# Field Experiments to Help Optimise Nitrogen Fixation by Legumes on Organic Farms

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**Introduction** During an organic rotation, the aim is to increase the nitrogen (N) content of the soil (and hence build up soil fertility) by recycling crop residues, applying manures/composts and from N fixed by legumes. IGER, with ADAS, Duchy College Cornwall and Abacus Organic Associates are developing improved guidance for organic farmers in the use of fertility-building crops. The main questions are: how to maximise N fixation and how to make the most efficient use of the fixed N? Available soil mineral N, which is generally thought to reduce N fixation, will be increased by manure applications, cutting/mulching and grazing. We describe an experiment to establish the extent to which animal and green manures can adversely affect N fixation. The results from the first year (2003) were reported recently (Hatch *et al*., 2004). Here we summarise the findings from 2 years' results (2003-4) to show the changes that occurred after the legume crop became fully established.

**Materials and methods** A 2-year study was undertaken on a well drained, reddish gravelly loam soil from the Crediton Series at IGER, North Wyke in south west England. Forty eight paired plots (1.5 x 10m) were prepared for planting either with, or without, composted farmyard manure (FYM) at a rate of 170 kg N/ha in autumn 2002. The plots were randomised and one half was sown with red clover, while the other half was sown with ryegrass. While the ryegrass stayed relatively weed free, the clover plots contained a significant proportion of grass that germinated from the seed bed. The plots were cut 4 times during each growing season and the following treatments (6 replicates to each) were applied: A. Red clover (herbage cut and removed); B. Ryegrass control (herbage cut and removed); C. Red clover (herbage cut and returned to plot) and D. Ryegrass control (herbage cut and removed: herbage from treatment A spread on this plot). Herbage returned to plots was mulched by spreading and mowing and a second application of FYM was made in autumn 2003. Herbage samples from each cut were analysed for dry matter, total carbon and N. N fixation was estimated by subtracting the N yields from the ryegrass controls, from that found in the corresponding clover/grass plots. Annual N yields (Table 1) were obtained from the cumulative harvests of each growing season, by combining the data from the ± FYM treatments (as these were not found to be significantly different).

**Table 1** Average N yields (kg N/ha per year) for treatments (combining the ± FYM data). Treatments (12 reps each) with different letter subscripts are significantly different ($P < 0.05$) within years

| Treatments | N sources | Year 1 (2003) | Year 2 (2004) |
|---|---|---|---|
| B | N obtained from soil | $120_c$ | $91_c$ |
| D | N obtained from soil + mulch | $146_b$ | $135_b$ |
| D-B | N from mulch | 26 | 44 |
| A | N from soil + fixation | $159_{ab}$ | $212_a$ |
| A-B | N from fixation | 39 | 121 |
| C | N from soil + fixation + mulch | $165_a$ | $230_a$ |
| C-D | N fixation in presence of mulch | 20 | 95 |
| (A-B)-(C-D) | Loss in fixation caused by mulching | 19 | 26 |

**Results and discussion** From the 170 kg N/ha applied as FYM each autumn, only 26 kg N/ha per year was recovered in the herbage and yield effects were only detected in the first harvests (data not shown). A trend for FYM to reduce N fixation was consistent, but not significant. Mulching increased the N yield of ryegrass (D) and clover/grass (C) in both years but the increase was only significant ($P<0.05$) in ryegrass. The benefit to clover was probably offset by a negative feed-back from added N in the mulch, leading to reduced fixation: a loss of 19 and 26 kg N/ha per year for years 1 and 2, respectively.

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**References**

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