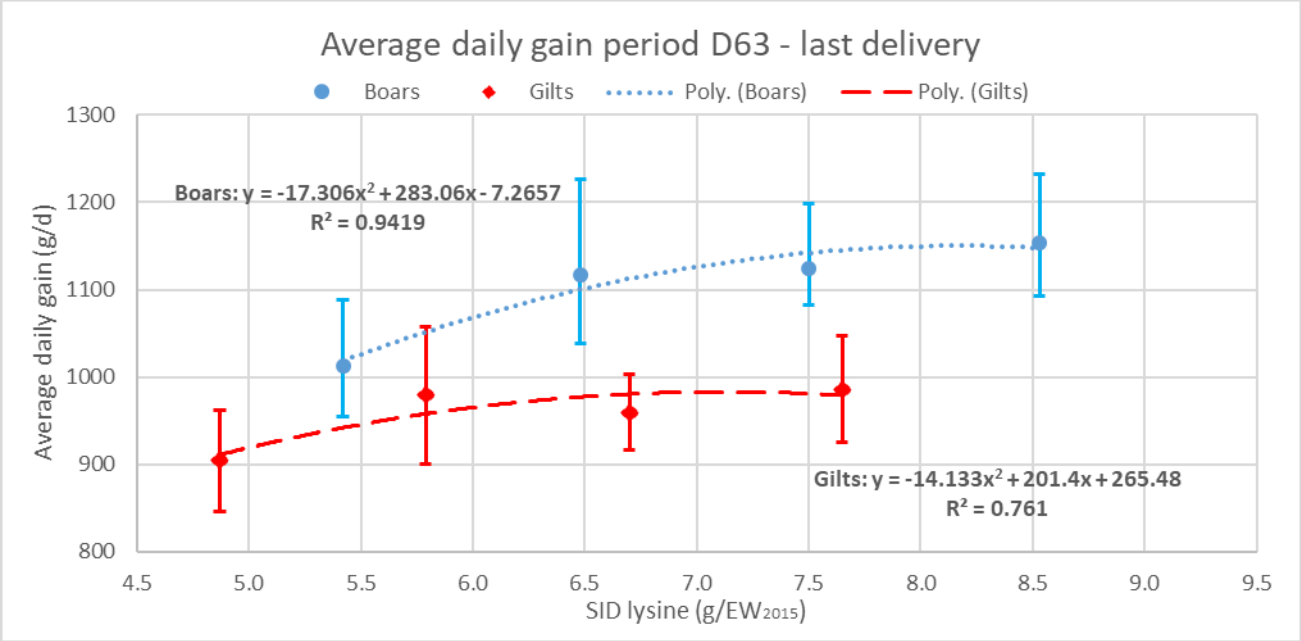

Figure 7 *Average daily gain from day 63 till last delivery of growing-finishing pigs (boars and gilts) (Farm A) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars[2] and gilts[3] (Van der Peet-Schwering and Bikker, 2018)). Recommended SID levels (100%) in finisher diets for current growing-finishing boars and gilts are 6.8 and 6.1 g/EW$_{2015}$, respectively.*

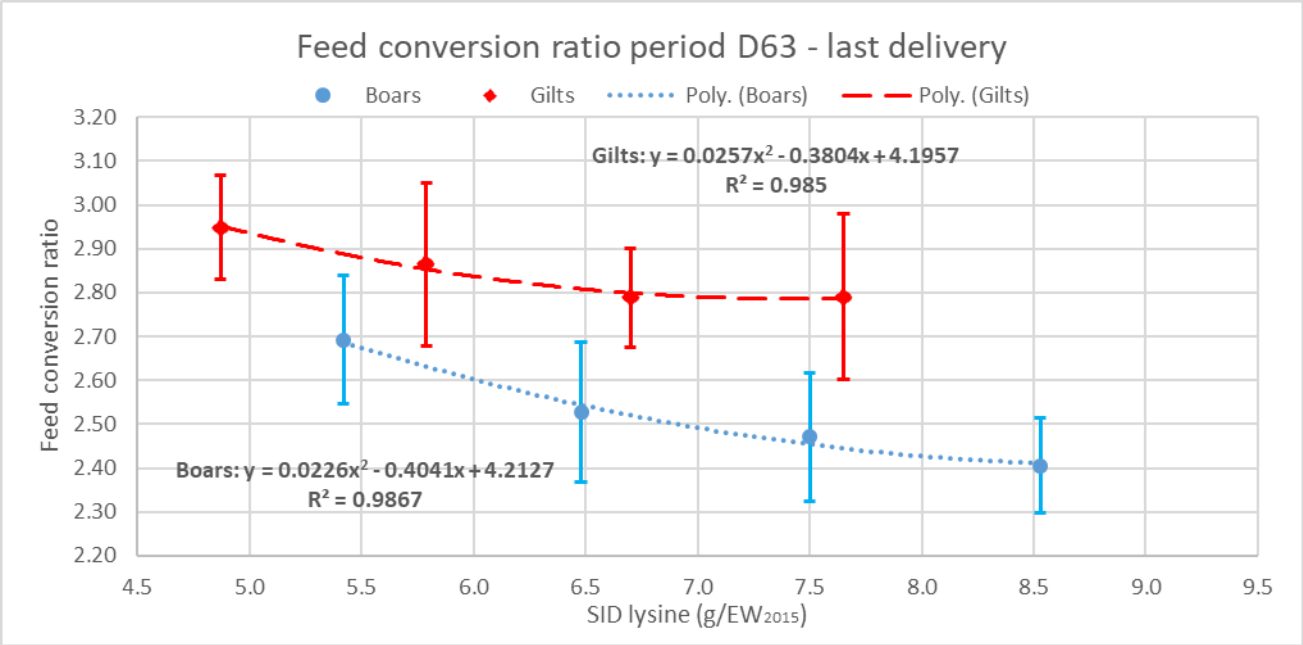

Figure 8 *Feed conversion ratio from day 63 till last delivery of growing-finishing pigs (boars and gilts) (Farm A) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars and gilts (Van der Peet-Schwering and Bikker, 2018)). Recommended SID levels (100%) in finisher diets for current growing-finishing boars and gilts are 6.8 and 6.1 g/EW$_{2015}$, respectively.*

Table 6 *Performance[1] from the start till day 35, day 35-63, day 63 till first delivery to the slaughterhouse and day 63 till slaughter of growing-finishing pigs (boars and gilts) (Farm B) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars[2] and gilts[3] (Van der Peet-Schwering and Bikker, 2018)).*

		SID level				SEM[4]	P-value				
	Sex	80%	95%	110%	125%	lysine	lys L[5]	lys Q[6]	sex	sex x lys L	sex x lys Q
BW (kg):											
Start	Boar	25.7^{ab}	25.5^{ab}	25.2^{a}	25.5^{ab}	0.24	0.54	0.86	0.084	0.96	0.40
	Gilt	26.0^{ab}	26.4^{b}	25.9^{ab}	26.0^{ab}						
Day 35	Boar	51.2^{a}	54.0^{b}	55.8^{c}	57.1^{c}	0.40	<0.001	0.006	0.52	0.45	0.32
	Gilt	51.5^{a}	55.3^{bc}	56.2^{c}	56.8^{c}						
Day 63	Boar	74.9^{a}	80.1^{bc}	82.4^{de}	83.9^{e}	0.50	<0.001	<0.001	0.022	0.58	0.30
	Gilt	72.7^{a}	78.9^{b}	80.7^{bcd}	81.0^{cd}						
First delivery	Boar	107.7^{b}	115.1^{e}	116.4^{e}	117.2^{e}	0.66	<0.001	<0.001	<0.001	0.68	0.89
	Gilt	101.6^{a}	109.0^{bc}	111.3^{cd}	111.7^{d}						
Slaughter	Boar	119.8^{b}	124.7^{cd}	125.3^{d}	125.0^{d}	0.38	<0.001	<0.001	0.13	0.03	0.83
	Gilt	117.8^{a}	123.0^{c}	124.7^{d}	125.1^{d}						
Start till day 35:											
ADG (g/d)	Boar	728^{a}	816^{b}	874^{cd}	904^{d}	11.4	<0.001	<0.001	0.68	0.26	0.49
	Gilt	727^{a}	826^{b}	863^{c}	882^{cd}						
ADFI (kg/d)	Boar	1.48^{a}	1.51^{ab}	1.52^{ab}	1.54^{b}	0.012	<0.001	0.08	0.003	0.70	0.25
	Gilt	1.53^{ab}	1.61^{c}	1.60^{c}	1.61^{c}						
SID lysine intake (g/d)	Boar	11.30^{a}	13.67^{b}	16.01^{c}	18.43^{d}	0.119	<0.001	0.39	0.72	0.72	0.28
	Gilt	11.17^{a}	13.96^{b}	16.14^{c}	18.47^{d}						
FCR	Boar	2.03^{d}	1.85^{b}	1.74^{a}	1.70^{a}	0.012	<0.001	<0.001	<0.001	0.14	0.78
	Gilt	2.11^{e}	1.96^{c}	1.86^{b}	1.83^{b}						
Day 35-63:											
ADG (g/d)	Boar	847^{bc}	930^{d}	951^{d}	954^{d}	7.7	<0.001	<0.001	<0.001	0.90	0.56
	Gilt	757^{a}	844^{b}	875^{c}	864^{bc}						
ADFI (kg/d)	Boar	2.08^{a}	2.10^{ab}	2.12^{abc}	2.16^{bc}	0.015	0.005	0.04	0.59	0.70	0.05
	Gilt	2.06^{a}	2.10^{ab}	2.17^{c}	2.09^{ab}						
SID lysine intake (g/d)	Boar	13.88^{b}	16.83^{d}	19.56^{f}	22.62^{h}	0.126	<0.001	0.09	<0.001	0.02	0.04
	Gilt	12.82^{a}	15.62^{c}	18.71^{e}	20.53^{g}						
FCR	Boar	2.46^{b}	2.28^{a}	2.23^{a}	2.26^{a}	0.018	<0.001	<0.001	<0.001	0.14	0.59
	Gilt	2.71^{c}	2.49^{b}	2.48^{b}	2.43^{b}						
Day 63 till first delivery (D100):											
ADG (g/d)	Boar	886^{c}	947^{d}	919^{cd}	902^{c}	10.5	0.08	0.01	<0.001	0.16	0.27
	Gilt	783^{a}	813^{ab}	829^{b}	828^{b}						
ADFI (kg/d)	Boar	2.54^{ab}	2.55^{b}	2.55^{b}	2.56^{b}	0.018	0.07	0.19	0.28	0.33	0.24
	Gilt	2.46^{a}	2.53^{ab}	2.55^{b}	2.53^{ab}						
SID lysine intake (g/d)	Boar	15.11^{b}	18.20^{d}	21.01^{f}	24.01^{g}	0.133	<0.001	0.35	<0.001	0.04	0.55
	Gilt	13.21^{a}	16.12^{c}	18.81^{e}	21.31^{f}						
FCR	Boar	2.87^{b}	2.70^{a}	2.78^{ab}	2.85^{b}	0.031	0.24	0.04	<0.001	0.20	0.08
	Gilt	3.17^{c}	3.12^{c}	3.09^{c}	3.07^{c}						
Day 63 till slaughter:											
No of days	Boar	52.4	48.5	47.5	47.1						
	Gilt	58.1	55.2	55.1	54.8						
ADG (g/d)	Boar	858^{b}	921^{d}	902^{cd}	874^{bc}	9.0	0.14	0.004	<0.001	0.45	0.06
	Gilt	775^{a}	798^{a}	801^{a}	805^{a}						
ADFI (kg/d)	Boar	2.56^{abc}	2.55^{abc}	2.51^{ab}	2.52^{abc}	0.015	0.55	0.29	0.40	0.007	0.09
	Gilt	2.50^{a}	2.57^{bc}	2.59^{c}	2.57^{bc}						
SID lysine intake (g/d)	Boar	15.28^{b}	18.19^{d}	20.75^{f}	23.68^{h}	0.118	<0.001	0.42	<0.001	0.80	0.39
	Gilt	13.41^{a}	16.35^{c}	19.11^{e}	21.65^{g}						
FCR	Boar	2.99^{c}	2.77^{a}	2.79^{ab}	2.90^{bc}	0.029	0.18	0.02	<0.001	0.50	0.004
	Gilt	3.23^{d}	3.22^{d}	3.24^{d}	3.20^{d}						

[1] Data are based on 8 pens (176 pigs) per treatment per sex; [2] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing boars are 8.7, 7.6 and 6.8 g/EW_{2015}, respectively; [3] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing gilts are 8.3, 7.1 and 6.1 g/EW_{2015}, respectively; [4] SEM = pooled SEM. Means are presented as least squares means; [5] lys L = linear effect of SID lysine level; [6] lys Q = quadratic effect of SID lysine level.

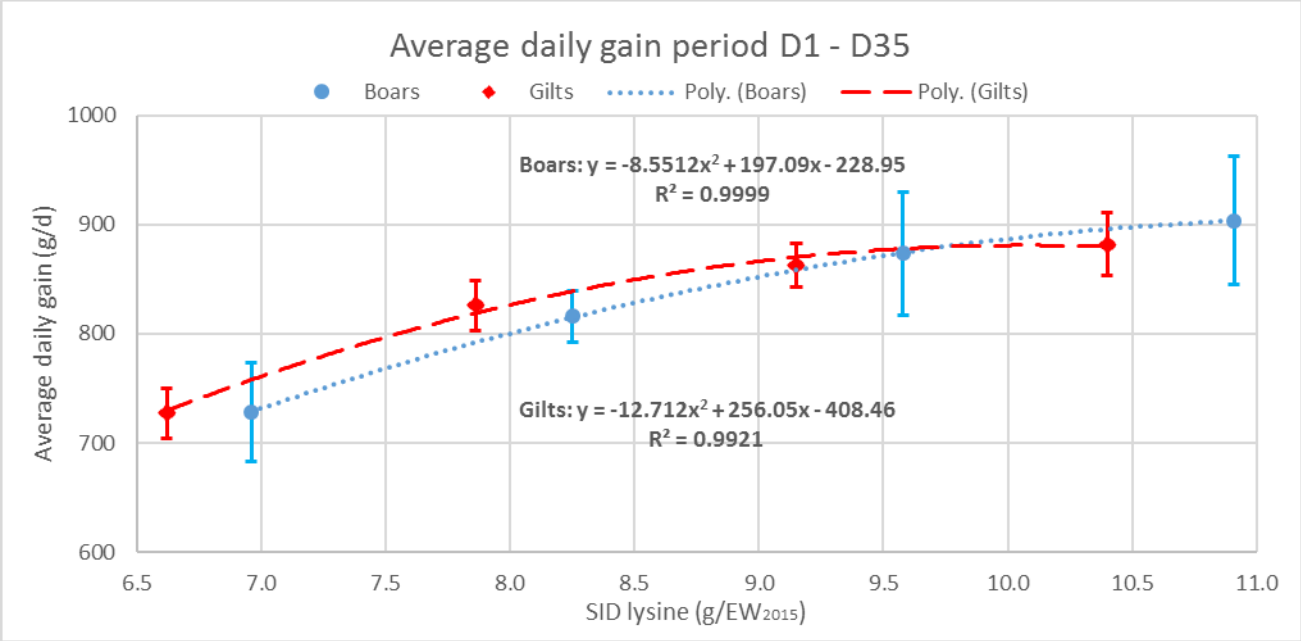

Figure 9 *Average daily gain from the start till day 35 of growing-finishing pigs (boars and gilts) (Farm B) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars and gilts (Van der Peet-Schwering and Bikker, 2018)). Recommended SID levels (100%) in starter diets for current growing-finishing boars and gilts are 8.7 and 8.3 g/EW$_{2015}$, respectively.*

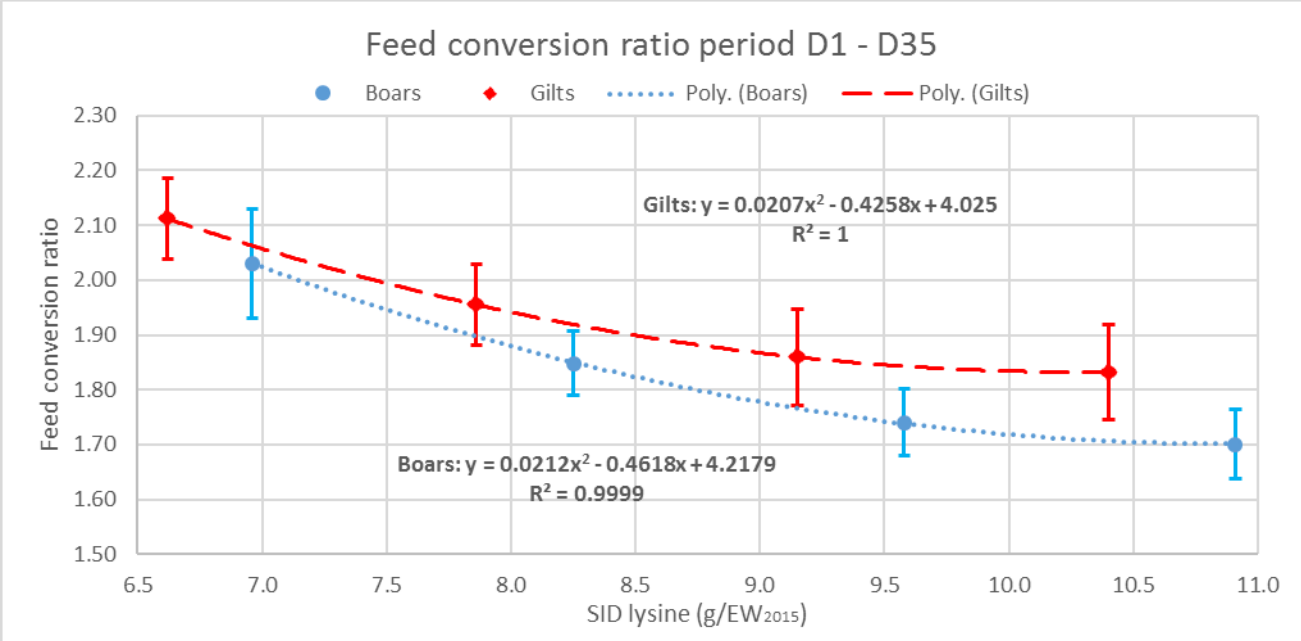

Figure 10 *Feed conversion ratio from the start till day 35 of growing-finishing pigs (boars and gilts) (Farm B) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars and gilts (Van der Peet-Schwering and Bikker, 2018)). Recommended SID levels (100%) in starter diets for current growing-finishing boars and gilts are 8.7 and 8.3 g/EW$_{2015}$, respectively.*

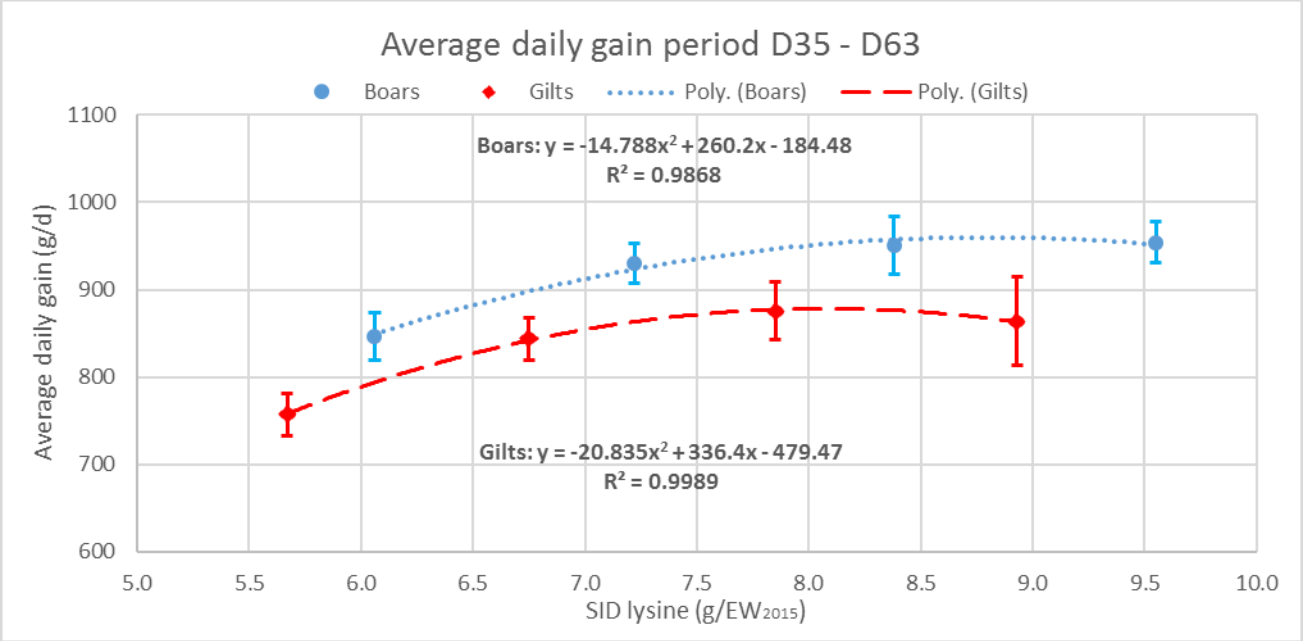

Figure 11 *Average daily gain from day 35 till day 63 of growing-finishing pigs (boars and gilts) (Farm B) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars and gilts (Van der Peet-Schwering and Bikker, 2018)). Recommended SID levels (100%) in grower diets for current growing-finishing boars and gilts are 7.6 and 7.1 g/EW$_{2015}$, respectively.*

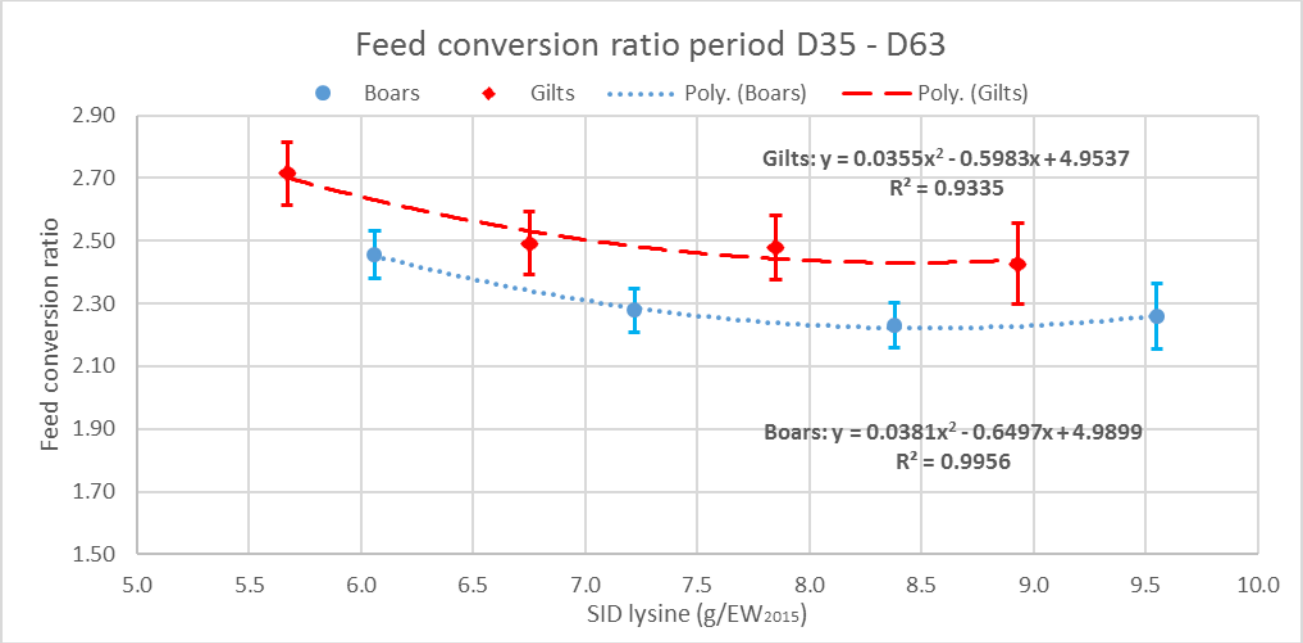

Figure 12 *Feed conversion ratio from day 35 till day 63 of growing-finishing pigs (boars and gilts) (Farm B) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars and gilts (Van der Peet-Schwering and Bikker, 2018)). Recommended SID levels (100%) in grower diets for current growing-finishing boars and gilts are 7.6 and 7.1 g/EW$_{2015}$, respectively.*

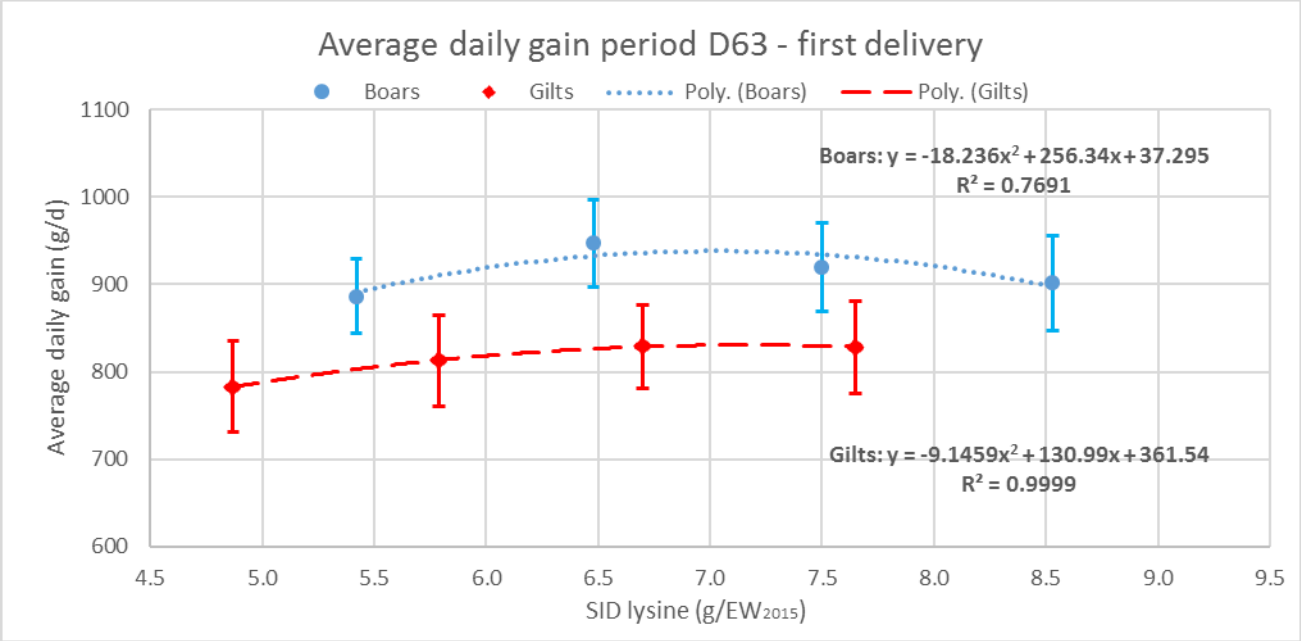

Figure 13 *Average daily gain from day 63 till first delivery of growing-finishing pigs (boars and gilts) (Farm B) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars and gilts (Van der Peet-Schwering and Bikker, 2018)). Recommended SID levels (100%) in finisher diets for current growing-finishing boars and gilts are 6.8 and 6.1 g/EW$_{2015}$, respectively.*

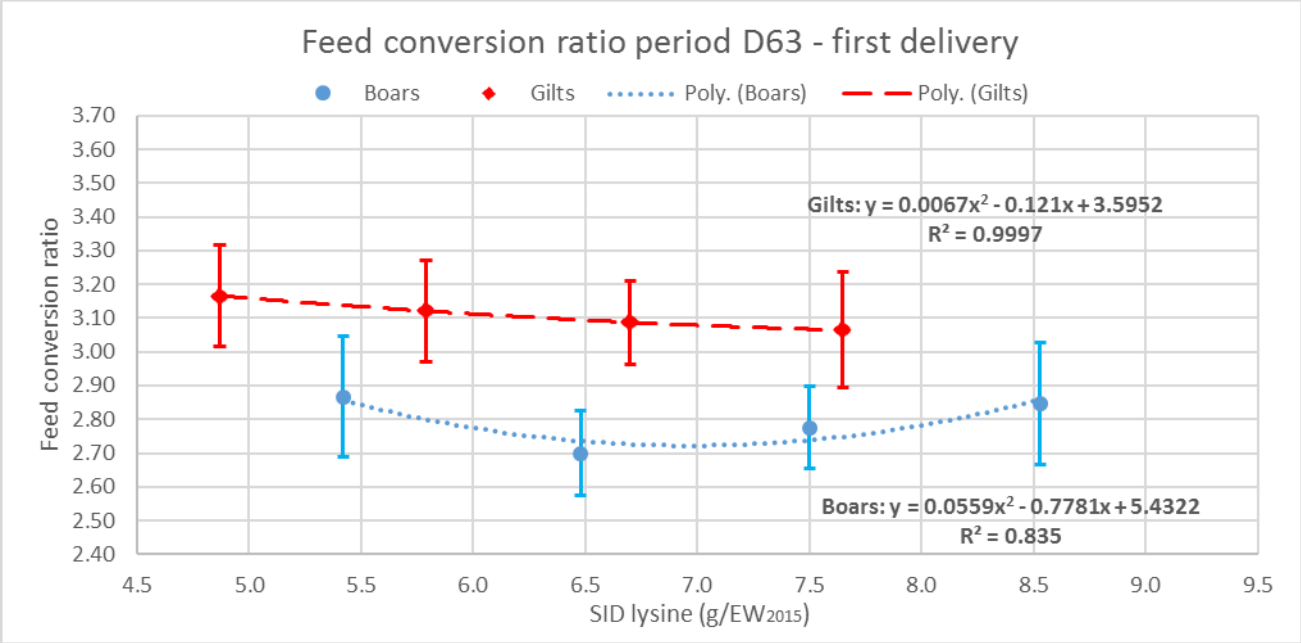

Figure 14 *Feed conversion ratio from day 63 till first delivery of growing-finishing pigs (boars and gilts) (Farm B) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars and gilts (Van der Peet-Schwering and Bikker, 2018)). Recommended SID levels (100%) in finisher diets for current growing-finishing boars and gilts are 6.8 and 6.1 g/EW$_{2015}$, respectively.*

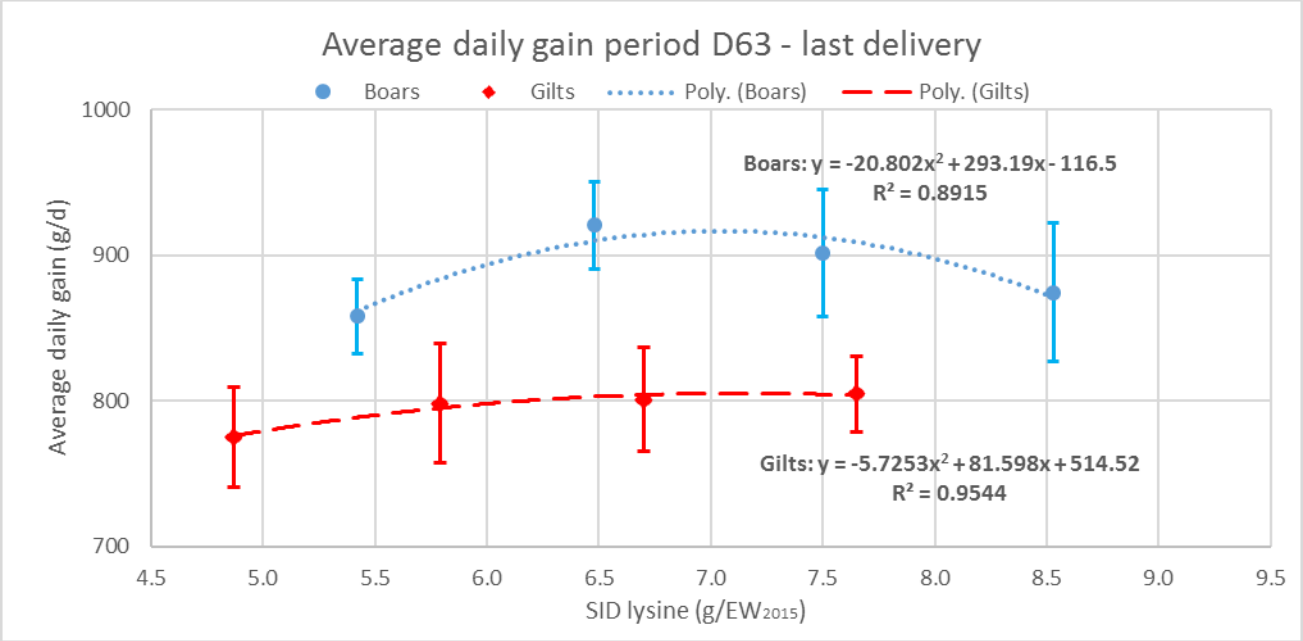

Figure 15 *Average daily gain from day 63 till last delivery of growing-finishing pigs (boars and gilts) (Farm B) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars and gilts (Van der Peet-Schwering and Bikker, 2018)). Recommended SID levels (100%) in finisher diets for current growing-finishing boars and gilts are 6.8 and 6.1 g/EW$_{2015}$, respectively.*

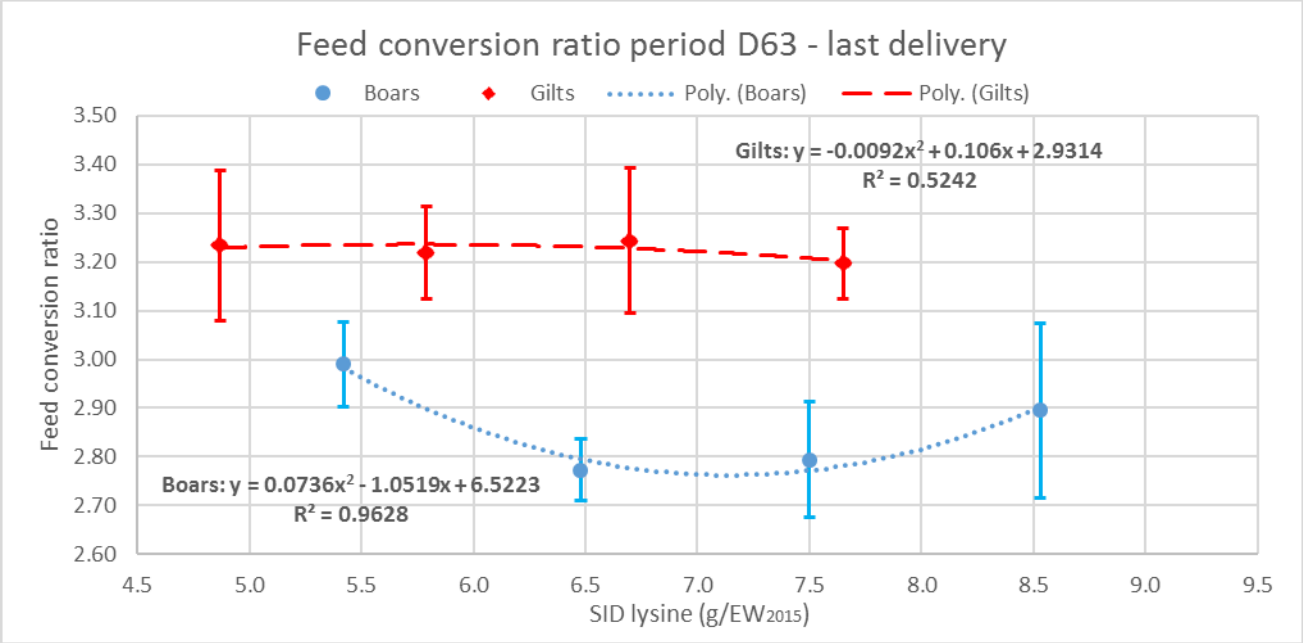

Figure 16 *Feed conversion ratio from day 63 till last delivery of growing-finishing pigs (boars and gilts) (Farm B) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boar[2] and gilts (Van der Peet-Schwering and Bikker, 2018)). Recommended SID levels (100%) in finisher diets for current growing-finishing boars and gilts are 6.8 and 6.1 g/EW$_{2015}$, respectively.*

3.3 Slaughter results

The slaughter results of the GF pigs are presented in Table 7 (Farm A) and Table 8 (Farm B).

Table 7 *Slaughter results of growing-finishing pigs (boars and gilts) (Farm A) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars[1] and gilts[2] (Van der Peet-Schwering and Bikker, 2018)).*

		SID level				SEM[3]	P-value				
	sex	80%	95%	110%	125%	lysine	lys L[4]	lys Q[5]	sex	sex x lys L	sex x lys Q
No of pigs	Boar	63	63	62	62						
	Gilt	61	59	65	61						
Slaughter weight (kg)	Boar	90.6^{a}	93.5^{b}	95.1^{b}	95.0^{b}	0.64	<0.001	0.04	0.79	0.73	0.82
	Gilt	90.8^{a}	94.8^{b}	93.9^{b}	95.4^{b}						
Meat %	Boar	59.7^{a}	59.9^{abc}	60.8^{e}	60.6^{de}	0.13	<0.001	0.26	0.83	0.23	0.65
	Gilt	59.9^{ab}	60.3^{bcd}	60.5^{cde}	60.6^{de}						
Muscle thickness (mm)	Boar	64.4^{a}	67.2^{b}	68.6^{bc}	68.9^{bc}	0.61	<0.001	0.34	0.03	0.30	0.34
	Gilt	67.6^{b}	69.4^{bc}	69.2^{bc}	70.8^{c}						
Backfat (mm)	Boar	13.0^{d}	12.7^{cd}	11.4^{a}	11.7^{ab}	0.20	<0.001	0.28	0.95	0.27	0.72
	Gilt	12.8^{cd}	12.3^{bcd}	12.0^{abc}	11.8^{ab}						
Dressing %	Boar	76.5^{abc}	76.4^{ab}	75.6^{a}	75.9^{a}	0.28	0.15	0.16	<0.001	0.84	0.49
	Gilt	78.3^{d}	77.2^{bc}	77.5^{cd}	77.5^{cd}						

[1] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing boars are 8.7, 7.6 and 6.8 g/EW_{2015}, respectively; [2] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing gilts are 8.3, 7.1 and 6.1 g/EW_{2015}, respectively; [3] SEM = pooled SEM. Means are presented as least squares means; [4] lys L = linear effect of SID lysine level; [5] lys Q = quadratic effect of SID lysine level.

Table 7 shows that meat% and backfat thickness were similar in boars and gilts. Muscle thickness and dressing% were higher in gilts. In boars, meat% was highest and backfat thickness was lowest at the 110% SID lysine level. Meat% and backfat thickness, however, were similar at the 110 and 125% SID lysine level. Muscle thickness was highest at the 125% SID lysine level, but did not differ from the muscle thickness at the 95 and 110% SID lysine level. In gilts, meat% and muscle thickness were highest and backfat thickness was lowest at the 125% SID lysine level. Meat%, muscle thickness and backfat thickness, however, were similar art the 95, 110 and 125% SID lysine level.

Table 8 *Slaughter results of growing-finishing pigs (boars and gilts) (Farm B) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars[1] and gilts[2] (Van der Peet-Schwering and Bikker, 2018)).*

		SID level				SEM[3]	P-value				
	Sex	80%	95%	110%	125%	lysine	lys L[4]	lys Q[5]	sex	sex x lys L	sex x lys Q
No of pigs	Boar	173	173	173	174						
	Gilt	170	170	173	173						
Slaughter weight (kg)	Boar	94.1^{a}	98.1^{b}	98.6^{bcd}	98.4^{bc}	0.31	<0.001	<0.001	0.20	0.03	0.87
	Gilt	94.0^{a}	98.3^{b}	99.8^{cd}	100.1^{d}						
Meat %	Boar	60.4^{a}	60.6^{abc}	61.0^{ac}	60.9^{abc}	0.11	0.25	0.32	0.56	0.06	0.79
	Gilt	60.5^{abc}	60.8^{abc}	60.4^{ab}	60.6^{abc}						
Muscle thickness (mm)	Boar	65.9^{a}	66.3^{ab}	67.9^{bc}	67.7^{bc}	0.37	0.01	0.50	<0.001	0.75	0.85
	Gilt	69.0^{cd}	70.3^{de}	70.1^{de}	71.0^{e}						
Backfat (mm)	Boar	12.0^{ab}	11.7^{ab}	11.2^{a}	11.3^{ab}	0.17	0.32	0.33	0.35	0.07	0.82
	Gilt	11.9^{ab}	11.4^{ab}	12.1^{b}	11.8^{ab}						

[1] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing boars are 8.7, 7.6 and 6.8 g/EW_{2015}, respectively; [2] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing gilts are 8.3, 7.1 and 6.1 g/EW_{2015}, respectively; [3] SEM = pooled SEM. Means are presented as least squares means; [4] lys L = linear effect of SID lysine level; [5] lys Q = quadratic effect of SID lysine level.

Table 8 shows that meat% and backfat thickness were similar in boars and gilts. Muscle thickness was higher in gilts. In both boars and gilts, meat% and backfat thickness were not affected by SID lysine level. In boars, muscle thickness was highest at the 110% SID lysine level but did not differ from the muscle thickness at the 95 and 125% SID lysine level. In gilts, muscle thickness was highest at the 125% SID lysine level, but did not differ from the muscle thickness at the 95 and 110% SID lysine level.

3.4 Health and faecal scores

The number of culled and veterinary treated GF pigs are presented in Table 9 (Farm A) and Table 10 (Farm B). Also the reasons of culling and veterinary treatment are presented.

Table 9 *Number of culled and veterinary treated growing-finishing pigs (boars and gilts) (Farm A) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars[1] and gilts[2] (Van der Peet-Schwering and Bikker, 2018)).*

	Boars				Gilts				P-value	
	80%	95%	110%	125%	80%	95%	110%	125%	sex	lysine
No of pigs at start	65	65	65	65	65	65	65	65		
No of culled pigs	2	2	3	3	4	6	0	4	0.40	0.49
Reason of culling:										
- GIT[3] disorder	0	0	1	2	0	1	0	1	[4]	[4]
- lung problems	0	0	0	0	2	3	0	0	[4]	[4]
- bad growth	0	0	1	1	0	0	0	1	[4]	[4]
- leg problems	1	1	1	0	0	1	0	0	[4]	[4]
- miscellaneous	1	0	0	0	1	1	0	0	[4]	[4]
- unknown	0	1	0	0	1	0	0	2	[4]	[4]
No of veterinary treated pigs	1	2	1	0	0	2	2	1	0.74	0.38
Reason of treatment:										
- leg problems	1	1	1	0	0	2	2	0	[4]	[4]
- lung problems	0	0	0	0	0	0	0	1	[4]	[4]
- miscellaneous	0	1	0	0	0	0	0	0	[4]	[4]

[1] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing boars are 8.7, 7.6 and 6.8 g/EW_{2015}, respectively; [2] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing gilts are 8.3, 7.1 and 6.1 g/EW_{2015}, respectively; [3] GIT = gastrointestinal; [4] Number too low for analysis.

Table 9 shows that the number of culled and veterinary treated pigs was not affected by sex or SID lysine level.

Table 10 *Number of culled and veterinary treated growing-finishing pigs (boars and gilts) (Farm B) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars[1] and gilts[2] (Van der Peet-Schwering and Bikker, 2018)).*

	Boars				Gilts				P-value	
	80%	95%	110%	125%	80%	95%	110%	125%	sex	lysine
No of pigs at start	176	176	176	176	176	176	176	176		
No of culled pigs	3	3	3	2	6	6	3	3	0.19	0.62
Reason of culling:										
- GIT[3] disorder	0	1	0	0	1	0	1	1	[4]	[4]
- lung problems	1	0	0	0	2	0	1	0	[4]	[4]
- tail wound	1	0	0	0	1	0	0	0	[4]	[4]
- leg problems	1	1	2	0	0	2	0	1	[4]	[4]
- unknown	0	1	1	2	2	4	1	1	[4]	[4]
No of veterinary treated pigs	7	5	5	10	8	5	2	3	0.17	0.34
Reason of treatment:										
- leg problems	2	4	2	4	3	2	1	0	0.15	0.77
- lung problems	5	1	2	5	4	3	1	3	0.68	0.22
- miscellaneous	0	0	1	1	1	0	0	0	[4]	[4]

[1] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing boars are 8.7, 7.6 and 6.8 g/EW_{2015}, respectively; [2] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing gilts are 8.3, 7.1 and 6.1 g/EW_{2015}, respectively; [3] GIT = gastrointestinal; [4] Number too low for analysis.

Table 10 shows that the number of culled and veterinary treated pigs was not affected by sex or SID lysine level.

On Farm A, in each pen the number of GF pigs with normal faeces (score = 0), soft faeces (score = 1) and watery faeces (score = 2) was scored. On Farm B, the faeces of the pigs was scored on pen level. The percentage of GF pigs with soft or watery faeces (score 1 and 2) within a pen in week 1-5 after the start is presented in Table 11 (Farm A). The mean faecal score in week 1-5 after the start is presented in Tables 11a (Farm A) and Table 12 (Farm B).

Table 11 *Percentage of growing-finishing pigs (boars and gilts) with soft or watery faeces (score 1 and 2)[1] within a pen (Farm A) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars[2] and gilts[3] (Van der Peet-Schwering and Bikker, 2018)).*

	Boars				Gilts				P-value		
Week	80%	95%	110%	125%	80%	95%	110%	125%	sex	lysine	sex x lysine
1	3.8^{ab}	1.8^{ab}	8.0^{ab}	3.0^{ab}	9.7^{b}	8.0^{ab}	4.3^{ab}	1.6^{a}	0.67	0.41	0.19
2	1.4^{a}	0.0^{a}	4.5^{a}	1.6^{a}	3.3^{a}	2.5^{a}	0.0^{a}	0.0^{a}	0.79	0.76	0.17
3	1.8^{ab}	0.0^{a}	0.4^{ab}	4.1^{b}	0.0^{a}	3.0^{ab}	0.0^{a}	0.0^{a}	0.33	0.60	0.09
4	0.0^{a}	0.0^{a}	0.0^{a}	4.2^{b}	0.0^{a}	1.6^{a}	0.0^{a}	0.0^{a}	0.34	0.09	0.02
5	0.0^{a}	4.5^{ac}	1.6^{abc}	0.0^{a}	0.0^{ab}	3.0^{abc}	1.6^{abc}	0.0^{ab}	0.62	0.08	0.95

[1] Faecal score was recorded weekly during the starter phase (5 weeks): normal faeces (score = 0), pasty faeces (score = 1), watery faeces (score = 2); [2] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing boars are 8.7, 7.6 and 6.8 g/EW_{2015}, respectively; [3] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing gilts are 8.3, 7.1 and 6.1 g/EW_{2015}, respectively.

Table 11a *Average faecal score of growing-finishing pigs (boars and gilts) within a pen (Farm A) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars[2] and gilts[3] (Van der Peet-Schwering and Bikker, 2018)).*

	Boars				Gilts				P-value		
Week	80%	95%	110%	125%	80%	95%	110%	125%	sex	lysine	sex x lysine
1	0.38^{abc}	0.13^{a}	0.75^{abc}	0.25^{abc}	0.88^{ac}	0.75^{abc}	0.38^{abc}	0.13^{ab}	0.69	0.35	0.17
2	0.13^{a}	0.00^{a}	0.38^{a}	0.13^{a}	0.25^{a}	0.25^{a}	0.00^{a}	0.00^{a}	0.81	0.82	0.19
3	0.13^{ab}	0.00^{a}	0.02^{a}	0.38^{b}	0.00^{a}	0.25^{ab}	0.00^{a}	0.00^{a}	0.38	0.51	0.09
4	0.00^{a}	0.00^{a}	0.00^{a}	0.38^{b}	0.00^{a}	0.13^{a}	0.00^{a}	0.00^{a}	0.30	0.07	0.02
5	0.00^{a}	0.38^{b}	0.13^{ab}	0.00^{a}	0.00^{a}	0.25^{ab}	0.13^{ab}	0.00^{a}	0.62	0.07	0.95

[1] Faecal score was recorded weekly during the starter phase (5 weeks): normal faeces (score = 0), pasty faeces (score = 1), watery faeces (score = 2); [2] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing boars are 8.7, 7.6 and 6.8 g/EW_{2015}, respectively; [3] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing gilts are 8.3, 7.1 and 6.1 g/EW_{2015}, respectively.

Table 11 and 11a shows that the percentage of GF with soft or watery faeces and the average faecal score were low and were not affected by sex or SID lysine level.

Table 12 *Average faecal score of pens (boars and gilts) (Farm B) that were fed diets differing in standardized ileal digestible (SID) lysine content (80, 95, 110 or 125% of the recommended level for current boars[2] and gilts[3] (Van der Peet-Schwering and Bikker, 2018)).*

	Boars				Gilts				P-value		
Week	80%	95%	110%	125%	80%	95%	110%	125%	sex	lysine	sex x lysine
1	0.13^{a}	0.00^{a}	0.19^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.19^{a}	0.13^{a}	0.99	0.13	0.48
2	0.06^{ab}	0.00^{a}	0.25b	0.19^{ab}	0.00^{a}	0.06^{ab}	0.06^{ab}	0.13^{ab}	0.17	0.19	0.49
3	0.13^{a}	0.06^{a}	0.00^{a}	0.13^{a}	0.00^{a}	0.00^{a}	0.06^{a}	0.06^{a}	0.36	0.60	0.36
4	0.06^{ab}	0.00^{a}	0.00^{a}	0.00^{a}	0.06^{ab}	0.13^{ab}	0.06^{ab}	0.19^{b}	0.03	0.77	0.42
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			

[1] Faecal score was recorded weekly during the starter phase (5 weeks): normal faeces (score = 0), pasty faeces (score = 1), watery faeces (score = 2); [2] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing boars are 8.7, 7.6 and 6.8 g/EW_{2015}, respectively; [3] Recommended SID levels (100%) in starter, grower and finisher diets for current growing-finishing gilts are 8.3, 7.1 and 6.1 g/EW_{2015}, respectively.

Table 12 shows that the average faecal score was low and was not affected by SID lysine level. In week 4, the average faecal score was higher in gilts than in boars.

3.5 Estimate of lysine requirements

The results of the broken-line analysis for the variables ADG and FCR from start till day 35, day 35-63, day 63 till first delivery to the slaughterhouse and day 63 till slaughter are presented in Table 13 and Figures 17-20 for Farm A.

Table 13 *Estimated parameters of a broken-line model to describe the response of ADG and FCR of growing-finishing pigs to an increase in dietary standardized ileal digestible (SID) lysine (g/EW_{2015}) from the start until day 35, day 35-63, day 63 until first delivery to the slaughterhouse and day 63 until slaughter of all pigs. The plateau (maximum ADG and minimum FCR), breakpoint (SID lysine in g/EW_{2015}) and slope are presented for boars and gilts separately only in case of a significant sex effect (P<0.05) on the respective parameter (Farm A).*

	Sex	plateau	P[1]	SID Lys (g/EW_{2015})	P[1]	slope	R^2	RMSE
Start till day 35:								
ADG (g/d)	Boar	963±26	0.20	10.5±0.60	0.06	51±12.9	37.8	74.6
	Gilt	922±18	0.03	9.0±0.64	0.004		63.4	
FCR	Boar	1.67±0.022	<0.001	10.6±0.36	0.008	-0.09±0.008	80.6	0.059
	Gilt	1.81±0.022		9.5±0.33	<0.001		87.3	
Day 35-63:								
ADG (g/d)	Boar	1126±16	<0.001	7.1±0.45	(0.30)	95±38	36.9	82.6
	Gilt	1060±18			(0.20)		45.9	
FCR	Boar	2.11±0.031	<0.001	7.4±0.45	(0.55)	-0.12±0.043	43.3	0.141
	Gilt	2.29±0.031			(0.32)		66.5	
Day 63 till first delivery (D86):								
ADG (g/d)	Boar	1169±20	<0.001	6.8±0.37	0.049	118±38	57.8	79.8
	Gilt	986±16		5.6±0.37	0.008		72.8	
FCR	Boar	2.27±0.057	<0.001	8.0±0.69	0.077	-0.12±0.034	53.3	0.155
	Gilt	2.62±0.042		6.3±0.57	0.017		69.6	
Day 63 until slaughter:								
ADG (g/d)	Boar	1139±19	<0.001	6.7±0.39	0.028	98.4±36.9	52.8	78.1
	Gilt	975±16		5.6±0.41	<0.001		74.7	
FCR	Boar	2.41±0.06	<0.001	8.0±0.82	0.118	-0.10±0.034	57.6	0.156
	Gilt	2.79±0.04		6.5±0.71	0.004		83.6	

[1] P-value of the sex effect on respective parameters. The p-values and R^2 in gray shading are derived from the broken line analyses of relative ADG and FCR within room, i.e. standardized for the mean performance of the room; [2] Adjusted R^2, percentage of variance explained by the model.

Table 13 and Figure 17 show that from start till day 35 (the starter phase), the optimum SID lysine level for ADG and FCR in boars was 10.5 and 10.6 g/EW_{2015}, respectively. In gilts, the optimum SID lysine level for ADG and FCR was 9.0 and 9.5 g/EW_{2015}, respectively.

Table 13 and Figure 18 show that from day 35-63 (the grower phase), the optimum SID lysine level for ADG and FCR in boars and gilts combined was 7.1 and 7.4 g/EW_{2015}, respectively, and not significantly different between the sexes.

Table 13 and Figure 19 show that from day 63 till first delivery, the optimum SID lysine level for ADG and FCR in boars was 6.8 and 8.0 g/EW_{2015}, respectively. In gilts, the optimum SID lysine level for ADG and FCR was 5.6 and 6.3 g/EW_{2015}, respectively.

Table 13 and Figure 20 show that from day 63 till slaughter (the finisher phase), the optimum SID lysine level for ADG and FCR in boars was 6.7 and 8.0 g/EW_{2015}, respectively. In gilts, the optimum SID lysine level for ADG and FCR was 5.6 and 6.5 g/EW_{2015}, respectively.

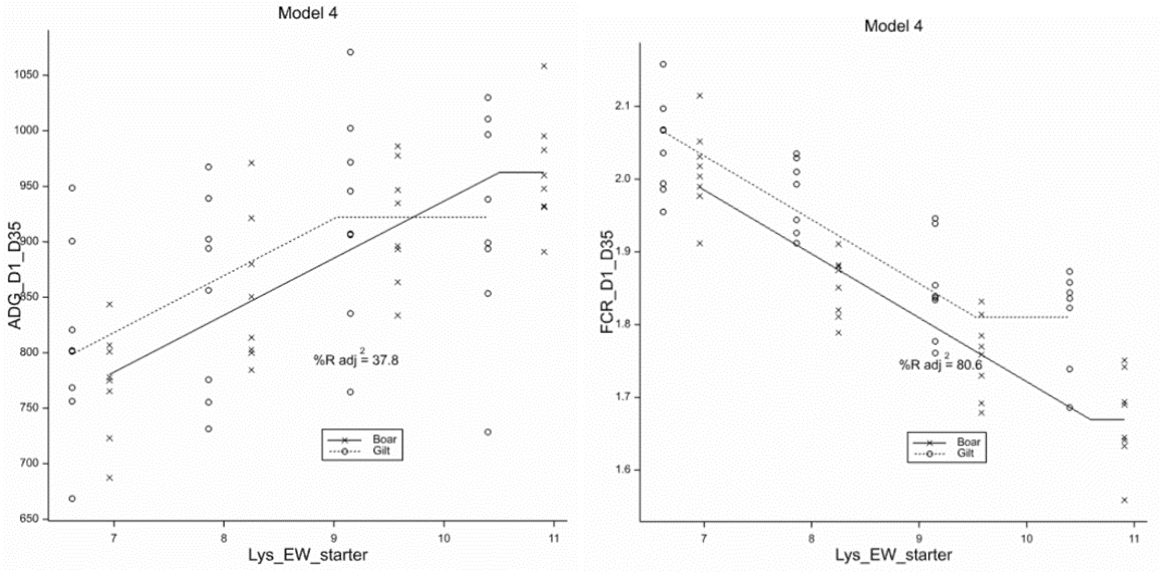

Figure 17 *The effect of increasing standardized ileal digestible (SID) lysine (g/EW$_{2015}$) on ADG and FCR from the start till day 35 of growing-finishing pigs using a broken-line model. The plateau, breakpoint (SID lysine in g/EW$_{2015}$) and slope below the breakpoint are presented for boars and gilts (Farm A). The plateau and breakpoint (model 4) for ADG and FCR differ between boars and gilts.*

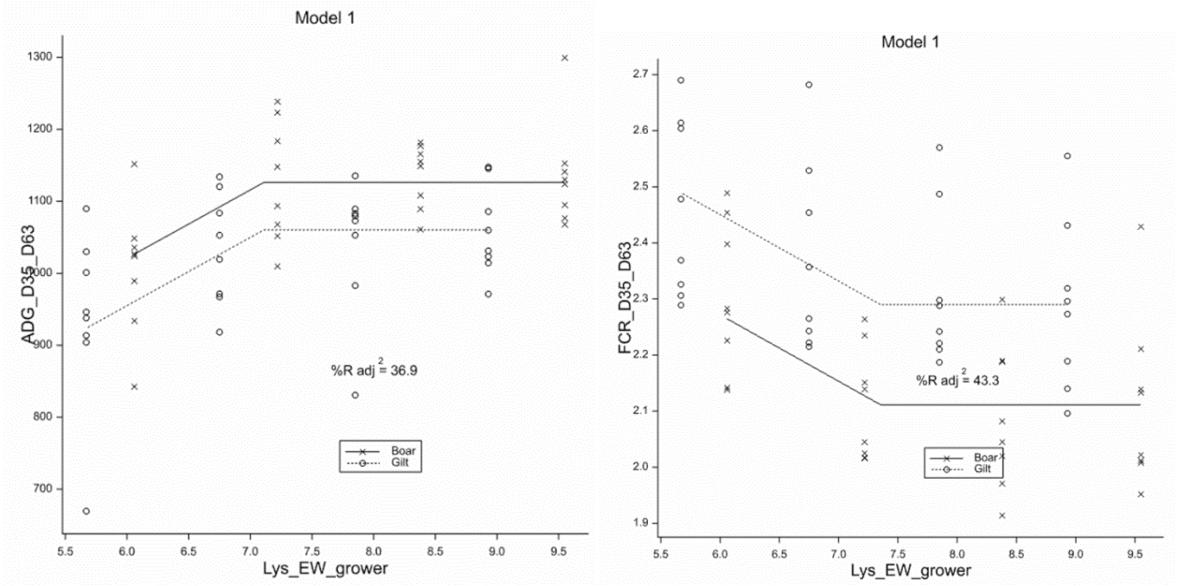

Figure 18 *The effect of increasing standardized ileal digestible (SID) lysine (g/EW$_{2015}$) on ADG and FCR from day 35 till day 63 of growing-finishing pigs using a broken-line model. The plateau, breakpoint (SID lysine in g/EW$_{2015}$) and slope below the breakpoint are presented for boars and gilts (Farm A). The plateau (model 1) for ADG and FCR differs between boars and gilts.*

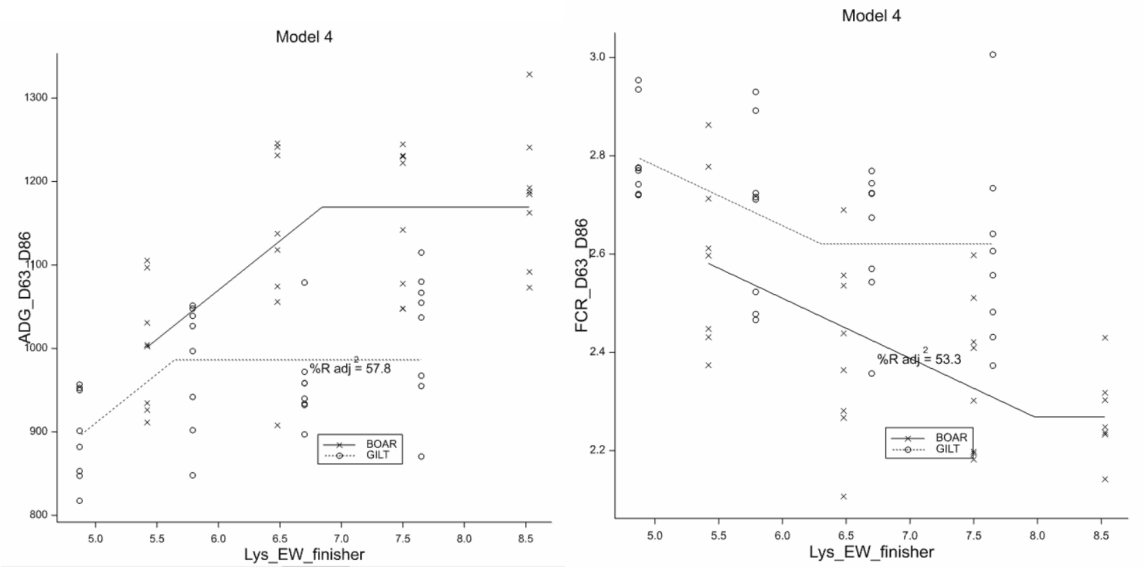

Figure 19 *The effect of increasing standardized ileal digestible (SID) lysine (g/EW$_{2015}$) on ADG and FCR from day 63 till first delivery of growing-finishing pigs using a broken-line model. The plateau, breakpoint (SID lysine in g/EW$_{2015}$) and slope below the breakpoint are presented for boars and gilts (Farm A). The plateau and breakpoint (model 4) for ADG and FCR differs between boars and gilts.*

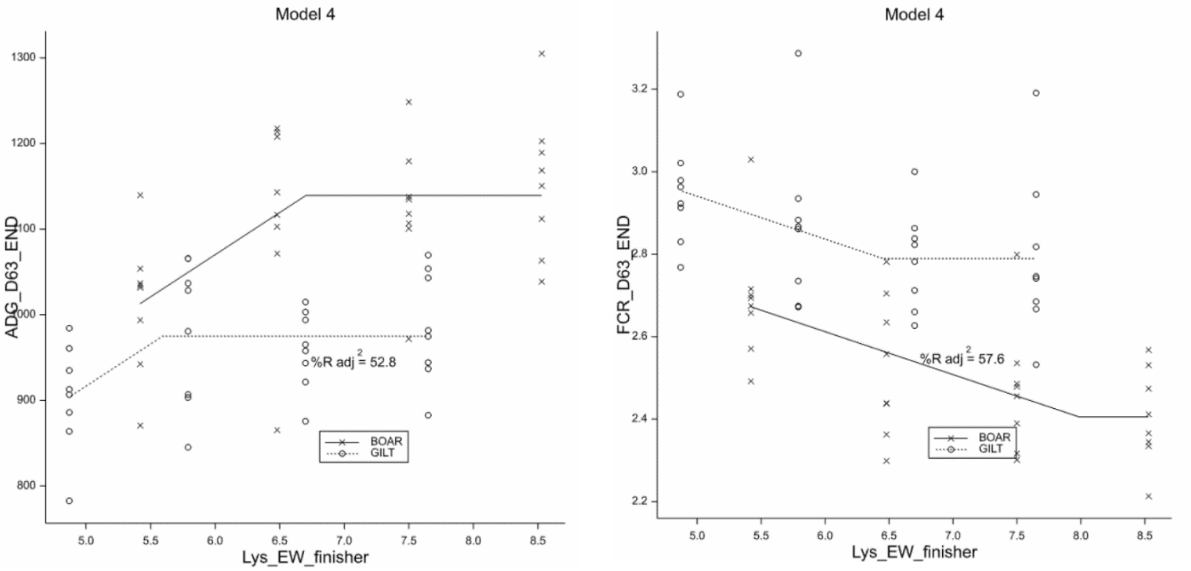

Figure 20 *The effect of increasing standardized ileal digestible (SID) lysine (g/EW$_{2015}$) on ADG and FCR from day 63 until slaughter of all growing-finishing pigs using a broken-line model. The plateau, breakpoint (SID lysine in g/EW$_{2015}$) and slope below the breakpoint are presented for boars and gilts (Farm A). The plateau and breakpoint (model 4) for ADG and FCR differs between boars and gilts.*

The results of the broken-line analysis for the variables ADG and FCR from start till day 35, day 35-63, day 63 till first delivery to the slaughterhouse and day 63 till slaughter are presented in Table 14 and Figures 21-24 for Farm B.

Table 14 *Estimated parameters of a broken-line model to describe the response of ADG and FCR of growing-finishing pigs to an increase in dietary standardized ileal digestible (SID) lysine (g/EW$_{2015}$) from the start until day 35, day 35-63, day 63 until first delivery to the slaughterhouse and day 63 until slaughter of all pigs. The plateau (maximum ADG and minimum FCR), breakpoint (SID lysine in g/EW$_{2015}$) and slope are presented for boars and gilts separately only in case of a significant sex effect (P<0.05) on the respective parameter, whereas tendencies for a sex effect on breakpoint were also included (Farm B).*

	Sex	plateau	P[1]	SID Lys (g/EW$_{2015}$)	P[1]	slope	P[1]	R[2]	RMSE
Start till day 35:									
ADG (g/d)	Boar	881±7.5	(0.32)	9.1±0.30	0.074	74±11.8		66.9	43.4
	Gilt			8.7±0.29					
FCR	Boar	1.70±0.030	<0.001	9.8±0.36	0.12	-0.11±0.014		71.2	0.082
	Gilt	1.85±0.021		8.9±0.34					
Day 35-63:									
ADG (g/d)	Boar	952±8.1	<0.001	7.5±0.19	0.11	75±10.4		77.8	32.9
	Gilt	870±8.1		7.1±0.19					
FCR	Boar	2.26±0.019	<0.001	7.0±0.22	(0.73)	-0.21±0.045		69.5	0.098
	Gilt	2.45±0.022							
Day 63 till first delivery (D100):									
ADG (g/d)	Boar	922±10.0	<0.001	6.4±0.43	(0.77)	32±16.9		48.5	53.8
	Gilt	831±11.5							
FCR	Boar	2.78±0.033	<0.001	6.5±0.19	(0.84)	-0.067±0.041		44.2	0.177
	Gilt	3.07±0.038							
Day 63 until slaughter:									
ADG (g/d)	Boar	899±7.6	<0.001	6.0±0.78	(0.99)	75±109	0.60	60.1	39.6
	Gilt	803±9.6				25±21			
FCR	Boar	2.82±0.02	<0.001	5.7±0.53	(0.74)	-0.71±1.60	0.017	66.7	0.13
	Gilt	3.22±0.02				-0.02±0.05			

[1] P-value of the sex effect on respective parameters; [2] Adjusted R^2, percentage of variance explained by the model.

Table 14 and Figure 21 show that from start till day 35 (the starter phase), the optimum SID lysine level for ADG in boars and gilts was 9.1 and 8.7 g/EW$_{2015}$, respectively. The optimum SID lysine level for FCR in boars and gilts was 9.8 and 8.9 g/EW$_{2015}$, respectively.

Table 14 and Figure 22 show that from day 35-63 (the grower phase), the optimum SID lysine level for ADG in boars and gilts was 7.5 and 7.1 g/EW$_{2015}$, respectively. The optimum SID lysine level for FCR in boars and gilts was 7.0 g/EW$_{2015}$.

Table 14 and Figure 23 show that from day 63 till first delivery, the optimum SID lysine level for ADG and FCR in boars and gilts combined was 6.4 and 6.5 g/EW$_{2015}$, respectively.

Table 14 and Figure 24 show that from day 63 till slaughter, the optimum SID lysine level for ADG and FCR in boars and gilts combined was 6.0 and 5.7 g/EW$_{2015}$, respectively.

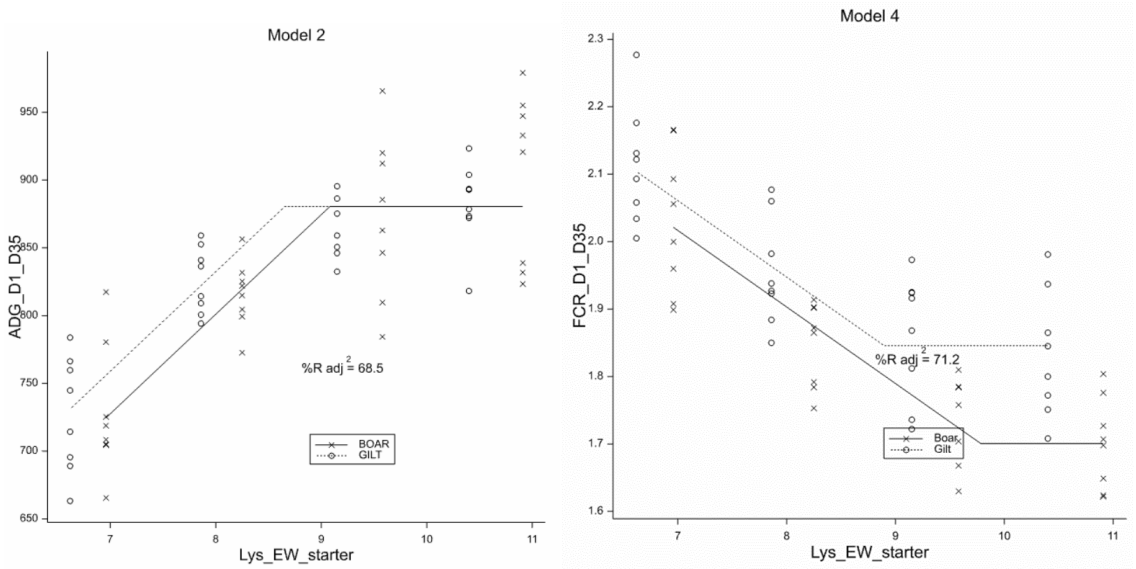

Figure 21 *The effect of increasing standardized ileal digestible (SID) lysine (g/EW$_{2015}$) on ADG and FCR from the start till day 35 of growing-finishing pigs using a broken-line model. The plateau, breakpoint (SID lysine in g/EW$_{2015}$) and slope below the breakpoint are presented for boars and gilts (Farm B). For ADG, only the breakpoint differed significantly between boars and gilts. For FCR, the plateau and breakpoint (model 4) differed between boars and gilts.*

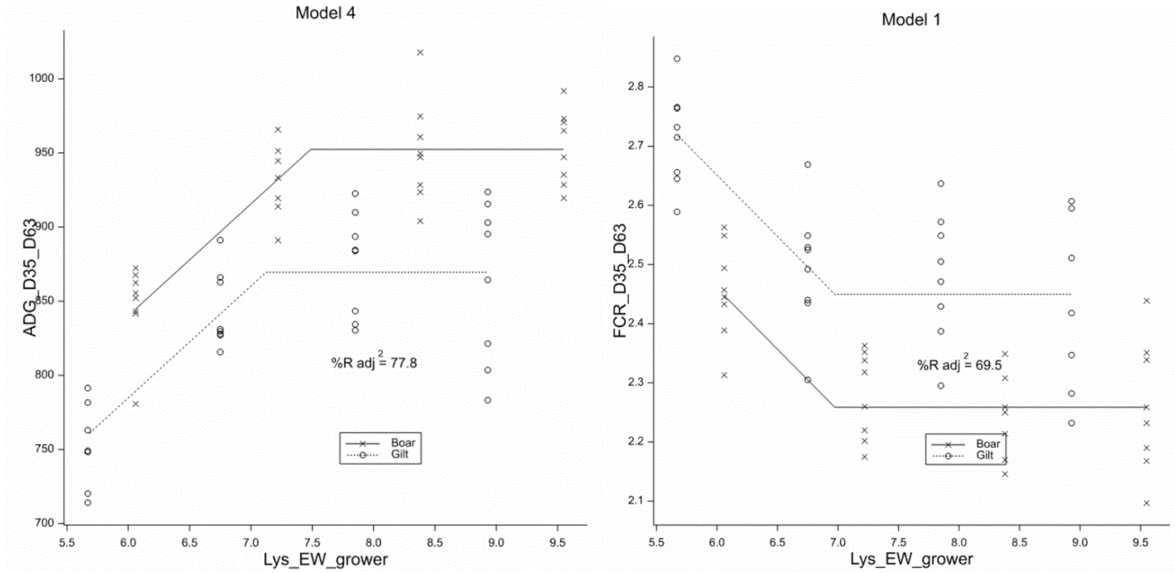

Figure 22 *The effect of increasing standardized ileal digestible (SID) lysine (g/EW$_{2015}$) on ADG and FCR from day 35 till day 63 of growing-finishing pigs using a broken-line model. The plateau, breakpoint (SID lysine in g/EW$_{2015}$) and slope below the breakpoint are presented for boars and gilts (Farm B). For ADG, the plateau and breakpoint (model 4) differed between boars and gilts. For FCR, only the plateau (model 1) differed between boars and gilts.*

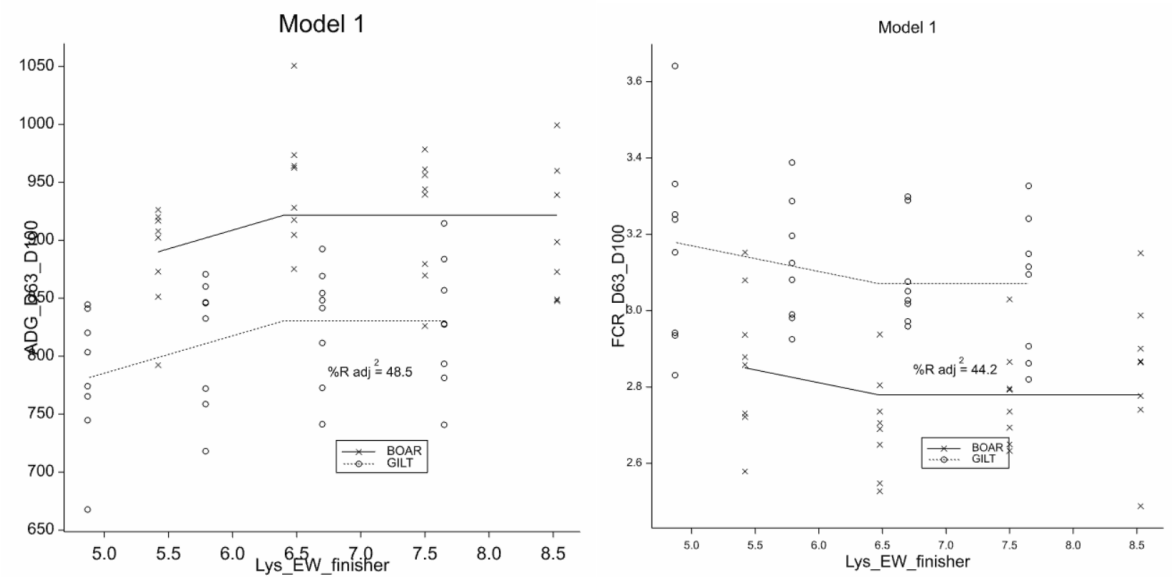

Figure 23 *The effect of increasing standardized ileal digestible (SID) lysine (g/EW$_{2015}$) on ADG and FCR from day 63 till first delivery of growing-finishing pigs using a broken-line model. The plateau, breakpoint (SID lysine in g/EW$_{2015}$) and slope below the breakpoint are presented for boars and gilts (Farm B). The plateau (model 1) for ADG and FCR differed between boars and gilts.*

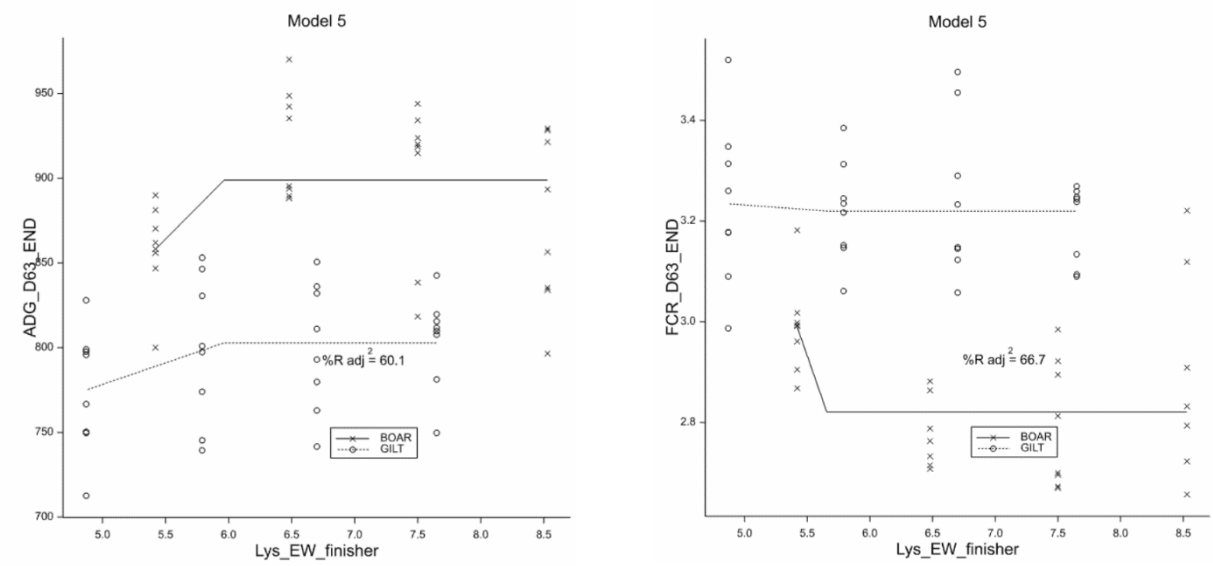

Figure 24 *The effect of increasing standardized ileal digestible (SID) lysine (g/EW$_{2015}$) on ADG and FCR from day 63 until slaughter of growing-finishing pigs using a broken-line model. The plateau, breakpoint (SID lysine in g/EW$_{2015}$) and slope below the breakpoint are presented for boars and gilts (Farm B). The plateau and slope (model 5) for ADG and FCR differed between boars and gilts.*

4 Discussion

The goal of this experiment was to validate the updated SID lysine recommendations for current GF pigs (Van der Peet-Schwering and Bikker, 2018) on two farms with GF gilts and boars. In Table 15, the performance and SID lysine requirement of current and future GF (Van der Peet-Schwering and Bikker, 2018) as predicted with InraPorc (Van Milgen et al., 2008) is presented. Besides, the optimal dietary SID lysine level and corresponding ADG and FCR of the GF boars and gilts on Farm A and Farm B as estimated with broken-line analysis are presented in Table 15.

Table 15 *ADG, FCR and standardized ileal digestible (SID) lysine requirement (in g/EW_{2015} and as a percentage of the recommended level for current growing and finishing (GF) male and female pigs) for the average current and future[1] GF pig (Van der Peet-Schwering and Bikker, 2018) and the required dietary SID lysine level (breakpoint) and corresponding ADG and FCR (plateau) of the GF pigs on Farm A and Farm B as estimated with broken-line analysis*

	Current GF pigs		Future GF pigs: 10% improved FCR		Farm A		Farm B	
	Boar	Gilt	Boar	Gilt	Boar	Gilt	Boar	Gilt
25-50 kg:								
ADG (g/d)	763	746	829	820	963	922	881	881
FCR	1.90	2.03	1.75	1.85	1.67	1.81	1.70	1.85
SID lysine (g/ EW_{2015})	8.7	8.3	9.6	8.7	10.5-10.6[2]	9.0-9.5	9.1-9.8	8.7-8.9
SID lysine (%)	100	100	110	105	121-122[2]	108-114	105-113	105-107
50-80 kg:								
ADG (g/d)	924	893	1014	990	1126	1060	952	870
FCR	2.18	2.37	1.99	2.10	2.11	2.29	2.26	2.45
SID lysine (g/ EW_{2015})	7.6	7.1	8.5	8.0	7.1-7.4	7.1-7.4	7.5-7.0	7.1-7.0
SID lysine (%)	100	100	112	112	93-97	100-104	99-92	100-99
80-120 kg:								
ADG (g/d)	911	874	1012	960	1139	975	899	803
FCR	2.62	2.87	2.37	2.56	2.41	2.79	2.82	3.22
SID lysine (g/ EW_{2015})	6.8	6.1	7.6	7.2	6.7-8.0	5.6-6.5	6.0-5.7	6.0-5.7
SID lysine (%)	100	100	112	117	99-118	92-107	88-84	98-93

[1] The daily gain of the future growing and finishing pigs is 10% higher than the daily gain of the current growing and finishing pigs and is realized by a 10% improved feed conversion ratio; [2] The optimal dietary SID lysine level (g/ EW_{2015} and %) is presented for ADG (first number) and FCR (second number).

Starter phase

During the starter phase (20-50 kg), the optimum dietary SID lysine level for ADG and FCR in boars on Farm A was 10.5 and 10.6 g/EW_{2015} (121 and 122% of the recommended level for current GF boars), respectively. ADG and FCR in boars reached a plateau at 963 g/d and 1.67, respectively. In gilts on Farm A, the optimum SID lysine level for ADG and FCR was 9.0 and 9.5 g/EW_{2015} (108 and 114% of the recommended level for current GF gilts), respectively. ADG and FCR in gilts reached a plateau at 922 g/d and 1.81, respectively. ADG and FCR of the GF pigs on Farm A were better than ADG and FCR of the current and future GF pigs resulting in a higher SID lysine requirement than recommended for the current and future GF pigs during the starter phase.

On Farm B, the optimum dietary SID lysine level for ADG and FCR in boars during the starter phase was 9.1 and 9.8 g/EW_{2015} (105 and 113% of the recommended level for current GF boars), respectively. ADG and FCR in boars reached a plateau at 881 g/d and 1.70, respectively. In gilts on Farm B, the optimum SID lysine level for ADG and FCR was 8.7 and 8.9 g/EW_{2015} (105 and 107% of the recommended level for current GF gilts), respectively. ADG and FCR in gilts reached a plateau at 881 g/d and 1.85, respectively. ADG of the GF pigs on Farm B was better than ADG of the current and

future GF pigs whereas FCR of the GF pigs on Farm B corresponds to the FCR of the future GF pigs resulting in a higher SID lysine requirement than recommended for the current GF pigs.

Overall, the FCR of the pigs on both farms in the starter phase was slightly below (better) that of "future" pigs and in line with that, the estimated SID lysine requirements were somewhat above the values calculated for the future pigs (Table 15). The estimated requirements of the boars on farm A were well above those of Farm B and above the recommendation for future boars.

It can be concluded that the recommended SID levels in starter diets of 8.7 and 8.3 g/EW_{2015} for current boars and gilts, respectively, are too low on both farms. For maximizing ADG and minimizing FCR, the recommended SID level in starter diets for boars and gilts was 10.6 and 9.5 g/EW_{2015}, respectively, on Farm A and 9.8 and 8.9 g/EW_{2015}, respectively, on Farm B.

Grower phase
During the grower phase (50-80 kg), the optimum dietary SID lysine level for ADG and FCR was not significantly affected by sex of the pigs, hence one estimate for the two sexes was made. For boars on Farm A this was 7.1 and 7.4 g/EW_{2015} (93 and 97% of the recommended level for current GF boars), respectively. ADG and FCR in boars reached a plateau at 1126 g/d and 2.11, respectively. In gilts on Farm A, the optimum SID lysine level for ADG and FCR was also 7.1 and 7.4 g/EW_{2015} (100 and 104% of the recommended level for current GF gilts), respectively. ADG and FCR in gilts reached a plateau at 1060 g/d and 2.29, respectively. ADG of the GF pigs on Farm A was higher than ADG of the current and future GF pigs whereas the FCR was slightly better than the FCR of the current GF pigs. This resulted in a slightly lower SID lysine requirement for boars and a slightly higher SID lysine requirement for gilts than recommended for the current GF pigs.
On Farm B, the optimum dietary SID lysine level for ADG and FCR in boars during the grower phase was 7.5 and 7.0 g/EW_{2015} (99 and 92% of the recommended level for current GF boars), respectively. ADG and FCR in boars reached a plateau at 952 g/d and 2.26, respectively. In gilts on Farm B, the optimum SID lysine level for ADG and FCR is 7.1 and 7.0 g/EW_{2015} (100 and 99% of the recommended level for current GF gilts), respectively. ADG and FCR in gilts reached a plateau at 870 g/d and 2.45, respectively. ADG of the GF pigs on Farm B corresponds with the ADG of the current GF pigs, whereas FCR of the GF pigs on Farm B was slightly worse than in the current pigs. This results for both boars and gilts in a SID lysine requirement as recommended for current GF pigs.
It can be concluded that the recommended SID levels in grower diets of 7.6 and 7.1 g/EW_{2015} for current boars and gilts, respectively, are in accordance with the SID lysine requirement of boars and gilts during the grower phase on Farm A and Farm B.

Finisher phase
During the finisher phase (80-120 kg), the optimum dietary SID lysine level for ADG and FCR in boars on Farm A was 6.7 and 8.0 g/EW_{2015} (99 and 118% of the recommended level for current GF boars), respectively. ADG and FCR from day 63 till slaughter in boars reached a plateau at 1139 g/d and 2.41, respectively. In gilts on Farm A, the optimum SID lysine level for ADG and FCR was 5.6 and 6.5 g/EW_{2015} (92 and 107% of the recommended level for current GF gilts), respectively. ADG and FCR from day 63 till slaughter in gilts reached a plateau at 975 g/d and 2.79, respectively. ADG of the boars on Farm A was better than ADG of the current and future boars whereas FCR corresponds with the FCR of the future boars resulting in a higher SID lysine requirement than recommended for the current boars during the finisher phase. ADG of the gilts on Farm A corresponds to ADG of the future gilts, whereas the FCR corresponds with the FCR of the current gilts resulting in a SID lysine requirement as recommended for current gilts.
On Farm B, the optimum dietary SID lysine level for ADG and FCR in boars during the finisher phase was 6.0 and 5.7 g/EW_{2015} (88 and 84% of the recommended level for current GF boars), respectively. ADG and FCR from day 63 till slaughter in boars reached a plateau at 899 g/d and 2.82, respectively. In gilts on Farm B, the optimum SID lysine level for ADG and FCR was also 6.4 and 5.7 g/EW_{2015} (98% and 93% of the recommended level for current GF gilts). ADG and FCR from day 63 till slaughter in gilts reached a plateau at 803 g/d and 3.22, respectively. ADG of the boars on Farm B corresponds with the ADG of the current boars whereas FCR was worse than in the current pigs resulting in a lower SID lysine requirement than recommended for the current boars. ADG and FCR of the gilts on Farm B

are worse than of the current gilts resulting in a slightly lower SID lysine requirement than recommended for the current gilts.
It can be concluded that the recommended SID level in finisher diets of 6.8 g/EW_{2015} for current boars, respectively, might be too low for boars on Farm A (not for maximizing ADG but for minimizing FCR) but is too high for boars on Farm B. The recommended SID level in finisher diets of 6.1 g/EW_{2015} for current gilts might be too low for gilts on Farm A (not for maximizing ADG but for minimizing FCR) but is in accordance with the SID lysine requirement of gilts during the finisher phase on Farm B. For maximizing ADG and minimizing FCR, the recommended SID level in finisher diets for boars and gilts is 8.0 and 6.5 g/EW_{2015}, respectively, on Farm A and 6.0 and 6.0 g/EW_{2015}, respectively, on Farm B.

Overall, some interesting observations based on the expected and determined growth performance and estimated requirements can be made:

- In general, the approach adopted by Van der Peet-Schwering and Bikker (2018) to define the growth performance based on ADG and FCR and derive the SID lysine requirements using InraPorc was confirmed by the present study. The difference in estimated requirements compared to recommendations for current pigs was largely explained by the lower or higher FCR realised in each phase on the two farms. The higher estimate of lysine requirements in the starter phase was in line with the lower (better) realised FCR compared to current pigs on both farms. The lower estimate of lysine requirements in the finisher phase was in line with the higher (worse) realised FCR compared to current pigs, especially on Farm B. Overall, the estimated lysine requirements were within 5% of expected values when the influence of FCR was taken into account. This result may give confidence to the approach based on InraPorc, using FCR as major criterion. The deviation in ADG between the two farms and the current pigs exceeded the differences in FCR. This was caused by differences in daily feed intake between the two farms and relative to the assumptions for current pigs. However, as demonstrated by Van der Peet-Schwering and Bikker (2018) differences in ADG mediated by feed intake have little effect on the optimal dietary SID lysine/EW_{2015}.
- The growth curve or description of the growth performance through different phases (Van der Peet and Bikker, 2018) using InraPorc did not adequately reflect the observed growth performance of the pigs on the two farms. Overall, the realised performance, especially FCR, was well above that of current pigs in the starter phase, relatively close to current pigs in the grower phase and, mainly on Farm B, below that of current pigs in the finisher phase. These results suggest that the growth curve of the pigs in VIC Sterksel, used to define the current pigs, deviates somewhat from the growth curve of the pigs on the two farms in the present study. For adequate application of lysine recommendations based on InraPorc, it would be recommended to (re)define the pigs on these two farms in InraPorc and to determine the growth and feed intake pattern on a representative group of farms. In Appendix 4, the boars and gilts on Farm A and Farm B are characterized with InraPorc and the SID lysine requirement estimated with broken-line analysis and based on InraPorc are presented.
- From the present study, it cannot be concluded that the recommendations for current pigs are inadequate. This depends on the mean performance level of present pig farms. The results, however, demonstrate that the pigs on the two farms in this study can already realise the performance level of future pigs, at least in the starter phase. It emphasises that for adequate application of the lysine recommendations of Van der Peet-Schwering and Bikker (2018) on individual farm level, it is necessary to obtain an adequate description of the growth performance of the pigs on the target farm in the starter, grower and finisher phase. This information can be used for a farm specific application of the general recommendations.
- InraPorc can be a good tool for nutritionist to predict the SID lysine requirement for growing and finishing boars and gilt on farms in practice. Information on both overall performance (ADG, ADFI and FCR) and performance during the starter, grower and finisher phase, however, is necessary for an accurate prediction of SID lysine requirement during all phases.

5 Conclusions

Based on the results of this study, the following conclusions were drawn:

- In general, the approach adopted by Van der Peet-Schwering and Bikker (2018) to define the growth performance based on ADG and FCR and derive the SID lysine requirements using InraPorc was confirmed by the present study. Adequate farm specific typing of growth performance of the pigs is crucial. The growth curve on a farm may deviate from that used for the current GF pigs in Van der Peet-Schwering and Bikker (2018).
- The recommended SID levels in starter diets of 8.7 and 8.3 g/EW_{2015} for current boars and gilts, respectively, were too low for the farms in this study. For maximizing ADG and minimizing FCR, the recommended SID levels in starter diets for boars and gilts were 10.6 and 9.5 g/EW_{2015}, respectively, on Farm A and 9.8 and 9.0 g/EW_{2015}, respectively, on Farm B.
- The recommended SID levels in grower diets of 7.6 and 7.1 g/EW_{2015} for current boars and gilts, respectively, are in accordance with the SID lysine requirement of boars and gilts during the grower phase on Farm A and Farm B.
- The recommended SID level in finisher diets of 6.8 g/EW_{2015} for current boars might be too low for boars on Farm A (for minimizing FCR, not for maximizing ADG) but too high for boars on Farm B. The recommended SID level in finisher diets of 6.1 g/EW_{2015} for current gilts might be too low for gilts on Farm A (for minimizing FCR, not for maximizing ADG) but is in accordance with the SID lysine requirement of gilts during the finisher phase on Farm B. For maximizing ADG and minimizing FCR, the recommended SID levels in finisher diets for boars and gilts were 8.0 and 6.5 g/EW_{2015}, respectively, on Farm A and 6.0 and 6.0 g/EW_{2015}, respectively, on Farm B.
- The difference in estimated requirements on Farm A and Farm B compared to recommendations for current pigs was largely explained by FCR realised in each phase on the two farms, relative to the FCR of current pigs.

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Appendix 1 Composition of the diets (%)

		Starter diet 125%	Starter diet 80%	Grower diet 125%	Grower diet 80%	Finisher diet 125%	Finisher diet 80%
Barley		20.0	20.0	23.0	23.0	23.0	23.0
Wheat		22.0	25.0	18.0	20.0	18.0	18.0
Maize		19.4	20.0	24.9	25.0	26.1	26.4
Soybean meal		20.0	16.4	12.2	10.0	5.0	4.0
Sunflower seed meal		7	7.0	10.0	9.3	11.0	10.2
Rapeseed meal		5.5	6.0	6.1	7.0	9.5	9.5
Wheat middlings		-	-	-	-	3.4	5.0
Palm oil		0.20	0.35	-	-	-	-
Molasses		1.5	2.0	2.0	3.0	1.5	2.3
Monocalcium phosphate		0.21	0.36	-	-	-	-
Salt		0.54	0.55	0.55	0.53	0.35	0.39
Limestone		1.1	1.0	1.1	1.1	1.0	1.0
Premix		0.23	0.23	0.20	0.20	0.20	0.20
Phytase		0.01	0.01	0.02	0.02	0.01	0.01
Syn lysine L liquid 50%		0.75	-	0.75	-	0.74	-
Syn methionine DL98		0.17	-	0.12	-	0.07	-
Syn threonine L98		0.22	-	0.20	-	0.18	-
Syn tryptophan 98		0.04	-	0.03	-	0.03	-
Syn valine 97		0.04	-	0.02	-	0.00	-
Acid		1.1	1.1	0.9	0.9	-	-
Calculated nutrients							
EW_{2015}		1.10	1.10	1.10	1.10	1.10	1.10
Crude ash	g/kg	52	52	50	49	47	48
Calcium	g/kg	6.2	6.2	6.1	6.1	5.9	5.9
Phosphorus	g/kg	4.7	4.9	4.3	4.2	4.7	4.6
Digestible P	g/kg	2.9	2.9	2.5	2.5	2.4	2.4
Na	g/kg	2.4	2.4	2.4	2.4	1.6	1.8
Crude protein	g/kg	205	189	187	174	174	163
Crude fibre	g/kg	48	47	51	51	57	57
Starch	g/kg	388	405	410	422	423	428
Crude fat	g/kg	30	32	29	29	31	31
dEB	meq	228	219	206	209	184	190
IK	g/kg	68	69	75	76	89	91
FK	g/kg	116	112	107	105	107	107
SID lysine[1]	g/kg	12.0	7.3	10.5	6.24	9.38	5.36
SID met+cys/SID lysine		0.63	0.77	0.64	0.87	0.65	0.99
SID threonine/SID lysine		0.69	0.78	0.70	0.82	0.71	0.88
SID tryptophan/SID lysine		0.21	0.27	0.21	0.29	0.21	0.31
SID isoleucine/SID lysine		0.58	0.89	0.58	0.92	0.57	0.96
SID leucine/SID lysine		1.06	1.63	1.08	1.74	1.10	1.86
SID valine/SID lysine		0.70	1.03	0.70	1.10	0.70	1.19

SID histidine/SID lysine		0.36	0.56	0.36	0.59	0.37	0.63
Vitamin D3 (3a671)	IE	2000	2000	1000	1000	1000	1000
Vitamin A (3a672a)	IE	6500	6500	5000	5000	5000	5000
Vitamin E (3a700)	IE	47	47	40	40	40	40
Total phytase added[1]	FTU	550	550	700	700	500	500
Lysine	g/kg	13.3	8.7	11.7	7.4	10.6	6.6
Methionine	g/kg	4.9	3.1	4.2	3	3.7	3
Threonine	g/kg	9.5	6.8	8.5	6.3	7.8	5.9
Tryptophan	g/kg	2.9	2.4	2.6	2.2	2.4	2.1
Isoleucine	g/kg	8.0	7.5	7.0	6.7	6.3	6.1
Leucine	g/kg	14.7	13.8	13.1	12.7	12.1	11.7
Valine	g/kg	9.9	8.9	8.7	8.2	8.0	7.7
Histidine	g/kg	4.9	4.6	4.4	4.2	4.0	3.9
Cysteine	g/kg	3.6	3.5	3.4	3.4	3.4	3.4
Phenylalanine	g/kg	9.6	9.0	8.5	8.2	7.8	7.5
Tyrosine	g/kg	6.2	5.7	5.4	5.1	4.8	4.7
Arginine	g/kg	13.1	12.1	11.6	11.0	10.7	10.2
Glycine	g/kg	8.8	8.4	8.2	7.9	7.8	7.6
Alanine	g/kg	8.7	8.2	8.0	7.7	7.5	7.3
Asparagine	g/kg	17.8	16.2	15.0	14.1	12.9	12.3
Glutamic acid	g/kg	40.0	38.3	36.3	35.6	34.0	33.3
Proline	g/kg	12.8	12.5	11.8	11.7	11.4	11.3
Serine	g/kg	9.3	8.7	8.1	7.8	7.4	7.2

[1] in the diets 0.13 g of SID lysine is attributed to phytase

Appendix 2 Analysed nutrients with NIR (g/kg)

	Starter diet 125%	Starter diet 80%	Grower diet 125%	Grower diet 80%	Finisher diet 125%	Finisher diet 80%
Farm A						
No of feed deliveries	6	6	6	6	4	5
Crude protein	202	186	184	173	173	165
Moisture	124	121	122	120	113	114
Crude ash	55	48	52	45	51	45
Crude fibre	48	49	53	52	57	57
Crude fat	30	32	29	30	35	36
Starch	376	400	401	422	418	434
Sugar	53	47	48	47	47	45
Farm B						
No of feed deliveries	4	4	5	5	11	11
Crude protein	202	187	184	173	175	166
Moisture	124	122	121	121	117	117
Crude ash	54	46	52	45	50	43
Crude fibre	47	47	52	51	56	56
Crude fat	30	32	29	30	34	35
Starch	378	404	407	425	416	433
Sugar	55	51	47	46	47	44

Appendix 3 Analysed nutrient composition (g/kg)

	Starter diet 125%	Starter diet 80%	Grower diet 125%	Grower diet 80%	Finisher diet 125%	Finisher diet 80%
Farm A						
Dry matter	876	879	878	881	885	885
Crude protein	210	189	189	173	176	164
Crude ash	51	50	46	46	44	44
Crude fat	26	28	25	26	28	29
Starch	356	377	391	402	399	403
Sugar	58	58	55	58	51	54
Crude fibre	49	51	55	55	59	57
ASP	17.32	15.52	14.76	13.65	12.43	11.71
THR	9.24	6.72	8.32	6.30	7.61	5.79
SER	8.08	7.16	7.32	6.65	6.22	6.02
GLU	38.64	36.52	35.80	34.03	32.74	31.75
GLY	8.84	8.33	8.28	7.83	7.83	7.56
ALA	8.79	8.25	8.10	7.72	7.55	7.27
VAL	9.97	8.99	8.91	8.37	8.15	7.85
ILE	8.20	7.63	7.35	6.89	6.53	6.17
LEU	14.43	13.48	13.22	12.43	11.85	11.36
TYR	6.96	6.53	6.28	5.87	5.39	5.35
PHE	9.36	8.65	8.55	8.01	7.53	7.24
HIS	5.69	5.30	5.08	4.87	4.83	4.56
LYS	13.54	9.02	11.89	7.71	10.78	6.84
ARG	13.24	12.02	11.90	10.95	10.73	10.15
PRO	13.23	12.30	12.21	11.77	11.62	11.54
TRYP	2.89	2.45	2.66	2.28	2.44	2.20
CYS.ox	3.54	3.46	3.37	3.36	3.28	3.33
MET.ox	4.71	3.04	4.08	2.93	3.67	2.94
Free AA:						
ASP	0.33	0.33	0.34	0.36	0.35	0.36
THR	2.33	0.34	2.27	0.42	2.09	0.40
SER	0.07	0.05	0.07	0.07	0.06	0.06
GLU	0.50	0.49	0.48	0.45	0.45	0.43
GLY	0.05	0.05	0.05	0.05	0.05	0.05
ALA	0.17	0.16	0.18	0.18	0.16	0.18
VAL	0.47	0.08	0.28	0.07	0.07	0.07
ILE	0.06	0.06	0.06	0.06	0.06	0.06
LEU	0.05	0.04	0.04	0.04	0.04	0.04
TYR	0.00	0.00	0.00	0.00	0.00	0.00
PHE	0.00	0.00	0.00	0.00	0.00	0.00
HIS	0.22	0.14	0.20	0.15	0.17	0.13

LYS	3.69	0.19	3.74	0.18	3.65	0.14
ARG	0.33	0.30	0.26	0.22	0.20	0.18
PRO	0.15	0.16	0.18	0.14	0.20	0.17
MET	1.42	0.00	1.00	0.00	0.65	0.00
Farm B						
Dry matter	878	881	878	880	888	887
Crude protein	209	191	191	176	173	165
Crude ash	50	50	47	47	44	44
Crude fat	27	28	26	26	28	30
Starch	361	375	378	401	399	396
Sugar	57	57	55	58	52	54
Crude fibre	49	48	55	54	62	60
ASP	16.94	15.21	14.54	13.99	12.75	12.07
THR	8.89	6.65	8.25	6.53	7.81	6.05
SER	7.75	7.42	6.91	6.98	6.57	6.44
GLU	37.99	36.54	34.69	34.76	33.22	32.48
GLY	8.65	8.22	8.09	8.05	7.95	7.71
ALA	8.68	8.12	7.97	7.89	7.68	7.48
VAL	9.82	8.90	8.77	8.44	8.30	8.06
ILE	8.12	7.49	7.12	7.00	6.55	6.29
LEU	14.33	13.27	12.83	12.63	11.98	11.59
TYR	6.92	6.48	6.03	5.97	5.60	5.35
PHE	9.35	8.57	8.33	8.07	7.75	7.42
HIS	5.70	5.36	5.07	4.80	4.78	4.63
LYS	13.18	8.78	11.60	7.77	10.74	6.92
ARG	12.86	12.01	11.40	11.28	10.79	10.25
PRO	13.11	12.49	11.77	12.24	12.08	11.87
TRYP	3.00	2.56	2.67	2.31	2.49	2.21
CYS.ox	3.51	3.65	3.41	3.32	3.36	3.36
MET.ox	4.73	3.05	4.03	2.91	3.68	2.99
Free AA:						
ASP	0.33	0.32	0.32	0.39	0.34	0.36
THR	2.36	0.38	2.25	0.45	2.12	0.39
SER	0.07	0.06	0.07	0.08	0.07	0.07
GLU	0.53	0.48	0.47	0.47	0.43	0.44
GLY	0.06	0.05	0.05	0.05	0.05	0.05
ALA	0.17	0.17	0.18	0.18	0.16	0.17
VAL	0.48	0.08	0.26	0.08	0.07	0.07
ILE	0.07	0.06	0.06	0.07	0.06	0.06
LEU	0.05	0.05	0.04	0.05	0.04	0.04
TYR	0.00	0.00	0.00	0.00	0.00	0.00
PHE	0.00	0.00	0.00	0.00	0.00	0.00
HIS	0.17	0.23	0.16	0.14	0.20	0.19
LYS	3.79	0.23	3.70	0.20	3.63	0.12
ARG	0.35	0.28	0.26	0.24	0.23	0.19
PRO	0.17	0.17	0.14	0.18	0.16	0.20
MET	1.45	0.00	0.96	0.00	0.62	0.00

Appendix 4 SID lysine requirements on Farm A and B predicted with InraPorc

In Table 1, the characterization of the boars and gilts on Farm A and Farm B and the performance and SID lysine requirements based on InraPorc (Van Milgen et al., 2008) are presented. Characterization of the boars and gilts on Farm A, based on overall performance and on performance during the starter, grower and finisher phase, was successful. On Farm B, it was more difficult to characterize the pigs properly. Because all the GF pigs were weighed at 1st delivery (the remaining pigs at second or third delivery were not weighed when they were delivered to the slaughterhouse), we decided to characterize the pigs on Farm B based on the performance from start till 1st delivery and based on the performance during the starter, grower and finisher (till 1st delivery) phase. In this way, the characterization of the boars on Farm B was quite successful. The characterization of the gilts on Farm B, however, was less successful, as the FRC during the starter, grower and finisher phase as predicted with InraPorc was somewhat higher than measured in this trial.
For all three phases (25-50 kg, 50-80 kg and 80-120 kg), the SID lysine requirement on Farm A and Farm B estimated with broken-line analysis (this trial) and based on InraPorc are presented. The daily SID lysine required for maintenance and protein deposition and the daily excess or deficiency of SID lysine during the growing-finishing period for the boars and gilts on Farm A and Farm B is presented in Figures 1-8.

Table 1 *Characterization of the boars and gilts on Farm A and Farm B and performance and SID lysine requirements based on InraPorc (Van Milgen et al., 2008)*

	Farm A		Farm B	
	Boar	Gilt	Boar	Gilt
Model input:				
Initial age (d)	70	70	70	70
BW[1] at start (kg)	23.7	23.8	25.2	25.9
Live BW at slaughter/1st delivery[2] (kg)	124.6	121.6	115.8	110.0
FI 50 kg[1]	1.93	2.05	1.80	1.83
FI 100 kg[1]	2.68	2.72	2.53	2.62
PD[1] mean (g/d)	185	159	152	138
Precocity	0.01500	0.01494	0.01540	0.01600
BWPDmax[1] (kg)	70	70	70	70
25-120[2] kg:				
ADG[1] (g/d)	1073	978	914	851
ADFI[1] (kg/d)	2.21	2.27	2.06	2.11
FCR[1]	2.06	2.32	2.26	2.48
Mean PD (g/d)	181	159	152	136
25-50 kg:				
ADG (g/d)	965	897	867	843
ADFI (kg/d)	1.62	1.67	1.53	1.62
FCR	1.67	1.86	1.76	1.92
Mean PD (g/d)	162	146	146	137
SID lysine (g/ EW_{2015}) trial	10.6	9.5	9.8	8.9
SID lysine (g/EW_{2015}) InraPorc	10.1	9.5	9.8	8.9
50-80 kg:				
ADG (g/d)	1122	1070	983	907
ADFI (kg/d)	2.35	2.45	2.15	2.14
FCR	2.09	2.29	2.19	2.36
Mean PD (g/d)	189	174	164	148
SID lysine (g/ EW_{2015}) trial	7.4	7.4	7.5	7.1
SID lysine (g/EW_{2015}) InraPorc	8.2	7.4	7.9	7.1
80-120[2] kg:				
ADG (g/d)	1148	987	909	817
ADFI (kg/d)	2.74	2.72	2.52	2.56
FCR	2.39	2.76	2.77	3.13
Mean PD (g/d)	195	160	148	125
SID lysine (g/ EW_{2015}) trial	8.0	6.5	6.5	6.5
SID lysine (g/EW_{2015}) InraPorc	7.6	6.5	6.5	6.5

[1] BW = body weight; FI 50 kg = feed intake at a BW of 50 kg; FI 100 kg = feed intake at a BW of 100 kg; PD = protein deposition; BWPDmax = BW at which the marginal PD becomes zero; ADG = average daily gain; ADFI = average daily feed intake; FCR = feed conversion ratio; PD = protein deposition.

[2] Live BW at slaughter: on Farm A (all pigs were weighed the day before slaughter); BW at 1st delivery on Farm B: on Farm B, all pigs were weighed at 1st delivery; the remaining pigs after 1st delivery were not weighed when they were delivered to the slaughterhouse. Therefore BW was calculated from slaughter weight. Because, in general, calculated BW is higher than live BW, the live BW at 1st delivery was used in the calculations with InraPorc.

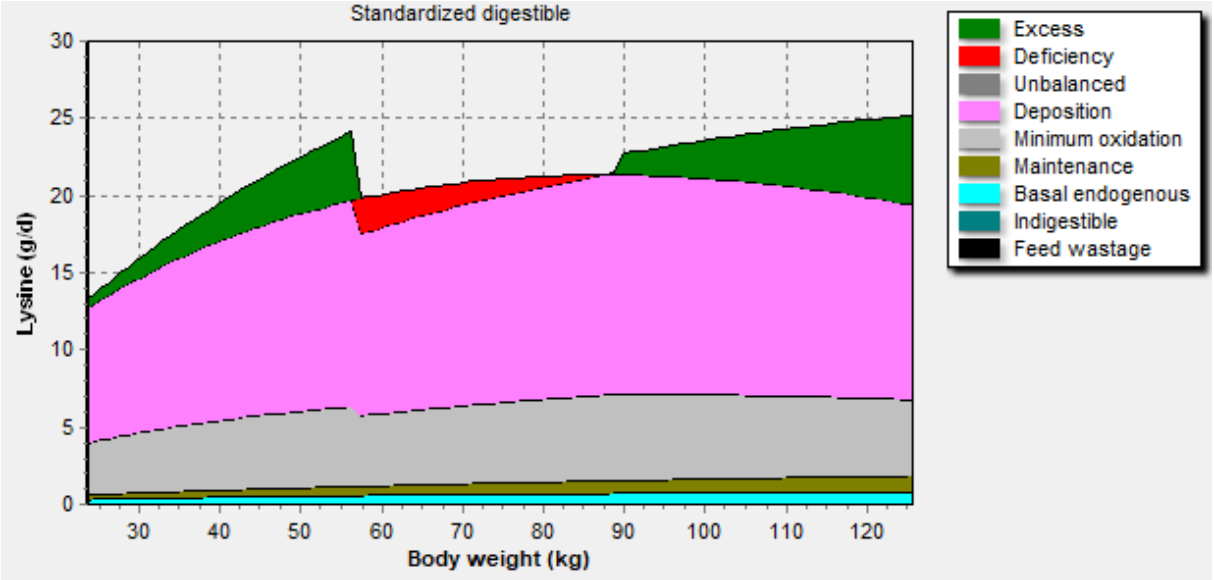

Figure 1 *Daily SID lysine requirement for boars on Fam A as estimated with broken-line analysis (starter diet: 10.6 g SID lysine/EW_{2015}; grower diet 7.4 g SID lysine per EW_{2015}; finisher diet 8.0 g SID lysine per EW_{2015}) compared with the requirement calculated with InraPorc*

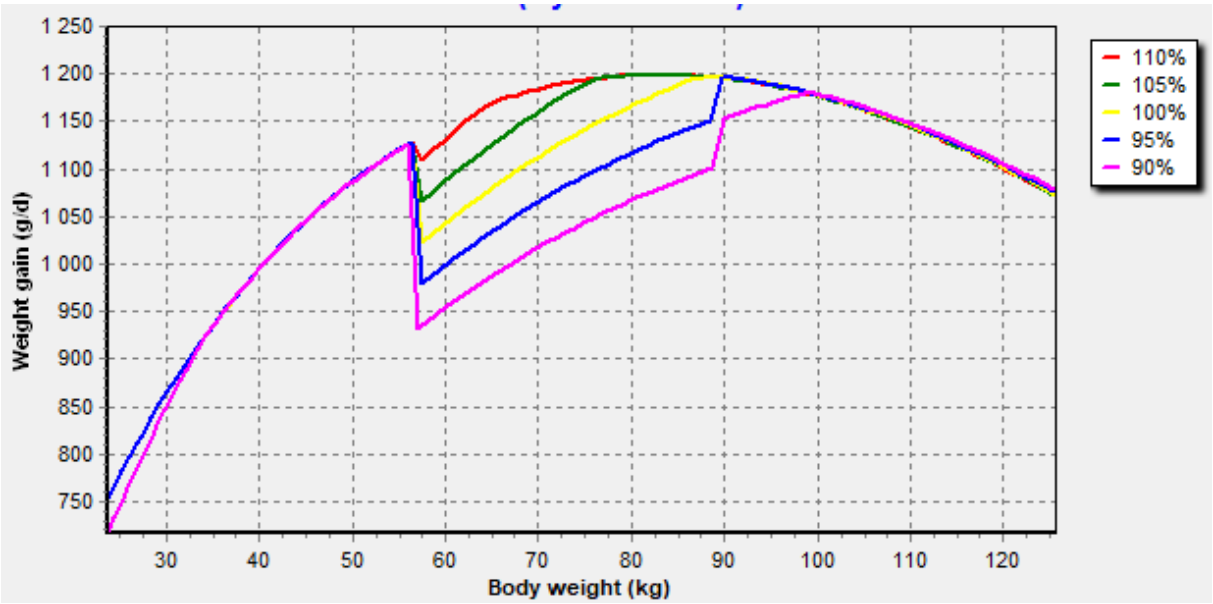

Figure 2 *Effect of 90, 95, 100, 105 and 110% supply of SID lysine as estimated with the broken-line model for boars on Farm A on daily gain predicted with InraPorc*

The results in Figure 1 and 2 show that during the starter and finisher phase, the required SID lysine level as estimated with broken-line analysis is 5% higher than predicted by InraPorc, as a 95% supply of SID lysine results in a similar ADG as a supply of 100%. Therefore, the recommended SID lysine level in starter and finisher diets for boars on Farm A might be 10.1 and 7.6 g/EW_{2015}, respectively, as predicted with InraPorc, instead of 10.6 and 8.0 g/EW_{2015}, respectively, as estimated with broken-line analysis (see Table 1). The recommended SID lysine level in the grower diet, however, might be 10% too low, as a 110% supply of SID lysine results in a higher ADG than a 100% supply. Therefore, the recommended SID lysine level in grower diet for boars on Farm A might be 8.2 g/EW_{2015} as predicted with InraPorc, instead of 7.4 g/EW_{2015}, as estimated with broken-line analysis.

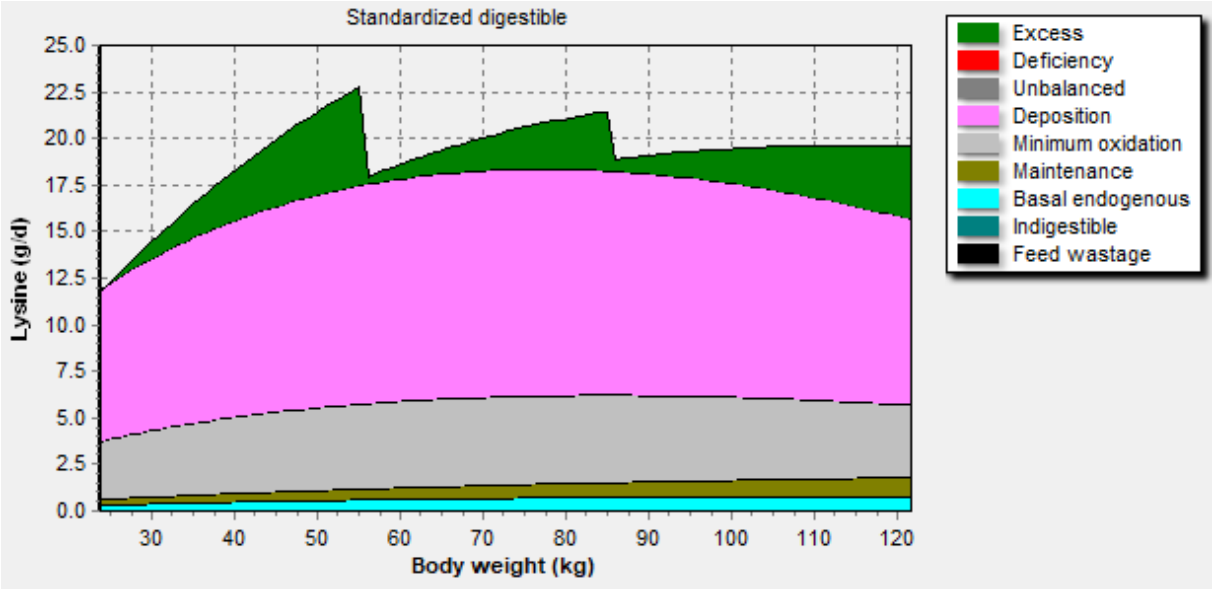

Figure 3 *Daily SID lysine requirement for gilts on Fam A as estimated with broken-line analysis (starter diet: 9.5 g SID lysine/EW_{2015}; grower diet 7.4 g SID lysine per EW_{2015}; finisher diet 6.5 g SID lysine per EW_{2015}) compared with the requirement calculated with InraPorc*

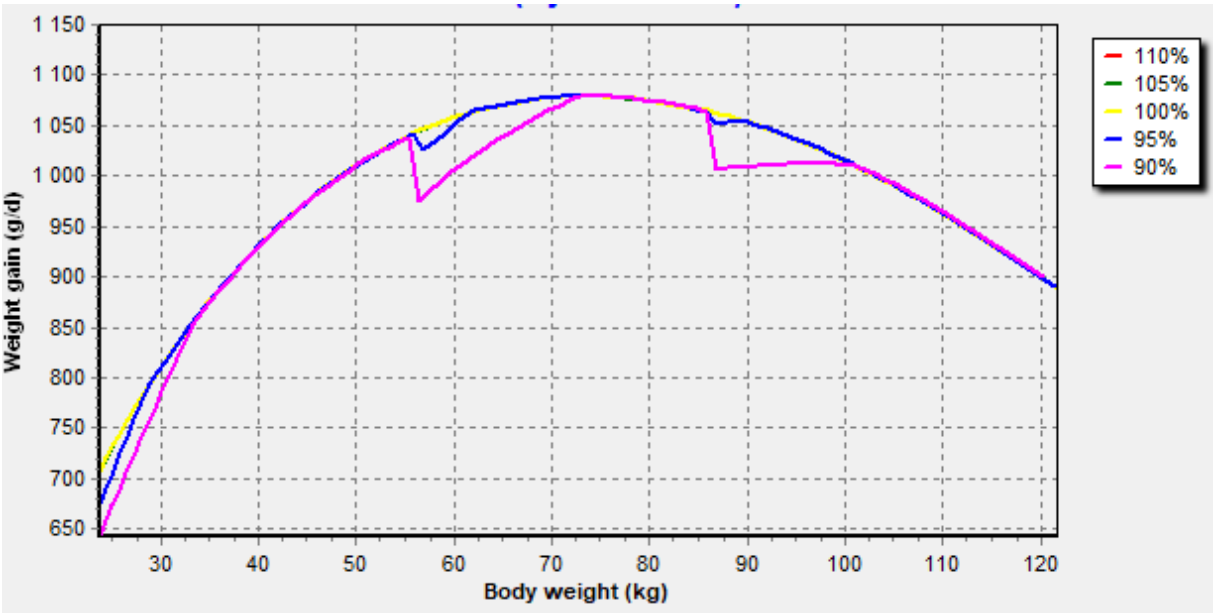

Figure 4 *Effect of 90, 95, 100, 105 and 110% supply of SID lysine as estimated with the broken-line model for gilts on Farm A on daily gain predicted with InraPorc*

The results in Figure 3 and 4 show that the recommended SID levels for gilts on Farm A during the starter, grower and finisher phase as estimated with broken-line analysis and as estimated with InraPorc are similar as a supply of 100% results in the highest ADG.

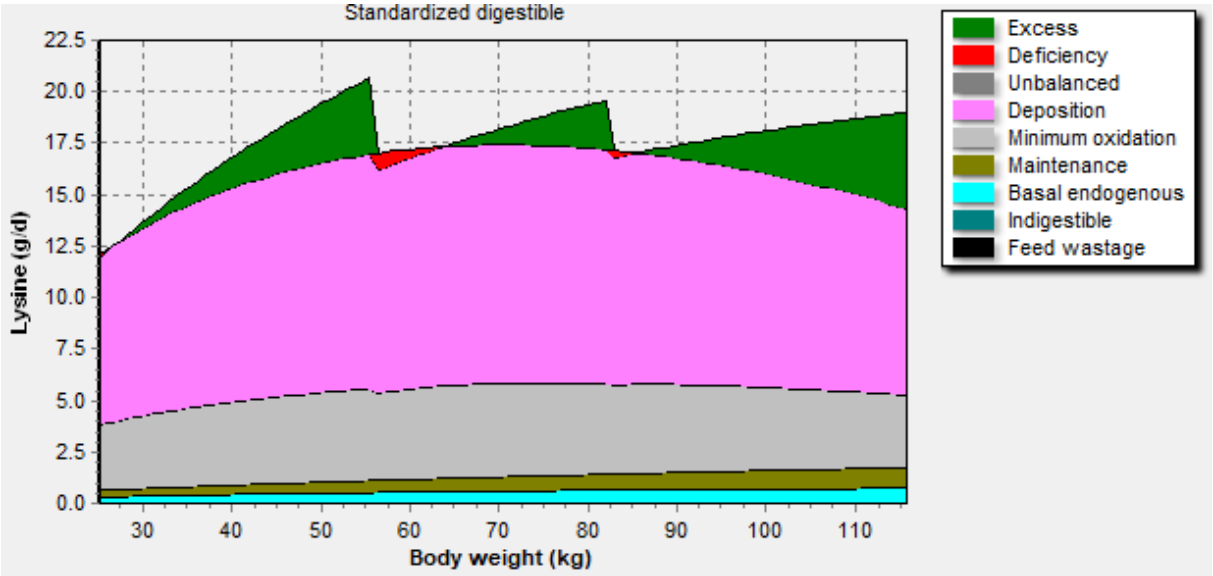

Figure 5 *Daily SID lysine requirement for boars on Fam B as estimated with broken-line analysis (starter diet: 9.8 g SID lysine/EW_{2015}; grower diet 7.5 g SID lysine per EW_{2015}; finisher diet 6.5 g SID lysine per EW_{2015}) compared with the requirement calculated with InraPorc*

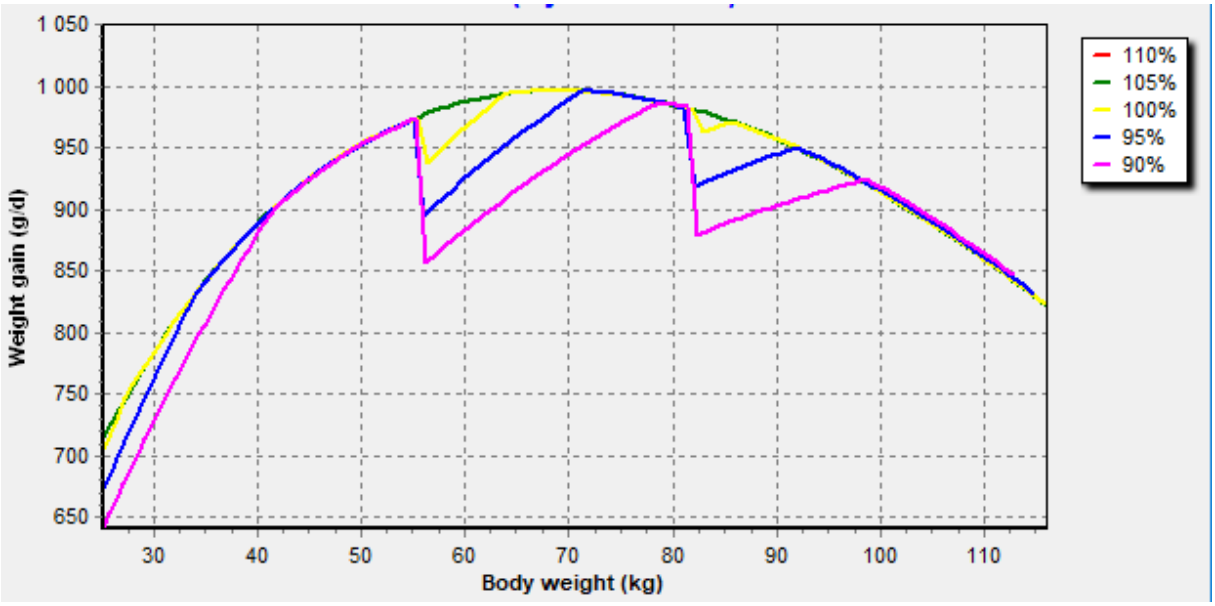

Figure 6 *Effect of 90, 95, 100, 105 and 110% supply of SID lysine as estimated with the broken-line model for boars on Farm B on daily gain predicted with InraPorc*

The results in Figure 5 and 6 show that the recommended SID levels for boars on Farm B during the starter and finisher phase as estimated with broken-line analysis and as estimated with InraPorc are similar as a supply of 100% results in the highest ADG. The recommended SID lysine level in the grower diet, however, might be 5% too low, as a 105% supply of SID lysine results in a higher ADG than a 100% supply. Therefore, the recommended SID lysine level in grower diet for boars on Farm B might be 7.9 g/EW_{2015}, as predicted with InraPorc, instead of 7.5 g/EW_{2015}, as estimated with broken-line analysis.

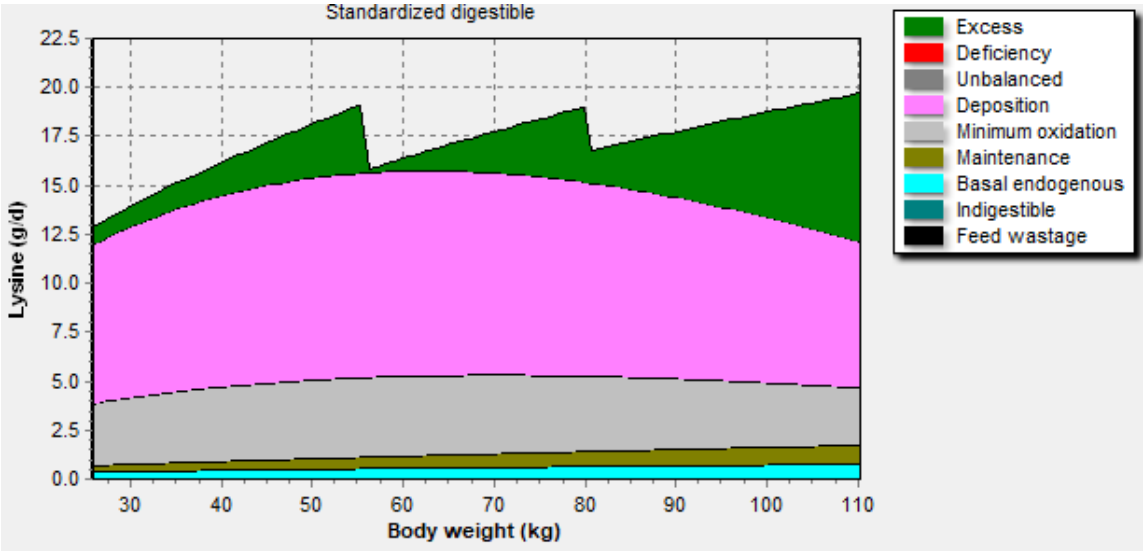

Figure 7 *Daily SID lysine requirement for gilts on Fam B as estimated with broken-line analysis (starter diet: 8.9 g SID lysine/EW$_{2015}$; grower diet 7.1 g SID lysine per EW$_{2015}$; finisher diet 6.5 g SID lysine per EW$_{2015}$) compared with the requirement calculated with InraPorc*

Figure 8 *Effect of 90, 95, 100, 105 and 110% supply of SID lysine as estimated with the broken-line model for gilts on Farm B on daily gain predicted with InraPorc*

The results in Figure 7 and 8 show that during the starter and finisher phase, the required SID lysine level as estimated with broken-line analysis is 5% higher than predicted by InraPorc, as a 95% supply of SID lysine results in a similar ADG as a supply of 100%. However, the FCR during the starter and finisher phase for gilts on Farm B as predicted with InraPorc is somewhat higher (worse) than estimated with the broken-line analysis. As a higher FCR results in a lower SID lysine requirement, the SID lysine recommendations as estimated with the broken-line analysis seems reliable. The recommended SID levels for gilts on Farm B during the grower phase as estimated with broken-line analysis and as estimated with InraPorc are similar as a supply of 100% results in the highest ADG.

In conclusion: InraPorc can be a good tool for nutritionist to predict the SID lysine requirement for growing and finishing boars and gilt on farms in practice. Information on both overall performance (ADG, ADFI and FCR) and performance during the starter, grower and finisher phase, however, is necessary for an accurate prediction of SID lysine requirement during all phases.

To explore the potential of nature to improve the quality of life

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Wageningen Livestock Research creates science based solutions for a sustainable and profitable livestock sector. Together with our clients, we integrate scientific knowledge and practical experience to develop livestock concepts for future generations.

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