



AFBI research on cattle N excretion rates
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Nitrates Action Programme 2019 - 2022

Stakeholders meeting 27 February 2019

Agri-Food and Biosciences Institute (AFBI) Agriculture Branch, Hillsborough

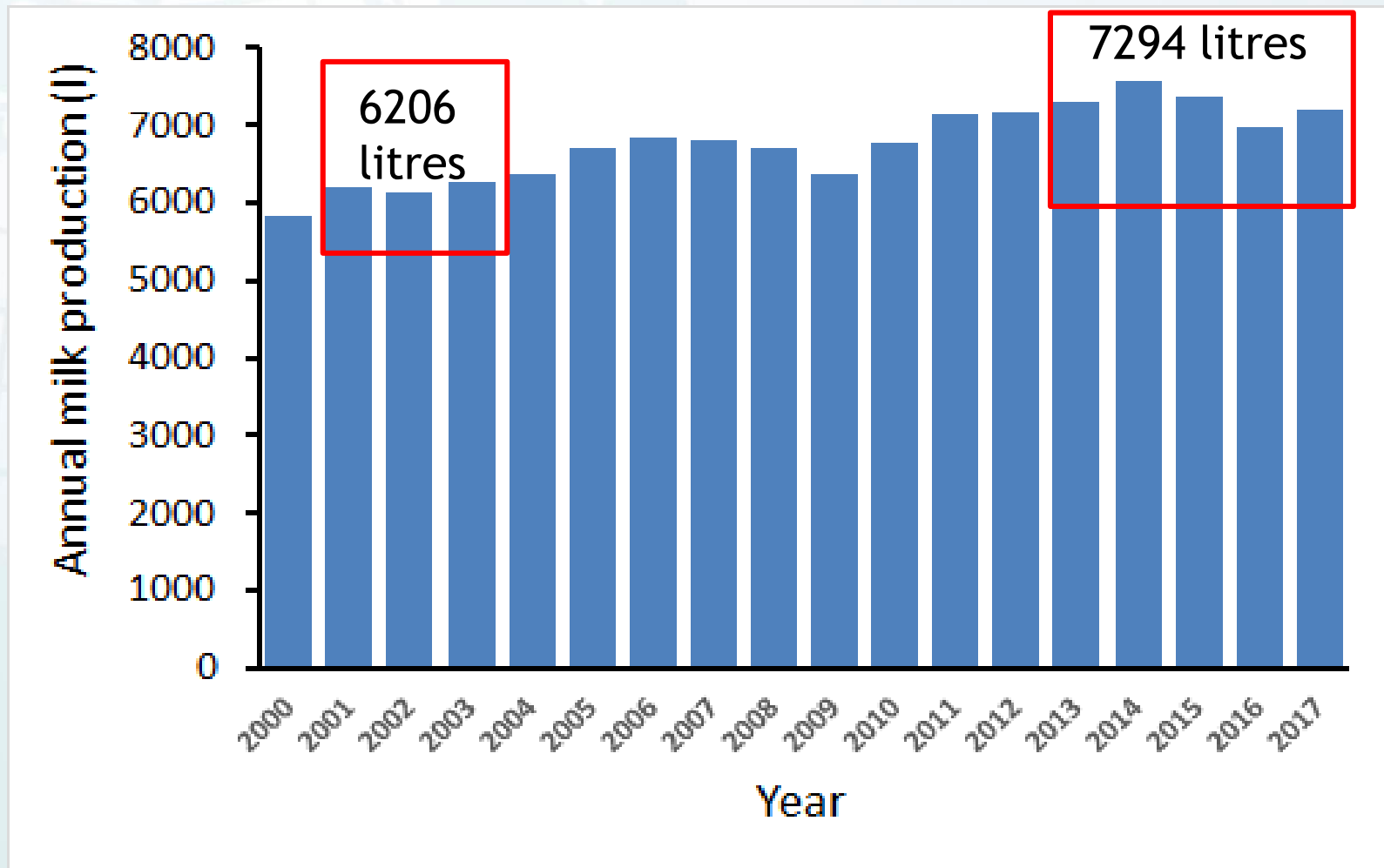
Why revisit the ruminant N excretion values?

- ◆ N excretion values for all classes of livestock are kept under review – updated as new data become available.
- ◆ Original analysis conducted in 2004, so much of the data used is between 15 and 25 years old
- ◆ Livestock production systems in Northern Ireland have changed significantly over that time
 - ◆ Average milk yields have increased
 - ◆ Diet protein levels have fallen
 - ◆ Livestock genetics have changed – efficiency?



Calculation of manure N excretion for dairy cattle

Changes in annual milk production per cow since 2000 *(Stats. Rev. of NI Agric)*



Original NAP based on 2001 - 2003 data, updated NAP based on 2013 - 2017 data

Calculation of N excretion values for dairy COWS

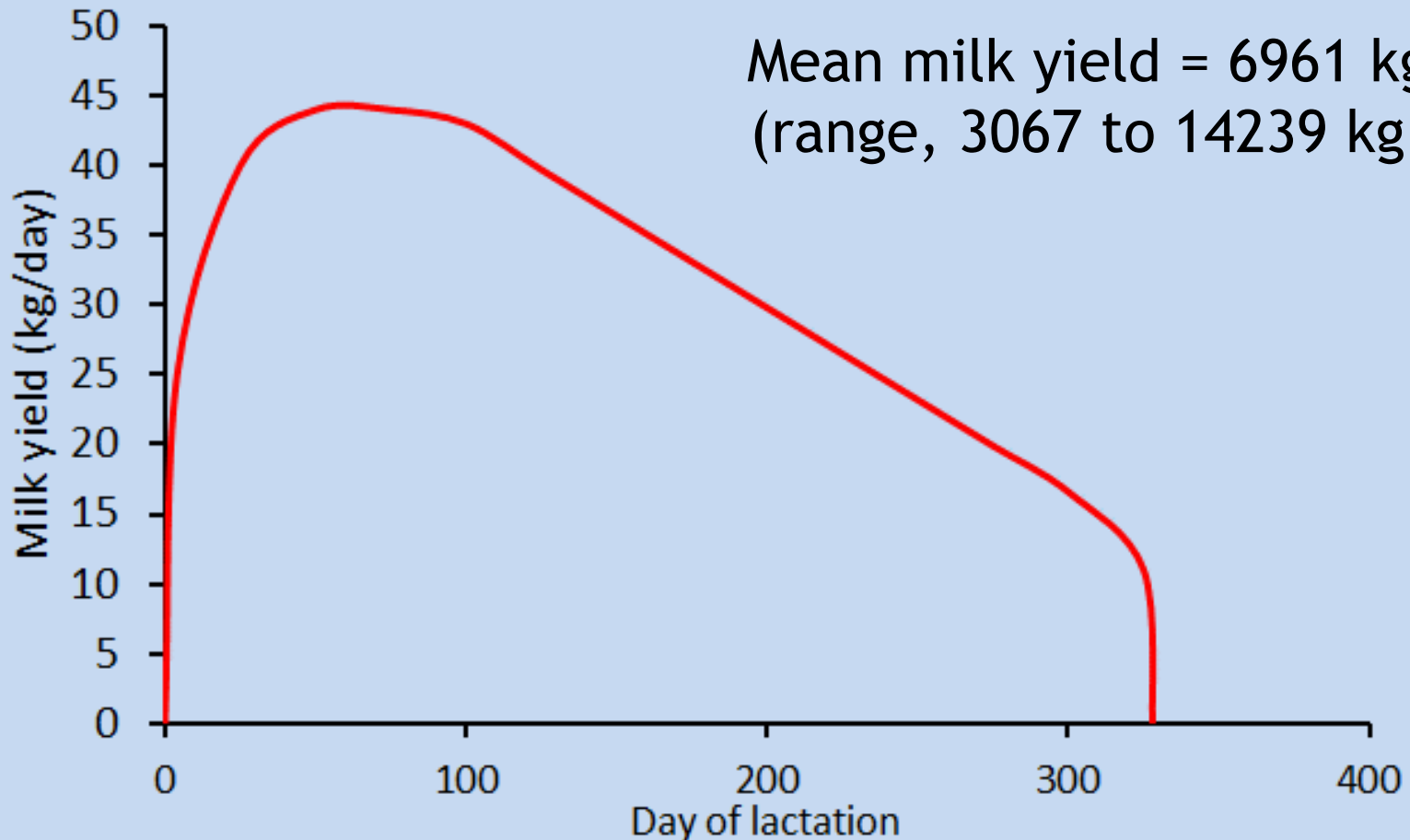
- ◆ Two main steps:
 - ◆ Establish the relationship between milk production and N intake: this allows us to calculate total N intake over one year for the average NI dairy cow
 - ◆ Establish the relationship between N intake and manure N excretion: this allows us to calculate total N excretion for the average NI dairy cow

Establishing the relationship between milk production and N intake (i)

Full lactation data obtained from 8 AFBI studies

25 treatments, 476 cows

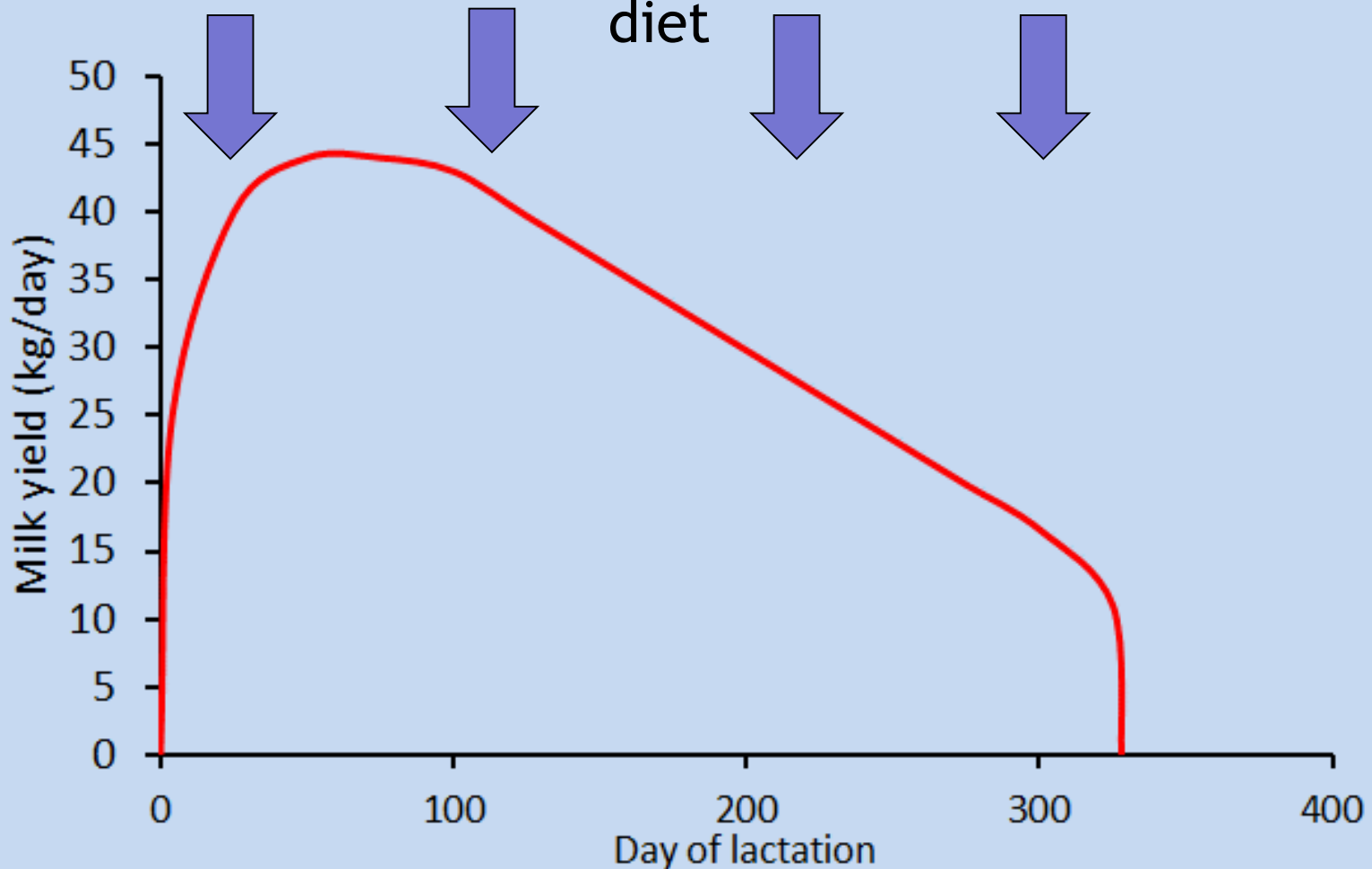
Mean milk yield = 6961 kg
(range, 3067 to 14239 kg)



Establishing the relationship between milk production and N intake (ii)

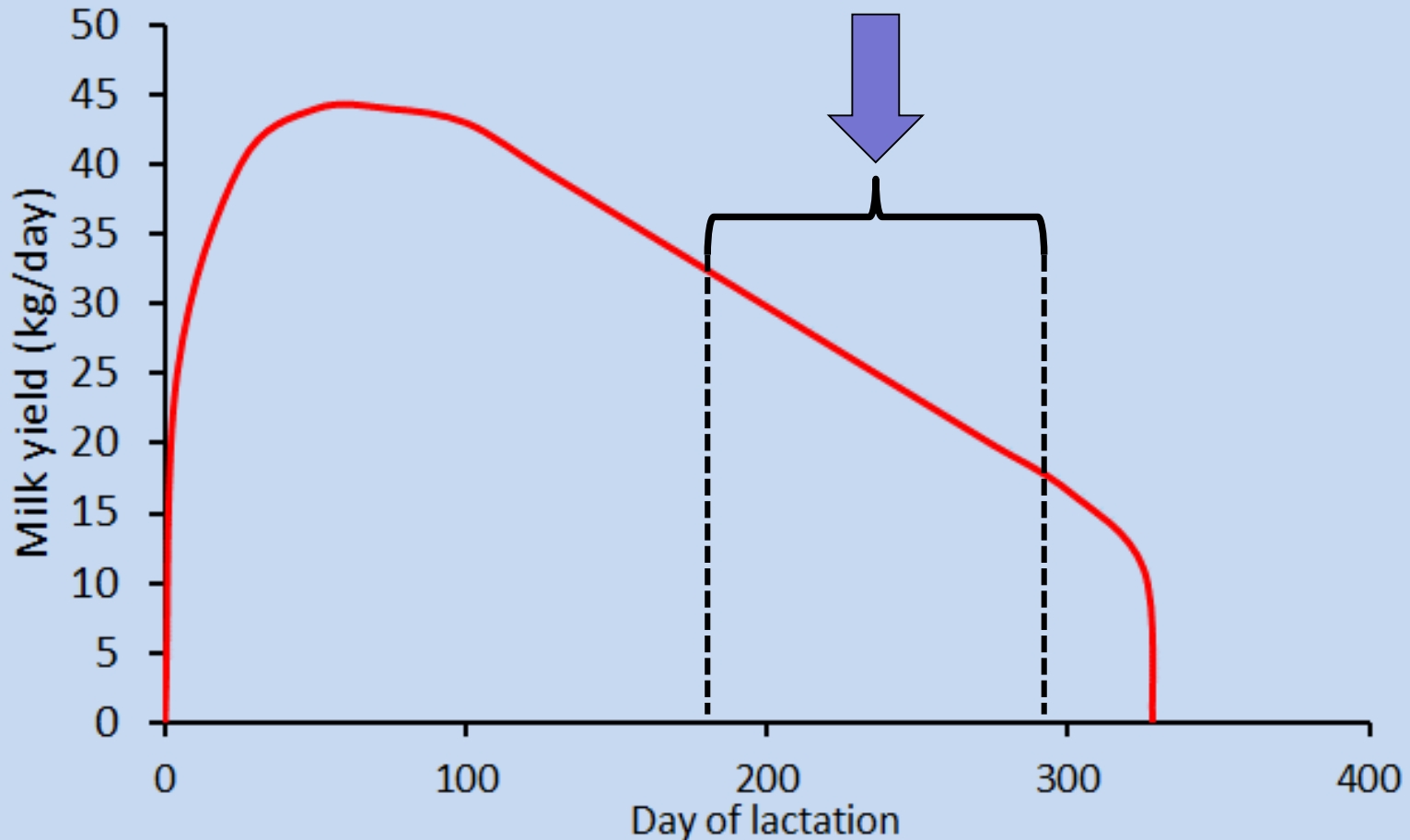
Total N consumed during the lactation calculated from DM intakes and N content of the

diet



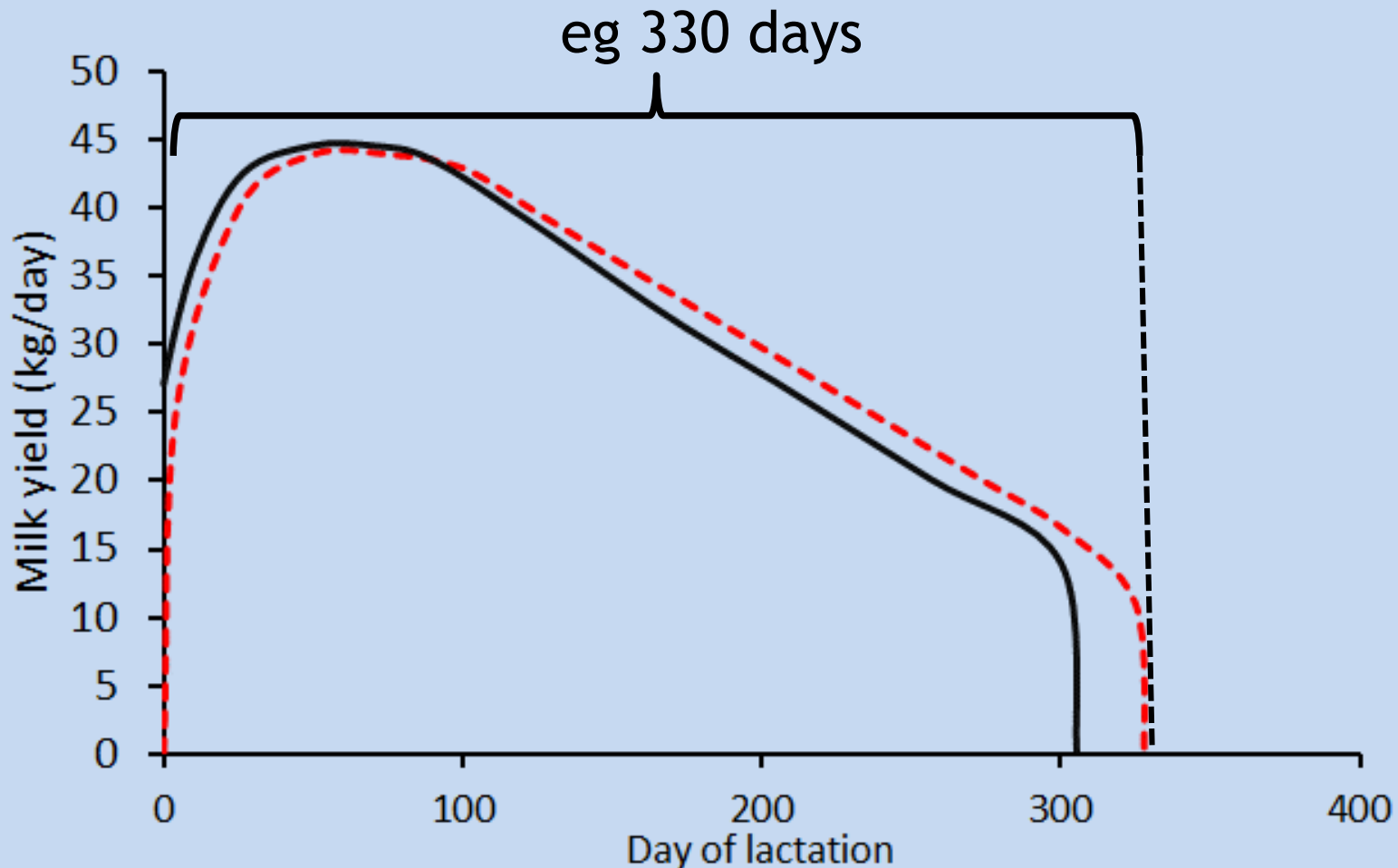
Establishing the relationship between milk production and N intake (iii)

During grazing, N intake of grazed grass calculated from FIM based on cow performance, and N content of the diet



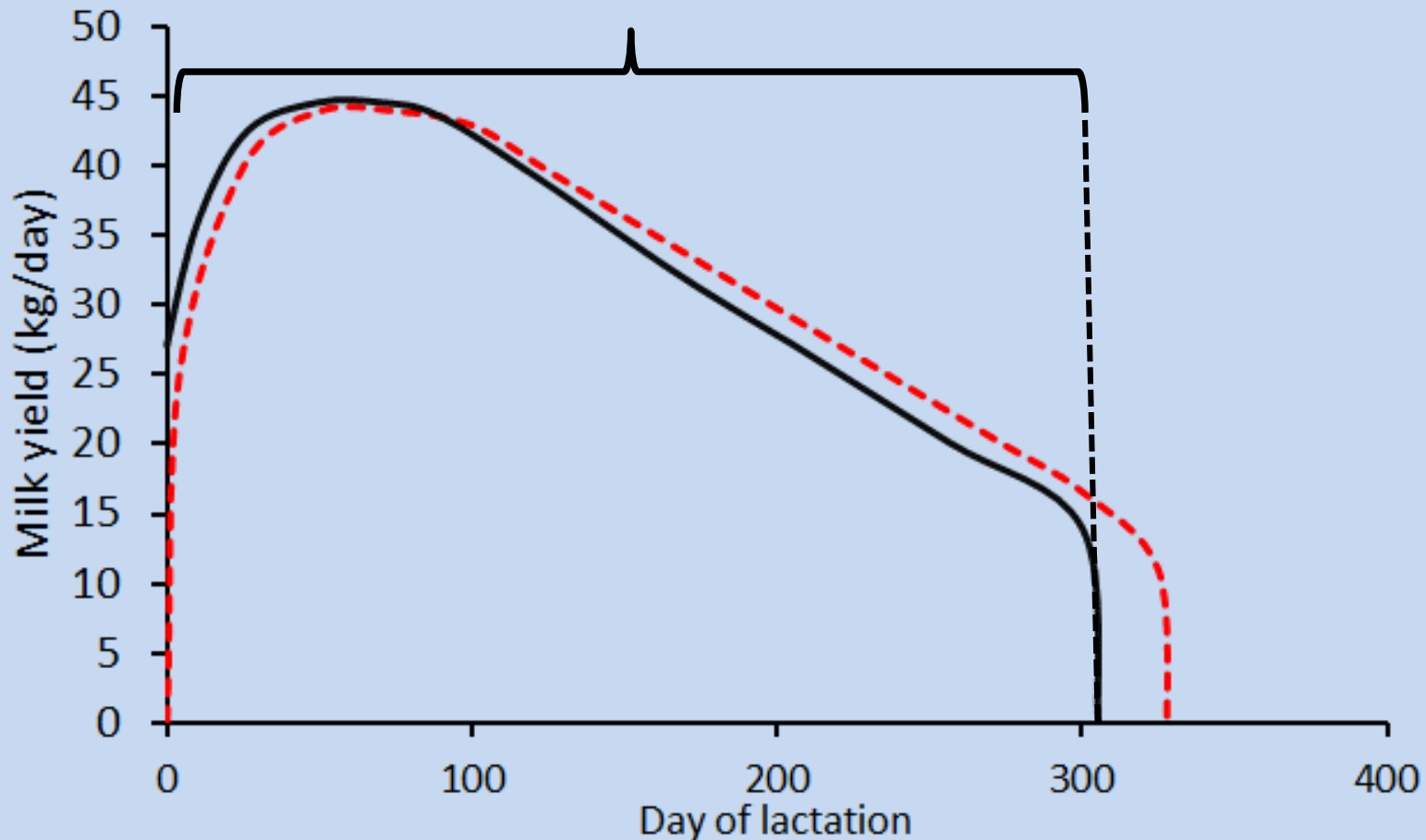
Establishing the relationship between milk production and N intake (iv)

Milk production and N intake for each cow then adjusted from actual lactation length

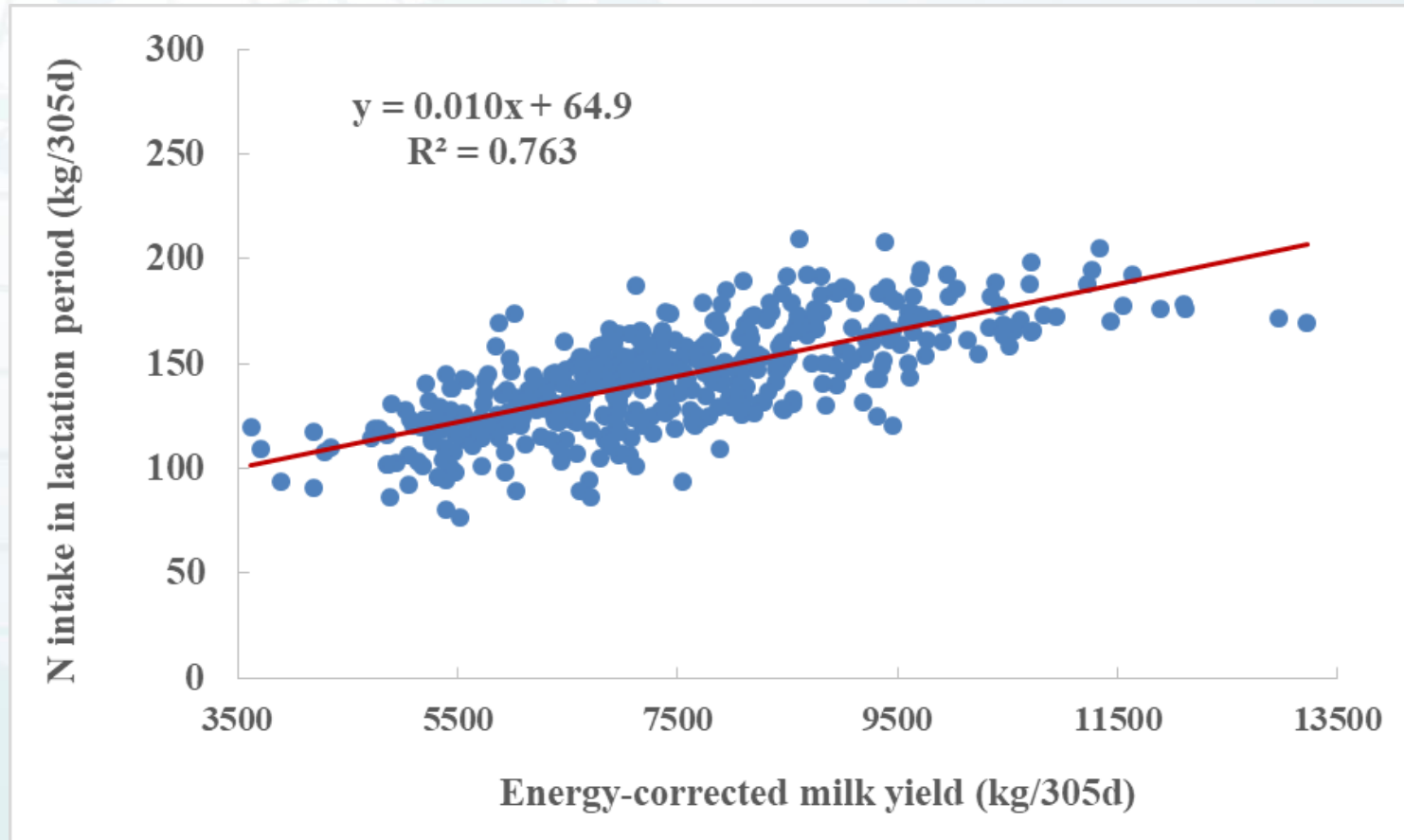


Establishing the relationship between milk production and N intake (iv)

....to a 305 day annual basis



Establishing the relationship between ECM yield and N intake (v)



ECM yield used due to higher composition of milk from AFBI herd (4.5% fat, 3.5% protein) compared to NI average (4.0% fat, 3.25% protein)

Calculation of N excretion from dairy cows

Average NI milk yield for last 5 years = 7250 litres @ 4.0% fat
and 3.24% protein

Equivalent to = 7400 kg ECM

N intake = $0.010 \text{ ECM} + 64.9$

= 138.9 Kg N consumed during lactation

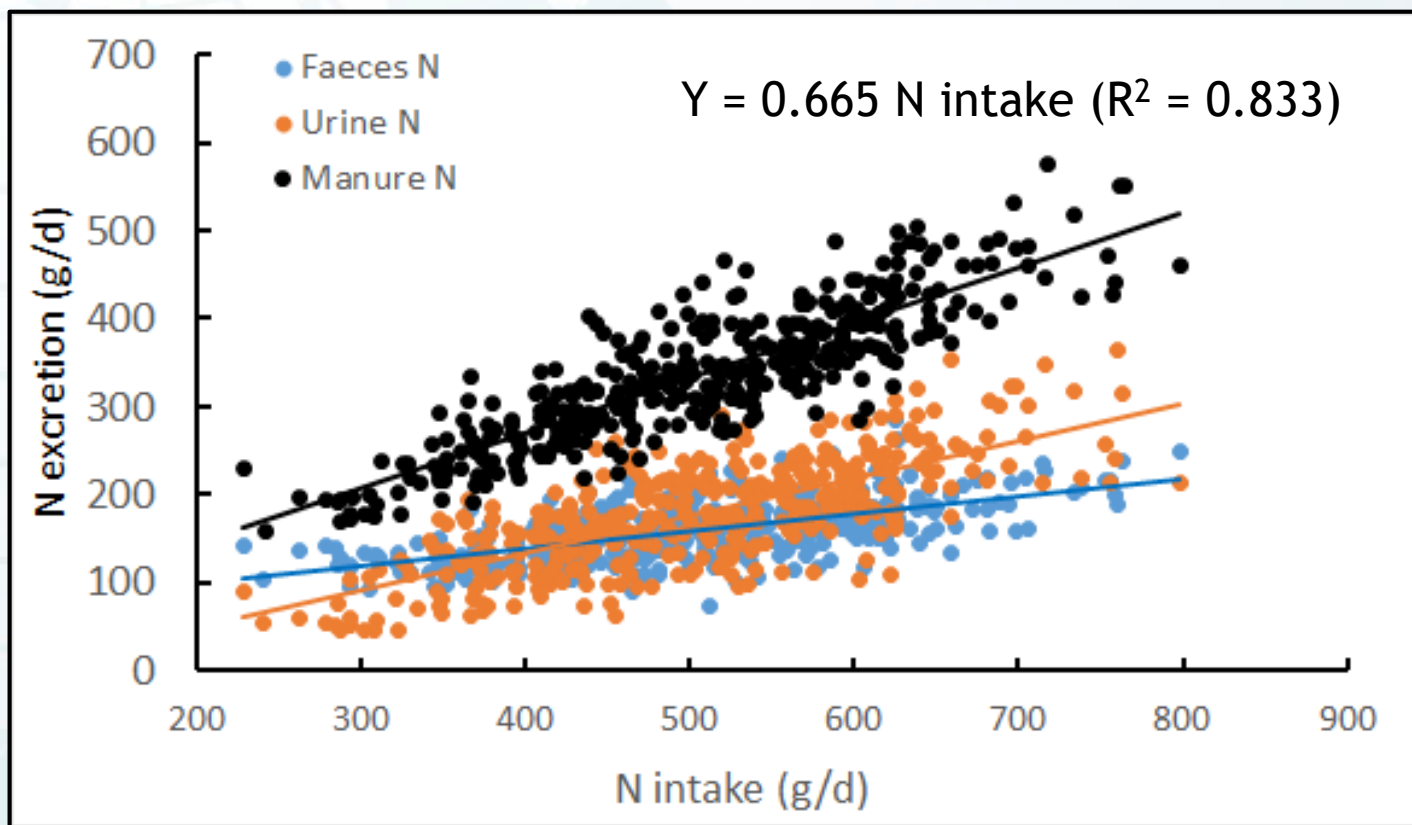
But how much of this is excreted in manure??

Previous NAP used an efficiency of 0.72

Is this still relevant with today's cows?

Has N use efficiency changed since the last NAP?

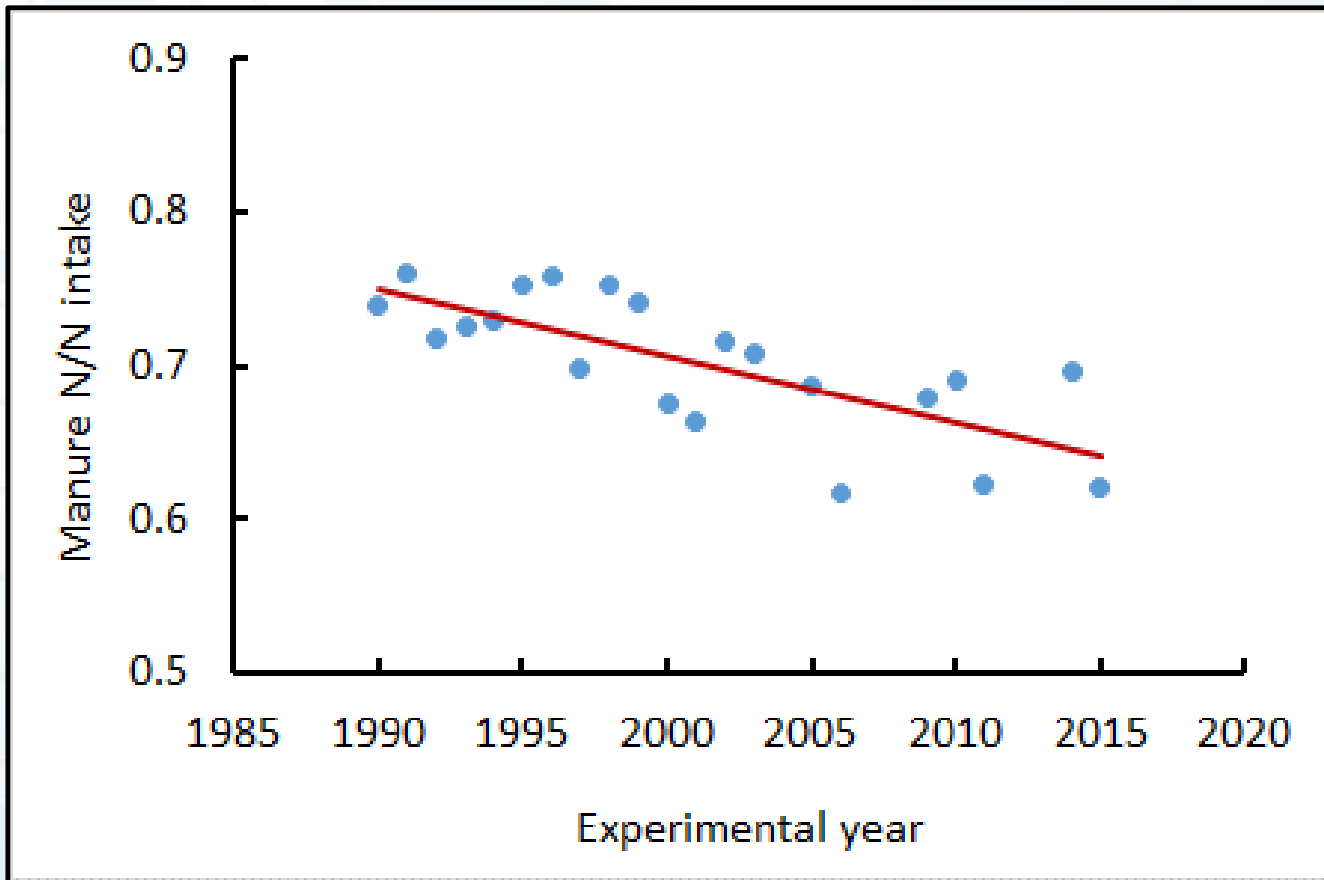
Examined using data collected over the last 15 from the AFBI Energy Metabolism Unit (388 cows)



Efficiency in previous NAP was 0.72 Revised efficiency is 0.665

N use efficiency has improved....Why?

Reason for improvement in N use efficiency?



Appears to be a continual long term improvement in efficiency over many years - most likely a genetic effect

Final calculation of N excretion for the average NI dairy cow

$$Y = 0.010 \times 7400 + 64.9$$
$$= 138.9 \text{ Kg N consumed during lactation}$$

$$\text{N consumed during lactation} \times \text{N use efficiency}$$
$$138.9 \times 0.665$$
$$= 92.4 \text{ kg N excreted during lactation}$$

Manure N output during the dry period calculated from published values = 8.1 kg/60 days

$$\text{So total manure N output (lactation + dry period) =}$$
$$92.4 + 8.1 = 100.4$$

$$= 100 \text{ kg manure N/cow/year}$$



*Calculation of manure N excretion for
growing cattle and suckler cows*

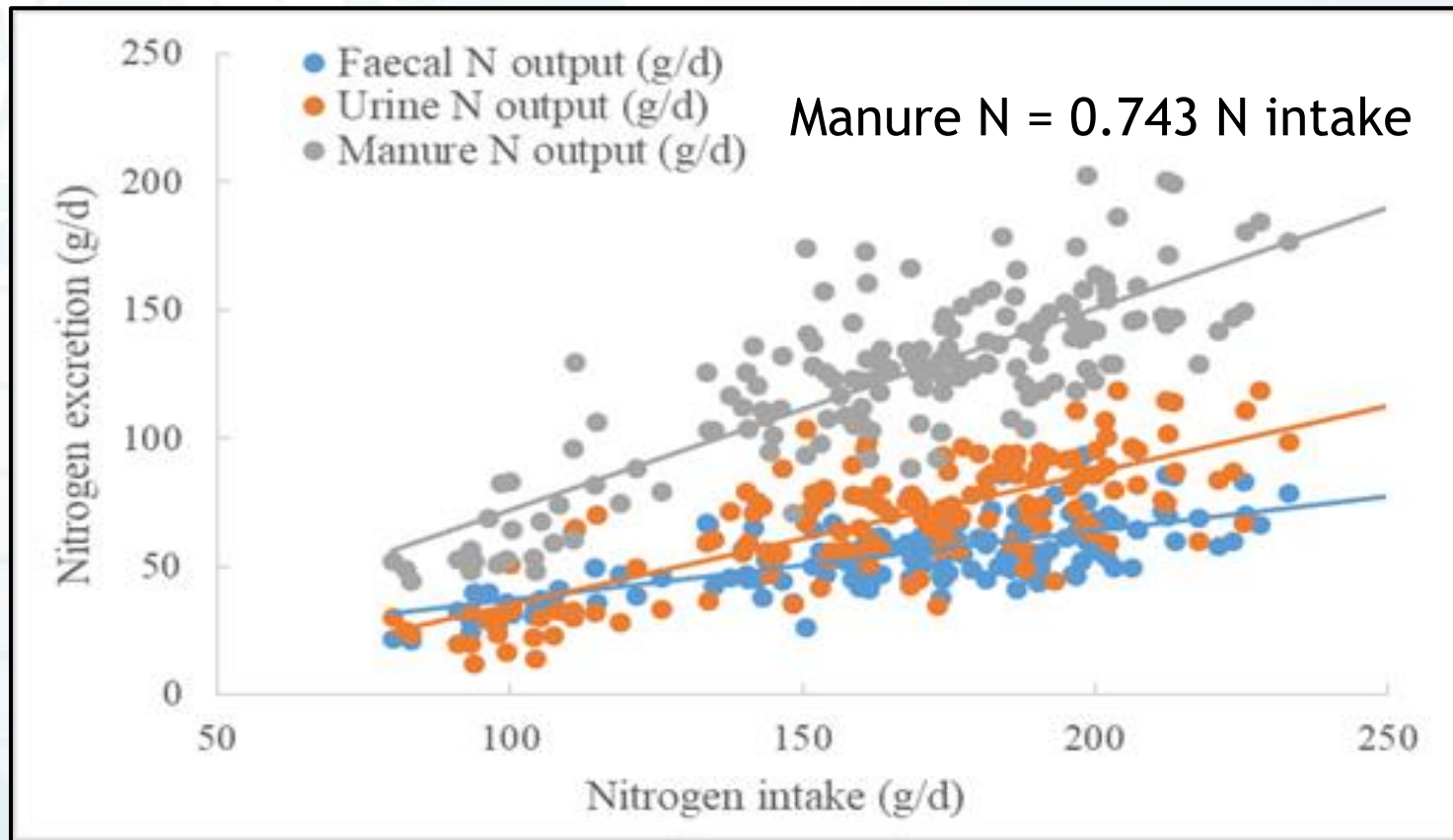
Calculation of N excretion values for growing cattle and suckler cows

- ◆ Two main steps:
 - ◆ Establish if there evidence that manure N use efficiency has improved over the last 15 years.
 - ◆ Develop equations to predict manure N excretion for different classes of cattle based on live-weight and diet characteristics

Has N use efficiency of cattle and suckler cows increased over the last 15 years

- ◆ Digestibility data obtained from AFBI energy metabolism unit
- ◆ Studies undertaken between 2003 - 2017
- ◆ Data from 128 growing cattle and 29 suckler cows
- ◆ Range in live-weight from 143 – 828 kg
- ◆ Range in diet composition
 - ◆ Crude protein from 9.5 - 20.1%
 - ◆ Forage proportion from 45 – 100%

The relationship between N intake and manure N output in growing cattle and suckler cows (2003 - 2017)



Efficiency in previous NAP was 0.781 Revised efficiency, 0.743

Efficiencies were significantly different: thus revision of excretions for growing cattle and suckler cows is required

Predicting manure N excretion from growing cattle and suckler cows

- ◆ Unlike for dairy cattle, long term intake data was not available for 'growing cattle': a different approach needed
- ◆ Manure N output prediction equations developed based on:
 - ◆ Animal live-weight
 - ◆ Diet N content
 - ◆ Forage proportion in the diet

$$\begin{aligned} \text{Manure N (g/d)} &= 0.171 \text{ live-weight (kg)} \\ &+ 3.92 \text{ diet N (g/kg DM)} \\ &+ 0.065 \text{ forage proportion (g/kg DM)} \\ &- 94.8 \end{aligned}$$

$$R^2 = 0.716$$

Prediction of manure N excretion from different classes of cattle

	Live-weight (kg) used in calculation	Revised excretions (kg N/head/year*)	2006 NAP excretions (kg N/head/year)
Dairy heifer (over 2 years)	500		
Dairy heifer (1 – 2 years)	400		
Beef suckler cow (over 2 years)	600		
Breeding bull	600		
Cattle (over 2 years)	500		
Cattle (1 – 2 years)	400		

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Cattle (over 2 years)	500		
Cattle (1 – 2 years)	400		

* Based on diets containing 14% crude protein and 70% forage on a DM basis

Prediction of manure N excretion from different classes of cattle

	Live-weight (kg) used in calculation	Revised excretions (kg N/head/year*)	2006 NAP excretions (kg N/head/year)
Dairy heifer (over 2 years)	500	45	
Dairy heifer (1 – 2 years)	400	39	
Beef suckler cow (over 2 years)	600	52	
Breeding bull	600	52	
Cattle (over 2 years)	500	45	
Cattle (1 – 2 years)	400	39	

* Based on diets containing 14% crude protein and 70% forage on a DM basis

Excretion rates for younger categories of cattle remain unchanged

Prediction of manure N excretion from different classes of cattle

	Live-weight (kg) used in calculation	Revised excretions (kg N/head/year*)	2006 NAP excretions (kg N/head/year)
Dairy heifer (over 2 years)	500	45	54
Dairy heifer (1 – 2 years)	400	39	47
Beef suckler cow (over 2 years)	600	52	54
Breeding bull	600	52	54
Cattle (over 2 years)	500	45	54
Cattle (1 – 2 years)	400	39	47

* Based on diets containing 14% crude protein and 70% forage on a DM basis

Excretion rates for younger categories of cattle remain unchanged