

ANNEX 7: SCIENTIFIC CASE TO DEVIATE FROM STANDARD N EXCRETION VALUES FOR PIGS

Nitrogen (N) excretion of growing and finishing pigs – proposed new values

Ten experimental diets were formulated and offered to pigs from 10 wks of age to finish. Pigs were weighed at 10 wk, 13 wk, 16 wk and at finish to calculate average daily gain (ADG) and average daily feed intake (ADFI). These values were used to calculate N excretion – representing N excretion without volatilisation. The diets were also offered in a digestibility trial and N excretion was determined through chemical analyses of urine and faeces – this represents N excretion with volatilisation.

The values for N intake, retention and excretion for the pigs on the digestibility trial are given in Table 1.

Table 1: N balance data as determined through chemical analysis

Diet	N intake (g/d)	N retention (g/d)	N excretion (g/d)
1	53.3	30.1	23.2
2	52.2	29.6	22.0
3	46.5	27.9	18.6
4	45.2	26.9	18.3
5	37.7	24.0	13.6
6	53.1	27.1	26.0
7	50.0	27.6	22.4
8	47.7	25.8	21.9
9	43.4	26.3	17.1
10	39.6	24.3	15.3

ADG measured in the performance trial was also used to calculate N retention using the internationally accepted assumption that 16% of growth is crude protein retention ($ADG * 0.16$, Whittemore *et al.*, 1988). Using the N intake values and this calculated figure for retention it was possible to calculate N excretion. Tables 2 and 3 present the N balance figures for pigs from 13-16 wk and 16 wk to finish respectively.

Table 2: N balance as calculated through performance data (13-16 wk, 39-55 kg)

Diet	ADG (g/d)	ADFI (g/d)	N intake (g/d)	N retention (g/d)	N excretion (g/d)
1	655	1653	51.0	16.8	34.2
2	721	1688	49.6	18.5	31.1
3	707	1661	44.8	18.1	26.7
4	730	1689	42.1	18.7	23.4
5	718	1655	37.8	18.4	19.4
6	631	1704	52.3	16.2	36.1

7	682	1699	48.7	17.5	31.2
8	667	1700	45.4	17.1	28.3
9	707	1779	43.7	18.1	25.6
10	678	1680	38.6	17.4	21.2

Table 3: N balance as calculated through performance data (16 wk-finish, 55-92 kg)

Diet	ADG (g/d)	ADFI (g/d)	N intake (g/d)	N retention (g/d)	N excretion (g/d)
1	957	2304	71.0	24.5	46.5
2	942	2325	68.3	24.1	44.2
3	926	2265	61.1	23.7	37.4
4	935	2295	57.2	23.9	33.3
5	963	2271	51.9	24.7	27.2
6	929	2285	70.2	23.8	46.4
7	905	2361	67.7	23.2	44.5
8	930	2291	61.2	23.8	37.4
9	943	2324	57.3	24.1	33.2
10	925	2302	52.9	23.7	29.2

It is obvious that N excretion is substantially higher when calculated through ADG and this is due to volatilisation. When excretion is determined through analyses of urine and faeces, the N in the urine is underestimated due to volatilisation. This occurrence has been widely accepted in the literature, and loss of N as ammonia occurs as soon as urine leaves the animal. Therefore, to meaningfully calculate N in the slurry, volatilisation must be taken account of. Table 4 shows the amount of volatilisation which occurred and the average value was found to be 29%.

Table 4: Amount of volatilisation occurring with total collection of faeces and urine

Diet	N excretion (g/d)		% Difference
	Determined	Calculated from ADG (13-16 wk)	
1	23.2	34.2	32.2
2	22.0	31.1	29.3
3	18.6	26.7	30.3
4	18.3	23.4	21.8
5	13.6	19.4	29.9
6	26.0	36.1	28.0
7	22.4	31.2	28.2
8	21.9	28.3	22.6
9	17.1	25.6	33.2
10	15.3	21.2	27.8
Average	19.8	27.7	28.5

For the following calculations volatilisation is assumed to be 29%.

Diet 3, formulated to contain 16.9% CP and 0.9% available lysine, is a typical diet offered to finishing pigs at AFBI Hillsborough. Therefore, the N excretion values obtained through offering this diet have been used to calculate N excretion of finishing pigs from 30-100 kg.

DIET 3 – 16.9% CP and 0.9% available lysine

For 31-65 kg category:

Intake = 1661 g/d
N intake = 44.8 g/d
ADG = 707 g/d
N retention = 18.1 g/d
N excretion = 26.7 g/d (including N which will be lost through volatilisation)
N excretion = 22.1 g/d (actual N in slurry after volatilisation)
N excretion/pig = $19.0 \times 46^* = \mathbf{0.87 \text{ kg N/pig}}$ (*assuming 46 days in stage)

For 66-100 kg category:

Intake = 2265 g/d
N intake = 61.1 g/d
ADG = 926 g/d
N retention = 23.7 g/d
N excretion = 37.4 g/d (including N which will be lost through volatilisation)
N excretion = 26.6 g/d (actual N in slurry after volatilisation)
N excretion/pig = $26.6 \times 43^* = \mathbf{1.14 \text{ kg N/pig}}$ (*assuming 43 days in stage)

Table 5 compares N excretion (kg/pig) values given in the DARD and DEFRA Action Programmes with the new values proposed in this document. DARD 2006 values are significantly higher than DEFRA 2008. The evidence from the results of this current study indicates that pigs excrete less N than the values published by DEFRA 2008 and DARD 2006.

Table 5: Comparison of N excretion values (kg/pig) for finishing pigs from DARD 2006 and DEFRA 2008

	DARD (2006)	DEFRA (2008) [^]	New values for 16.9% CP
Sows + litter	19.5	15.9	As for DEFRA
Boar	16.0	17.5	As for DEFRA
Gilt	13.0	11.1	As for DEFRA
Weaner 1	0.26 (7-18 kg)	0.09* (7-12 kg)	As for DEFRA
Weaner 2	0.46 (18-35 kg)	0.29** (13-30 kg)	As for DEFRA
Grower	Not given	1.1 [#] (31-65 kg)	0.87 (31-65 kg)
Finisher	2.69 (35-105 kg)	1.45 ^{##} (66-100 kg)	1.14 (66-100 kg)
Total (wean to 100 kg)	3.41	2.93	2.39

[^] DEFRA 2008 values are generally lower as N volatilisation has been accounted for

* N excretion kg/pig calculated using DEFRA assumptions of occupancy rate and days in accommodation – $(365 \times 71\%) / 21 = 12.3$ cycles. Therefore, $1.1 / 12.3 = 0.09$ kg N/pig.

** $(365 \times 82\%) / 21 = 14.3$ cycles. Therefore, $4.2 / 14.3 = 0.29$ kg N/pig

$(365 \times 89\%) / 46 = 7.0$ cycles. Therefore, $7.7 / 7.0 = 1.1$ kg N/pig

$(365 \times 86\%) / 43 = 7.3$ cycles. Therefore, $10.6 / 7.3 = 1.45$ kg N/pig

Letter to John Speers (DARD) and Maggie Smith (DOE) 11 December 2009

At the first meeting of the Nitrates Review Scientific Working Group, it was agreed that CAFRE would write to you as joint Chairs of the Project Management Board to provide information on recent research findings regarding nitrogen excretion from pigs.

The Agri-food and Biosciences Institute (AFBI) has recently conducted research which investigated the CP levels in diets of finishing pigs and the subsequent effect on nitrogen excretion levels. The results have shown that finishing pigs excrete less nitrogen than the value quoted in the NI Nitrates Action Programme (2.01 vs. 2.69 kg N/pig).

In reviewing the area, AFBI has also suggested that the values for sows and weaning pigs, quoted in the DEFRA 2008 Nitrates Action Programme be adopted. The NI Nitrates Action Programme was based on a previous publication by DEFRA (2003) and the values quoted then for nitrogen excretion did not take full account of the nitrogen lost through volatilisation. However, the current DEFRA Nitrates Action Programme (2008) publication has now taken account of volatilisation.

AFBI propose that the values laid out in the Nitrates Action Programme be changed according to the following table:

	NI Nitrates Action Programme	DEFRA Nitrates Action Programme	Proposed values
Sows + litter	19.5	15.9	As for DEFRA

Boar	16.0	17.5	As for DEFRA
Gilt	13.0	11.1	As for DEFRA
Weaner 1	0.26 (7-18 kg)	0.09 (7-12 kg)	As for DEFRA
Weaner 2	0.46 (18-35 kg)	0.29 (13-30 kg)	As for DEFRA
Grower	Not given	1.1(31-65 kg)	0.87 (31-65 kg)
Finisher	2.69 (35-105 kg)	1.45(66-100 kg)	1.14 (66-100 kg)
Total (wean to 100 kg)	3.41	2.93	2.39

The scientific case to support these changes is given in the attached document.

The work carried out by AFBI was conducted using diets typical of those now used by commercial pig producers throughout Northern Ireland (16.9% CP and 0.9% available lysine). CAFRE confirm that the proposed “new” values are reflective of the situation on commercial pig farms across Northern Ireland.

It would be of great benefit to use this information when reviewing the NI Nitrates Action Programme as the new values will allow for a more accurate calculation of the actual nitrogen in pig slurry, thus resulting in more efficient use when land spread.

If you require more information please discuss with Ian McCluggage and/or Elizabeth McCann.

Yours sincerely

John Fay (College of Agriculture, Food and Rural Enterprise Director)