Novel methods for estimating urinary N production from two contrasting dairy systems

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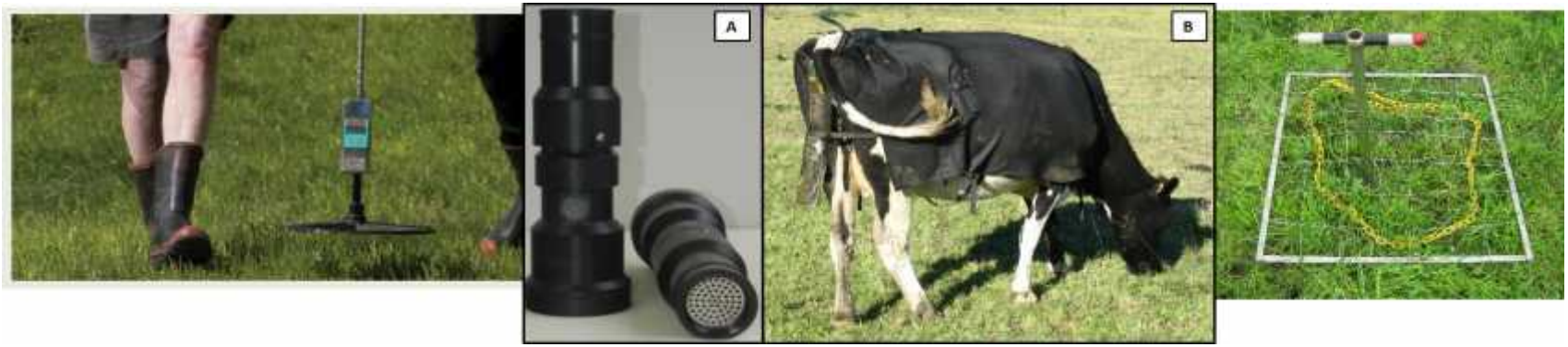

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Background

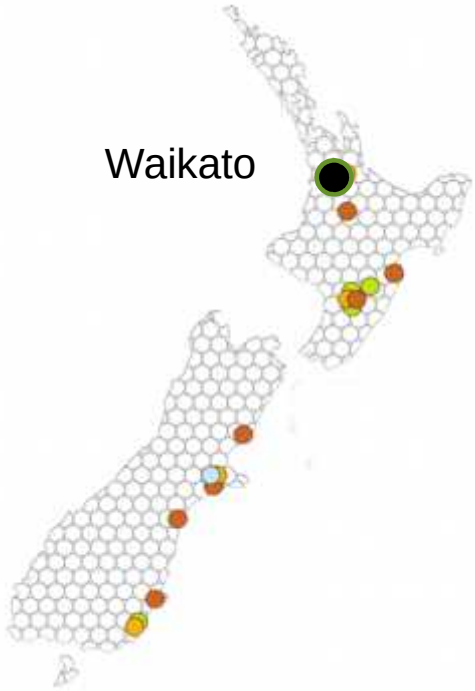
- Water quality (N, P and sediment) decreases with amount of dairy in a catchment
- Industry owning the problem and funding research to find solutions:
  - **e.g. Pastoral 21 Programme ('P21')**
- Objective of P21 is to develop:
  - ***Adoptable* dairy farm systems that**
  - **Decrease N loss by 40%, and increase profit**
- Objective of this paper:
  - To explain how contrasting farm systems deliver decreases in N leaching by estimating urine-N production

Proposed solution: Waikato

Key features:

- Two 13 ha ‘farmlets’
- Reduced N fertiliser inputs
- Stocked at a lower rate
- Cows off paddock for parts of day autumn-winter
  - More effluent captured and recycled
- Higher genetic merit cows
- Improved dietary balance

CURRENT	FUTURE
150 kg N/ha/year	**50** kg N/ha/year
3.2 cows/ha	**2.6** cows/ha
nil	**6-16 hours/day** autumn/winter
BW **139**	BW **222**
nil	Up to **400 kg** grain/cow



Future system = similar production, less N leached

Four years of measurements:

Farmlet	Current	Future	Diff.
N fertiliser (kg/ha)	137	52	- 38%
Pasture growth (t DM/ha/yr)	17.0	15.5	- 9%
Milksolids (kg/cow)	371	440	+ 19%
Milksolids (kg/ha)	1200	1158	- 3.5%
Nitrate leaching (kg N/ha/yr)	**54**	**31**	**- 43%**

Year	N leached (kg N/ha)	
	Current	Future
2012	50	22
2013	67	38
2014	63	42
2015	35	22

Explaining why …

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Estimating urinary N load (the major source of leached N)

1. N balance:

Annual calculation, based on regular pasture monitoring

N surplus = N intake in pasture + supplements - N output in milk

Proportion as urine (%) = 29.9 + (11.9 × N concentration of diet (%N))

2. Urine patch:

- **Late spring/early summer, autumn, winter**; 5-6 hours between morning and afternoon milking
- Measured: no. of urinations; urine patch area; N content per patch (Welten et al., 2013)
- Urine N (g/cow) = estimated N content of urine patch x no. of urinations

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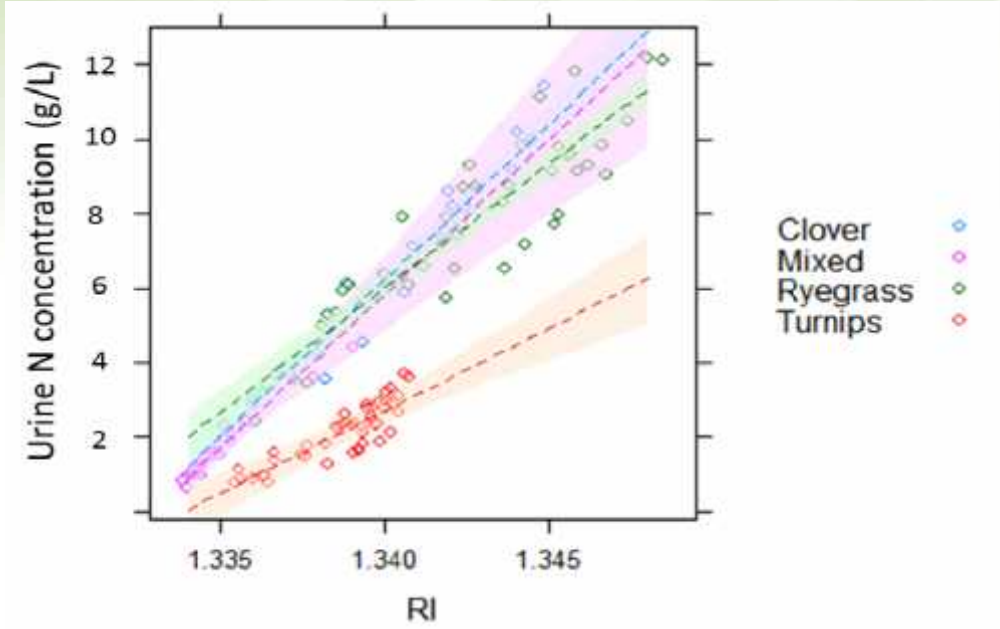
Measuring urinary N load

3. Urine sensor:

- **Early summer and autumn; 72 hours per campaign**
- Measured: no. of urinations; urine volume; N concentration (Betteridge et al., 2013)
- Urine N (g/cow) = estimated N content of urination x no. of urinations



Shepherd et al., 2016

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Results

Method:	N balance	
Timescale:	Annual	
Metric	Current	Future
	kg N/cow	
Urine N per cow	98	98
	kg N/ha	
Urine N per ha	317	257
Difference		*-19%*

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Results

Method:	N balance	
Timescale:	Annual	
Metric	Current	Future
	kg N/cow	
Urine N per cow	98	98
	kg N/ha	
Urine N per ha	317	257
Difference		*-19%*

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Results

Method:	N balance		Urine patch	
Timescale:	Annual		6 hours	
Metric	Current	Future	Current	Future
	kg N/cow		g N/cow	
Urine N per cow	98	98	24	23
	kg N/ha		g N/ha	
Urine N per ha	317	257	78	60
Difference		*-19%*		*-23%*

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Results

Method:	N balance		Urine patch		Urine sensors	
Timescale:	Annual		6 hours		24 hours	
Metric	Current	Future	Current	Future	Current	Future
	kg N/cow		g N/cow		g N/cow	
Urine N per cow	98	98	24	23	184	195
	kg N/ha		g N/ha		g N/ha	
Urine N per ha	317	257	78	60	585	504
Difference		*-19%*		*-23%*		*-14%*

Average reduction in urine produced = 19%

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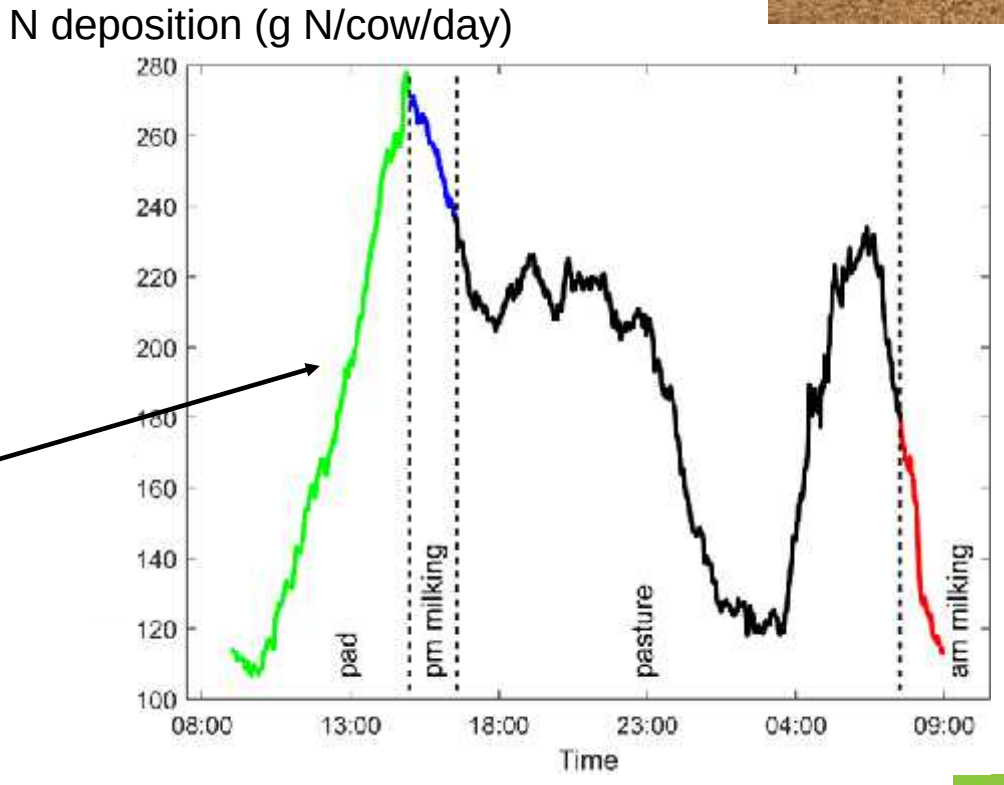
Results

- Estimates of urine production take no account of where deposited
- Diurnal variation in N load
- 23% of daily load deposited on stand-off pad in 6 hours



Shepherd et al. (submitted)

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Comparison with N leached

Four years of measurements:

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Milksolids (kg/cow)	371	440	+ 19%
Milksolids (kg/ha)	1200	1158	- 3.5%
Nitrate leaching (kg N/ha/yr)	**54**	**31**	**- 43%**

c. 19% from less urine
Rest due to something else
- stand-off?

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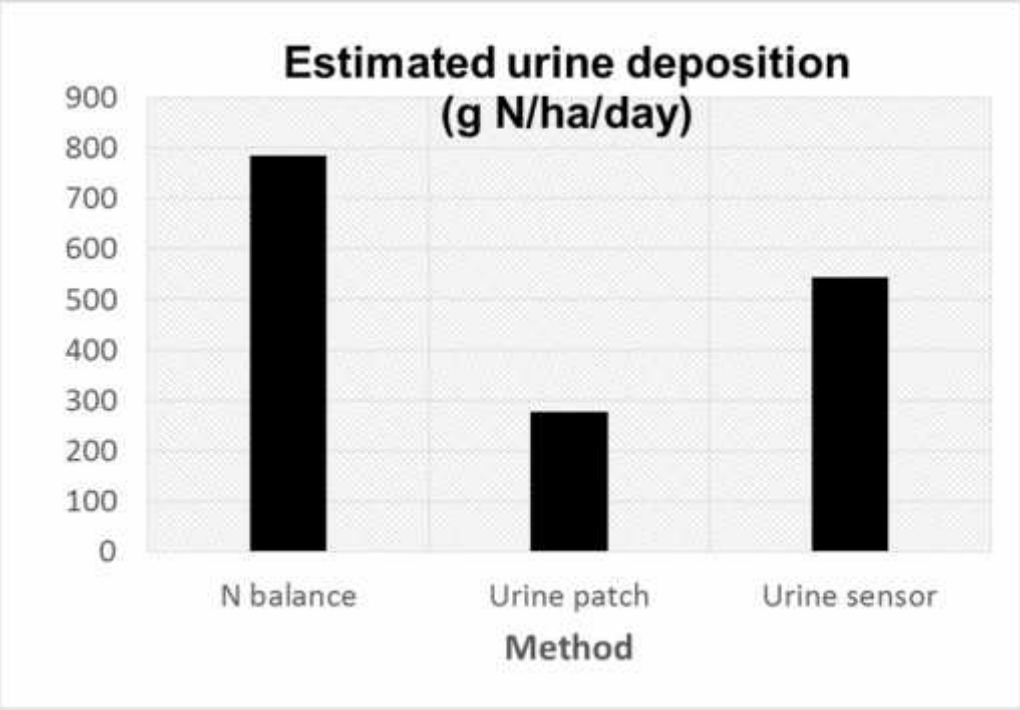
Comparison of methods

- Convert urine N to a standard g/ha/day
- Absolute values differ between methodologies
- Possible reasons:
  - Scale of measurement
  - Duration of measurement
  - Other?



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Conclusions

- Measurements at different scales helps understand N leaching mechanisms
- All methods show less urine production in the Future system (14-23% less)
- Large variation in daily estimates of urine between methods (270-870 g N/day)
- Further research required to understand these differences
- Urine sensors look to be a valuable research tool
- *Improved farm system decreases N leaching and (almost) maintains production – but not profit*

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Acknowledgements

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