

### Reference 40

Tonitto, C; David, MB; Drinkwater, LE 2006 Replacing bare fallows with cover crops in fertilizer-intensive cropping systems: A meta-analysis of crop yield and N dynamics AGRICULTURE ECOSYSTEMS & ENVIRONMENT, 112, 58–72. 10.1016/j.agee.2005.07.003

### Background and objective

Diversified crop rotations using cover crops to provide a variety of ecosystem functions, including biological N fixation (BNF), could maintain yields while reducing N losses. Although leguminous plants used as green manures are capable of fixing N in quantities which exceed cash crop demand, the prospect of replacing significant quantities of Haber-Bosch N with BNF is widely viewed as impractical due to yield reductions. Likewise, the practice of replacing bare fallows with non-leguminous cover crops in systems receiving Haber-Bosch N is generally deemed not economically viable. Objectives: 1) How does the replacement of Haber-Bosch N with legume-derived N affect yield? 2) How does the management of a non-leguminous cover crop affect yield? 3) How do the N dynamics in conventional versus diversified agroecosystems differ? Here, only results regarding the effect of legume green manures on N dynamics are reported.

### Search strategy and selection criteria

They searched the literature by using electronic databases, including BIOSIS, Agricola, and Web of Science. The Science Citation Index was used to identify papers citing some of the key early papers that fit our parameters. Finally, citation lists from relevant, recent literature reviews were also used to obtain studies. For some studies, Data Thief software was used to extract needed data from figures. When they came across studies that met selection criteria, but did not report the values needed in the paper, the author(s) were contacted. Studies compiled in our legume covercrop yield database had the following characteristics: (1) winter legume cover crop followed by an unfertilized cash crop compared to the control, (2) cash crop production every year, (3) no manure or other N additions applied during any phase of the diversified rotation, and (4) cover crop biomass incorporated into the soil or killed before crop planting, with no biomass removal. They excluded studies if legume treatments had excessive applications of inorganic N fertilizer or if the green manures were being compared to a zero N control. Only legume cover crops are considered for this analysis (cash crop after non-legume cover crops is fertilized, so non-legume cover crop were removed in our analysis).

### Data and analysis

A meta-analysis was conducted to analyze the response of yield and soil N status in legume and non-legume cover crop systems compared with conventional systems, using MetaWin version 2.1 software. Because nearly all of the studies we used did not report any measure of variance or the number of replicates, we conducted an unweighted meta-analysis. Although a more rigorous weighted analysis is possible with known variance and replicates for each study, the statistical significance of our unweighted meta-analysis is enhanced by the calculation of confidence intervals (CI). After a mean effect size was calculated, a bias-corrected 95% confidence interval was generated by a bootstrapping procedure (5000 iterations) using the MetaWin software.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
35	Arable crops	Fertilization using cover crops as green manure (with distinction between legume and non-legume)	Bare soil with mineral-N fertilization	Metric: Soil nitrogen leaching; Effect size: Logarithm of ratio of considered metrics in system with fertilization with legume cover crops as green manure to the considered metrics in systems with bare soil and N fertilization.	50

### Results

- Though a limited sample size, the comparison between legume-fertilized systems and conventional systems showed a significant, 40% reduction in nitrate leaching.
- Legume-fertilized systems had post-harvest soil inorganic N pools ranging from 50% below to 80% above conventional systems.
- NULL
- NULL
- NULL

### Factors influencing effect sizes

- N cover crop input to soil : NA

### Conclusion

The potential for reduced N leaching from green manure fertilized systems due to greater retention of organic N is supported by short-term isotopic experiments, long-term systems comparisons, and this meta-analysis.