Practical and Cost-Effective Methods for Reducing N Losses from Fertiliser Urea and Cow Urine

Bert Quin
Quinspread Technologies Limited, PO Box 125-122, St Heliers, Auckland, New Zealand
quinspread@xtra.co.nz, www.quinspread.co.nz, +64 21 427 572

Summary

- Granular urea is by far the most commonly used N fertiliser on NZ dairy farms (estimated for 400,000 tpa). However, its relatively low cost comes at the cost of substantial losses to the environment, as ammonia volatilisation, nitrous oxide emission, and nitrate leaching.
- Its use also contributes to higher N levels in pasture, which in turn contributes to higher N excretion in cow urine. Gaseous and leaching losses from cow urine patches represent the single largest contribution of N to the environment in this country.
- Quinspread Technologies have developed new on-truck processing technology, whereby granular urea is converted to a high-solids fluid containing urease inhibitor, and DCD nitrification inhibitor if required, on board the fertiliser spreading truck. This greatly enhances plant N uptake, partly through facilitating direct uptake of urea through the leaves, partly by minimising ammonia volatilisation, and partly because the slower conversion of urea to ammonium-N in turn results in slower conversion to nitrate-N, reducing nitrate leaching losses and nitrous oxide formation.
- This technology is already operating commercially in NZ and Victoria, Australia, and providing average conversions of N to additional DM of 30-31 kg DM/kg N, compared to 10-11 with granular urea, in both countries.
- Although urine patches can also be treated with this technology, by applying fluidised DCD either by itself or mixed with fertiliser, this is a relatively inefficient method of reducing urine-N loss, as after any one grazing, typically only 2-3% of the pasture grazed has been affected by urine. Also, DCD has short-lived effectiveness, requiring frequent applications.
- For this reason, a simple device comprising hanging tassels impregnated with inhibitor has been designed for attachment to the tail of the cow. When the tail is raised for urination, the urine stream dissolves inhibitor from the beads, ensuring immediate treatment of the urine in the soil. This prototype, the last of several studied since 2002, was developed jointly by the author and Bishop Research, and is currently undergoing pre-production testing on dairy cows.

Fluidisation Trial Results

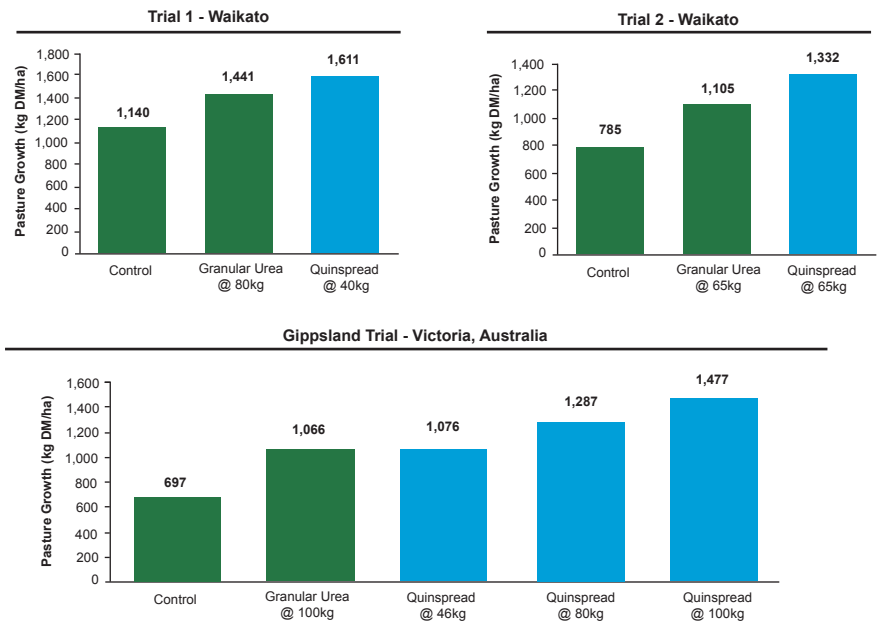
- All trials conducted in the Waikato and Gippsland have demonstrated fluidised, urease inhibitor-treated urea to be at least twice as effective as granular urea (Fig. 1).
- This means that the farmer has the option of either achieving a much higher yield with a given application rate of N, or achieving a targeted increase in feed with literally half the quantity of N. A Cost-Benefit Model developed by Quinspread Technologies utilises actual trial results, fertiliser costs and milksolids payouts to calculate the net benefit to the farmer (Table 1).
- Most dairy farmers, given that they were already using high rates of granular urea to achieve near-maximum production, have adopted the option of using this new technology to maintain or increase production while using far less fertiliser N. This has enormous implications for the environment, as well as improving farm profitability.

Table 1. Cost-Benefit Model, Waikato Trial 1 80kg/ha Granular Urea vs 40kg/ha Quinspread

	Urea	Quinspread Fluidised NBPT-treated Urea		
	80kg/ha	40kg/ha	N to achieve same net as urea	
Product Cost per Tonne	$871	$970	$970	*1*
On truck fluidising cost (per Ha)	$0	26	26	*1*
Km from Works	20	20	20	
Hectares	40	40	40	
Tonnes	3.2	1.6	0.9	
Bulk Cartage $/tonne	$50.00	100.00	183.49	*1-2*
Spreading and tracking/ha	$12	$14	$14	*2*
Spread rate kg/ha	80	40	22	
%N	46%	46%	46%	
Kg N applied per ha	36.8	18.4	10.0	
Applied cost per ha	86	83	65	
Response (kg DM per Kg N)	9	28	28	
Extra DM per ha	337	507	276	
Cost per Kg dry matter	0.25	0.16	0.24	
Total cost for job	3,427	3,312	2,606	
Financial Returns				
Kg DM per kg MS	12	12	12	
Payout/kg MS	$5.10	$5.10	$5.10	
Utilisation	80%	80%	80%	
Gross return per ha	$115	$172	$94	
Gross return for farm	**$4,583**	**$6,895**	**$3,758**	
Margin				
Nett return per ha	$29	$90	$29	
Total return for job	**$1,156**	**$3,583**	**$1,152**	
Improvement over Urea		310%	100%	

[1] Fertiliser & processing costs can be split 50/50 between sharemilker and owner
[2] Spreading costs to be paid by sharemilker
[1-2] Cartage costs split based on sharemilking agreement

Figure 1. Pasture Growth of Granular Urea and Quinspread Urease Inhibitor-treated urea in examples of Waikato and Gippsland Trials



How are these Results Possible?

- Urease inhibitor-treated granular urea derives its 40-50% improvement in efficiency through a combination of reduced ammonia volatilisation and, as an indirect effect of the slower conversion of urea, reduced nitrate leaching.
- Fluidised straight urea derives its improvement from some uptake of urea directly by plant leaves, and some reduction in volatilisation, because of the reduced elevation in pH in the soil solution. Urea applied as a true solution (as typically done in the past) will mainly run off the leaf and/or be volatilised as ammonia before uptake can occur.
- Fluidised urease inhibitor-treated urea at least additively combines the advantages of urease inhibitor-treated granular urea and fluidised straight urea. In fact, the greater than additive results achieved in field trials is likely to be mainly a consequence of improved plant uptake of urea, as the presence of urease inhibitor will inhibit the urease enzyme present on the surface of plant leaves.
- Plants are capable of taking up a high proportion of their N requirements directly through the leaves if given the opportunity (unlike most other major nutrients), and that the net energy cost of conversion to protein is lower than that of nitrate taken up though the leaves.
- Lower energy requirements mean more energy is available for leaf and root growth, in turn meaning more efficient uptake of soil nutrients, including N. These factors help to explain why conversions of kg fertiliser N to increased kg DM average 30-31, compared to only 10-11 for granular urea.

Spread of Fluidised Urea on Pasture

Obstacles to Rapid Adoption of the New Fluidised Technology

- Access to and servicing of finance for Fluidator trucks (approx. $300,000 each)
- Focusing the attention of both farmers and spreading contractors on the much improved bottom line for both, rather than on the higher spreading cost that must be charged by the contractor.
- Convincing scientists and farm consultants that “Fluidised Inhibitor-treated Urea” is not another “Maxicrop”, but rather new technology that has resulted from looking closely at what happens with granular urea use, and deciding how best to minimise losses and increase plant uptake.
- Convincing fertiliser importers and suppliers that although this technology will result in significant reductions in fertiliser N use, the resulting improvements to the environment and to farm profitability will strengthen the entire agricultural industry in New Zealand.

“TAURINE” Tail-Attached Device for Incorporating Inhibitor in Urine

- Although urine patches can also be treated by applying DCD to the entire paddock, this is a relatively inefficient method of reducing urine-N loss, as after any one grazing, typically only 2-3% of the pasture grazed has been affected by urine. Also, DCD has short-lived effectiveness, requiring frequent applications.
- For this reason, a simple device comprising hanging tassels impregnated with inhibitor has been designed for attachment to the tail of the cow. When the tail is raised for urination, the urine stream dissolves inhibitor from the beads, ensuring immediate treatment of the urine in the soil. This prototype, the last of several studied since 2002, was developed jointly by the author and Bishop Research, and is currently undergoing pre-production testing on dairy cows.

Cow wearing pre-production version of ‘Taurine’ inhibitor-release tassels