Field trials on the performance of LessN for enhancing nitrogen utilisation in pasture

Part 1, First Harvest

A report prepared for

Donaghys

By

IWM Consultancy

SUMMARY

A total of six field trials were conducted on commercial dairy farms in mid Canterbury between December 2010 and March 2011 to evaluate pasture response to different nitrogen fertiliser treatments. Trials compared urea application at 40 and 80 kg/ha with or without a microbial additive (LessN) to enhance nitrogen utilisation. Assessments were made within the grazing period of farmers (approximately four weeks) by pasture probe and by mowing a strip in each plot. Significant increases in pasture production were obtained with either the high rate of urea or half rate of urea plus LessN. As an average of all the trials, pasture dry matter measured by mowing increased 34% from 1038 kg/ha in the control to 1398 kg/ha with application of LessN plus 40 kg urea. An application of 40 kg urea without LessN as solid or dissolved in water gave between 13.5 to 18.9% increase in pasture dry mater. Pasture productivity estimated by probe reading produced similar results. Highly significant differences in probe reading values were obtained between treatments in all the trials. As an average of all the trials, there was an increase in pasture production of 43 and 44% with a mixture of LessN plus 40 kg/ha urea and 80 kg/ha urea, respectively. The low rate of urea in the absence of LessN resulted in smaller increases in pasture production which was not always statistically significant.

This report presents results from the first set of harvests within the first grazing period. In two trials (on Ross Stewart and on Peter Webster farms) plots were maintained after harvest for further assessment of residual effect of treatments before second grazing. The results of these will be submitted in another report.

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Introduction

Excessive use of nitrogen fertilisers such as urea has been blamed for pollutions in ground water and eutrophication of lakes around farming areas. Dairy farmers in particular depend on regular fertiliser application to enhance growth. Donaghys nitrogen fertiliser enhancer "LessN" is developed as an additive to fertilisers with the aim of reducing the nitrogen fertiliser requirement through improving efficiency of nitrogen utilisation. If this is true, farmers can get the same growth increase with less fertiliser input. This would result in less impact on the environment and better economy for the farmers. The current study was therefore initiated aiming to provide independent assessment and reliable data on the performance of LessN on pasture production.

To test the effects of LessN on pastures, six field trials were carried out between December 2010 and March 2011 on commercial dairy farms in mid Canterbury. The trials had the following Objectives:

1. To evaluate the performance of LessN as a supplementary addition to urea for improving the efficiency of nitrogen response.
2. To compare LessN with control and urea application treatments in replicated and randomised experiments.
3. To collect, analyse and interpret the data and present an independent report.

Methodology

A detailed protocol was received from Donaghys on 7/12/2010 and was the basis of the work. Briefly, there were six field trials on dairy farms in mid-Canterbury conducted over the summer/autumn of 2010-11. The paddocks were selected based on the criteria set in Donaghys protocol to represent a good stand of perennial ryegrass / white clover with no obvious stress symptoms. One main condition was that the paddock received no nitrogen fertiliser for at least 6 weeks prior to the commencement of trials. Treatment applications were carefully timed to fit within the farmers' grazing cycle, approximately 4 weeks.

Each trial compared urea application at 40 and 80 kg/ha in solid form, dissolved urea in water at 40 kg/ha with or without LessN at 3 L/ha, and a control giving a total of five treatments. Plots were 4 m wide and 30 to 40 m long depending on the site. All treatments were laid out in completely randomised block designs (CRBD) with eight replicates.

Application of solid urea was made using a hand held fertiliser spreader, and liquid treatments were sprayed using a truck mounted sprayer fitted with a 4-m boom with eight nozzles. At a pressure of 26 psi and a speed of 6 km/h, the sprayer delivered 225 L/ha water.

Assessments of treatment effects were made by both pasture probe (30 readings in each plot) at the start and at the end of each grazing cycle (dates in Table 1) and also by mowing a strip of 0.5 x 10 m in each plot at harvest. The fresh weight of grass was taken using a tripod scale, and a subsample of each was taken to measure water content by putting in an oven at 70° C for two days. These were used for calculating dry weight values in each plot.

All data were arranged and tabulated in MS Excel worksheets and analysed using Genstat statistical programme.

Table 1. Details of trials carried out on different farms.

Owner/ manager	Location	Last urea application	Last grazing	Total soil N kg/ha	Soil temp (°C)	Application date	First harvest
Dean Geddes	Tai Tapu	No urea*	28/01/2011	242	21.5	2/02/2011	1/03/2011
Heath Smith	Dunsandel	15/12/2010	31/01/2011	211	20.5	4/02/2011	28/02/2011
Max Hurley	Springston	15/12/2010	1/02/2011	215	22	8/02/2011	4/03/2011
Steven Delaca	Dunsandel	30/12/2010	8/02/2011	149	20.5	10/02/2011	7/03/2011
Ross Stewart**	Green Park	17/12/2010	11/02/2011	166	21	17/02/2011	15/03/2011
Peter Webster	Pendarves	20/01/2011	25/02/2011	99	22	3/03/2011	24/03/2011

* No urea was applied since spring 2010.

** Pasture contained plenty of plantain, chicory and dandelion plants.

Results

Analysis of variance showed very highly significant differences among treatments for pasture dry matter (DM) estimated by pasture probe in all trials (Table 2). Values for the control treatments ranged from 738 to 1454 kg/ha DM reflecting a range of soil fertility and management levels across the farms. Mean comparison by LSD test confirmed significant increases in pasture DM over the control with either solid urea at 80 kg/ha or a mixture of liquid urea at 40 kg/ha and LessN at 3 L/ha in all trials (Fig. 1, Table 2). As an average of all the six trials, there was an increase of over 43% in pasture dry matter production within one grazing period with either of these treatments. There were no significant differences between these two treatments in pasture productivity as estimated by probe reading. The low rate of

urea (40 kg/ha) on its own either as solid or dissolved in water resulted in smaller increases in pasture production which was statistically significant in three farms i.e. Heat, Max and Peter.

Table 2. Pasture dry matter (kg/ha) in different treatments measured within one grazing cycle in six dairy farms in Canterbury during the summer of 2010-11. Values estimated by pasture probe reading.

Treatment	Dean	Heath	Max	Steven	Ross	Peter	Mean	%
Control	950.3	1201.0	738.3	1454.0	1242.9	1159.8	1124.4	0.0
LessN40	1517.8	1746.6	1294.4	1833.6	1649.1	1634.3	1612.6	43.4
Liq U40	1214.9	1657.0	1053.8	1604.4	1446.5	1414.0	1398.4	24.4
Solid U40	1127.4	1595.4	1103.8	1752.0	1290.8	1430.0	1383.2	23.0
Solid U80	1400.3	1753.5	1355.9	1972.8	1718.6	1526.0	1621.2	44.2
F test	***	***	***	***	***	***		
$LSD_{0.05}$	235.9	284.5	136.3	156.3	252.2	149.1		

Pasture dry matter values measured by mowing a strip in each plot showed smaller level of significance between treatments than the values obtained by probe reading. Nevertheless, significant or highly significant differences were found in five trials except the one conducted on Heath Smith's farm (Table 3). In line with the values estimated by probe reading, DM by mowing showed significant increases over the control with either an application of urea at 80 kg/ha or a mixture of liquid urea at 40 kg/ha and LessN at 3 L/ha in four trials. In the trial conducted on Peter's farm, the only significant increase over the control was by the LessN plus urea application.

Values for the control plots measured by mowing treatments ranged between 839 and 1693 kg/ha in the trials (Table 3). As an average of all the six trials, there was an increase of 32% in pasture dry matter production with urea application at 80 kg/ha and 34% with an application of half this rate plus LessN.

Table 3. Pasture dry matter (kg/ha) in different treatments measured within one grazing cycle in six dairy farms in Canterbury during the summer of 2010-11. Values estimated by mowing.

Treatment	Dean	Heath	Max	Steven	Ross	Peter	Mean	%
Control	963.5	1693.2	838.8	862.5	902.4	969.8	1038.3	0.0
LessN40	1285.5	1892.4	1468.4	1146.8	1259.7	1293.5	1391.0	34.0
Liq U40	1272.6	1747.6	1181.2	985.3	1068.9	1154.4	1235.0	18.9
Solid U40	1098.3	1754.1	1109.6	1038.4	955.4	1111.9	1178.0	13.5
Solid U80	1396.3	1968.4	1496.9	1090.1	1189.9	1087.8	1371.6	32.1
F test	*	ns	**	*	**	*		
$LSD_{0.05}$	251.8	ns	354.9	180.4	206.3	192.3		

Analysis of variance for pasture fresh weight values obtained by mowing showed very highly significant differences among treatments for two trials and highly significant differences for another two trials while the trial on Peter Delaca's farm showed significant F test at 7% probability level (Table 4). Similar to dry weight measurements, fresh weight of pasture was significantly increased by either the high rate of urea or LessN plus half rate of urea in most trials. The increase in fresh weight as an average of all the trials amounted to 39% with these treatments over the control.

Table 4. Pasture fresh weight (kg/ha) in different treatments measured within one grazing cycle in six dairy farms in Canterbury during the summer of 2010-11. Values measured by mowing.

Treatment	Dean	Heath	Max	Steven	Ross	Peter	Mean	%
Control	3660.0	6850.0	2762.5	3725.0	4512.5	4675.0	4364.2	0.0
LessN40	5157.5	8125.0	5337.5	5100.0	6375.0	6350.0	6074.2	39.2
Liq U40	5060.0	7200.0	4087.5	4287.5	5362.5	5587.5	5264.2	20.6
Solid U40	4067.5	7575.0	3887.5	4820.0	4687.5	5337.5	5062.5	16.0
Solid U80	5862.5	8350.0	5475.0	5025.0	6175.0	5487.5	6062.5	38.9
F test	***	ns	***	**	**	0.07		
$LSD_{0.05}$	1064.8	ns	1265.0	818.9	1023.0	1115.8		

Analysis of variance for pasture growth rate in daily dry matter production showed very highly significant F test in all trials. Values for the control ranged between 30.8 and 60.6 kg/ha/day in different farms (Table 5). Application of urea at 40 kg/ha resulted in significant increases in growth rate in some farms while the high rate of urea or the half rate plus LessN resulted in significant increases in growth rate in all trials. Moreover the magnitude of increase was greater with the latter treatments. As an average of all the six trials, the increase in pasture growth rate with 40 kg/ha urea was 23 or 24% compared with 43 to 44% with either 40 kg/ha urea plus LessN or with 80 kg/ha urea.

Table 5. Growth rate of pasture (kg/ha/day) in different treatments measured during one grazing cycle in six dairy farms in Canterbury during the summer of 2010-11.

Treatment	Dean	Heath	Max	Steven	Ross	Peter	Mean	%
Control	33.9	48.0	30.8	60.6	47.8	44.6	44.3	0.0
LessN40	54.2	69.9	53.9	76.4	63.4	62.9	63.4	43.2
Liq U40	43.4	66.3	43.9	66.8	55.6	54.4	55.1	24.3
Solid U40	40.3	63.8	46.0	73.0	49.6	55.0	54.6	23.3
Solid U80	50.0	70.1	56.5	82.2	66.1	58.7	63.9	44.3
F test	***	***	***	***	***	***		
$LSD_{0.05}$	8.43	11.38	5.68	6.51	9.70	5.74		

In conclusion, it can be seen from the results obtained from the six field trials on commercial dairy farms that LessN had a positive effect on pasture growth rate and final DM production. On average, urea at 40 kg/ha increased pasture DM up to 24% compared to the control and adding LessN at 3 L/ha to this treatment increased pasture DM to 43% (Figs 2 & 3). The increase in pasture productivity obtained with the LessN treatment was similar to that of urea application at 80 kg/ha. This will result in reducing input cost for the farmers and less impact on the environment.

Acknowledgment

The farmers and their staff have been extremely helpful in providing the land and co-operating in conducting these trials.

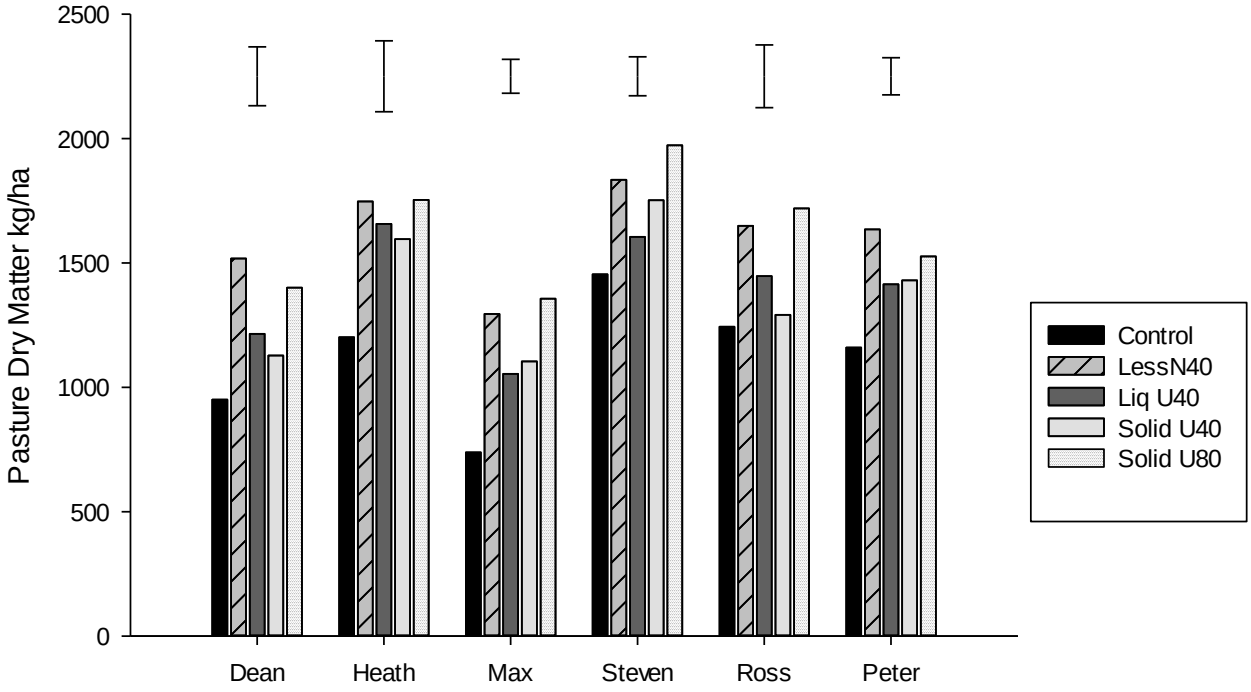

Figure 1. Pasture dry matter affected by nitrogen treatments in different field trials estimated by probe reading. Error bars are $LSD_{0.05}$ values for each set of bar graphs.

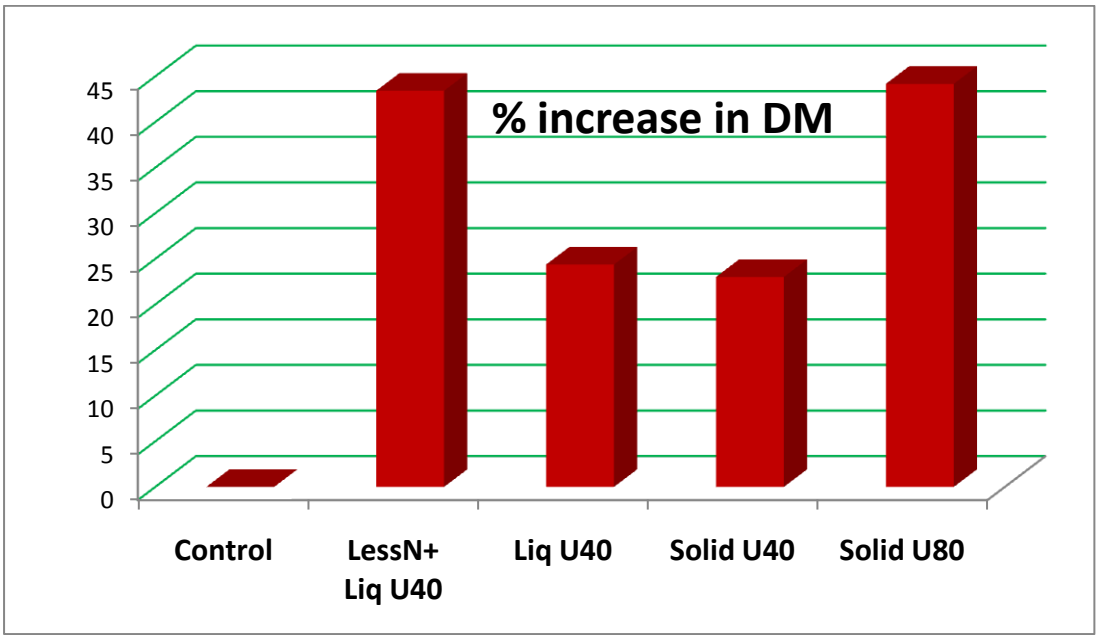

Figure 2. Percent increase in pasture dry matter estimated by probe readings averaged over six dairy farms in Canterbury during the summer of 2010-11.

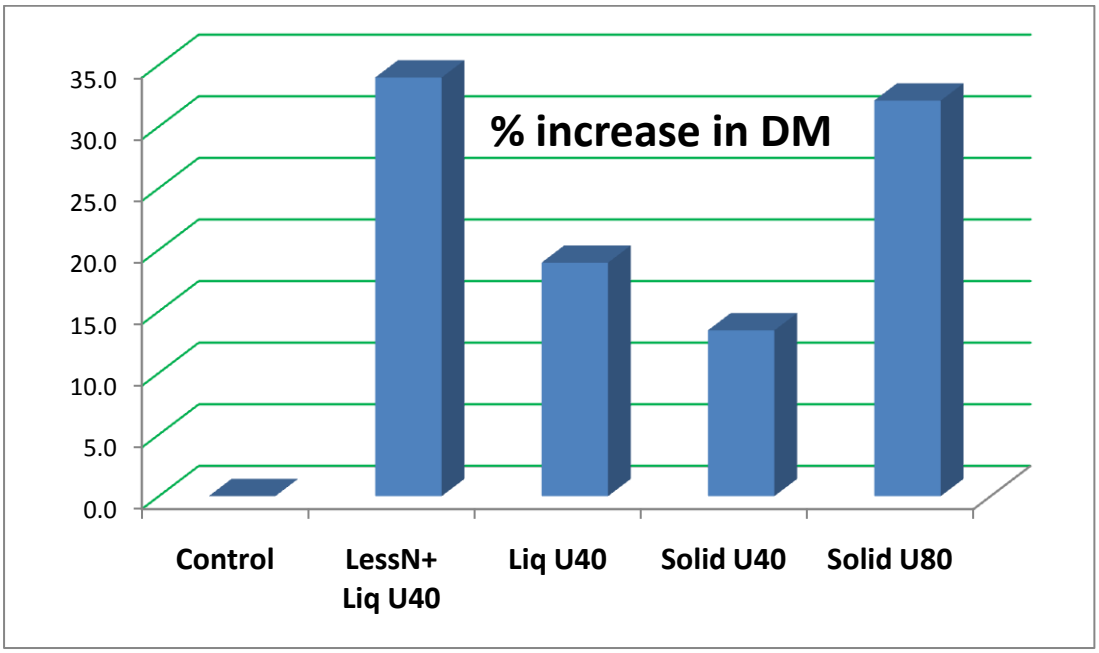

Figure 3. Percent increase in pasture dry matter measured by mowing averaged over six dairy farms in Canterbury during the summer of 2010-11.