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Stakeholders Task and Finish (7)

Review of nitrogen, phosphorus excretion values for Dairy Cattle

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Overview of presentation

- Overview of the approach adopted
- Review of key steps in calculation of N and P excretion levels
- Comparison of revised values with previous values NI values and current Dutch values
- Use of banding and optimum bands

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Overview of approach taken

- Excel based model
- Calculations undertaken for cows producing between 4000 and 12,500 litres (500 litre intervals)
  1. Calculate total energy requirement of a dairy cow over a 12-month period
  2. Convert into DM intake and separate intake into different diet components
  3. Apply N concentration to each diet component to determine total N intake
  4. Apply a N utilisation value to determine N excreted
  5. Same model used to determine P excretion
- As far as possible assumptions align with those in the ammonia inventory

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Step 1: Calculation of dairy cow intakes

1. Across the range of milk yields (4000 – 12,500 litres) calculate the total energy requirement of a dairy cow over a 12-month period based on equations in Feed-into-milk
   - Milk plus
   - Maintenance plus
   - Movement plus
   - Pregnancy plus
   - Growth

2. Convert energy intakes to DM intake across a range of milk yields using assumed ME content of feeds

	ME Content (MJ/kg DM)
Concentrates	13.0 – 13.5
Grazed grass	11.1
Grass silage	10.7
Maize/Whole-crop	10.3

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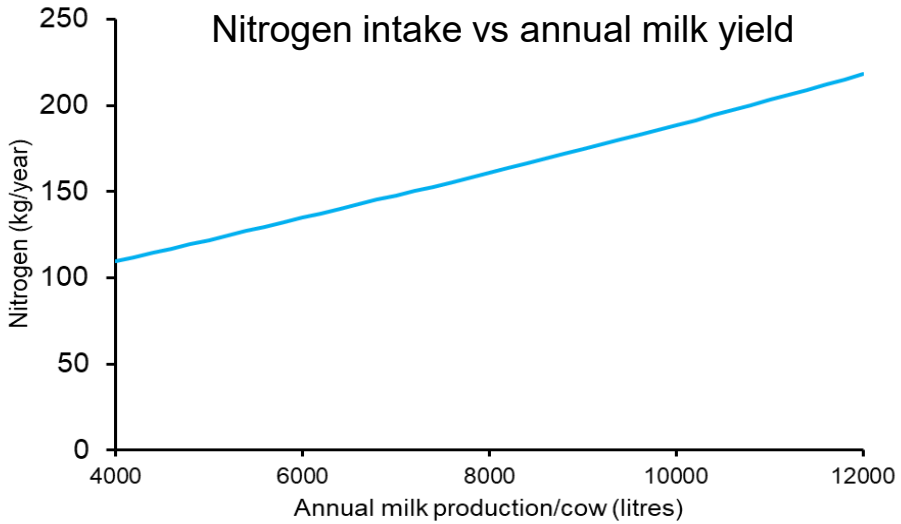
Step 2: Partition total intake to different diet components (DMI, kg/year)

Milk yield	Concentrate	Grazed grass	Grass silage	Maize/whole crop silage	Total DMI
<6000	1250	2002	1858	0	5110
6000 - 6500	1493	1849	1991	2	5334
6501 - 7000	1735	1697	2075	52	5559
7001 - 7500	1978	1545	2157	101	5781
7501 - 8000	2221	1394	2237	149	6001
8001 - 8500	2464	1244	2314	197	6219
8501 - 9000	2707	1095	2388	244	6434
9001 - 9500	2950	947	2459	290	6647
9501 – 10,000	3193	802	2528	335	6858
>10,000	3436	658	2593	379	7066

Step 3: Apply the N content to each diet component to determine total N intake

	Crude protein content (g/kg DM)
Concentrates	19 – 22%
Grazed grass	17.3
Grass silage	12.4
Maize/Whole-crop	8.8

Values adopted were based on outcomes of a series of meetings between CAFRE, NIGTA and AFBI (2021) to review existing data, source new data and fill gaps with 'considered opinion' (Ammonia Inventory)



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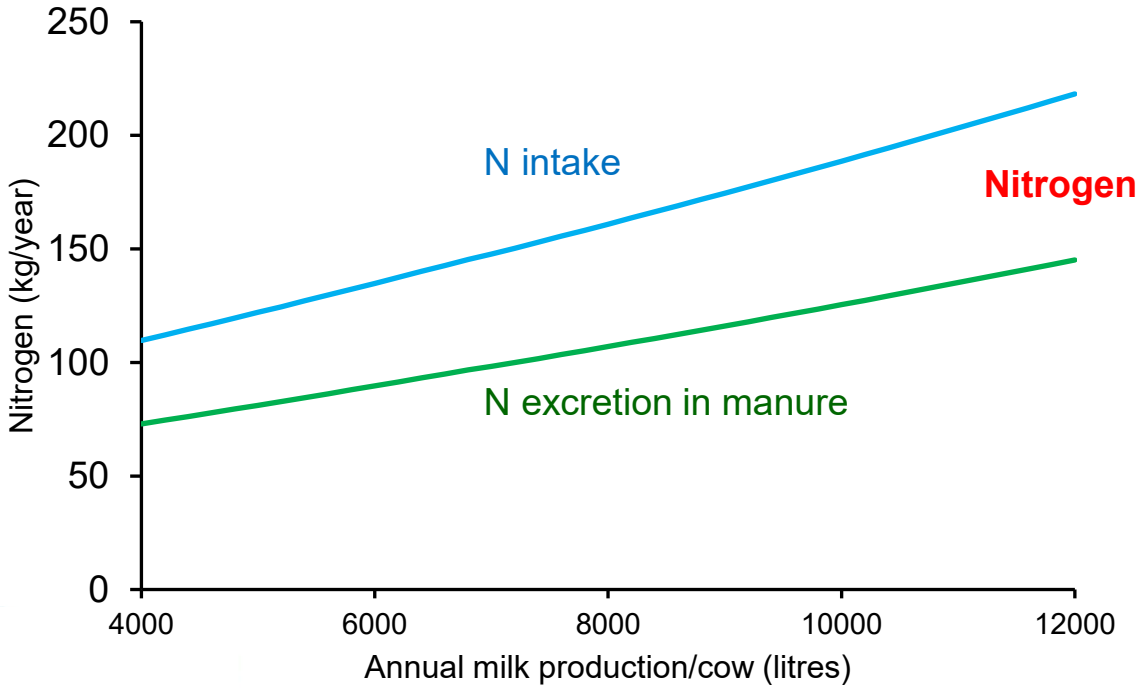
Step 4: Apply N use 'inefficiency factor' (66.5%)



Nitrogen (in)efficiency = 66.5%

Calculating phosphorus excretion in manure

- Approach used previously involved assuming the N : P ratio in manure was 5.4 : 1
- Given the decline in the P content of dairy cow diets over last decade, the N : P ratio is slurry is likely to have changed – however, we do not have current data on N : P ratios in slurry.
- Given this, a 'balance approach' has been adopted
- P excreted in manure = P intake minus P retained by the cow minus P output in calf minus P output in milk
- Uses same model as for N excretion, but applies P values to inputs (feeds) and outputs

	Assumed P content of feeds (% DM)
Concentrates	0.53 (0.47 fresh)
Grazed grass	0.34
Grass silage	0.31
Maize/Whole-crop	0.22

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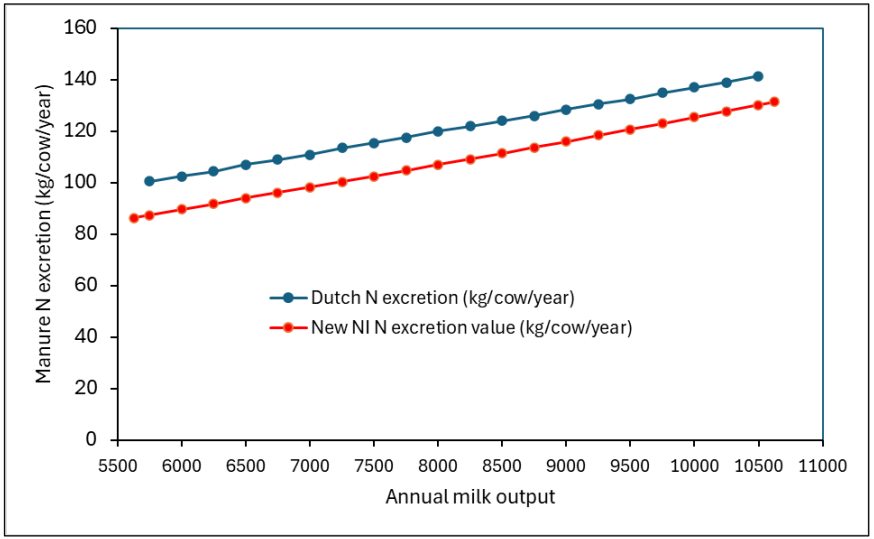
N and P excretions within banding proposed in initial NAP Consultation May 2025

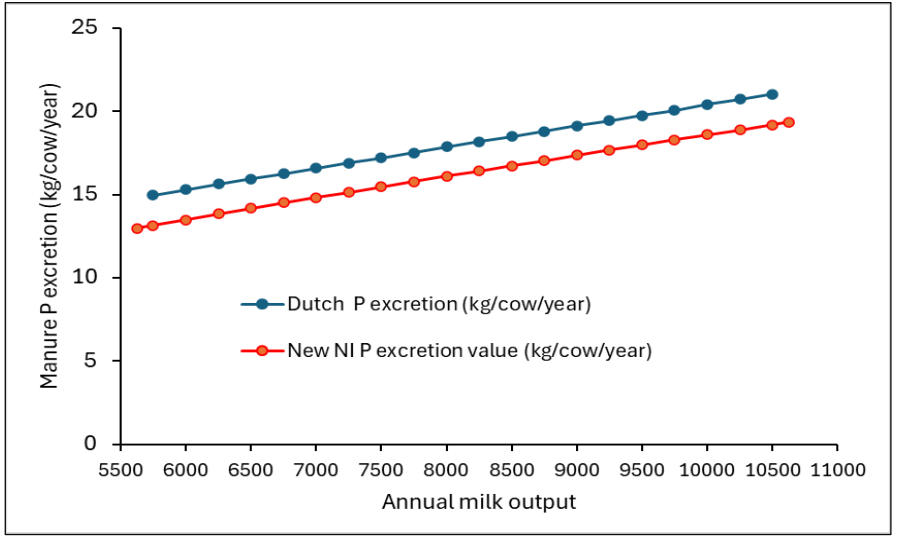
Milk yield band (litres)	N excretion per cow (kg/year)	P excretion per cow (kg/year)
< 6000 litres	88	13
6001 - 6500	92	14
6501 – 7000	96	15
7001 – 7500	100	15
7501 – 8000	105	16
8001 – 8500	109	17
8501 – 9000	114	17
9001 – 9500	118	18
9501 – 10,000	123	18
>10, 000 litres	128	19

How do the NI values compare with the Dutch values?

Manure N excretion



Manure P excretion



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Use of Banding

- A single excretion value ‘penalises’ lower input herds
- Banding implemented in many other countries
- Banding allows more precise calculation for individual farms
- Reflects the wide range in milk production systems
- Multiple bands reduces the impact of a small change in yield on any farm
- Added complexity?/ Practicalities of determining which yield band a herd is in?
- Aim to streamline admin and practicalities
- Two banding options considered: 5 bands (Option 1) and 7 bands (Option 2)

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Revised Banding – Option 1

Milk yield band (litres)	N excretion per cow (kg/year)	P excretion per cow (kg/year)
< 6000 litres	85	13
6001 - 8000	98	15
8001 – 10,000	116	17
10,000 – 12,000	135	20
>12,000 litres	149	22

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Revised Banding – Option 2

Milk yield band (litres)	N excretion per cow (kg/year)	P excretion per cow (kg/year)
< 5000 litres	77	11
5000 - 7000	90	13
7001 – 8000	103	15
8001 – 9000	112	17
9001 – 10,000	121	18
10,001 – 12,000	135	20
>12,000 litres	149	22

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Options for high output herds operating lower protein diets

- Recognition that higher output herds are particularly impacted by banding
- Also recognised that prediction of N inputs 'less good' at these higher milk yields as data for modelling is less available
- Some of these farmers are feeding protected amino acids and may be reducing protein levels which the model does not reflect

Milk yield band (litres)	N excretion per cow (kg/year)
< 5000 litres	77
5000 - 7000	90
7001 – 8000	103
8001 – 9000	112
9001 – 10,000	121
10,001 – 12,000	135
>12,000 litres	149

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Development of an individual farm N excretion model for herds producing more than 10, 000 litres milk/cow/year

Objectives

- To develop a model that will allow these higher input herds to adopt an ‘own-farm’ N excretion value (if is lower than predicted by model)
- Model should be simple
- Model should be scientifically robust
- Must be able to validate inputs

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Overview of model

- Model adopts most of same assumptions/equations as used in banding approach.
- Model calculates the total energy requirement of the whole dairy herd over 12 months and total N excretion. The converts that to N excretion per cow.
- Model exists in Excel spreadsheet format. A user-friendly interface will be developed
- 4 components
  - Animal ‘model’
  - Concentrate ‘model’
  - Grazing ‘model’
  - Conserved forage ‘model’

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Animal model

- 4 animal input values required
  1. Mean number of dairy cows (from NIFAIS)
  2. Total milk output (12 months)
  3. Average milk fat % (12 months)
  4. Average milk protein % (12 months)

Rolling 12-month Litres	
April 2025 - March 2026	2,082,239

Rolling 12-month Milk Quality (Wei	
April 2025 - March 2026	
	Producer
BFat %	4.62
Protein %	3.51

- Model calculates total metabolizable energy requirement of the dairy herd over a 12-month period
- Based on energy for Milk + Maintenance + Movement + Pregnancy + Growth

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Concentrate model

- Requires tonnage of each straight fed to the dairy herd over 12 months (includes default CP and ME values, unless something unusual)
- Requires tonnage of purchased concentrates fed to dairy herd over 12 months (farmer must input CP and ME values of each concentrate)
- Requires tonnage of additives/fats/oils/minerals etc fed to the dairy herd over 12 months (default and inputted options)
- This provides information on total N consumed via concentrates and how much of the cow's energy requirements is supplied from concentrates

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‘Concentrate’ model (straights)

		Name	tonnes fed per Year (fresh)	Dry matter (%)	Metabolisable Energy (MJ/kg DM)	Default crude protein (%, fresh)	Own crude protein value, if you wish to use (%, fresh)
Straights	Straight 1	Wheat		86	13.6	10.25	
	Straight 2	Barley		86	13.2	9.5	
	Straight 3	Maize		86	13.8	7.7	
	Straight 4	Maize gluten feed		88	12.9	20.2	
	Straight 5	DDGS (maize)		89	14	26.5	
	Straight 6	Wheat feed		88	11.3	16.5	
	Straight 7	Rape seed meal		90	12	35.5	
	Straight 8	Soyabean meal		89.6	13.4	46.5	
	Straight 9	Soya hulls		93.2	14.2	10.25	
	Straight 10	Sugat beet pulp		89.8	12.5	8.25	
	Straight 11	Palm kernal meal		90	11.5	15.5	
	Straight 12	Enter other straight here (box will always appear for one more straight)					

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‘Concentrate’ model (Concentrates/blends)

		Name	tonnes fed per Year (fresh)	Dry matter (%)	Metabolisable Energy from feed compounder (MJ/kg DM)	Declared crude protein (g/kg fresh)
Purchased concentrates/blend	Concentrate/blend 1	Blend mix (lo CP)	18	89	12.5	160
	Concentrate/blend 2	Blend mix (high CP)	120	89	13	210
	Concentrate/blend 3	Parlour pellet A	86	89	13.2	213
	Concentrate/blend 4	Parlour pellet B	10	89	12.6	185
	Concentrate/blend 5	Dry cow blend	30	89	12.5	165
	Concentrate/blend 6					
	Concentrate/blend 7					
	Concentrate/blend 8					
	Concentrate/blend 9					
	Concentrate/blend 10					

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‘Concentrate’ model (other products)

		Name	tonnes fed per Year (fresh)	Dry matter (%)	Metabolisable Energy (MJ/kg DM)	Crude protein (g/kg fresh)
Other products included in the diet ie minerals, vitamins, fats, oils etc	Product 1	Mineral/vitamins	1.3	99	0	0
	Product 2	Molasses	3.5	75	12.7	40
	Product 3	Megalac	0.8	95	29	0
	Product 4	Amino acids	0.4	95	13	180
	Product 5					
	Product 6					

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'Grazing model'

- A simplified approach has been adopted on the basis that grazing will not be a significant component of most of these systems.
- Days grazing each month
- Average number of cows in grazing group
- Average number of hours at grass during month (drop down menu)
  - 1 - 4 hr (translates to grass intake of 3 kg DM/cow/day)
  - 4 - 8 hr (translates to grass intake of 6 kg DM/cow/day)
  - 8 - 16 hr (translates to grass intake of 9 kg DM/cow/day)
  - 16 - 24 hr (translates to grass intake of 12 kg DM/cow/day)
- Composition of grass (default values available, but option for inputting measured values)
- Provides information on total N consumed via grazed grass and how much of the cows energy requirements is provided by grass

‘Grazing model’

	Days in month	Days your cows grazed during month	Average number of cows in grazing group	Average number of hours grazing/day	Estimation of 'grazing days' and 'housing days'	Estimated intake (kg DM/cow/day)	Default ME content of grass (MJ/kg DM)	Default CP content of grass (% DM basis)	Measured ME content of grass if diferent from default (% DM basis)	Measured CP content of grass if diferent from default (MJ/kg DM)
				From drop down menu (1 - 4 hr, 4 - 8 hr, 8 - 16 hr, 16 - 20 hr) (translates as 0.25, 0.5, 0.75, 1.0 of day)		1- 4 = 3, 4-8 = 6, 8-16 = 9, 16-20 = 12				
January	31						11.5	22		
February	28						11.75	22		
March	31			.			12.0	22.8		
April	30						11.9	19.2		
May	31						11.5	16.2		
June	30	4	30	0.75	90	9	11.4	15.4		
July	31	20	30	1	600	12	11.4	15.9		
August	31	20	30	1	600	12	11.3	17.3		
September	30						11.2	19.5		
October	31						11.2	22.2		
November	30						11.1	22		
December	31						11	22		

Forage model (excludes grazing)

- Estimate of tonnage of each forage type fed to the dairy herd over 12 months, and protein and ME content
- For some forages there will be default values (eg straw)
- Other forages (eg grass silage, maize silage, whole crop silage) will require a lab analysis
- These forages are assumed to supply the remaining energy requirements of the cow.
- However, we know that the total calculation (concentrate + grass + forage) will likely either overestimate or underestimate energy supplied by the diet. The model will therefore adjust intakes of all forage either ‘up’ or ‘down’ on a pro-rata basis to meet 100% of energy requirements.
- The forage model provides information on total N consumed via forages (excluding grazing)

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Forage model (excludes grazing)

	Forage type (drop down: Barley straw, wheat straw, Grass silage, maize silage, WC silage, other)	Identifier (eg silo, bales)	tonnes fed per Year (fresh)	Dry matter (%)	Analysed metabolisable Energy (MJ/kg DM)	Analysed crude protein (g/kg fresh)
Forage 1	Barley straw	Bales	16	86	6.5	40
Forage 2	Wheat straw	Bales	1	86	6	36
Forage 3	Grass silage	Pit 1	300	35	12	130
Forage 4	Grass silage	Pit 2	300	28	11.2	140
Forage 5	Grass silage	Pit 3	360	32	11.6	145
Forage 6	Maize silage	Pit 4	150	30	10.5	105
Forage 7	Maize silage	Pit 5	100	28	10.4	110
Forage 8	Whole crop	Pit 6	50	40	9.8	85

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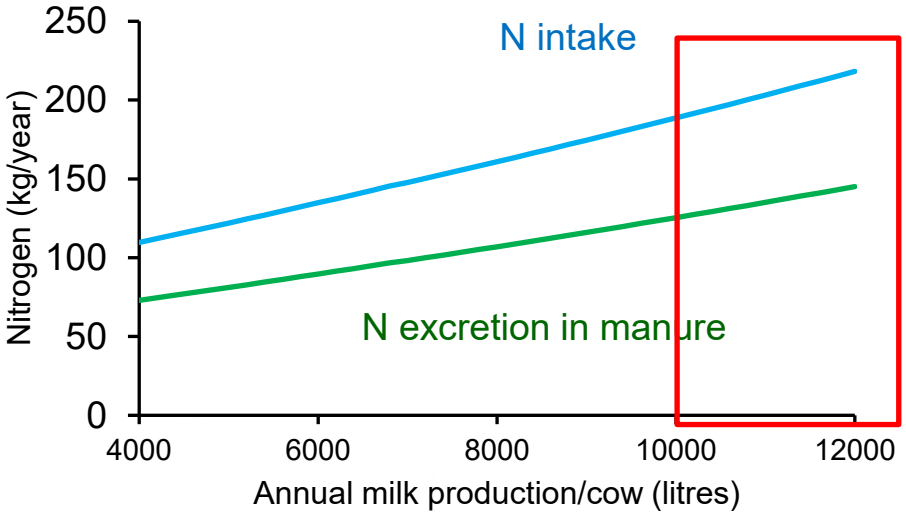
Apply N use 'inefficiency factor' (66.5%)

- Model sums the total N consumed by the dairy herd = N from concentrates + N from grass + N from 'forages'
- Apply AFBI N (in)efficiency factor of 66.5% to determine N excreted in manure



Nitrogen (in)efficiency = 66.5%

Road testing and validation of the model

- Model has been presented to nutritional consultants, nutritionists with commercial feed companies, NIGTA representatives and CAFRE
- Agreed that information required is normally available on higher input herds
- Model has been tested and validated with actual Northern Ireland farm data
- Following slides highlights scenario testing for a ‘typical’ high output herd

Typical high output herd (11, 700 litres): total diet at 16% CP

- 11, 700 litres per cow (4.15% fat and 3.30% protein)
- No grazing
- Multi cut grass silage, plus maize silage
- 4.1 t concentrate/cow/year (assumed as 18% CP)
- Total diet CP calculated as 16%

	N excretion values (kg/cow/year)			
	Total diet = 16% CP			
Based on actual milk yield)	**142**			
Based on N banding (10000 – 12000 litres)	**135**			
Based on actual farm input data	**130**			

Typical high output herd (11, 700 litres): Total diet at 15% CP

- 11, 700 litres per cow (4.15% fat and 3.30% protein)
- No grazing
- Multi cut grass silage, plus maize silage
- 4.1 t concentrate/cow/year (assumed as 16% CP)
- Total diet CP calculated as 15%

	N excretion values (kg/cow/year)			
	Total diet = 16% CP	**Total diet = 15% CP**		
Based on actual milk yield)	**142**	**142**		
Based on N banding (10000 – 12000 litres)	**135**	**135**		
Based on actual farm input data	**130**	**122**		

Typical high output herd (10, 500 litres): total diet at 16% CP

- **10,500 litres per cow** (4.15% fat and 3.30% protein)
- No grazing
- Multi cut grass silage, plus maize silage
- 3.5 t concentrate/cow/year (assumed as 17.5% CP)
- Total diet CP calculated as 16.0%

	N excretion values (kg/cow/year)			
	Total diet = 16% CP	**Total diet = 15% CP**	**10,500 litres, Total diet = 16.0% CP**	
Based on actual milk yield)	**142**	**142**	**130**	
Based on N banding (10000 – 12000 litres)	**135**	**135**	**135**	
Based on actual farm input data	**130**	**122**	**119**	

Typical high output herd (10, 500 litres): total diet at 15% CP

- **10,500 litres per cow** (4.15% fat and 3.30% protein)
- No grazing
- Multi cut grass silage, plus maize silage
- **3.5** t concentrate/cow/year (assumed as 15.8% CP)
- Total diet CP calculated as 15.0%

	N excretion values (kg/cow/year)			
	Total diet = 16% CP	Total diet = 15% CP	10,500 litres, Total diet = 16.0% CP	10,500 litres, total diet = 15% CP
Based on actual milk yield)	142	142	130	130
Based on N banding (10000 – 12000 litres)	135	135	135	135
Based on actual farm input data	130	122	119	111

Summary of scenario testing

- If higher output herds are adopting lower protein diets, the model may provide a lower N excretion value than either the standard ‘yield band value’ or the value derived solely from the ‘actual milk yield’ on the farm.

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