Fertiliser Quality Council

Report of the Expert Panel on the trial programme conducted by Donaghys to support their claims regarding the agronomic performance of LessN

(18 September 2012)

Background

The Fertiliser Quality Council (FQC) received a complaint concerning the claims made by Donaghys about the agronomic performance of LessN. The FQC then asked its Expert Panel to review the evidence for the claims made for this product. This is the report of that panel.

Summary of main points

1. On their website Donaghys claim that LessN "is the world's only nitrogen enhancer. By adding LessN to dissolved (liquid) urea you can halve the amount of nitrogen you apply and still get an increase in DM production over applying a full rate of nitrogen (solid) by spreading. By adopting the LessN system and spraying on urea farmers can:

    - **Halve** their urea use
    - Dramatically increase their nitrogen response rate
    - Grow **more** pasture than spread urea
    - Grow pasture **faster** than spread urea
    - And significantly reduce the cost of dry matter production."
2. To support these assertions Donaghys have conducted or commissioned approximately 67 field trials throughout the country from 2007 to 2011.
3. The results of all these field trials are publicly available on the website. In addition, Donaghys have met with representatives of the FQC and have provided additional information on trial design and results when requested. Donaghys are to be commended on the extent of their research program and the free availability of the results.
4. This report does not make recommendations as to whether farmers should or should not purchase LessN. The focus of the report is on the design and conduct of the field trial program and provides an assessment as to whether that program is appropriate to support the claims made for LessN by Donaghys.
5. The trial design and conduct has changed slightly over time. Donaghys have provided the FQC with a copy of a detailed protocol describing the layout and conduct of the trials. This protocol is dated 7 December 2010 and it appears that this was the protocol followed in the later trials.

6. In 21 August 2009, Robert Sanson of AsureQuality reviewed the trial program up to that time. Donaghys have provided FQC with a copy of this review which was generally favourable.
7. This current review concludes that the overall trial program has been designed and conducted in a scientifically credible manner. However, as with all trials, care must be taken not to extend the findings beyond what was actually tested in the trials. This applies particularly to the claim, reproduced in Paragraph 1, that farmers can "**halve** their urea use".
8. Most of the early trials focused on the nitrogen response obtained between one grazing and the next in a dairy farm situation. Typically this was between 21 and 25 days. This is short relative many other trials assessing nitrogen responses and a potential criticism of the trial design is that there may have been ongoing residual nitrogen responses that were not detected. A number of trials have however, addressed this potential criticism by continuing measurements of pasture growth beyond the first grazing after fertilizer application. In these trials there is no evidence of residual effects that would change the original interpretation of the data.
9. The effectiveness of LessN has only been tested comprehensively at the urea application rate of 40 kg/ha (18.4 kg/N ha) and any conclusions as to its effectiveness should not be extended to other application rates. The wording on the website, referred to in Paragraphs 1 and 7, should be modified to reflect this.
10. The method of measuring pasture yield (i.e. probe v mower) appears to have an effect on the sizes of the nitrogen responses obtained. This does not change the overall conclusions from the trials but could affect assessments of the cost-effectiveness of using LessN.
11. The balance of evidence suggests that LessN added with urea (40 kg urea ha^{-1}) has a positive effect on pasture growth compared with that achieved with urea alone.
12. The performance of LessN (and hence its cost effectiveness) appears to vary between sites. At this stage it is not clear whether this is just the normal random variation that could be expected in a large series of field trials or whether there are identifiable factors that affect the performance of LessN. Further statistical analysis of the complete dataset may identify factors that affect the effectiveness of LessN. This would then enable more precise information to be given to farmers.

Description of trial data

13. Donaghys are to be commended for the amount of trial work they have conducted and the ready availability of the results on their website (www.donaghys.com/201.html)
14. To date there have been approximately 67 trials assessing the performance of LessN on pasture. These were conducted between 2007 and 2011. Of these, approximately 9

were not responsive to N fertilizer application. This leaves 58 trials, the results of which are presented and summarized on the LessN website.

15. In 51 of these trials the main treatments were control (no N added), urea at 40 kg/ha (urea40), urea at 80 kg/ha (urea80) and urea at 40 kg/ha + LessN (urea40+LessN). In most trials the urea (+ LessN where appropriate) was dissolved in water prior to application. The application rate of the resulting solution was equivalent to 200 litres/ha. A similar quantity of water was applied to the control. The rates of fertilizer N application were 18.4 kg N/ha and 36.8 kg N/ha for the 40 and 80 kg urea/ha treatments respectively.
16. A further 7 trials had a similar range of treatments, excluding urea40.
17. A small number of trials included some additional treatments. These included urea spread in granular form and LessN applied alone without added urea.
18. The way in which these trials have been conducted has changed slightly over time. Donaghys have provided the FQC with a copy of a detailed protocol describing the layout and conduct of the trials. This protocol is dated 7 December 2010 and it appears that this was the protocol followed in the later trials.
19. The treatment plots were quite large. In most trials the plots were 3 or 4 m wide and 30 m long. On some occasions the requirements of the trial site required minor changes to these dimensions, but in all cases the areas on which pasture measurements were made were large enough to encompass much of the small scale variation observed in grazed pastures.
20. The protocol specifies that there be 8 replicates of each treatment arranged in a randomized block design. In some early trials, conducted prior to the development of the new protocol, only 5 replicates were used but in all cases there was an acceptable level of replication. The results were analysed statistically by an analysis of variance.
21. In nearly all trials pasture mass was measured using a pasture probe. On one occasion a rising plate meter was used in place of the pasture probe. In some trials pasture mass was also measured by mowing. The protocol specifies in great detail the procedure to be followed when using either a probe or a mower to measure pasture mass and these procedures appear to be scientifically rigorous
22. The average duration of the trials was 25 days but 33 trials had shorter durations than this and the shortest period between fertiliser application and pasture measurement was 15 days. Pasture mass was usually only assessed on one occasion after the treatments had been applied. Thirteen trials were of significantly longer duration and in many of these, pasture mass was assessed on more than one occasion.

Effect of LessN

23. If the complete data set is considered, there is evidence for a positive effect of LessN (when added with urea) on pasture growth. The appropriate comparison is urea40 with urea40 + LessN. In both treatments the urea was dissolved in water. There were 51 N-responsive trials that contained these two treatments (Paragraph 15).
24. In this initial analysis, the pasture growth data at all the trial sites was that obtained using a pasture probe or a plate meter.
25. In 34 of these 51 trials, pasture growth was statistically significantly greater in the urea40+LessN treatment than in the urea40 treatment. In the remaining 17 trials there was no statistically significant difference between the two treatments. On no occasion was pasture growth on the urea40+lessN treatment statistically significantly lower than the urea40 treatment.
26. Although there were 17 trials in which there was no statistically significant difference between the urea40 and the urea40+LessN treatments, there were only two in which the measured yield from the urea40 treatment was greater than that from the urea40+LessN treatment. Thus in 49 out of 51 trials, pasture growth as measured by a pasture probe or rising plate meter was greater in the urea40+LessN treatment than in the urea40 treatment. In some cases the yield differences were small and of no practical significance, but none-the-less it appears that LessN is having some effect.
27. Most of the trials were conducted by Donaghys' staff, but a number were conducted by independent researchers. Within the 51 trials discussed above there were 14 trials conducted by independent researchers. In 9 of these there was no statistically significant difference between the urea40 alone and the urea40+LessN treatments and in the other 5 trials pasture production in the urea40+Less N treatment was significantly higher than in the urea40 treatment.
28. Although in 9 of the trials the differences in pasture production between the urea40+LessN and the urea40 treatments were not statistically significant, in only two cases was the measured pasture production higher in the urea40 treatment.
29. In contrast, in the 37 in-house trials conducted by Donaghy's staff, pasture production on the LessN treatments was always higher than in the urea alone treatments and in 29 of these trials the difference was statistically significant.
30. The results from the independent trials are therefore less clear-cut than from the in-house trials. Donaghys have suggested to the FQC that this disparity may in part be due to a small number of the independent trials having been established in less than ideal circumstances. On one occasion there had been 200 mm of rain immediately prior to application and on another occasion the soil temperature was much lower than recommended by Donaghys for the application of LessN. But even with these difficulties

the balance of evidence from the independent trials suggests that LessN added with urea has a positive effect on pasture growth compared to that achieved with urea alone.

Method of pasture measurement

31. In 20 of the trials, pasture yield was assessed by mowing as well as by pasture probe or plate meter. Most of these trials (14) were conducted by independent researchers.
32. In 18 of these 20 trials, pasture yields measured by pasture probe or plate meter were higher from the urea40+LessN treatments than from the urea40 treatments, and in 10 of these trials the differences were statistically significant. On the two occasions when the yields from the urea40+LessN treatment were less than the urea40 treatment, the differences were small and not statistically significant.
33. When pasture yields were measured by mowing, pasture yields from the Urea40+LessN treatments were again higher than from the urea40 treatments in 17 of the 20 trials, but in only one trial (Foxton, Spring 08) was the difference statistically significant, and in that trial the pasture yields determined by mowing appear anomalously high. It therefore appears that differences between treatments were more clear-cut when pasture yields were assessed by pasture probe or plate meter than when they were measured by mowing. This point was also highlighted by some of the scientists who conducted the independent trials.
34. To investigate this difference between methods of pasture assessment the average fertilizer response as measured by mowing and pasture probe/plate meter in the 20 trials was calculated (Table 1).

Table 1. Average N fertilizer response (kg DM/ha) for 20 trials as measured by a pasture probe and by mowing.

Treatment	Probe (kg/ha)	Mown (kg/ha)	Difference between measurement methods (kg/ha)
Urea40	260	253	7
Urea80	474	439	35
Urea40+LessN	469	460	9

35. When the data from all 20 trials were considered (Table 1) there was little difference in the sizes of the measured N responses measured by mowing and the pasture probe.
36. However, as noted in Paragraph 33, the trial conducted at Foxton in Spring 2008 appeared to have anomalously high yields when measured by mowing – but not when

measured by the pasture probe. The mowed yields at that trial were so high that they had a marked effect on the average nitrogen responses calculated for the 20 trials.

37. When the results of this trial were omitted and the average nitrogen responses as measured by mowing and the pasture probe were recalculated for the remaining 19 trials (Table 2) the nitrogen fertilizer responses measured by mowing were smaller than when measured by the pasture probe

Table 2. Average fertilizer response (kg DM/ha) for 19 trials (omitting the Foxton, Spring 08 trial) as measured by a pasture probe and by mowing

Treatment	Response Probe (kg/ha)	Response Mown (kg/ha)	Difference between measurement methods (kg/ha)
Urea40	262	218	44
Urea80	466	366	100
Urea40+LessN	461	354	107

38. The generally smaller nitrogen responses measured by mowing would explain why in all but one of the 20 mown trials the differences between the urea40 and the urea40+LessN trials were not statistically significant, whereas in the same 20 trials the differences between these two treatments when measured by the pasture probe were statistically significant on 10 occasions.
39. This issue was discussed further with Donaghys. There are several reasons why responses to N fertiliser could be greater when assessed by a pasture probe rather than by mowing. Chief amongst these is the likelihood that addition of N fertilizer increases pasture mass below the mowing height as well as above it. This would be detected by the probe but not by mowing.
40. Although the differences in pasture production measured by the pasture probe and mowing are small they can have important effects on the interpretation of the trial results, and particularly the economics of LessN use.
41. Based on the comparison between pasture measurement by mowing and pasture probe/plate meter for 20 trials in the previous paragraphs, it is probably fair to say that if all the trials had used mowing to measure pasture yields, the differences in pasture production between the urea40 and the urea40+LessN treatments would have been smaller, and fewer of the differences would have been statistically significant. It is likely however, that the balance of evidence would still suggest that LessN is having a positive effect.

Comparison of the urea40+LessN treatment with the urea80 treatment

42. The main point in the advertising is not that adding LessN to urea applied at 40 kg/ha increases the N response, but that urea at 40 kg/ha + LessN is equivalent to urea at 80 kg/ha. This claim is based on the data derived from the pasture probe/plate meter measurements and presented in the summary table on the website.
43. There are 58 trials that include the comparison between urea40+LessN and urea80. In these 58 trials the yields of the two treatments are often similar and as a result there are few statistically significant differences between them. The average yield for the urea40+LessN treatment over the 58 trials is 1391 kg/ha, which is similar to the average yield from the urea80 treatment of 1379 kg/ha. In 32 trials the yield from the urea40+LessN is greater than the yield from the urea80 treatment, and in 26 trials the reverse is the case.
44. Based on these data it is reasonable to conclude that the average pasture responses to the urea40+LessN and the urea80 treatments were similar. There are however a number of questions about these data.
45. The detailed trial protocol provided by Donaghys (dated 7 December 2010) specifies that the urea80 treatment be applied as granular urea, and this was the protocol followed in the series of nine independent trials conducted in 2011. Similarly, in the cost comparison on the website between urea applied at 40 kg/ha with LessN and urea applied at 80 kg/ha, it is assumed that the urea40+LessN treatment is sprayed on and the urea80 treatment is applied in granular form. This is reasonable because these would be the normal practices adopted by farmers.
46. Before 2011 however, it appears that in most of the trials the urea80 treatment was dissolved in water prior to application. Therefore, by using the data from these earlier trials to support the claim that there is little difference between the urea40+LessN and the urea80 treatments, as they would be applied by farmers, Donaghys are assuming that there is no difference between spraying the urea80 treatment on as a liquid and applying it as solid granules. This is discussed further below.
47. Three trials are identified on the website as including a comparison of the spreading and spraying treatments. In one of these (Donaghys – Rolleston – Autumn 2009) the yield from the sprayed urea80 treatment was slightly greater than from the spread urea80 treatment – although the difference was not statistically significant. In the other two trials (Donaghys - North Canterbury – Summer 2008/09 and Donaghys – Leeston – Summer 2009/10) the yield from the sprayed urea80 treatment was less than from the spread urea80 treatment – although again the differences were not statistically significant.
48. In these other two trials however, the comment is made that the sprayed urea80 treatment resulted in some leaf burn on the clovers. In the discussion of the North

Canterbury trial this leaf burn is linked to the unexpectedly poor performance of the sprayed urea80 treatment in that trial. In the discussion of the North Canterbury trial it is also noted that similar leaf burn had been observed in two other trials.

49. Thus it would appear that in at least four trials the application of the urea80 treatment as a liquid resulted in some leaf burn of clovers and in one of these trials Donaghys note that this coincided with a poorer than expected performance of the urea80 treatment. The possibility of leaf burn is not a problem for farmers because they would not normally dissolve urea in water and apply it at the rate of 80 kg/ha. But it could raise some questions about the comparison between the urea40+LessN and the urea80 treatments.
50. However, although the possibility of pasture burn when the urea80 treatment was sprayed on does raise a potential question about the trial design, it does not appear that the impact on yields was large. As noted in paragraph 45, nine trials were conducted in 2011 using granular urea for the urea80 treatment. In these nine trials the average pasture production from the urea40+LessN treatment (1476 kg/ha) was only slightly less than the urea80 treatment (1497), which is consistent with the conclusions drawn from the whole set of 58 trials (Paragraph 43).
51. The 9 trials conducted in 2011 also contained a comparison between spread and sprayed urea at 40 kg/ha. In only one of these trials was there a statistically significant difference in the yields of these two treatments. Therefore, based on the available evidence there appears to be little difference between the spread and sprayed urea treatments and Donaghys would be justified in using data from the sprayed urea80 treatment to support their assertion that there is little difference in nitrogen response between the urea80 and the urea40+LessN treatments.
52. Although it is probably fair to say that the urea40+LessN and the urea80 treatments produced similar average yields in the trials it must be stressed that this comparison only involved one pair of treatments (urea40+LessN and urea80). No evidence is presented that similar conclusions would hold true at other rates of urea application. Donaghys have pointed out that they “never recommend(s) other rates and only talk(s) about 40 kg/ha urea as the LessN system – this is the only label rate and how the LessN system is described”. Never-the-less, as noted in Paragraph 1, the website contains the categorical statement in the advertising that the use of LessN allows farmers to “halve their urea use”. Donaghys may wish to consider some qualification of this statement.
53. A final point relates to the cost comparison between the urea40+LessN and the urea80 treatments in the brochure on the website. In this comparison, the N fertiliser response assumed for the urea40+LessN treatment is close to that presented in the summary of trials presented on the website. But the N fertiliser response for the urea80 treatment is an estimate from published literature and has no relationship to the series of trials.

54. This is not made very clear on the website and there is no explanation of why this course of action was taken. The N fertilizer response for the urea80 treatment taken from the literature is slightly smaller than the average measured in the 58 trials. If the measured N fertilizer response for the urea80 treatments was used in the cost comparison it would not change the overall conclusion but it would reduce slightly the cost advantage to the urea40+LessN treatment.

Extended Trials

55. A possible criticism of the trial design is the short duration of many of the trials. The average length of the trials was 25 days and the median was approximately 24 days. Eighteen trials lasted 21 days or less.
56. The duration of the trials was chosen to fit in with the normal grazing rotation of the farms, but it could be argued that this was insufficient time for the full N response to be expressed, and this would be particularly applicable to the higher rates of N application (e.g. urea80). If this was the case it would confound the comparison between the urea40+LessN and the urea80 treatments. Similarly, if LessN increased the speed of the response but not the total size of the response, then it would be advantaged by short duration trials.
57. At least fourteen trials were of considerably longer duration – between 40 and 165 days.
58. There was a range of trial designs in these extended trials. The simplest two trials each had only pasture growth measurement 40 or 42 days after a single fertilizer application. Several of the other trials involved a single fertilizer application and measurement of pasture growth between the fertilizer application and the first grazing, and then again between the first and second grazings. Other trials involved one or more re-applications of the fertilizer treatments after grazing or harvesting, and then one or more measurements of pasture growth over a variable number of grazing cycles. One trial had three pasture growth measurements over 47 days without any grazing.
59. Despite this variation in trial designs, it was possible to identify 15 occasions when there were at least two measurements of pasture growth after the application of the fertilizer treatments. From these 15 comparisons, the average N responses in the first and second measurement periods were calculated (Table 3). Although the circumstances of each trial varied greatly, it might be expected that if the nitrogen fertiliser response to the urea80 treatment occurred more slowly than in the urea40+LessN treatment then there would be a noticeable change in the relative performance of these two treatments between the first and second harvests. This was not the case (Table 3). This is reassuring and suggests that in these trials the urea80 treatment did not have a much larger residual response than the urea40+LessN treatment.

Table 3. Average pasture growth responses over control in the first and second growth periods in 15 comparisons

Treatment	Response (First Growth Period) kg/ha	Response (Second Growth Period) kg/ha
Urea40	198	71
Urea80	445	205
Urea40 + LessN	412	220

Conclusions

60. Donaghys have made a considerable effort to demonstrate the effectiveness of LessN and they should be commended for this.
61. They have conducted or commissioned 67 field trials using both Donaghys staff and independent contractors.
62. There is a detailed protocol for conducting the trials, but it is apparent that the trial design has changed over time. However, it is our assessment that these changes would not invalidate the conclusions from the series of trials.
63. The trial design and conduct has been submitted for review by an outside agency and that review was generally favourable.
64. The balance of evidence suggests that adding LessN to urea applied at 40 kg/ha has a positive effect on pasture growth compared to applying urea alone at the same rate.
65. Donaghys' claims are based on the average of all the trial results. But the increase in N fertilizer response achieved by LessN varies from trial to trial. At this stage it is not clear whether this variation is simply the random variation that can be observed in any series of trials – or whether there are some site factors that affect the performance of LessN. It is recommended that Donaghys undertake further statistical analysis of the complete data set in an attempt to isolate factors that may affect the performance of LessN.
66. It is also recommended that Donaghys seek to publish the results of the trials in a refereed scientific journal.
67. It is recommended that Donaghys modify their claim on the front page of their website that by using LessN farmers can halve their application rate of urea. The main reason for this, is that this assertion has only been tested at one rate of urea application. To make such a generalized statement (without an accompanying reference to the rate of application) is probably not justified by the trial data.
68. It is recommended that Donaghys use a nitrogen response ratio of 12.5:1 (rather than the current 11:1) for urea applied at 80 kg/ha in the cost comparison in the brochure available on the website. The nitrogen response ratio of 12.5:1 would be closer to the

average value measured in the urea80 treatments and would be consistent with the major thrust of the marketing – which is that the urea80 and the urea40+LessN treatments are equivalent.