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PREDICTION OF NITROGEN, PHOSPHORUS, AND DRY MATTER EXCRETION BY SWINE BASED ON DIET CHEMICAL COMPOSITION, FEED INTAKE, AND NUTRIENT RETENTION (1)

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ABSTRACT

Estimation of nutrient excretion is an essential component in the development of a comprehensive nutrient management plan. Current estimates of nutrient excretion by various classes of swine are outdated and do not allow for prediction of nutrient excretion based on dietary nutrient intake or retention. Thus, our intentions were to develop models for prediction of nutrient excretion based on differing nutritional schemes. The basic approach was a mass balance that calculates nutrient excretion as the difference in nutrient intake (nutrient content and feed intake; NRC, 1998) and nutrient retention (production level, lean growth potential, etc). Estimates of nitrogen, phosphorus, and dry matter excretion were developed for the weanling pig (5 to 20 kg), the growing-finishing pig (20 to 120 kg), and the gestating and lactating sow. For the weanling and growing-finishing pig, intake of nitrogen and phosphorus were estimated based on feed intake and the dietary concentration of the nutrient needed to support a specific fat-free lean tissue gain. Nutrient retention was estimated based on a specific fat-free lean gain. A similar approach was taken to estimate nutrient intake and retention by the sow with the exception that nutrient retention associated with the litter and(or) placenta were estimated. Our estimates of excretion are 14.2, 39.3, 28.8, and 85 g of nitrogen/d and 2.3, 6.7, 9.0, and 21.3 g of phosphorus/d for weanling, growing-finishing, gestation, and lactation phases, respectively. These estimates of nitrogen excretion are greater than current MWPS and NRCS estimates for the weanling pig. The estimate of nitrogen excretion by the growing-finishing pig is greater than these other estimates, but phosphorus is lower. Our estimates for the gestating and lactating sow are quite similar to estimates provided by MWPS and NRCS. The models predict changes in nutrient excretion via dietary manipulation accurately based on published data. Due to the lack of information concerning nutrient excretion under commercial conditions, comparison of the results reported herein to that obtained on commercial farms is difficult. However, based upon the methodology utilized, nutrient excretion can be predicted based upon feed intake, nutrient content of the diet, and production level for pigs managed under commercial conditions.

KEYWORDS. Pigs, nitrogen, phosphorus, excretion

INTRODUCTION

Accurate estimation of manure and nutrient excretion is an essential component of environmental planning for new and existing swine production systems. The development and implementation of a Comprehensive Nutrient Management Plan requires accurate estimates of nutrient excretion from swine facilities. Current estimates of excretion generally are based on values published by the Midwest Plan Service (MWPS), Natural Resources Conservation Service (NRCS), and American Society of Agricultural Engineers (ASAE). However, these estimates are outdated and do not directly allow for modifying excretion based on changes in diet, feed intake, and growth potential. The increasing variety of feed ingredient options, changes in nutritional programs to match improving genetic potential, and feeding strategies designed to reduce nutrient excretion impact the amount and composition of nutrient excretion. Standard methods for estimating nutrient excretion must adapt to these changes and provide methodologies reflective of the specific nutritional programs and genetics used in swine production. The ASAE and Federation of Animal Science Societies (FASS) have initiated a joint effort to review existing standards and develop new, feed program-based models for estimating manure and nutrient excretion. The outcome of the proposed work is to accurately estimate manure and nutrient excretion based upon diet composition, feed intake, and nutrient retention for various classes of swine.

METHODOLOGY

The methodology used to predict nitrogen and phosphorus excretion is based on the difference between nutrient intake and nutrient retention. Dry matter excretion was estimated by assuming the dry matter digestibility of typical diets used in each production phase. In order to predict nitrogen and phosphorus excretion, development of equations for prediction of nutrient intake and retention were needed. The basis for the prediction of nutrient intake and retention, particularly for nitrogen, was the Nutrient Requirements for Swine (NRC, 1998). This publication provided equations for prediction of daily feed intake, chemical composition of the diet needed to meet a specific lean tissue accretion, and nitrogen retention for all weight classes of swine. Additional equations were developed to predict phosphorus retention by swine based on the published literature. We chose only to predict dry matter, nitrogen, and phosphorus excretion due to the limited information available for other nutrients.

Prediction of feed and nutrient intake:

The prediction of feed intake for weanling (5 to 20 kg) and growing-finishing (20 to 120 kg) pigs was based on equations of NRC (1998). Digestible energy intake for 5 to 20 kg pigs was predicted using the following equation:

$$\text{DE intake, kcal/d} = -133 + (251 \times \text{BW}) - \left(0.99 \times \text{BW}^2\right)$$

(1)

For growing-finishing pigs, the following equation was used:

$$\text{DE intake, kcal/d} = 1{,}250 + \left(188 \times \text{BW}\right) - \left(1.4 \times \text{BW}^2\right) + \left(0.0044 \times \text{BW}^3\right)$$

(2)

where DE = digestible energy and BW = body weight in kilograms. Feed intake is then calculated by dividing DE intake by DE concentration of the diet.

Feed intake during gestation was estimated based on the DE intake necessary to support maintenance, whole body protein and fat accretion, and protein accretion of the developing litter and placental tissue. Feed intake is a function of body weight, a targeted gestation weight gain, and the expected litter size (for complete explanation see NRC, 1998). Feed intake of the lactating sow was determined in a similar manner. The DE intake needed to support maintenance, litter growth rate, and sow body weight change during lactation was estimated (NRC, 1998). Feed intake for both gestation and lactation was calculated by dividing daily DE intake by DE concentration of the diet.

Crude protein and phosphorus intake were then calculated by multiplying the percentage concentration of crude protein and phosphorus in the diet by feed intake (g/d). Crude protein concentration of the diet is calculated based on the amount of lysine necessary to meet the animal's needs for a predicted whole body protein accretion. Crude protein concentration of the diet for all classes of swine was calculated using the following equation (NRC, 1998):

$$\text{Crude protein, \%} = 5.22 + \left(15.51 \times \text{True digestible lysine, \%}\right)$$

(3)

Nitrogen intake is then calculated by dividing crude protein intake by 6.25.

Phosphorus requirements, expressed as a concentration of the diet, were calculated for the weanling and growing-finishing pig by a modification of the equation proposed by NRC (1988). The prediction equation is:

$$\text{Phosphorus, \%} = (-0.097 \times (\ln \text{BW, kg})) + 0.8508$$

(4)

Phosphorus concentration of the diet for gestating and lactating sows was that provided by NRC (1998). Dry matter intake is calculated by multiplying the estimated percentage of dry matter in the diet by feed intake.

Prediction of nutrient retention:

Nitrogen

Nitrogen retention for weanling and growing-finishing pigs was predicted based on body weight and daily fat-free lean (FFL) gain. Average daily FFL gain (for equation see NRC, 1998) for the period of 20 to 120 kg provided by the user is corrected to a fractional fat-free lean gain using the following equation:

(5) Fractional FFL gain at a given body weight between 20 and 120 kg, g/d

$$= \begin{pmatrix} 0.4767 + (0.02147 \times \text{BW}) \\ -(0.0002376 \times \text{BW}^2) \\ +(0.000000713 \times \text{BW}^3) \end{pmatrix} \times (\text{Avg FFL}(20 \text{ to } 120 \text{ kg}))$$

Due to the lack of information concerning FFL or whole body protein gain in the 5 to 20-kg pig, prediction of nitrogen retention in the weanling pig is challenging. Because of this lack of information, daily FFL gain in the weanling pig was estimated using the FFL gain growth curve of NRC (1998) for the 20 to 120-kg pig and extrapolating back to 5 kg, with the assumption that FFL gain decreased in a linear manner from 20 to 5 kg. While we realize that lean gain in the weanling pig may not be linear during this time frame, especially the first few days post-weaning, the following was used to calculate FFL gain in the weanling pig:

$$= (0.1267 + (0.0347 \times \text{BW})) \times (\text{Avg FFL } (20 \text{ to } 120 \text{ kg}))$$

(6) Fractional FFL gain at a given body weight between 5 and 20 kg, g/d

Fractional FFL gain is converted to whole body protein gain by dividing fractional fat-free lean gain by 2.55 (NRC, 1998). Nitrogen retention is then calculated by dividing whole body protein gain by 6.25.

Nitrogen retention in the gestating sow was based on data from NRC (1998). Nitrogen retention is a function of sow maternal lean tissue gain, and the anticipated number of pigs born. Nitrogen retention in the gestating sow is estimated by:

$$= ((((\text{Maternal lean tissue gain, kg}) \div 115) \times 23) \times 16) \div 10$$

(7) Maternal nitrogen retention, g/d

and nitrogen retention in the products of conception:

$$= \text{No. of pigs} \times 0.34 \text{ g N/d}$$

(8)

The total nitrogen retained by the sow is the sum of nitrogen retention for maternal gain and for products of conception.

As for the gestating sow, nitrogen retention of the lactating sow was based on NRC (1998). Nitrogen retention is a function of maternal protein change and protein gain of the litter. Nitrogen retained for maternal protein change is calculated using the following (NRC, 1998):

$$= (((\text{Maternal lean tissue change, kg} \div \text{Lactation length, d}) \times 23) \times 16) \div 10$$

(9) Maternal nitrogen retained, g/d

and nitrogen retained associated with the growing litter is calculated by:

$$= \left(\left(\begin{pmatrix} (\text{litter wean wt, kg} \times 20 \times 10) \\ -(\text{litter birth wt, kg} \times 23 \times 10) \end{pmatrix} \div \text{Lactation length, d} \right) \div 6.25 \right)$$

(10) Nitrogen retained by litter, g/d

assuming that whole body protein content is 23 and 20% for the pig at birth and weaning, respectively. Another method to calculate nitrogen retention by the sow is to calculate the amount of nitrogen necessary to support a given litter growth rate. In order to do so, milk production is estimated based on the number of pigs nursed and daily litter weight gain (NRC, 1998).

$$= \begin{pmatrix} (\text{Daily pig weight gain, g/d} \times \text{No. of pigs} \times 4.92) \\ -(90 \times \text{No. of pigs}) \end{pmatrix} \div 1{,}208$$

(11) Estimated milk production, kg/d

Nitrogen retained for milk synthesis is calculated assuming sow's milk contains 5.50% crude protein. Thus, milk production in grams multiplied by 5.5% equals the amount of crude protein produced per day for milk. Crude protein divided by 6.25 would equal the amount of nitrogen needed per day to support milk synthesis for the litter.

Because the estimate of nitrogen secreted in the milk does not take into account the nitrogen excreted by the litter, we chose to estimate nitrogen retention by the lactating sow by adding the nitrogen retained by the litter (Eq. 10) to that retained by the sow (Eq. 9).

Phosphorus

The retention of phosphorus by weanling and growing-finishing pigs was predicted based on data of Jongbloed (1987). However, other data (Rymarz et al, 1982; Mahan and Shields, 1998) were used for comparison purposes. Phosphorus retention in the weanling pig is a function of body weight and is estimated using data from Jongbloed (1987) with minor modifications.

$$= \left(\left(4.7494 \times \text{ending BW, kg}\right) + 1.754\right) - \left(\left(4.7494 \times \text{initial BW, kg}\right) + 1.754\right)$$

(12) Phosphorus retained by the weanling pig, g

Phosphorus retained per day is then calculated by dividing the result of Eq. 11 by the number of days between weights.

Phosphorus content in the growing-finishing pig can be predicted in a similar manner (Jongbloed, 1987):

$$= \left(\left(4.7635 \times \text{ending BW, kg}\right) + 18.763\right) - \left(\left(4.7635 \times \text{initial BW, kg}\right) + 18.763\right)$$

(13) Phosphorus retained by the growing-finishing pig, g

However, we assumed that phosphorus retention by the growing-finishing pig would change in relation to FFL (nitrogen) gain. Thus, it was necessary to develop a prediction equation for phosphorus retention based on nitrogen retention or content of the pig. In order to do so, nitrogen content of the pig needed to be estimated. Nitrogen content of the pig is predicted using a user-provided estimate of dressing percentage (yield) and carcass FFL percentage at 120 kg. Dressing percent and carcass FFL percentage were assumed to change with increasing body weight in a linear manner. The following were used to estimate dressing percentage and FFL percentage at a given body weight between 20 and 120 kg.

$$= \left(\text{DP, \% @ 120 kg} - \left(\left(120 \text{ kg} - \text{initial BW, kg}\right) \times 0.05\right)\right)$$

(14) Dressing percentage at a given body weight, %

$$= \left(\text{FFL, \% @ 120 kg} + \left(\left(\text{120 kg - initial BW, kg}\right) \times 0.07\right)\right)$$

(15) Carcass FFL (%) at a given body weight, %

Dressing percentage and FFL percentage are then used to predict nitrogen content of the carcass at a given body weight by:

$$= \left(\text{BW, kg} \times \text{predicted DP, \%}\left(\text{Eq.14}\right) \times \text{predicted FFL, \%}\left(\text{Eq.15}\right)\right) \div 15.94 \div 10$$

(16) Nitrogen content at a given body weight, g

Phosphorus content is then estimated based on Jongbloed (1987)

$$= \left(0.2256 \times \text{nitrogen weight, g}\left(\text{Eq.16}\right)\right) - \left(0.000008 \times \text{nitrogen weight}^2\right) - 0.03$$

(17) Phosphorus content at a given body weight, g

Phosphorus retained per day is then calculated by subtracting beginning phosphorus content from ending phosphorus content and dividing by the number of days between weights.

Prediction of phosphorus retention in the gestating and lactating sow is more difficult due to the limited data available for these classes of swine. For the gestating sow, phosphorus retention is a function of sow weight gain, and the phosphorus associated with the pigs and placenta. Phosphorus content of maternal weight gain, pigs, and placenta were based on data of Mahan and Newton (1995). Based on these data, it was assumed that the phosphorus content of the gestating sow ranged from 0.55 to 0.60%, and the phosphorus content of the pigs and placenta were 0.57 and 0.08%, respectively. Phosphorus content of maternal sow weight gain was estimated using the following:

$$= \left(\left(3.9717 \times \text{maternal weight gain, kg}\right) + 93.039\right) \div 115$$

(18) Phosphorus retained in sow weight gain, g/d

Phosphorus retention in the pigs and placenta were determined based on the anticipated number of pigs born and pig birth weight.

$$= \left(\text{litter birth weight, kg} \times 0.57 \times 10\right) \div 115 \text{ days}$$

(19) Phosphorus retained in pigs, g/d

$$= \left(\left(\text{wt gain of conceptus, kg - litter birth wt, kg}\right) \times 0.08 \times 10\right) \div 115$$

(20) Phosphorus retained in placenta, g/d

Total phosphorus retained per day by the gestating sow is the sum of that for sow weight gain (Eq. 18), pigs (Eq. 19), and placenta (Eq. 20).

Phosphorus retention by the lactating sow was assumed to be a function of sow body weight change during lactation and phosphorus content of litter weight gain. As for the gestating sow, phosphorus content of the lactating sow was assumed to range from 0.55 to 0.60% (Mahan and Newton, 1995). The phosphorus content of pig weight gain was assumed to be 0.57% of body weight at birth and 0.636% of body weight at weaning (Mahan and Newton, 1995). Phosphorus content of the milk was assumed to be 0.15%. In order to determine total phosphorus retention by the lactating sow and litter, the user must provide sow body weight at farrowing and weaning, pig birth weight and weaning weight, and the number of pigs weaned. Phosphorus retention associated with sow weight change during lactation is estimated by the following:

$$= \begin{pmatrix} (\text{sow BW at weaning, kg} \times 0.55 \times 0.88 \times 10) \\ -(\text{sow BW postfarrowing, kg} \times 0.60 \times 0.88 \times 10) \end{pmatrix} \div \text{lactation length, d}$$

(21) Phosphorus retained in maternal weight change, g/d

and phosphorus retained by the litter was estimated by:

$$= \begin{pmatrix} (\text{litter wt at weaning, kg} \times 0.64 \times 10) \\ -(\text{litter BW at birth, kg} \times 0.57 \times 10) \end{pmatrix} \div \text{lactation length, d}$$

(22) Phosphorus retained in litter weight change, g/d

Phosphorus retained in milk was estimated based on daily milk production (Eq. 11) multiplied by 0.15% phosphorus in milk. Because the estimate of phophorus secreted in the milk does not take into account the phosphorus excreted by the litter, we chose to estimate phosphorus retention by the lactating sow by adding the phosphorus retained by the litter (Eq. 22) to that retained by the sow (Eq. 21).

Prediction of excretion

Nitrogen and phosphorus excretion is estimated by subtraction of retention from intake. However, dry matter excretion was estimated in a different manner. Dry matter excretion is estimated based on the dry matter digestibility of the diet:

$$\begin{aligned} &= (\text{feed intake, g/d} \times \text{diet DM, \%}) \\ &- ((\text{feed intake, g/d} \times \text{diet DM, \%}) \times \text{DM digestibility, \%}) \end{aligned}$$

(23) Dry matter excretion, g/d

Results of Prediction Equations

Table 1 lists the outputs from the prediction equations for the weanling and growing-finishing pigs, and for the gestating and lactating sow. Estimates of body weight gain and feed intake, as well as whole body protein and phosphorus retention are provided.

Table 1. Prediction of intake, retention, and excretion of DM, N, and P for various classes of swine.

	Weanling[a]	Grow-Finish[b]	Gestating sow	Lactating sow
Starting wt, kg	5	20	175	175
Ending wt, kg	20	120	215	170
Days in period	36	120	115	21
BW gain, kg/d	0.417	0.83	0.35	-0.24
Feed intake, kg/d	0.701	2.40	1.88	4.93
Feed:gain	1.68	2.89		
Average CP in diet, %	21.9	15.4	12.4	18.1
Average P in diet, %	0.61	0.44	0.60	0.60
FFL gain, g/d (20 – 120 kg)	320	320		
Fractional FFL gain, g/d	165			
Whole body CP gain, g/d[c]	64.5	123	52.8	386.0
Whole body P gain, g/d[d]	1.98	3.92	2.22	7.30
Anticipated pigs born			12	
Anticipated pigs weaned				10
Daily milk production, kg/d				7.40
DM intake, kg/d	0.617	2.11	1.65	4.34
DM excreted, g/d	86.4	380.0	297.0	781.3
DM excreted for period, kg	3.11	45.8	34.2	16.4
N intake, g/d	24.5	59.0	37.3	142.8
N retained, g/d	10.3	19.7	8.5	57.5
N excreted, g/d	14.2	39.3	28.8	85.2
N excreted, kg for period	0.511	4.73	3.31	1.79
P intake, g/d	4.29	10.65	11.3	29.6
P retained, g/d	1.98	3.92	2.22	8.27
P excreted, g/d	2.31	6.73	9.03	21.3
P excreted, kg for period	0.083	0.81	1.04	0.448

[a]Assumes weanling pigs fed a high, nutrient-dense, corn-soybean meal-animal protein diet with 5% added fat.

[b]Assumes growing-finishing pigs fed a corn-soybean meal diet with 2-3% added fat.

[c]Includes N associated with body lean tissue change, and as needed, that associated with the litter.

dIncludes P associated with body lean tissue change, and as needed, that associated with the litter.

COMPARISON TO OTHER PUBLISHED VALUES

Table 2 shows a comparison between our estimates of excretion and those reported by MWPS (2000), NRCS (1992), and ASAE (2002).

Table 2. Comparison of excretion estimates

Class	Present	MWPS	NRCS	ASAE	% diffa
Weanling pig, 5 to 20 kg					
N, g/d	14.2	9.1	5.5	NA	195
P, g/d	2.3	2.0	2.3	NA	107
Grow-Finish, 20 to 120 kg					
N, g/d	39.3	36.3	24.8	31.7	128
P, g/d	6.7	10.0	9.5	11.0	66
Gestating sow					
N, g/d	28.8	22.7	31.8	NA	106
P, g/d	9.0	8.0	10.0	NA	100
Lactating sow					
N, g/d	85.2	81.7	82.2	NA	104
P, g/d	21.3	26.0	26.2	NA	82

aOur estimate as a percentage of the average estimate of MWPS, NRCS, and ASAE.

Our estimates of nitrogen excretion for the weanling pig are greater than those of MWPS and NRCS. This marked difference in nitrogen excretion may be due to the differences in the method used to generate these values or due to the estimates of feed intake and growth in the weanling pig. Using our methodology and assuming a similar percentage of nitrogen retention for the MWPS estimates, for pigs to excrete that amount assumed by MWPS, daily nitrogen intake would be 15.7 g, which is approximately 9 grams per day fewer than our estimate of intake. This disparity would be much greater for NRCS estimates with a nitrogen intake of 9.5 g/d. In order for these estimates of intake, dietary crude protein concentration or daily feed intake would have to be markedly lower than those we predicted. Furthermore, if nitrogen intake for MWPS and our model were equal, this would lead to a very high rate of lean tissue accretion in the weanling pig to obtain the estimate of excretion of MWPS. These two scenarios may suggest that the estimates of nitrogen excretion by MWPS and NRCS were based on very low nitrogen intakes.

For the growing-finishing pig, our estimate of nitrogen excretion is slightly greater and our estimate of phosphorus excretion is lower than previous estimates. Once again, these differences may be due to the methodology used to predict excretion, and(or) estimates of dietary composition, feed intake, and nutrient retention. Our estimate of nitrogen retention (33%) by the growing-finishing pig is slightly lower than that reported by Kornegay and Harper (1997), but agrees with data of Dourmad et al. (1992). Our estimate of phosphorus excretion is slightly lower than the other estimates, but it is important to note that the dietary levels used in our methodology are those needed to support a specific lean tissue accretion.

Our estimates of nitrogen and phosphorus excretion by the sow agree quite well with the average of MWPS and NRCS estimates. The MWPS estimate of nitrogen excretion by the gestating sow is lower than our current estimate, but for the lactating sow, these two estimates are quite similar. The general agreement in these estimates of excretion is most likely due to the fact that estimates of feed intake and dietary nitrogen and phosphorus content would not vary as much as for the weanling and growing-finishing pig.

Overall, our estimates of nitrogen excretion agree very well with estimates provided by Dourmad et al. (1992). In fact, our estimates of nitrogen retention of 33, 23, and 40% for growing-finishing pigs, gestating and lactating sows, respectively, are very similar to those estimated by these authors. However, our estimate of nitrogen retention by the weanling pigs is lower than that predicted by Dourmad et al. (1992).

It is important to note that the predicted excretion values reported herein are associated with the intake of nutrient necessary to support a given production level (e.g., lean growth rate, milk production). Thus, no allowances were made for nitrogen and phosphorus content of the diet. Greater intakes of nitrogen and phosphorus due to dietary allowances would result in greater excretion estimates than those provided. Also, another possible explanation for the differences in predicted values is the fact the predicted values we propose are based on an "as-excreted" basis and not on an "as-removed" basis as we do not account for losses of nitrogen during storage.

One difficulty in evaluating our estimates is the lack of data concerning nitrogen and phosphorus excretion of pigs housed in commercial conditions. However, there have been many reports evaluating the effect of dietary manipulation on nutrient excretion by growing-finishing pigs (Carter et al, 1996; Cromwell and Coffey, 1993; Kornegay and Harper, 1997). These nutritional manipulations include the feeding of low-protein, amino acid-supplemented diets and the use of phytase which have been found to decrease nitrogen and phosphorus excretion by 20 to 40%. To test our methodology, we compared nitrogen and phosphorus excretion of pigs fed a standard diet to pigs fed a low-protein, amino-acid supplemented diet containing phytase. Our estimates are shown in Table 3.

Table 3. Comparison of excretion for pigs fed a standard diet and those fed a low-protein diet containing phytase1

	Diet		
	Standard	Reduced CP, P	% reduction
N excreted, g/d	39.3	31.6	20
P excreted, g/d	6.73	4.34	36

1Standard diet was formulated to meet requirements for specific lean tissue accretion. Reduced CP, P = crude protein reduced by 2-percentage units with amino acid supplementation and phosphorus lowered by 0.10% with phytase addition.

The 20% reduction in nitrogen excretion by reducing crude protein by 2-percentage units with amino acid supplementation agrees well with the reductions reported under experimental conditions (Cromwell and Coffey, 1993). Also, the reduction in phosphorus excretion with the use of phytase agrees with many published reports (Cromwell and Coffey, 1993; Kornegay and Harper, 1997). Thus, it appears the model will accurately predict the effects of dietary manipulation on nutrient excretion.

CONCLUSION

The development and implementation of a comprehensive nutrient management plan requires accurate estimates of nutrient excretion from swine facilities. The models developed allow for the prediction of nutrient excretion based upon inputs associated with dietary nutrient content, feed intake, and production potential (e.g., lean growth rate, milk production). Our estimates of nitrogen and phosphorus excretion differ from those published by MWPS, NRCS and ASAE, but most likely better define excretion by various classes of swine due to the methodology employed. Also, comparisons between the predicted values reported herein and previous estimates are not directly inferred as our estimates are reported on an “as-excreted” basis, and not on an “as-removed” basis. While “average” values of excretion are provided, excretion estimates may be predicted for a given production system based on user-provided inputs. While the methodology used in the models is our best estimate based on the data available, additional research is needed, especially in the area of nutrient retention in relation to production level for all classes of swine, in order to more accurately predict nutrient excretion. As well, prediction of excretion for other nutrients (e.g., Zn, Cu, S, etc) is difficult due to the lack of data concerning retention of these nutrients by the pig.

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APPENDIX

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Below is an example calculating nitrogen, phosphorus, and dry matter excretion for a growing (20 to 50 kg) pig.

Table 4. Example calculation of N, P, and DM excretion1

Step	Description	Start	End	Avg/Total
1	Weight, kg	20	50	
2	No. days between weights			39
3	DE required, kcal/d (Eq. 2)	4,485	7,700	
4	DE concentration of diet, kcal/kg	3,580	3,580	
5	Feed intake, g/d (((Step 3/Step 4)*1000) or own estimate)	1,252	2,150	1,701

6	DM, % of diet	88	88	
7	DM digestibility, %	82	82	
8	ADG, g/d (difference in wt/No. of days * 1000)			769
9	Feed:Gain (Step 5/Step 8 or own estimate)			2.21
10	CP, % in diet	20.87	17.06	18.9
11	N intake, g/d ((Step 5 * Step 10/100)/6.25)			51.4
12	P, % in diet (Eq. 4 or own estimates)	0.564	0.475	.52
13	P intake, g/d (Step 5 * Step 12/100)			8.85
14	FFL gain, g/d (Eq. 5 or own estimates)	261	334	
15	Whole body protein gain, g/d (Step 14/2.55)	102.4	130.9	
16	Dressing percent, % (Eq. 14 or own estimates)	69.0	70.5	
17	FFL, % (Eq. 15 or own estimates)	59.0	56.9	
18	N in pig, g (Eq 16)	511	1,259	
19	N retained, g/d (difference in Step 18/No. of days)	16.4	20.9	19.2
20	P in pig, g (Eq. 17)	113.1	271.2	
21	P gain, g/d (difference in Step 20/No. of days)			4.05
22	N excreted, g/d (Step 11 – Step 16)			32.2
23	N excreted for period, kg (Step 22 * No. of days/1000)			1.26
24	P excreted, g/d (Step 13 - Step 21)			4.80
25	P excreted for period, g (Step 24 * No. of days)			187
26	DM excreted, g/d (Eq. 23)			269
27	DM excreted for period, kg (Step 26 * No. of days/1000)			10.51

1Assumes 320 g FFL gain/d for 20 to 120 kg, average dressing percent at 120 kg of 74%, and average FFL (%) of 52% at 120 kg.