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ERITYS-project report

**Sini Perttilä, Heidi Högel, Jenni Vattulainen, Jouni Nousiainen,  
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## Abstract

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Marja-Liisa Sevón-Aimonen<sup>1</sup>, Kaisa Kuoppala<sup>1</sup>, Marketta Rinne<sup>1</sup>, Juha Grönroos<sup>2</sup> and  
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The official excretion calculations provide the amounts of dry matter, organic matter and nutrients excreted in faeces and urine by different livestock species and categories. Natural Resources Institute Finland (Luke) is responsible for the national excretion calculations in Finland. The results of the calculations are used e.g. in estimating emissions during manure management and use into air (greenhouse gases, ammonia) and waters [phosphorus (P), nitrogen (N)], in estimating the quantity and composition of manure produced in Finland and in setting the targets to improve manure utilisation (nutrient balances, circular economy). The calculations and their results can also be used in manure-related life cycle assessments (LCA) and in practical steering of livestock production e.g. during environmental permitting involving manure storage capacity and sufficient field area for spreading manure.

The amounts of nutrients excreted are calculated as the difference between nutrient intake in feeds and nutrients retained in the animals and their products. The components included in the calculations are dry matter, organic matter, N and P. The excretion calculations of pigs are conducted separately for different animal categories based on their weight and type of production (breeding, piglet production, meat production).

The critical factor of nutrient excretion calculations is to accurately estimate the amounts and nutrient concentrations of feeds consumed by the animals. For the calculations, this was obtained by estimating the energy requirement of the animals according to the published Finnish feeding recommendations (taking into account production phase, amounts of piglet production and growth rate). The diet composition was based on field data and expert assessments. There is much less uncertainty in estimating the intake of nutrients than in the amounts of nutrients retained in the animals themselves. The detailed steps in the calculations are described in the report.

Based on the results with year 2023 as an example, the annual N and P excretions of one fattening pig place were 13.5 and 2.55 kg, respectively. For a sow place (sow and piglets before weaning), the annual N and P excretions were 21.1 and 5.54 kg, respectively.

**Keywords:** excretion, pig, nitrogen, phosphorus, urine, faeces, swine

## Tiivistelmä

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Virallinen erityyslaskenta tuottaa vuosittain eri kotieläinten sonnassa ja virtsassa eritetyn kuiva-  
aineen, orgaanisen aineen ja ravintoaineiden määrän. Luonnonvarakeskus (Luke) on vastuussa  
Suomen kansallisesta erityyslaskennasta. Laskennan tuloksia käytetään esimerkiksi arvioitaessa  
päästöjä lannan käsittelyssä ilmakehään (kasvihuonekaasut, ammoniakki) ja vesiin [fosfori (P),  
typpi (N)], arvioitaessa Suomessa tuotetun lannan määrää ja koostumusta sekä määriteltäessä  
sen hyödyntämisen tavoitteita (ravinnetaseet, kiertotalous). Laskentaa ja sen tuloksia voidaan  
hyödyntää myös lantaan liittyvissä elinkaariarvioinneissa (LCA) ja kotieläintuotantoon liittyvissä  
ohjauskäytänteissä kuten esimerkiksi lantavarastojen ympäristöluissa ja lannan levityspinta-  
aloissa.

Eritettyjen ravinteiden määrä lasketaan rehuista saatujen ravintoaineiden ja eläimeen ja niistä  
saataviin tuotteisiin pidättyneiden ravintoaineiden erotuksena, eli

”ravintoaineiden saanti – ravintoaineiden pidättyminen = ravinteiden erittyminen”.

Laskennassa mukana olevat komponentit ovat N, P, kuiva-aine ja orgaaninen aine. Sikojen  
erityyslaskenta suoritetaan erikseen eri eläinryhmille painon ja tuotantotyyppin (jalostus, porsas-  
tuotanto, lihantuotanto) mukaan.

Eläimen syömän rehun koostumuksen arviointi on yksi erityyslaskennan kriittisistä tekijöistä.  
Tässä laskennassa rehun koostumus arvioitiin laskemalla eläinten energiantarve suomalaisiin  
ruokintasuositukseen perustuen ottaen huomioon tuotantovaihe, porsastuotanto ja kasvu-  
vauhti. Dieetin koostumus perustui sidosryhmiltä kerättyyn tietoon sekä asiantuntija-arvioihin.  
Ravintoaineiden saannin arvioinnissa on paljon vähemmän epävarmuustekijöitä kuin eläi-  
meen pidättyvien ravinteiden arvioinnissa. Laskennan yksityiskohdat on kuvattu tässä rapor-  
tissa.

Vuonna 2023 yhden lihasikapaikan vuotuinen typen ja fosforin erityys oli 13,5 ja 2,55 kg. Emak-  
kopaikan (emakko ja porsaas ennen vieroitusta) vastaavat typen ja fosforin erityykset olivat 21,1  
ja 5,54 kg.

**Avainsanat:** erityys, sika, typpi, fosfori, virtsa, sonta

## Abbreviations

Abbreviation	Definition
<b>CP</b>	Crude protein, g/kg
<b>DM</b>	Dry matter, g/kg
<b>DMD</b>	Dry matter digestibility, g/g
<b>DMI</b>	Dry matter intake, kg/day
<b>EBW</b>	Empty body weight, kg
<b>EBW<sub>DM</sub></b>	Dry matter content of EBW, kg
<b>EBW<sub>K</sub></b>	Potassium content of EBW, kg
<b>EBW<sub>N</sub></b>	Nitrogen content of EBW, kg
<b>EBW<sub>P</sub></b>	Phosphorus content of EBW, kg
<b>EBW<sub>protein</sub></b>	Protein content of EBW, kg
<b>EBW<sub>water</sub></b>	Water content of EBW, kg
<b>FCR</b>	Feed conversion rate, MJ NE/kg growth
<b>FI</b>	Feed intake, kg/day
<b>LW</b>	Live weight, kg
<b>NE<sub>a</sub></b>	Net energy, adult pig, expressed in MJ/kg
<b>NE<sub>g</sub></b>	Net energy, growing pig, expressed in MJ/kg
<b>NE<sub>diet</sub></b>	Concentration of net energy in diet, MJ/kg DM
<b>NE<sub>req</sub></b>	Total NE requirement, MJ/day
<b>N</b>	Nitrogen
<b>N<sub>diet</sub></b>	Nitrogen content of diet, g/kg
<b>OM</b>	Organic matter, g/kg
<b>OMD</b>	Organic matter digestibility, g/g
<b>OM<sub>diet</sub></b>	Organic matter content of diet, g/kg
<b>OMI</b>	Organic matter intake, kg/day
<b>P</b>	Phosphorus

## Definitions

<b>Pig category</b>	<b>Definition</b>
<b>Gilt, insemination</b>	Insemination phase of a female pig before first farrowing
<b>Gilt, gestation</b>	Gestation phase of a female pig before first farrowing
<b>Gilt, lactation</b>	Lactation period of a female pig after first farrowing
<b>Sow, insemination</b>	Insemination phase of a female pig after farrowing
<b>Sow, gestation</b>	Gestation phase of a female pig after farrowing
<b>Sow, lactation</b>	Lactation period of a female pig after farrowing
<b>Boar, growing</b>	Male pig after weaning before reaching mature weight
<b>Boar, maintenance</b>	Male pig after reaching adult weight
<b>Fattening pig, growing</b>	Growing phase of a pig raised for fattening
<b>Fattening pig, finishing</b>	Finishing phase of a pig raised for fattening
<b>Piglet, nursing</b>	Piglet before weaning
<b>Piglet, weaned</b>	Piglet after weaning phase

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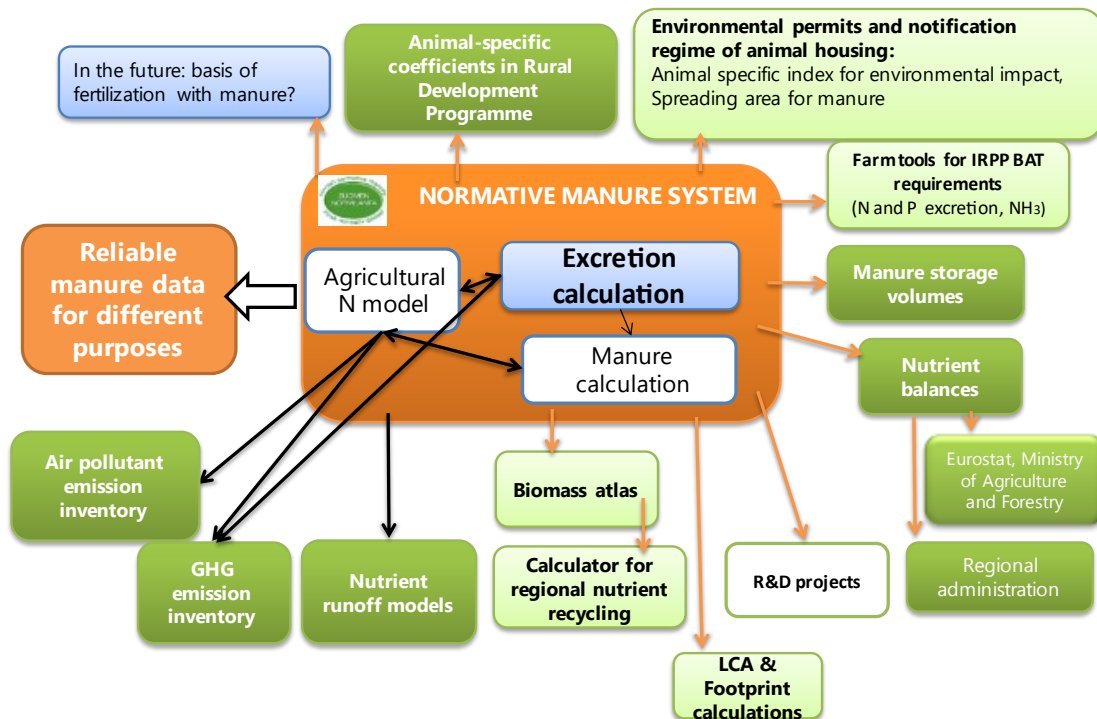
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# 1. Introduction

The results of livestock excretion calculation are needed for many manure-related agri-environmental measures aiming at enhanced manure utilisation and minimisation of emissions. As manure is the most important source of ammonia emissions, has a significant effect on the greenhouse gas emissions from agriculture and has a major role in national nutrient balances and hence also the nutrient loading into waters, the manure data behind these emission inventories is crucial for fulfilling the international and national emission reduction targets set for Finland. The same data is also used as the background data for regulation, including e.g. environmental permitting of animal houses, capacity requirements for manure storages and the average nutrient content of manure to be used e.g. in planning manure fertilisation. The agri-environmental measures in the Common Agricultural Policy (CAP) also affects manure use. The impact assessment of CAP thus requires manure data as do its subsequent revision and planned actions for the following programme periods.

Furthermore, the need for circular economy has been raised and Finland has been especially active in promoting nutrient recycling. As manure is the most significant source of recyclable nutrients in biomasses, the manure data behind planning new actions towards improved nutrient recycling, is important. New tools to assist in such planning, both in authoritative and practical level, have been produced and include a national biomass atlas and a calculator for regional nutrient recycling. Such tools require solid, updated manure data. Simultaneously, enhanced use of manure energy content and organic matter can be planned and subsequently implemented. Excretion calculations are also used in research and by companies in the field of livestock products with the aim of reducing the environmental impact of the production. For example, lifecycle and carbon food print calculations depend on updated manure data.

Natural Resources Institute Finland (Luke) is responsible for the national excretion calculations in Finland (Laki ruoka- ja luonnonvaratilastoista 562/2014). The excretion calculations provide the amounts of dry matter (DM), organic matter (OM) and nutrients excreted by animals in faeces and urine. The excretion calculations form the basis for many other calculations and evaluations (Figure 1), so it is critical that the calculations are as correct as possible. Data on excretion of animals is needed for several purposes ranging from estimating emissions during manure management into air (greenhouse gases, ammonia) and waters [phosphorus (P) and nitrogen(N)], to estimate the quantity and quality of manure produced in Finland and setting the targets to improve its utilisation (nutrient balances, circular economy). The calculation system is meant to provide consistent, up-to-date information on average manure quality and composition for all stakeholders e.g. in policymaking, research, technology development and farms. The ultimate aim of the calculation is also to set a solid base for a Finnish up-to-date database for manure-related information, such as nutrient excretion rates and the results from the normative system. The reports describing the excretion calculations for cattle (Nousiainen et al. 2023) and horses (Saastamoinen et al. 2024) have recently been published.



**Figure 1.** The nutrient excretion calculations form the basis of several other calculations (IRPP BAT = Intensive rearing of poultry or pigs; Best available techniques).

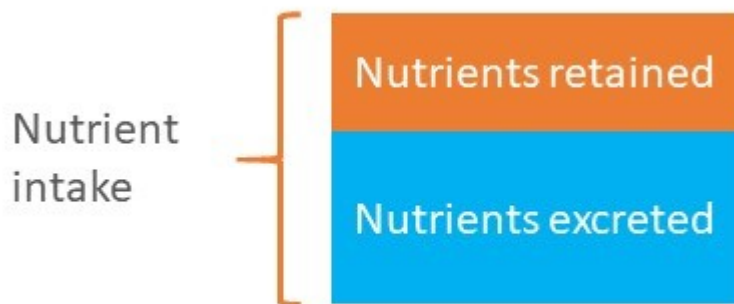
The reformation of the excretion calculation for pigs was made in the Luke-funded project ERITYS and in projects SiFos and Manure Standards. Specialists in animal nutrition, physiology and animal production were included in the work as a permanent part of excretion calculation administration.

This report documents the excretion calculation system for pigs built by Natural Resources Institute Finland (Luke) and Finnish Environment Institute SYKE. Both the calculation methods and the initial data used were verified, clarified, and updated according to the most recent available knowledge collected together with stakeholders and producer associations. The system calculates excreted quantities and qualities for different pig categories, starting from feeding of the animals and proceeding along the nutrient retention and excretion of the animals.

While the excretion calculation of pigs is documented here and the results published, development of the work continues. The system will benefit from e.g. carcass composition in pigs at different meat-% and growth level. Overall, the system is never “ready” but needs regular up-dating and maintenance. It is also important to remember, that the results shown in the report describe the average situation in Finland, and the actual excretions may vary depending on the feed fed to animals, production stage etc.

## 2. Background data

The critical factor in nutrient excretion calculations is to accurately estimate the nutrient concentrations of feeds and the amounts of nutrients consumed by the animals. The amounts of nutrients excreted by pigs are calculated as the difference between nutrient intake as feed and the nutrients retained in the animals and their products, i.e. as “nutrient input – nutrient uptake = nutrient excretion” (Figure 2). The components included in the calculations are dry matter (DM), organic matter (OM), N, and P. The principles of the calculations are the same as previously published for cattle (Nousiainen et al. 2023) and for horses (Saastamoinen et al. 2024).



**Figure 2.** The principle of nutrient calculations: excretion is intake minus retention.

The mass balance calculations for DM, OM, N and P are based on the data on animals, feed composition, and feed nutrient digestibility. Calculations were conducted separately for different production periods for each animal category (Table 1). Final amounts of excretion per pig per year were summed from the different feeding periods.

The source data (number of animals) for the national calculations was obtained from the registries of Luke (Luke 2025a). Data on diet composition was obtained from Finnish feed companies A-Rehu Ltd, Hankkija Ltd and Rehux Ltd, data on production parameters from Finnish slaughterhouses Atria Ltd, HKFoods Ltd and Snellman Ltd, and data on carcass composition from Luke’s previous experiments. Calculations are executed annually using the data from previous year (i.e., calculations for 2023 are done in 2024 and so on). Number of animals is updated every year, but since the other background data used are gathered from the stakeholders, it is updated in every few years in co-operation with the feed companies and slaughterhouses.

### 2.1. Animal categories

The excretion calculations of pigs are conducted separately for different animal categories. The animals are divided in different categories based on their gender, age, and period of production (Table 1).

**Table 1.** The animal categories and production periods for which nutrient excretion was calculated.

Animal category	Production period
Gilts	Growth period
	Piglet production
Sows	Piglet production
Boars	Growth period
	Breeding
Weaned piglets	Growth period
Fattening pigs	Meat production

## 2.2. Feeding phases, diets and nutrient requirements

Production periods were divided into feeding phases according to the average amount of feeding phases and their duration (the time for a specific diet used) used in Finnish pig farms (personal communication with feed companies) (Table 2).

**Table 2.** Feeding phases used in excretion calculations.

Animal category	Production period	Feeding phase	Duration of the feeding phase, d
Gilts	Growth period	Breeding pig I	35
		Breeding pig II	21
		Breeding pig III	23
		Breeding pig IV	70
	Piglet production	Insemination	20
		Gestation	117
Lactation		32	
Sows	Piglet production	Insemination	10
		Gestation	117
		Lactation	32
Boars	Growth period	Breeding pig I	35
		Breeding pig II	21
		Breeding pig III	25
		Breeding pig IV	116
	Breeding	Maintenance	->
Piglets	Growth period	Weaned piglet I	25
		Weaned piglet II	28
Fattening pigs	Meat production	Growing pig I	24
		Finishing pig II	30
		Finishing pig III	35

Ingredient compositions and nutrient contents of diets used in the calculations in the different production periods and feeding phases were obtained from Finnish feed companies A-Rehu Ltd, Hankkija Ltd and Rehux Ltd in autumn 2025. Average values for nutrient content in diets were calculated and are presented in Table 3.

**Table 3.** Nutrient contents of diets used in the excretion calculations in different production periods and feeding phases.

Animal category	Feeding phase	MJ NE/kg DM	DM, g/kg	OM, g/kg	N, g/kg	P, g/kg	Avail. P, g/kg
Gilts	Breeding pig I	10.9	878	826	26.0	4.9	2.8
	Breeding pig II	10.8	877	821	24.0	4.7	2.7
	Breeding pig III	10.1	878	821	23.0	4.5	2.5
	Breeding pig IV	10.0	877	822	20.0	4.8	2.6
Sows	Insemination	11.0	875	824	24.0	5.0	3.0
	Gestation	10.0	877	822	20.0	4.8	2.6
	Lactation	11.6	880	826	25.0	5.5	3.3
Boars	Breeding pig I	10.9	878	826	26.0	4.9	2.8
	Breeding pig II	10.8	877	827	24.0	4.7	2.7
	Breeding pig III	10.1	879	825	23.0	4.7	2.5
	Breeding pig IV	10.0	877	822	20.0	4.8	2.6
	Maintenance	10.0	877	822	20.0	4.8	2.6
Piglets	Nursing piglet	12.0	888	846	26.0	5.5	3.3
	Weaned piglet I	11.4	880	834	26.0	5.2	3.0
	Weaned piglet II	11.1	880	824	27.0	4.8	2.9
Fattening pigs	Growing pig I	10.9	878	826	26.0	4.9	2.8
	Finishing pig II	10.8	877	827	24.0	4.7	2.5
	Finishing pig III	10.7	875	831	22.0	4.2	2.4

MJ = megajoule; NE = net energy; DM= dry matter; OM = organic matter; N = nitrogen; P = phosphorus; avail. P = available phosphorus

Feed and especially nutrient intake are the key features in nutrient excretion calculations. In this report, the estimation of feed intake was based on net energy requirements ( $NE_{req}$ ) according to Finnish nutrient requirements (Kuoppala et al. 2024) and feeding recommendations given to pig farms by slaughterhouses and feed companies. The energy requirements of pigs in feeding recommendations are presented as megajoules (MJ) of net energy (NE) per day, MJ NE/d separately for growing pigs (weight under 150 kg, MJ  $NE_g$ ) and for adult pigs (MJ  $NE_a$ ). The average energy demand of pigs used in excretion calculations were calculated from daily energy recommendations in different feeding phases and duration of the feeding period (Table 4).

**Table 4.** Energy requirements ( $NE_{req}$ , MJ NE) of animals in different production periods and feeding phases (per day and feeding phase) used in excretion calculation.

Animal category	Feeding phase	$NE_{req}$ , MJ NE per day	$NE_{req}$ , MJ NE per feeding phase
Gilts	Breeding pig I	18.0	630
	Breeding pig II	26.0	546
	Breeding pig III	24.0	552
	Breeding pig IV	24.0	1 680
	Insemination	28.0	560
	Gestation	23.5	2 750
	Lactation	65.0	2106
	Nursing piglets	0.107	41.6
Sows	Insemination	28.0	280
	Gestation	25.5	2 973
	Lactation	70.0	2 268
	Nursing piglets	0.107	44.2
Boars	Breeding pig I	20.0	700
	Breeding pig II	24.0	504
	Breeding pig III	27.0	675
	Breeding pig IV	27.0	3 132
	Maintenance (365 d)	24.9	4 183
Piglets	Weaned piglet I	4.50	113
	Weaned piglet II	10.2	286
Fattening pigs	Growing pig I	20.0	480
	Finishing pig II	24.0	720
	Finishing pig III	32.0	1 120

$NE_{req}$  = net energy requirement

### 2.3. Production, growth and carcass composition

Production data is used to estimate nutrient retention and to calculate excretion per animal, per year, per animal place and, also as a sum of national yearly values. Average production results were calculated from data collected from slaughterhouses and farms in spring 2023 and autumn 2025 (Tables 5 and 7). Growth per day (kg/d) and feed conversion rate (FCR, MJ NE/kg growth) were calculated using equations [1–3] (Table 6) and production periods during year using equations [4] and [5] (Table 8).

**Table 5.** Weight at the start and at the end, total growth, and daily growth of pigs at different feeding phases used in excretion calculation.

Animal category	Feeding phase	Weight at start, kg	Weight at end, kg	Growth, kg/phase	Growth, g/day	FCR, MJ NE/kg
Gilts	Breeding pig I	32.0	60.0	28.0	800	22.5
	Breeding pig II	60.0	78.0	18.0	857	30.3
	Breeding pig III	78.0	98.0	20.0	870	27.6
	Breeding pig IV	98.0	150	52.0	743	32.3
	Insemination	150	165	15.0	750	37.3
	Gestation	165	225	60.0 <sup>1</sup>	513	45.8
	Foetus	0.00	1.40	1.40	12.3	-
	Lactation	225 <sup>2</sup>	215	-10.0 <sup>3</sup>	-309	-210.6
	Nursing piglets	1.44	7.60	6.16	190	6.8
Sows	Insemination	241	247	5.80	580	48.3
	Gestation	247	287	40.0 <sup>4</sup>	343	74.3
	Foetus	0.00	1.44	1.44	12.3	-
	Lactation	261	241	-20.0 <sup>5</sup>	-617	-113.4
	Nursing piglets	1.44	7.50	6.06	187	7.30
Boars	Breeding pig I	32.0	63.0	31.0	886	22.6
	Breeding pig II	63.0	82.0	19.0	905	26.5
	Breeding pig III	82.0	108	26.0	1 040	26.0
	Breeding pig IV	108	220	112	966	28.0
	Maintenance	220	254->	33.5 <sup>6</sup>	199	125
Piglets	Weaned piglet I	7.60	14.6	7.00	280	16.1
	Weaned piglet II	14.6	32.0	17.4	621	16.4
Fattening pigs	Growing pig I	32.0	55.0	23.0	958	20.9
	Finishing pig II	55.0	85.0	30.0	1 000	24.0
	Finishing pig III	85.0	122	37.0	1 057	30.3

FCR = feed conversion rate, MJ NE/kg growth

<sup>1</sup> Average growth of gilts during gestation is estimated to be 60 kg.

<sup>2</sup> Afterbirths are subtracted from weight at the end of gestation period to get gilts'/sows' weight at the beginning of the lactation period. Weight of foetuses are presented separately in excretion calculation (not included in gilts'/sows' weight).

<sup>3</sup> During lactation period gilts are losing 10 kg of their weight.

<sup>4</sup> Average weight gain of sows during gestation is estimated to be 40 kg.

<sup>5</sup> During lactation period average weight loss of sows is estimated to be 20 kg.

<sup>6</sup> Adult boar's weight is estimated to be 254 kg on average. After growing periods (weight 220 kg) boar is still growing 34 kg to get that estimated adult size during the first year of life.

**Table 6.** Equations for calculating the total growth, growth per day and feed conversion rate.

No	Equation
[1]	Growth = weight at the end of feeding phase, kg – weight at the start of feeding phase, kg
[2]	Growth, kg/d = (weight at the end of feeding phase, kg – weight at the start of feeding phase, kg) / duration of the feeding phase, d
[3]	Feed conversion rate (FCR), MJ NE/Kg = feed intake (MJ NE) / growth, kg during feeding phase

**Table 7.** Average production results and number of production periods used in calculations.

Production data	
Number of gestations per sow per year	2.30
Sow places empty, days per gestation period	7.00
Piglets born alive, per sow per year, pcs	35.5
Piglets born dead, per sow per year, %	6.20
Piglets dead before weaning, per sow per year, %	14.4 <sup>(1)</sup>
Weaned piglets, per sow per year, pcs	29.3 <sup>(2)</sup>
Boars per sow, %	2.60
Sow replacement rate per year, %	45.8
Piglets born alive, per gilt (at first farrowing), pcs	13.0
Piglets born dead, per gilt (at first farrowing), %	7.00
Piglets dead before weaning, per gilt per litter (first farrowing), %	7.50 <sup>(1)</sup>
Weaned piglets, per gilt per litter (first farrowing), pcs	12.0 <sup>(2)</sup>
Weaning age, days	32.4
Number of weaned piglet production periods (Eq. 4)	6.40
Weaned piglets' places empty between batches, days per batch	4.00
Number of fattening pig production batches per year (Eq. 5)	3.80
Fattening pig places empty between batches, days per batch	7.00

<sup>1</sup> From piglets born alive per sow/gilt per year.

<sup>2</sup> Born, dead born, dead before weaning and weaned piglets per sow and gilt are average values of slaughterhouses; values cannot be derived from each other.

**Table 8.** Equations for calculating the number of piglet production periods and fattening pig batches.

No	Equation
[4]	Number of weaned piglet production periods = 365 / Sum of length of feeding periods of Weaned piglet I, d and Weaned piglet II, d + Empty, d
[5]	Number of fattening pig batches = 365 / Sum of length of feeding periods of Growing pig I, Finishing pig II, d and Finishing pig III, d + Empty, d

For the amounts of retained nutrients, the nutrient content of the carcasses of different pig categories were used (Table 10). Nutrient content in carcasses was calculated per empty weight of pigs (EBW, g/kg) using equations in Table 9.

For the nutrient content of carcasses values from previous experiments at Luke were used. These results were compared to de Lange et al. (2003), where same kind of experimental design was used. However, pigs are genetically different nowadays and the AutoFom™ and Hennesy GP -measurements have been updated since 1999–2000 when the experiment was conducted. Therefore, a report on differences between calibration cuts (Honkavaara 2016) were used to update the carcass nutrient composition values from 1999 to 2020. The modelling experiment data from 1999–2000 (Sevón-Aimonen 2001) was grouped according to meat percent and the composition corresponding to fattening pigs in 2020 (meat-% 59 and slaughter weight 91 kg (Niemistö 2020) was selected to be used when forming the equations. This information was used for calculating the empty body weight (EBW) [Eq. 6] (Table 9). The protein content (kg) of different pig categories (Table 10) were used for calculating the amounts of the chemical components so that the sum of protein, water, fat, and ash corresponded to the empty weight. Even though the calculations were corrected for the development in pig genetics, the values should be considered as estimates and would need an update.

Routinely, only weight of the carcass and carcass composition are measured and reported by slaughterhouses. The portion of red meat is calculated according to AutoFom™ (Busk et al. 1999) and Hennesy GP -measurements (Kirton et al. 1987) using calibrated equations, which are updated on average every five years. More accurate carcass composition measurements are rarely done due to high expenses. The lack of accurate measurements poses a challenge to nutrient retention evaluation. More exact carcass composition and nutrient content can be evaluated in an experimental setup where the carcass composition, empty weight and nutrient content of the whole carcass are analysed from pigs at different weights during the growth period.

**Table 9.** Equations for calculating the live weight, empty body weight and nutrient contents of empty body weight (EBW) (based on Sevón-Aimonen 2001 and personal communications with Niemistö 2020).

No	Equation
[6]	$EBW, \text{ kg} = LW \times 0.95$
[7]	$EBW_{DM}, \text{ g/kg} = EBW - EBW_{water}$
[8]	$EBW_N = EBW_{protein}/6.25$
[9]	$EBW_P, \text{ g/kg} = 0.0829 \times \text{ash g/kg EBW} + 2.6457$

LW = live weight, kg; EBW = empty body weight, kg;  $EBW_{DM}$  = Dry matter content of EBW;  $EBW_{water}$  = Water content of EBW;  $EBW_{protein}$  = Protein content of EBW;  $EBW_N$  = Nitrogen content of EBW;  $EBW_K$  = Potassium content of EBW;  $EBW_P$  = Phosphorus content of EBW

In the modelling experiment by Sevón-Aimonen (2001), the content of phosphorus and potassium were not measured. Content of potassium in the empty body weight (EBW) were therefore calculated from the average ratio to other nutrients according to the data collected from several experiments (Rymarz et al. 1982, Fandrejewski & Rymarz 1986, Hendriks & Moughan 1993, Pettey et al. 2015). Phosphorus was calculated from ash using equation [Eq. 9] (Table 9). Nutrient contents of carcasses used in the excretion calculations are presented in Table 10.

**Table 10.** Nutrient content in carcass per kg empty weight (EBW) (g/kg) of the pigs used for calculating nutrient retention on animals. Calculated based on modelling experiment by Sevón-Aimonen (2001).

	DM, g/kg	Ash, g/kg	N, g/kg	P, g/kg
Gilt	456	28.4	25.8	5.00
Sow, inseminating	457	28.2	25.9	4.98
Sow, gestating	460	28.1	25.9	4.98
Sow, lactating	471	27.9	25.7	4.96
Boar	479	27.3	25.9	4.91
New-born piglet	184	27.2	20.5	4.90
Weaned piglet, 8,5 kg	248	29.4	23.9	5.08
Weaned piglet, 25 kg	329	30.0	25.9	5.13
Fattening pig, growing, 50 kg	371	29.6	26.3	5.10
Fattening pig, finishing, 80 kg	406	29.1	26.3	5.06
Fattening pig, finishing, 120 kg	436	28.6	26.2	5.01

DM = dry matter; N = nitrogen; P = phosphorus

### 3. Calculation

Nutrition excretion was calculated with a mass balance calculation subtracting nutrient retention from nutrient intake. The mass balance calculations for DM, OM, N and P are based on the data on nutrient intake (feed content) and animals' production (growth and production). Calculations were conducted by dividing every animal category into production periods and feeding phases according to feeding programs used in Finnish pig farms. Final amounts of excretion per animal per year were summed from the results of different feeding periods. Background data used is presented in Chapter 2.

#### 3.1. Nutrient intake

Dry matter intake (DMI, kg DM/period) was calculated as NE requirement divided by diet NE content in kg of DM [Eq. 10] (Table 11). Feed intake (FI, kg/feeding period) was calculated using [Eq. 11] and OM, N, P, and ash intake (kg) were calculated using [Eq. 12–15] (Table 11). Nutrient intake for different animal categories is presented in Table 12.

**Table 11.** Equations for calculating the intake of feed and nutrients.

No	Equation
[10]	$DMI, \text{ kg/period} = NE_{\text{req}}, \text{ MJ/period} / NE_{\text{diet}}, \text{ MJ/kg DM}$
[11]	$FI, \text{ kg/period} = DMI, \text{ kg/period} / DM_{\text{diet}}, \% \times 100$
[12]	$OMI, \text{ kg/period} = OM_{\text{diet}}, \text{ g/kg} \times FI, \text{ g/period}$
[13]	$\text{Intake of N, g/period} = FI, \text{ kg/period} \times N_{\text{diet}}, \% / 100$
[14]	$\text{Intake of P, g/period} = P_{\text{diet}}, \text{ g/kg} \times FI, \text{ kg/period}$
[15]	$\text{Ash, kg/period} = DMI, \text{ kg/period} - OMI, \text{ kg/period}$

DMI = dry matter intake; fresh;  $NE_{\text{req}}$  = requirement of net energy;  $NE_{\text{diet}}$  = diet NE content; FI = feed intake;  $DM_{\text{diet}}$  = diet DM concentration; OMI = organic matter intake;  $OM_{\text{diet}}$  = diet OM concentration; N = nitrogen;  $N_{\text{diet}}$  = diet N concentration; P = phosphorus;  $P_{\text{diet}}$  = diet P concentration

**Table 12.** Dry matter and nutrient intake of pigs in different categories, per production periods and feeding phases used in excretion calculations.

Animal category	Feeding phase	DMI, kg	OMI, kg	N, kg	P, kg	Ash, kg
Gilts	Breeding pig I	57.8	54.4	1.71	0.32	3.42
	Breeding pig II	50.6	47.3	1.38	0.27	3.23
	Breeding pig III	54.7	51.1	1.43	0.28	3.55
	Breeding pig IV	168	158	3.74	0.93	10.5
	Growth period total	331	377	8.26	1.80	20.7
	Insemination	50.9	47.9	1.40	0.29	2.97
	Gestation	275	258	6.11	1.51	17.2
	Lactation	182	171	5.22	1.13	11.0
	Nursing piglets of gilt	3.47	3.30	0.10	0.02	0.17
	Production period total	511	480	12.8	2.96	31.3
Sows	Insemination	25.5	24.0	0.70	0.15	1.48
	Gestation	297	279	6.61	1.64	18.6
	Lactation	196	184	5.62	1.22	11.8
	Nursing piglets of sow	3.69	3.51	0.11	0.02	0.18
	Production period total	522	490	13.0	3.00	32.1
Boars	Breeding pig I	64.2	60.4	1.90	0.36	3.80
	Breeding pig II	46.7	44.0	1.28	0.25	2.66
	Breeding pig III	66.8	62.7	1.75	0.36	4.11
	Breeding pig IV	313	294	6.96	1.72	19.6
	Growth period total	491	461	11.9	2.69	30.1
	Maintenance (365 d)	909	854	20.2	5.01	53.9
Piglets	Weaned piglet I	9.87	9.36	0.29	0.06	0.51
	Weaned piglet II	25.7	24.1	0.79	0.14	1.62
	Weaned piglet total	35.6	33.5	1.08	0.20	2.13
Fattening pigs	Growing pig I	44.0	41.5	1.32	0.25	2.58
	Finishing pig II	66.7	62.9	1.83	0.35	3.73
	Finishing pig III	105	99.4	2.63	0.50	5.26
	Fattening pig total	215	204	5.78	1.10	11.6

DMI = dry matter intake; OMI = organic matter intake; N = nitrogen; P = phosphorus

### 3.2. Retention of nutrients

Retention of DM, OM, N, P, and ash (kg) to animals during growth, to sow during pregnancy (including placentas, foetal membranes, foetal water, and growing uterus) and to foetuses were calculated using [Eq. 16–20] (Table 13). For sows, adult gilts (>150 kg) and boars in maintenance (>220 kg) the carcass compositions of sows in different production phases, boar and gilt presented in Table 10 were used. For boars weighing under 220 kg and gilts weighing under 150 kg same [Eq. 16–20] (Table 13) were used but carcass compositions were calculated as follows:

- For fattening pigs weighing 32–55 kg, gilts weighing 32–60 kg and boars weighing 32–63 kg mean of carcass composition of weaned piglets, 25 kg and fattening pigs, 50 kg was used.
- For fattening pigs weighing 55–85, boars weighing 63–82 and gilts weighing 60–78 kg means carcass composition of growing pig, 50 kg and finishing pig, 80 kg was used.
- For boars weighing 82–108 kg and for gilts weighing 78–98 kg carcass composition of finishing pigs weighing 80 kg was used. For fattening pigs weighing 85–122 kg the mean carcass composition of growing pig, 80 kg and finishing pig 120 kg was used.
- For boars weighing 108–220 kg and gilts weighing 98–150 kg, carcass composition of finishing pigs weighing 120 g was used.

Animal growth (kg) used in equations are shown in Table 5.

The results for every animal category are summed from the feeding phases and production periods calculated separately and are presented in Appendices 1–5.

**Table 13.** Equations to calculate nutrient retention.

No	Equation
[16]	DM retained, kg = DM carcass, g/kg / 1000 × growth, kg
[17]	OM retained, kg = (DM carcass, g/kg – Ash carcass, g/kg) / 1000 × growth, kg
[18]	N retained, kg = N carcass, g/kg / 1000 × growth, kg
[19]	P retained, kg = P carcass, g/kg / 1000 × growth, kg
[20]	Ash retained, kg = DM retained, kg – OM retained, kg

DM = dry matter; OM = organic matter; N = nitrogen; P = phosphorus

**Table 14.** Dry matter and nutrient retention to pigs in different categories, per production periods and feeding phases used in excretion calculations.

Animal category	Feeding phase	DM, kg	OM, kg	N, kg	P, kg	Ash, kg
Gilts	Breeding pig I	9.32	8.52	0.69	0.14	0.79
	Breeding pig II	6.65	6.15	0.45	0.09	0.50
	Breeding pig III	7.72	7.17	0.50	0.10	0.55
	Breeding pig IV	21.6	20.1	1.29	0.25	1.41
	Growth period total	45.2	42.0	2.93	0.57	3.26
	Insemination	6.51	6.11	0.37	0.07	0.40
	Gestation	26.2	24.6	1.47	0.28	1.60
	Foetuses of gilt	3.71	3.17	0.41	0.10	0.55
	Lactation	-4.47	-4.21	-0.24	-0.05	-0.26
	Nursing piglets of gilt	17.2	15.1	1.65	0.35	2.03
	Production period total	49.1	44.8	3.66	0.76	4.32
Sows	Insemination	2.52	2.36	0.14	0.03	0.16
	Gestation	17.5	16.4	0.98	0.19	1.07
	Foetuses of sow	4.38	3.73	0.49	0.12	0.64
	Lactation	-8.94	-8.41	-0.49	-0.09	-0.53
	Nursing piglets of sow	18.2	16.1	1.75	0.37	2.16
	Production period total	33.7	30.2	2.88	0.61	3.50
Boars	Breeding pig I	10.3	9.44	0.77	0.15	0.88
	Breeding pig II	7.0	6.49	0.47	0.09	0.53
	Breeding pig III	10.0	9.3	0.65	0.13	0.72
	Breeding pig IV	46.4	43.4	2.78	0.53	3.04
	Growth period total	73.8	68.6	4.67	0.90	5.17
	Maintenance (365 d)	33.2	31.3	1.79	0.34	1.89
Piglets	Weaned piglet I	1.65	1.46	0.16	0.03	0.20
	Weaned piglet II	5.44	4.94	0.43	0.09	0.50
	Weaned piglet total	7.09	6.40	0.59	0.12	0.69
Fattening pigs	Growing pig I	7.65	7.00	0.57	0.11	0.65
	Finishing pig II	11.1	10.2	0.75	0.15	0.84
	Finishing pig III	14.8	13.8	0.92	0.18	1.01
	Fattening pig total	33.5	31.0	2.24	0.43	2.50

DM= dry matter; OM = organic matter; N = nitrogen; P = phosphorus

### 3.3. Total excretion

Diet energy and nutrients are used for maintenance, growth, and production (lactation, re-production). Losses of energy and nutrients are excreted in faeces and urine, and as heat (loss of energy).

Total excretion (Table 16) was calculated with the [Eq. 21–30] (Table 15).

**Table 15.** Equations to calculate excretion of dry matter, organic matter, nitrogen, phosphorus, and ash.

No	Equation
	<b>For boars, piglets, fattening pigs, gilts, and sows not gestating</b>
[21]	DM excreted, kg/feed period = DMI – DM retained
[22]	OM excreted, kg/feed period = OMI – OM retained
[23]	N excreted, kg/feed period = N Intake – N retained
[24]	P excreted, kg/feed period = P Intake – P retained
[25]	Ash excreted, kg/feed period = Ash Intake – Ash retained
	<b>For gestating gilts and sows</b>
[26]	DM excreted, kg/feed period = DMI – DM retained in gestating gilt/sow – DM retained in foetuses
[27]	OM excreted, kg/feed period = OMI – OM retained in gestating gilt/sow – OM retained in foetuses
[28]	N excreted, kg/feed period = N Intake – N retained in gestating gilt/sow – N retained in foetuses
[29]	P excreted, kg/feed period = P Intake – P retained in gestating gilt/sow – P retained in foetuses
[30]	Ash excreted, kg/feed period = Ash Intake – Ash retained in gestating gilt/sow – Ash retained in foetuses

DM = dry matter; DMI = dry matter intake; OM = organic matter; OMI = organic matter intake; N = nitrogen; P = phosphorus.

**Table 16.** Total dry matter and nutrient excretion of pigs from different categories, per production periods and feeding phases.

Animal category	Feeding phase	DM, kg	OM, kg	N, kg	P, kg	Ash, kg
Gilts	Breeding pig I	48.5	45.9	1.02	0.19	2.63
	Breeding pig II	43.9	41.2	0.93	0.18	2.73
	Breeding pig III	46.9	43.9	0.93	0.18	2.99
	Breeding pig IV	146	137	2.44	0.68	9.09
	Growth period total	286	268	5.33	1.23	17.4
	Insemination	44.4	41.8	1.03	0.22	2.57
	Gestation	245	230	4.23	1.13	15.0
	Lactation	186	175	4.98	1.18	11.3
	Nursing piglets of gilt	-14.6	-11.8	-1.55	-0.33	-1.90
	Production period total	462	435	8.69	2.20	27.0
Sows	Insemination	22.9	21.6	0.56	0.12	1.33
	Gestation	276	259	5.14	1.33	16.9
	Lactation	205	192	5.14	1.31	12.4
	Nursing piglets of sow	-14.6	-12.6	-1.65	-0.35	-1.99
	Production period total	488	460	9.19	2.41	28.6
Boars	Breeding pig I	53.9	50.9	1.13	0.21	2.93
	Breeding pig II	39.6	37.5	0.80	0.16	2.13
	Breeding pig III	56.8	53.4	1.10	0.23	3.39
	Breeding pig IV	267	250	4.18	1.19	16.5
	Growth period total	417	392	7.22	1.79	25.0
	Maintenance (365 d)	876	823	18.4	4.67	52.0
Piglets	Weaned piglet I	8.22	7.90	0.13	0.02	0.32
	Weaned piglet II	20.3	19.2	0.36	0.06	1.12
	Weaned piglet total	28.5	27.1	0.49	0.08	1.44
Fattening pigs	Growing pig I	36.4	34.5	0.75	0.13	1.93
	Finishing pig II	55.6	52.7	1.08	0.21	2.89
	Finishing pig III	89.9	85.6	1.71	0.33	4.25
	Fattening pig total	182	173	3.54	0.67	9.07

DM = dry matter; OM = organic matter; N = nitrogen; P = phosphorus

### 3.4. Excretion divided into faeces and urine

Digestibility values of OM, CP and P in diets fed during different feeding periods were calculated using the Finnish Feed Tables (Kuoppala et al. 2024) and feed formulas obtained from Finnish feed companies. Calculated nutrient digestibility values are shown in Table 17. The quantity of DM excreted in faeces equals to the intake of indigestible feed [Eq. 31] (Table 18). Digestibility of DM (DMD) was calculated from digestibility of organic matter (OMD) using [Eq. 32] (Table 18) based on several published trials (Helander et al. 1994, Valaja & Näsi 1995, Valaja & Siljander-Rasi 1998, Mroz et al. 2000, Jongbloed et al. 2004, Partanen et al. 2007).

**Table 17.** Nutrient digestibility (g/g) of feeds fed to pigs from different categories, per production period and feeding phase.

Animal category	Feeding phase	DM	OM	CP	P	Ash
Gilts	Breeding pig I	0.83	0.85	0.83	0.60	0.60
	Breeding pig II	0.83	0.85	0.79	0.60	0.60
	Breeding pig III	0.83	0.85	0.83	0.59	0.59
	Breeding pig IV	0.77	0.79	0.76	0.56	0.56
Sows	Insemination	0.77	0.79	0.76	0.52	0.52
	Gestation	0.77	0.79	0.76	0.56	0.56
	Lactation	0.84	0.86	0.86	0.62	0.62
Boars	Breeding pig I	0.78	0.80	0.83	0.61	0.61
	Breeding pig II	0.76	0.78	0.79	0.58	0.58
	Breeding pig III	0.76	0.78	0.82	0.57	0.57
	Breeding pig IV	0.77	0.79	0.76	0.56	0.56
	Maintenance	0.77	0.79	0.76	0.56	0.56
Piglets	Nursing piglet	0.85	0.87	0.87	0.63	0.63
	Weaned piglet I	0.85	0.87	0.85	0.64	0.64
	Weaned piglet II	0.84	0.86	0.85	0.65	0.65
Fattening pigs	Growing pig I	0.83	0.85	0.83	0.59	0.59
	Finishing pig II	0.83	0.85	0.81	0.57	0.57
	Finishing pig III	0.83	0.85	0.79	0.57	0.57

DM = dry matter; OM = organic matter; N = nitrogen; P = phosphorus

For DM content of faeces of sows and fattening pigs, average values based on feeding experiments conducted at Luke were used: 32.7% for sows and 25.8% DM for fattening pigs. For DM content of faeces of piglets, the value of fattening pigs (25.8%) was used. For DM content of faeces of boars and gilts, an average value of sows and fattening pigs was used (29.3%). For DM content of urine, 2% was used.

Mass balance of sows and its nursing piglets were calculated as combined and the values for piglets were negative, because of the nutrients retained in piglets and the milk sows had produced.

Faecal and urinary nutrient output (Table 19 and 20) were calculated using [Eq. 33–44] (Table 18).

**Table 18.** Equations used to calculate the total excretion of faeces, urine, and nutrient contents in them.

No	Equation
[31]	Indigestible DM excreted, kg/feed period = DMI – DM retained
[32]	Digestibility of DM (DMD), g/g = $((1.0572 \times (100 \times \text{OMD, g/g})) - 6.9357) / 100$
[33]	Output of faeces, kg/feed period = Indigestible DM, kg / Faeces DM content, % $\times 100$
[34]	Output of urine, kg/feed period = DM excreted in urine, kg / Urine DM content, % $\times 100$
[35]	DM in faeces = $(1 - \text{DMD}) \times \text{DMI}$ , kg
[36]	OM in faeces = $(1 - \text{OMD}) \times \text{OMI}$ , kg
[37]	N in faeces = $(1 - \text{Digestibility of N}) \times \text{N Intake}$ , kg
[38]	P in faeces = $(1 - \text{Digestibility of P}) \times \text{P Intake}$ , kg
[39]	Ash in faeces = DM in faeces – OM in faeces
[40]	DM in urine = OM in urine + Ash in urine
[41]	OM in urine = $((1.3047 \times \text{N in urine} / \text{Length of the feeding period, d} + 54.1148) \times \text{Length of the feeding period, d}) / 1000$
[42]	N in urine = N excreted, kg – N in faeces, kg
[43]	P in urine = P excreted, kg – P in faeces, kg
[44]	Ash in urine = Ash excreted, kg – Ash in faeces, kg

DM = dry matter; DMI = dry matter intake; DMD = dry matter digestibility; OMD = organic matter digestibility; OM = organic matter; OMI = organic matter intake; N = nitrogen; P = phosphorus

**Table 19.** Dry matter and nutrient excretion *in faeces* of pigs from different categories, per production period and feeding phase.

Animal category	Feeding phase	DM, kg	OM, kg	N, kg	P, kg	Ash, kg	Faeces, kg
Gilts	Breeding pig I	9.87	8.16	0.29	0.13	1.71	38.3
	Breeding pig II	8.60	7.10	0.29	0.11	1.53	33.5
	Breeding pig III	9.30	7.67	0.24	0.11	1.67	36.2
	Breeding pig IV	39.3	33.1	0.90	0.41	6.27	153
	Growth period total	67.2	56.0	1.72	0.76	11.2	260
	Insemination	11.9	10.1	0.34	0.14	1.85	36.5
	Gestation	64.4	54.1	1.47	0.67	10.3	197
	Lactation	29.1	23.9	0.73	0.43	5.20	88.9
	Nursing piglets of gilt	0.52	0.43	0.01	0.01	0.09	2.01
	Production period total	106	88.5	2.55	1.24	17.4	324
Sows	Insemination	5.96	5.03	0.17	0.07	0.93	18.2
	Gestation	69.6	58.5	1.59	0.72	11.1	213
	Lactation	31.3	25.7	0.79	0.46	5.60	95.8
	Nursing piglets of sow	0.55	0.46	0.01	0.01	0.10	2.14
	Production period total	106	89.7	2.56	1.26	17.7	329
Boars	Breeding pig I	14.4	12.1	0.32	0.14	2.28	55.7
	Breeding pig II	11.4	9.70	0.27	0.11	1.74	44.3
	Breeding pig III	16.4	13.8	0.31	0.15	2.56	63.4
	Breeding pig IV	73.3	61.7	1.67	0.76	11.7	284
	Growth period total	116	97.2	2.58	1.16	18.3	448
	Maintenance (365 d)	213	180	4.85	2.20	33.3	726
Piglets	Weaned piglet I	1.48	1.22	0.04	0.02	0.26	5.72
	Weaned piglet II	4.12	3.38	0.12	0.05	0.75	16.0
	Weaned piglet total	5.60	4.59	0.16	0.07	1.01	21.7
Fattening pigs	Growing pig I	7.52	6.22	0.22	0.10	1.30	29.1
	Finishing pig II	11.4	9.44	0.35	0.15	1.94	44.1
	Finishing pig III	17.9	14.9	0.55	0.22	2.96	69.3
	Fattening pig total	36.8	30.6	1.12	0.47	6.20	143

DM = dry matter; OM = organic matter; N = nitrogen; P = phosphorus

**Table 20.** Dry matter and nutrient excretion *in urine* of pigs from different categories, per production periods and feeding phases.

Animal category	Feeding phase	DM, kg	OM, kg	N, kg	P, kg	Ash, kg	Urine, kg
Gilts	Breeding pig I	2.81	1.89	0.73	0.06	0.92	141
	Breeding pig II	2.33	1.14	0.64	0.08	1.19	117
	Breeding pig III	2.57	1.25	0.69	0.07	1.33	1 298
	Breeding pig IV	6.61	3.79	1.55	0.27	2.82	331
	Growth period total	14.3	8.07	3.61	0.47	6.26	717
	Insemination	1.79	1.08	0.69	0.08	0.71	89.7
	Gestation	11.1	6.34	2.76	0.47	4.78	556
	Lactation	7.81	1.76	4.25	0.75	6.05	391
	Nursing piglets of gilt	-0.20	1.75	-1.56	-0.34	-1.95	-10.1
	Production period total	20.5	10.9	6.14	0.96	9.59	1 026
Sows	Insemination	0.94	0.54	0.39	0.05	0.40	47.2
	Gestation	12.1	6.31	3.55	0.61	5.78	605
	Lactation	8.52	1.76	4.35	0.85	6.76	426
	Nursing piglets of sow	-0.33	1.75	-1.66	-0.36	-2.08	-16.3
	Production period total	21.2	10.4	6.63	1.15	10.9	1 062
Boars	Breeding pig I	2.54	1.90	0.81	0.07	0.65	127
	Breeding pig II	1.53	1.14	0.53	0.05	0.39	76.4
	Breeding pig III	2.18	1.35	0.78	0.08	0.83	109
	Breeding pig IV	11.1	6.28	2.51	0.43	4.86	557
	Growth period total	17.4	10.7	4.64	0.63	6.72	870
	Maintenance (365 d)	38.5	19.8	13.6	2.46	18.7	1924
Piglets	Weaned piglet I	1.41	1.35	0.09	0.004	0.06	70.5
	Weaned piglet II	1.89	1.52	0.24	0.01	0.38	94.6
	Weaned piglet total	3.30	2.87	0.33	0.01	0.43	165
Fattening pigs	Growing pig I	1.93	1.30	0.53	0.03	0.63	96.4
	Finishing pig II	2.58	1.62	0.73	0.06	0.95	129
	Finishing pig III	3.18	1.90	1.16	0.11	1.29	159
	Fattening pig total	7.70	4.82	2.42	0.20	2.87	384

DM = dry matter; OM = organic matter; N = nitrogen; P = phosphorus

## 4. Nutrient excretion of pig production in Finland

Detailed excretion calculation results for different animal categories in pig production using input data from year 2023 are presented in Appendices 1–5.

- Appendix 1: Gilts
- Appendix 2: Sows and nursing piglets
- Appendix 3: Boars
- Appendix 4: Fattening pigs
- Appendix 5: Piglets

Results are reported per animal per growth and/or production and/or feeding period. For fattening pig and weaned piglet, the total excretion of the production periods is also presented.

### 4.1. Total excretion of N and P

Total excretion of N and P and total mass of faeces and urine (1000 of tons/year) of different animal categories per year were calculated using the number of pigs in Finland in 2023 (Table 21). Since all pigs will not live for the whole year (for example fattening pigs) and some animals also move from one category to another during the year (i.e. piglets to fattening pigs or to breeding pigs, gilts to sows etc.), the exact number of animals for one year is difficult to present. Number of animals in Table 21 is based on pig registry and official animal statistics in Finland (Luke 2025a). To get more accurate calculation results, an estimation of the number of young boars, gilts and fattening pigs is also needed (Table 22). For boars and gilts, the total number of animals per year was calculated by adding together the number of adult (> 50 kg) boars and gilts (Table 21) and the estimated number of boars and gilts in size category of 20–50 kg (Table 22). For the weaned piglets the number of piglets in Table 21 was multiplied with the number of piglet production periods per year (Table 7), and the number of sows was multiplied with the average number of gestation periods per sow per year (Table 7). For fattening pigs, the total number of slaughtered pigs per year was used.

**Table 21.** Number of pigs in different categories in 2023 in Finland.

Animal category	Number of animals
All pigs	984 340
Boars, > 50 kg	760
Gilts, > 50 kg	25 850
Other pigs, 20–50 kg <sup>1</sup>	229 010
Piglets, < 20 kg	303 560
Fattening pigs, 50–80 kg	167 020
Fattening pigs, 80–110 kg	145 680
Fattening pigs, > 110 kg	54 150
Sows, > 50 kg	84 170

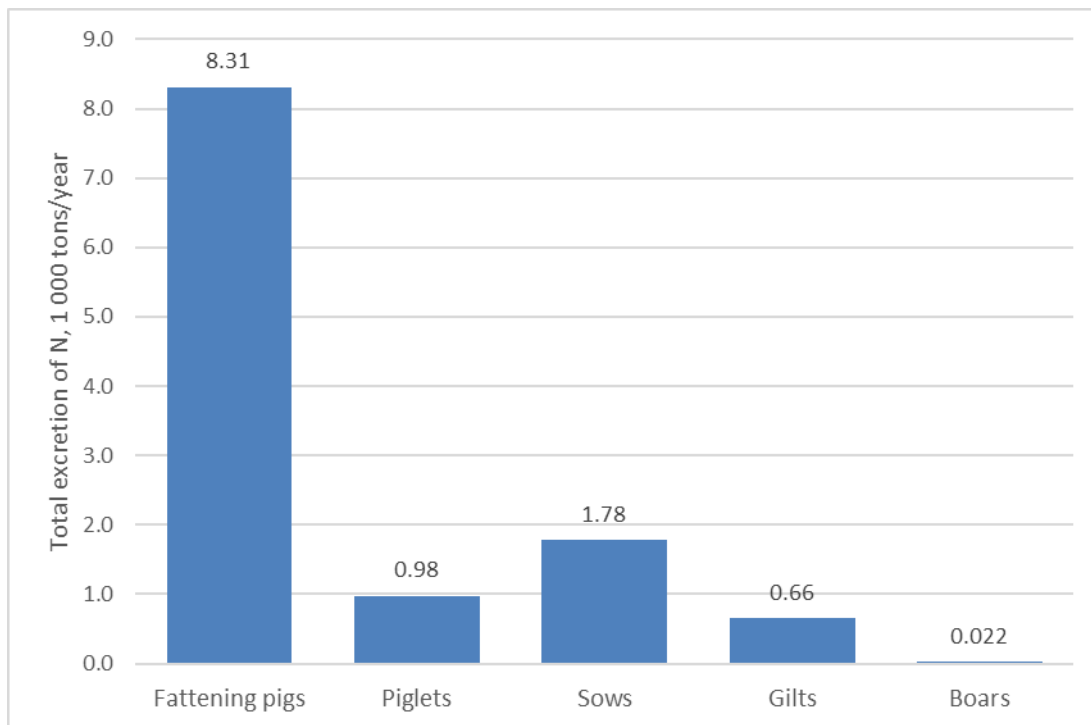
<sup>1</sup> Includes young breeding pigs and fattening pigs.

**Table 22.** An estimated number of younger pigs in 2023.

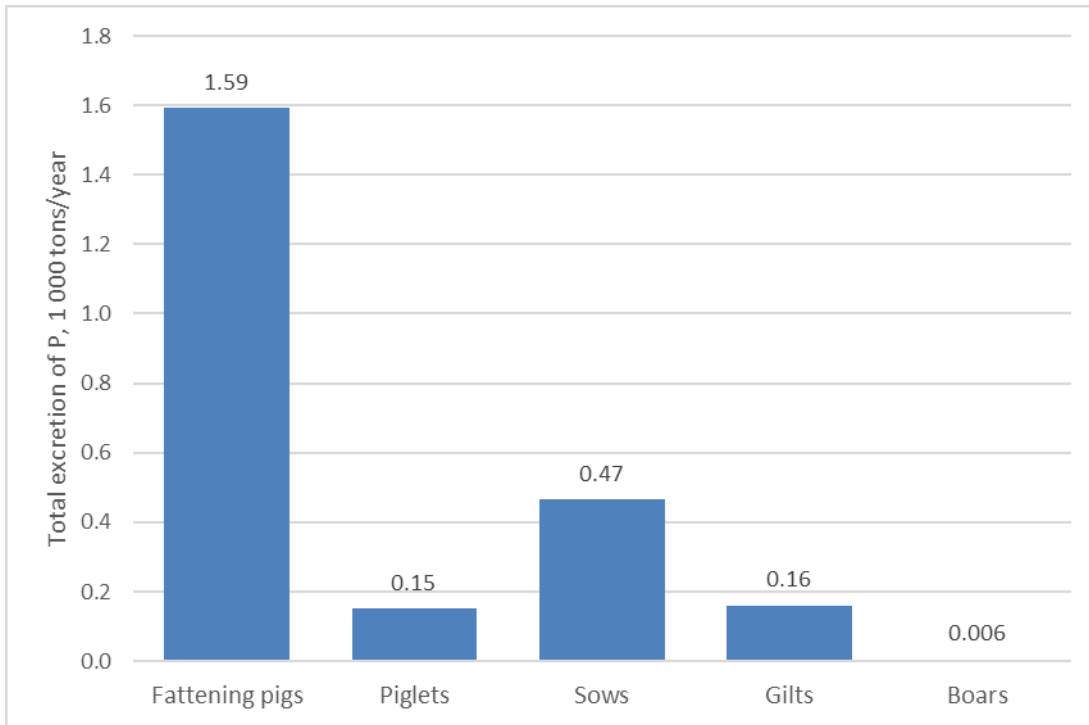
Animal category	Number of animals
Boars, < 20 kg	586
Boars, 20–50 kg	442
Gilts, < 20 kg	19 944
Gilts, 20–50 kg	15 046
Fattening pigs, < 20 kg	283 030
Fattening pigs, 20–50 kg	213 522

The number of growing boars, gilts and fattening pigs under 50 kg can be estimated from the number of other pigs (20–50 kg) and number of piglets (< 20 kg) by using the ratio (%) of boars, gilts, and fattening pigs to each other. In 2023, the boars made 0.19%, gilts 6.57% and fattening pigs 93.2% of the total population of boars, gilts, and fattening pigs under the LW of 50 kg.

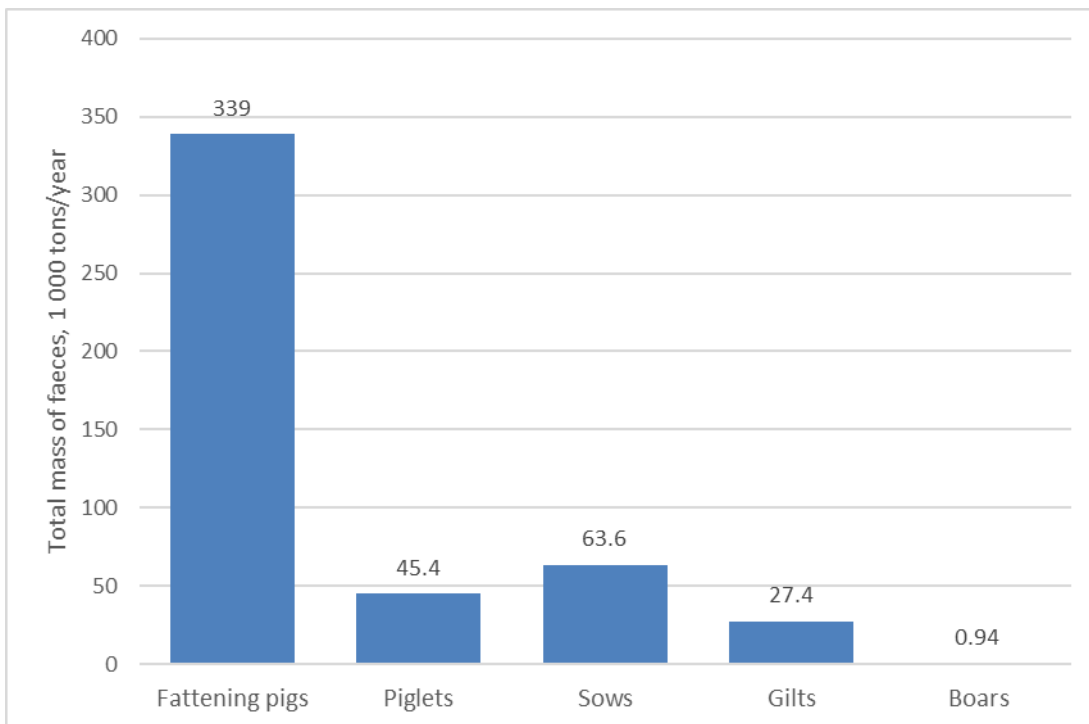
Results of total excretion in 2023 are shown in Figures 3–6.



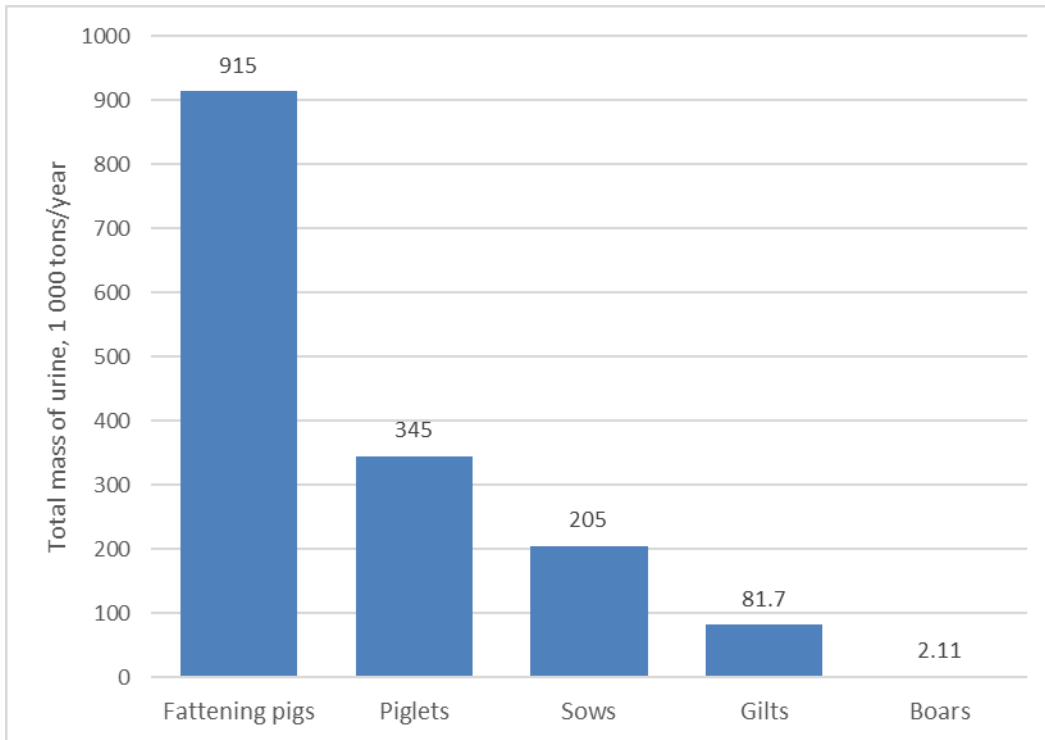
**Figure 3.** Total excretion of nitrogen (1 000 tons/year) in different pig categories.



**Figure 4.** Total excretion of phosphorus (1 000 tons/year) in different pig categories.



**Figure 5.** Total quantity of faeces (1 000 tons/year) of different pig categories.

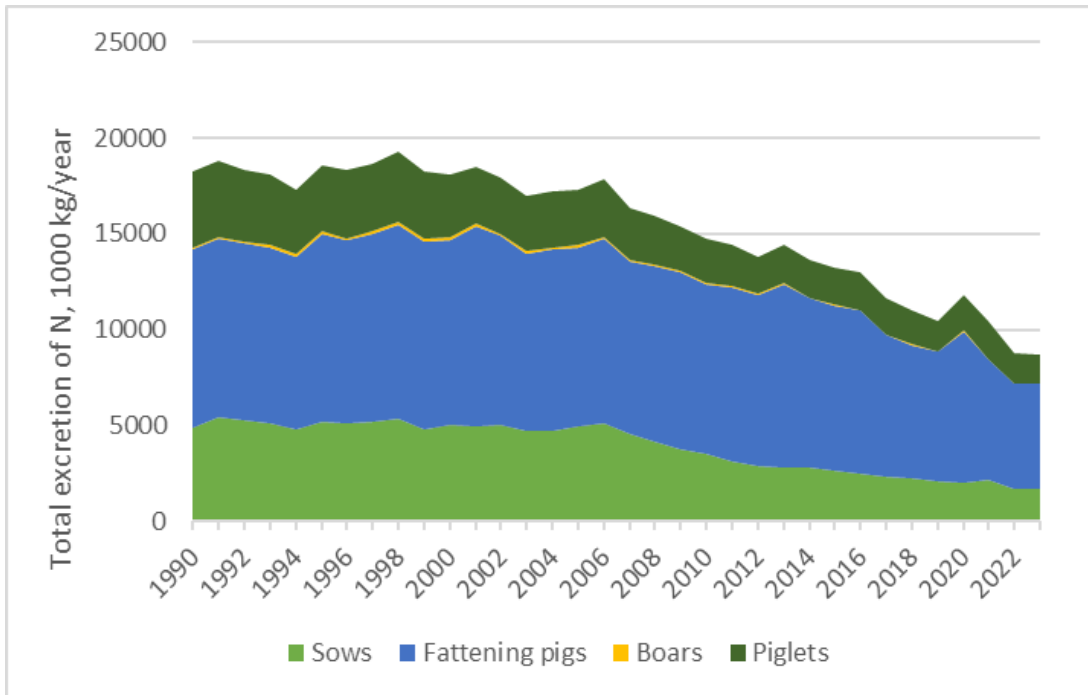


**Figure 6.** Total quantity of urine (1 000 tons/year) of different pig categories.

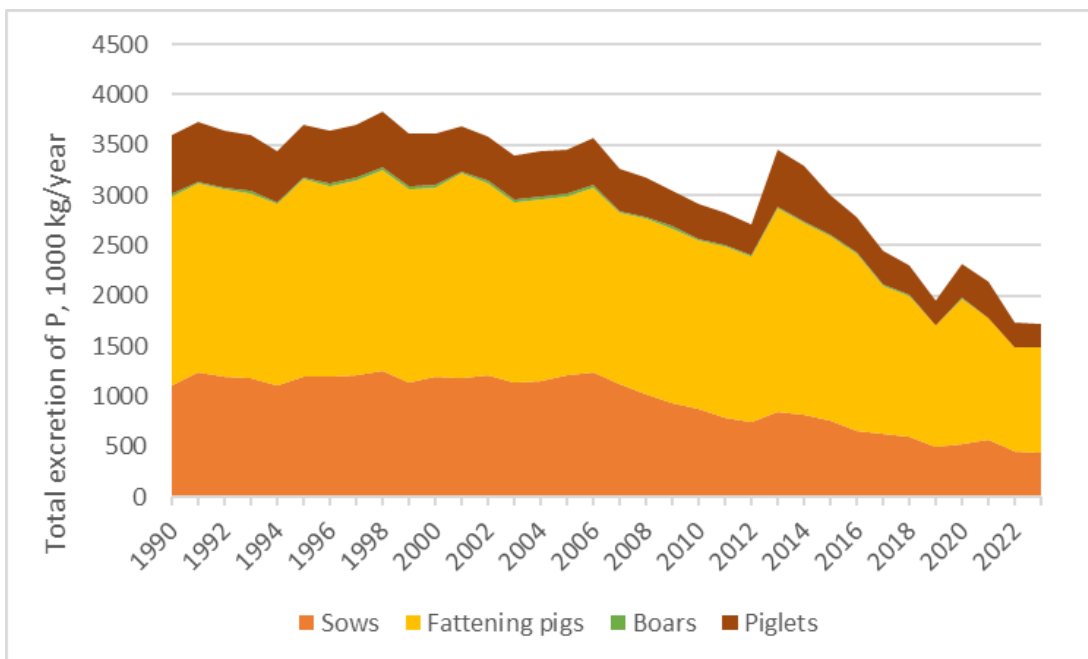
## 4.2. Time series for excretion of pigs in Finland

Annual excretion calculations form a continuous time series, which can show a trend in the excretion of the whole pig population in Finland. The time series is also required for the emission inventories of greenhouse gas and ammonia emissions from manure. The starting point for the time series is year 1990, and the time series is updated with a new annual data point every year when the calculations are completed, or completely, if the calculation method is changed.

Figure 7 shows the time series for the N excretion and Figure 8 for the P excretion of Finnish pigs from year 1990 to 2023. Excretion is presented as thousands of kilograms per year. Different pig categories are shown in different colours. Time series show the effects of changes in diet composition, and also the change in the number of animals throughout the time series. For example, the noticeable peak in the N excretion in 2020 (Figure 7) is due to an increase in Finland's pig population from 2019 to 2020.



**Figure 7.** Total nitrogen (N) excretion for pigs in Finland, thousands of kilograms, from 1990 to 2023.



**Figure 8.** Total phosphorus (P) excretion for pigs in Finland, thousands of kilograms, from 1990 to 2023.

To form a time series for the excretion, a lot of information is needed from the production, i.e. the daily growth rates, diet conformation, slaughter weights, length of production periods etc. For this purpose, a comprehensive data was collected from the stakeholders during autumn 2025. Because the lack of some of the data, especially from the beginning of the time series, mainly from 1990 to early 2000's, it was partly calculated based on the trends seen in later on the time series. For the diet formulation, Finnish feed tables and nutrient

requirements (Kuoppala et al. 2024, Luke 2025b) were used where stakeholder data was unavailable. Time series is updated annually with the changing number of animals, but the update of diet composition needs more resources and data from stakeholders and will be done in every four to five years in the future. Because of the limitations of accurate data available from all the parameters since 1990, timeseries are more of a reflection of the actual excretion with the best possible data available at the time being.

There is a clear decline in both N and P excretion timeseries. This is due to the decrease of whole pig population in Finland throughout this timeline, from over 1.3 million pigs in 1990 to under 1 million in 2023. Also, especially the adding of phytase enzyme in the feeding has decreased the need to give P in the diet and has also had an impact on the P excretion. The breeds used in pig production have also developed during 1990–2023 and at the same time, breeding the production efficiency and at the same time the utilisation of nutrients have developed. This all accounts into declining trend seen in both N and P excretion.

### 4.3. Sensitivity analysis of fattening pigs' excretion

There is many uncertainties concerning the excretion calculations of domestic animals, most of which include the actual feed intake, diet composition and retention of nutrients into the animal. To reduce the effects of these uncertainties, a sensitivity analysis can be done to be able to understand which variables effect the excretion calculation results the most.

Sensitivity analyses for pigs' excretion were conducted so that only one variable at a time was changed; length of the production period, feed intake, dry matter intake (DMI), or diet CP or P concentration was increased or decreased 10% from the average values used in the calculations. Changes on production period has also an effect on growth and weight of the animal which was acknowledged in the calculation. Sensitivity analysis was conducted only for fattening pigs, separately for every feeding phase (Table 23).

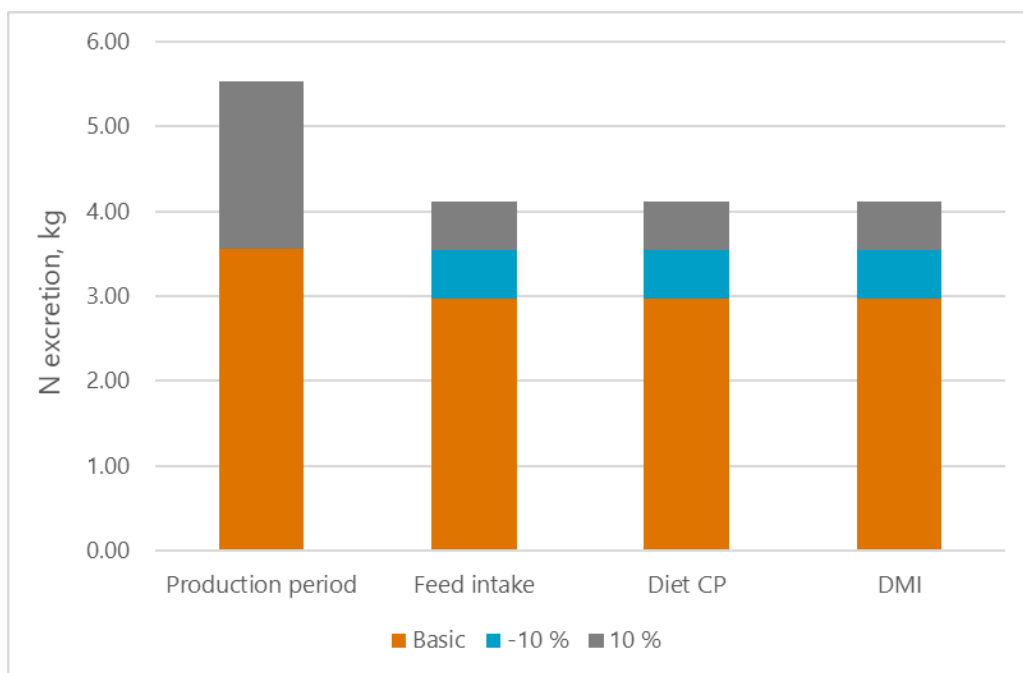
**Table 23.** Input values used in sensitivity analysis calculation of N and P excretion.

		Growing pig, 25–55 kg	Finishing pig, 55–80 kg	Finishing pig, > 80 kg
Production period, days	Basic	24.0	30.0	35.0
	+10%	26.4	33.0	38.5
	-10%	21.6	27.0	31.5
Feed intake, g/day	Basic	2 091	2 535	3 418
	+10%	2 300	2 789	3 760
	-10%	1 882	2 282	3 076
CP, g/kg	Basic	165	150	138
	+10%	181	165	151
	-10%	148	135	124
P, g/kg	Basic	4.90	4.70	4.20
	+10%	5.40	5.10	4.60
	-10%	4.40	4.20	3.80
DMI, g/day	Basic	1 835	2 222	2 991
	+10%	2 018	2 444	3 290
	-10%	1 651	2 000	2 692

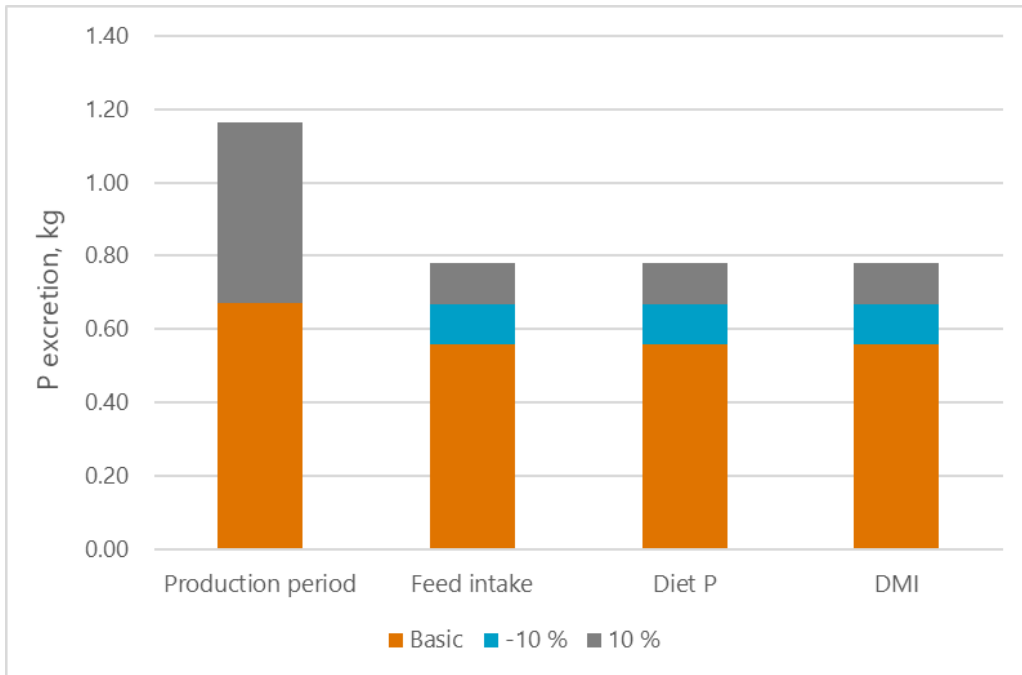
CP = crude protein; P = phosphorus; DMI = dry matter intake

The change in the length of the production period had an effect on excretion of all nutrients studied and the most significant effect on N and P excretion of all variables tested (Figures 9–11). The change in the FI, DMI and concentration of diet CP or P all had a same magnitude effect on P and N excretion (Figures 9 and 10). Variables FI and DMI had same magnitude effect on volume of faeces and urine whereas the CP concentration of the diet had the smallest effect of the variables tested (Figure 11).

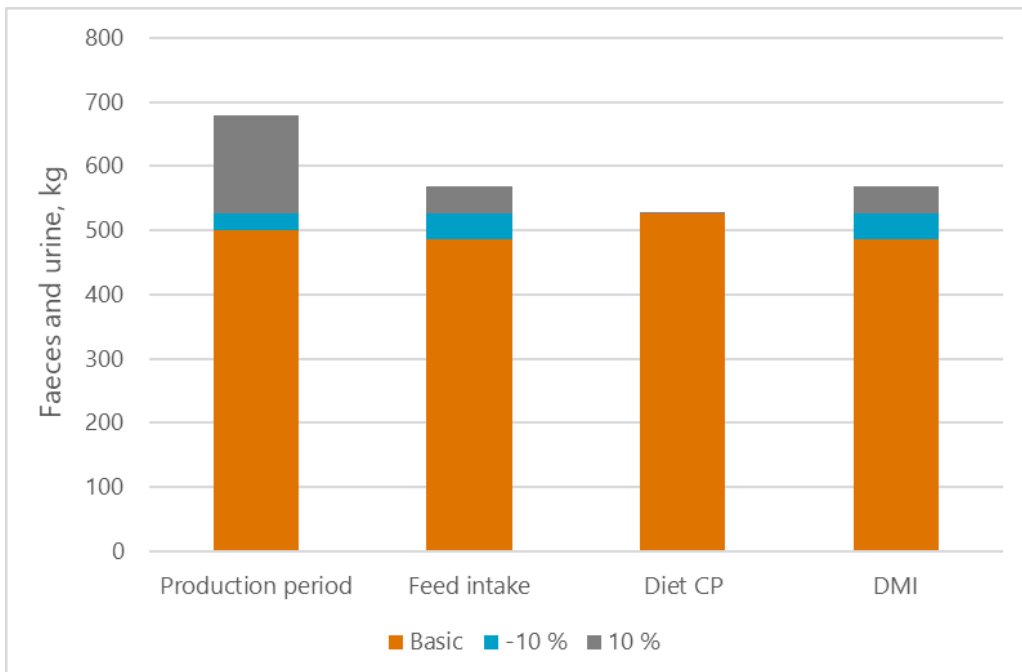
The length of the production period understandably affects the total excretion: the less time the pig stays on production, the less it eats and thus also excretes. Same logic applies for the total FI and DMI; if the animal eats less, it also excretes less and vice versa, since retention of nutrients happens only to some extent. Diet CP concentration affects understandably nitrogen excretion, but it doesn't have a clear effect on the total faecal or urinal excretion, since those are more affected by the diet's digestibility and DM concentration.



**Figure 9.** Total N excretion of a fattening pig from 32 kg onwards when the length of the production period, feed intake (FI), dry matter intake (DMI) or diet crude protein (Diet CP) concentration were changed in the calculation. Grey colour represents 10% increase and blue 10% decrease from the average level (border between grey and blue).



**Figure 10.** Total P excretion of a fattening pig from 32 kg onwards when the length of the production period, feed intake (FI), dry matter intake (DMI) or diet phosphorus (Diet P) concentration were changed in the calculation. Grey colour represents 10% increase and blue 10% decrease from the average level (border between grey and blue).



**Figure 11.** Total faeces and urine excretion of a fattening pig from 32 kg onwards when the length of the production period, feed intake (FI), dry matter intake (DMI) or diet crude protein (Diet CP) concentration were changed in the calculation. Grey colour represents 10% increase and blue 10% decrease from the average level (border between grey and blue).

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## Appendices

**Appendix 1.** Summary of intake and excretion of nutrients of a gilt during growth period (from 25 kg to adulthood) and gilt and its piglets during first farrowing expressed as kg or g per animal per day. Mean values given as weighted arithmetic mean.

	Growing period (32 kg-adult)	Insemination and gestation	Lactation	Gilt, total
Piglets born	13.0			
Weaned piglets	12.0			
Length of the period, d	149	137	32.0	318
Live weight <sup>1</sup>				
Initial, kg	32.0	150	225	32.0
Final, kg	150	225	215	215
Gain, kg/d	0.792	0.547	-0.313	-
Intake <sup>2</sup>				
Total DM intake, kg/d	2.22	2.38	5.71	2.64
Total OM intake, kg/d	2.08	2.23	5.37	2.48
Total N intake, g/d	55.5	54.8	164	66.3
Total P intake, g/d	12.1	13.2	35.6	14.9
Total output				
DM, kg/d	1.92	2.11	5.32	2.35
OM, kg/d	1.80	1.98	5.03	2.21
Nitrogen, g/d	35.8	38.3	106	44.0
Phosphorus, g/d	8.27	9.87	26.2	10.8
Faecal output				
Mass, kg/d	1.75	1.70	2.81	1.84
DM, kg/d	0.45	0.56	0.91	0.54
OM, kg/d	0.38	0.47	0.75	0.45
Nitrogen, g/d	11.6	13.2	23.0	13.4
Phosphorus, g/d	5.10	5.88	13.5	6.29
Urinary output				
Mass, kg/d	4.81	4.71	11.7	5.47
DM, g/d	96.2	94.2	235	109
OM, g/d	54.2	54.1	108	59.7
Nitrogen, g/d	24.2	25.2	82.9	30.6
Phosphorus, g/d	3.17	3.99	12.7	4.49

DM = dry matter; OM = organic matter; N = nitrogen; P = phosphorus

<sup>1</sup> Weight gain of the gilt during gestation does not include the foetuses.

<sup>2</sup> Intake includes the feeding of the nursing piglets during the lactation period (feeding period of piglets 32 days).

**Appendix 2.** Summary of intake and excretion of nutrients of a sow and its piglets expressed as kg or g per animal per day. Mean values given as weighted arithmetic mean.

	Insemination and gestation	Lactation	One farrowing period (total)
Farrowing periods per year	2.30		
Piglets per year	35.5		
Weaned piglets per year	29.3		
Weaning age, d	32.4		
Length of the period, d	127	32.4	159
Live weight <sup>1</sup>			
Initial, kg	247	261	
Final, kg	287	241	
Gain, kg/d	0.343	-0.617	
Intake <sup>2</sup>			
Total DM intake, kg/d	2.55	6.15	3.28
Total OM intake, kg/d	2.39	5.78	3.08
Total N intake, g/d	57.7	177	77.7
Total P intake, g/d	14.1	38.3	18.1
Total output			
DM, kg/d	2.36	5.86	3.07
OM, kg/d	2.21	5.54	2.89
Nitrogen, g/d	45.0	108	57.8
Phosphorus, g/d	11.5	29.7	15.2
Faecal output			
Mass, kg/d	1.83	3.02	2.07
DM, kg/d	0.60	0.98	0.68
OM, kg/d	0.50	0.81	0.56
Nitrogen, g/d	13.9	24.7	16.1
Phosphorus, g/d	6.24	14.6	7.94
Urinary output			
Mass, kg/d	5.15	12.6	6.68
DM, g/d	103	253	134
OM, g/d	54.2	108	65.2
Nitrogen, g/d	31.1	83.0	41.7
Phosphorus, g/d	5.21	15.2	7.24

DM = dry matter; OM = organic matter; N = nitrogen; P = phosphorus

<sup>1</sup> Weight gain of the sow during gestation does not include the foetuses.

<sup>2</sup> Intake includes the feeding of the nursing piglets during the lactation period (feeding period of piglets 31.4 days).

**Appendix 3.** Summary of intake and excretion of nutrients of a boar during growth period (from 25 kg to adulthood), during maintenance and during the first year of age expressed as kg or g per animal per day. Mean values given as weighted arithmetic mean.

	Growth period (25 kg-adult)	Maintenance	1st year
Length of the period, d	197	-	365
Live weight			
Initial, kg	32	220	32
Final, kg	220	254	254
Gain, kg/d	0.95	0.20	0.61
Intake			
Total DM intake, kg/d	2.49	2.56	2.49
Total OM intake, kg/d	2.34	2.34	2.34
Total N intake, g/d	60.4	55.4	58.1
Total P intake, g/d	13.7	13.7	13.7
Total output			
DM, kg/d	2.12	2.40	2.25
OM, kg/d	1.99	2.26	2.11
Nitrogen, g/d	36.6	50.5	43.0
Phosphorus, g/d	9.09	12.8	10.8
Faecal output			
Mass, kg/d	2.27	1.99	2.14
DM, kg/d	0.59	0.58	0.59
OM, kg/d	0.49	0.49	0.49
Nitrogen, g/d	13.8	13.3	13.2
Phosphorus, g/d	5.88	6.03	5.95
Urinary output			
Mass, kg/d	4.41	5.27	4.81
DM, g/d	88.3	105	96.2
OM, g/d	54.1	54.2	54.2
Nitrogen, g/d	23.6	37.2	29.8
Phosphorus, g/d	3.21	6.75	4.84

DM = dry matter; OM = organic matter; N = nitrogen; P = phosphorus

**Appendix 4.** Summary of intake and excretion of nutrients of a piglet expressed as kg or g per animal per day. Mean values given as weighted arithmetic mean.

	Weaned piglet, < 15 kg	Weaned piglet, 15-25 kg	Weaned piglet, total
Length of the period, d	25	28	53
Live weight			
Initial, kg	7.6	14.6	7.6
Final, kg	14.6	32	32
Gain, kg/d	0.28	0.62	0.46
Intake			
Total DM intake, kg/d	0.39	0.92	0.67
Total OM intake, kg/d	0.37	0.86	0.63
Total N intake, g/d	11.7	28.2	20.4
Total P intake, g/d	2.33	5.01	3.75
Total output			
DM, kg/d	0.33	0.73	0.54
OM, kg/d	0.31	0.69	0.51
Nitrogen, g/d	5.32	12.9	9.34
Phosphorus, g/d	0.98	1.99	1.51
Faecal output			
Mass, kg/d	0.23	0.57	0.41
DM, g/d	59.0	147	106
OM, g/d	48.7	121	86.6
Nitrogen, g/d	1.75	4.23	3.06
Phosphorus, g/d	0.84	1.76	1.32
Urinary output			
Mass, kg/d	2.82	3.38	3.12
DM, g/d	56.4	67.6	62.3
OM, g/d	54.1	54.1	54.1
Nitrogen, g/d	3.57	8.69	6.28
Phosphorus, g/d	0.14	0.23	0.19

DM = dry matter; OM = organic matter; N = nitrogen; P = phosphorus

**Appendix 5.** Summary of intake and excretion of nutrients of a fattening pig expressed as kg or g per animal per day. Mean values given as weighted arithmetic mean.

	Growing pig, 25–55 kg	Finishing pig, > 55 kg	Fattening pig, total
Length of the period, d	24	65	89
Live weight			
Initial, kg	32.0	55.0	32.0
Final, kg	55.0	122	122
Gain, kg/d	0.96	1.03	1.01
Intake			
Total DM intake, kg/d	1.83	2.64	2.42
Total OM intake, kg/d	1.73	1.93	2.29
Total N intake, g/d	55.1	68.6	62.0
Total P intake, g/d	10.3	13.2	11.8
Total output			
DM, kg/d	1.52	2.24	2.04
OM, kg/d	1.44	2.13	1.94
Nitrogen, g/d	31.4	42.9	39.8
Phosphorus, g/d	5.60	8.23	7.52
Faecal output			
Mass, kg/d	1.21	1.74	1.60
DM, kg/d	0.31	0.45	0.41
OM, kg/d	0.26	0.38	0.34
Nitrogen, g/d	9.37	13.8	12.6
Phosphorus, g/d	4.21	5.67	5.27
Urinary output			
Mass, kg/d	4.02	4.43	4.32
DM, g/d	80.3	88.6	86.4
OM, g/d	54.1	54.2	54.2
Nitrogen, g/d	22.0	29.0	27.1
Phosphorus, g/d	1.39	2.56	2.25

DM = dry matter; OM = organic matter; N = nitrogen; P = phosphorus



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