

EDITORIAL

Nitrogen Workshops provide a forum for the exchange of information and discussion of recent developments and improvements in our understanding of nitrogen cycling in the soil-plant-atmosphere system. Initially organised by scientists from the UK in the 80s, N workshops have moved to other European countries since 1994 (Gent, Belgium in 1994; Braunschweig, Germany in 1996; Copenhagen, Denmark in 1999).

The 11th Nitrogen workshop, held in Reims (France) from 9 to 12th September 2001, was organised by the INRA, Environment & Agronomy Department, represented by the Agronomy research laboratories of Reims and Laon¹, which are attached to the Environment & Agronomy Department of INRA. Three-hundred scientists from forty countries (mainly Europe) attended the workshop. It emphasised the understanding of organic matter cycling in soils (C & N) and recent developments in tools for managing soil and fertiliser nitrogen with contributions from intensive, low-input and organic agriculture (including forests) in various climates. Three themes were addressed during the workshop: (i) the decomposition of added organic matter (i.e. plant residues and agricultural wastes) with contributions related to residue quality and location, interactions with soil structure, organic / inorganic interactions, gross N transformations, and gas losses associated with organic matter transformations; (ii) the long-term evolution of C & N in agro-ecosystems as affected by organic matter management, N fertilisation and soil tillage, with communications on carbon sequestration, mineralisable nitrogen, soil quality indices and environmental impacts, and (iii) management of nitrogen on field, catchment and regional scales with presentations dealing with decision support systems for N fertilisation, crop and soil diagnostic tools, agro-ecological indicators and precision agriculture.

The workshop was organised in plenary sessions (25 oral communications) and poster sessions (228 posters). Communications, selected from the different oral or poster sessions, were then reviewed according to the procedure of *Agronomie: Agriculture and Environment* and are published in this present special issue. Elsewhere, discussion took place in 9 thematic working groups (TWG), whose themes, objectives and main conclusions are summarised below.

TWG1, **“Inputs and turnover of C and N through root systems: how should these be quantified?”** was organised and presented by Dr. I.R. Fillery (CSIRO Plant Industry, WA) and Dr. E.S. Jensen (The Royal Veterinary & Agricultural University, Denmark). This discussion group mainly concentrated on methodology issues associated with the application of in situ ¹⁵N labelling techniques currently being advocated to determine below ground residue N turnover in pasture and crop species: the use of single pulse vs. multiple pulse-labelling techniques to accurately determine N inputs, the lack of a standard method to physically recover roots and the representativeness of the sampled roots. Main priorities for future research were identified as: (i) checking and improving the ¹⁵N methodology; (ii) carrying out longer-term studies to estimate root inputs to soil organic matter, and (iii) developing combined studies of C and N inputs in below-ground residues.

TWG2, **“N availability of organic wastes”** was organised and presented by Dr. H. Kirchmann (Swedish University of Agricultural Sciences, Sweden) and Dr. S. Houot (INRA, France). One of the main subjects of the discussion concerned the type and composition of wastes. It was noticed that often, little information on the chemical composition of organic matter of wastes was available, particularly for “new types” of wastes. These new wastes derive from new treatment methods for animal effluents, or source-separated household composts, or biogas residues. The rules determining the input of N to soil through wastes differ greatly between countries and a discussion on the pros and cons of the different regulations was held. The main research priorities were identified as the need for improved characterisation methods and the development of models that focus on waste quality.

TWG3, **“Where is the missing N in grassland budgets?”** was organised and presented by Dr. C. Watson (Queen’s University of Belfast DARD, Northern Ireland) and Dr. S. Ledgard (AgResearch, New Zealand). After giving several examples of N budgets under grasslands, emphasising the large amount of N that is unaccounted for, specific issues were discussed: (i) the possible underestimation of gaseous losses due to the spatial and temporal variability of processes and short-comings of methods; (ii) the difficulty of accurately quantifying changes in soil organic C and N, and (iii) the importance of consistency in analytical methods in long-term studies. Possible mitigation strategies were discussed with an emphasis on the need for integrated studies that take into account a combination of management strategies and analysis of interactive events.

TWG4, **“Organic resource quality and integrated soil fertility management”** was organised and presented by Dr. L.S. Jensen (KVL, Denmark) and Dr. B. Vanlauwe (BBF-UNESCO-GIGIM, Kenya). Measurement and management of organic resource quality was the first theme, under which were discussed: (i) the need for new resource quality measurements (e.g. NIR, mechanical strength of plant tissues); (ii) the need to consider and evaluate better the quality of roots and exudates, waste products and manures, and to take into account possible interactions between organic sources of various qualities, and (iii) the

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interest of building up an organic resource database that covers both tropical and temperate organic residues from various agro-ecosystems. The relevance of organic resource quality was also discussed, particularly in a long-term perspective (e.g. impact of drastic land use changes on the quantity and quality of soil organic matter).

TWG5, “**Modelling carbon and nitrogen in the soil/plant system**” was organised and presented by Dr. J. Smith (Aberdeen University, UK) and Dr. P. Garnier (INRA, France). In the first part, the use of models to reduce the adverse environmental impacts of nitrogen was discussed. Two key questions were addressed: (i) how we can we predict the overall environmental impact of N?, and (ii) what system do we need to reduce its overall environmental impact? For both questions, the discussion focussed on the issue of scales: what is the validity of applying models that were formulated and evaluated on a field scale to a regional scale? Reduction of environmental impacts can only be achieved by working on all scales: regional (political), farm (economical) and plot (changes in practices). The main question for the future was: how do we compare the environmental impact of different forms of N pollution?

In the second part, the group discussed the modelling of soil organic matter decomposition as a function of organic inputs. Despite the quite wide variability in the pools and processes of OM models, all the modellers agreed on the need for better characterisation of the amount and quality of soil organic matter, which is vital to adequately initialise the models. Another aspect discussed was related to the characterisation of continuous, seasonal and single organic inputs into soil, their correct identification and inclusion and how they are correctly known and taken into account in the models.

TWG6, “**Advances in the measurements of gross and net fluxes**” was organised and presented by Dr. J. Luxhoi (KVL, Denmark) and Dr. D. Hatch (IGER, UK). Firstly, the main methods of quantifying soil N supply and those methods involving ^{15}N stable isotopes were presented. From the discussion it was obvious (and well known) that no one method is perfect. The ^{15}N dilution technique is the only approach that permits real understanding of the underlying processes of the mineralisation-immobilisation turnover in soil. However, simpler options of quantifying mineralisation are still preferable. Subsequently, new advances in the use of ^{15}N dilution were presented and discussed, such as links between soil gross N fluxes and soil fauna diversity, or how the resolution of N processes on a fine scale can improve the understanding of controlling factors on a larger scale. The group was particularly concerned that newcomers to these techniques should not be put off from employing them by the difficulties of defining standards, methods and procedures in the use of ^{15}N dilution techniques.

TWG7, “**Physical and chemical controls over C and N cycling in soils**” was organised and presented by Dr. D. Angers (AAC, Canada) and Dr. C. Chenu (INRA, France). The first aim of the group was to present and discuss the different approaches and methods that can be used to highlight and quantify the physical and chemical controls over the mineralisation and stabilisation of C and N. The main conclusion was that basic knowledge of the formation and turnover of soil aggregates is needed to help de-couple the SOM dynamics from the soil structure dynamics. The second aim was to discuss the integration of physical and chemical controls in soil organic matter models (SOM associated with clay and silt or located inside micro- or macro-aggregates). The main research priorities were identified as: (i) the need for more detailed studies on the different processes of stabilisation of SOM, which are interactive and may not apply to the same time scale, and (ii) more studies of the mechanisms of N stabilisation processes and interactions of C and N.

TWG8, “**The use of plant N-status indicators as quick tools to manage in season N-fertilisation for arable crops**” was organised and presented by Dr. J.P. Goffart (CRAGx Gembloux, Belgium) and Dr. M.J. Jeuffroy (INRA, France). The main characteristics, the performances and the practical conditions of use of the existing tools were discussed. It was emphasised that more investigation is required into the sensitivity, specificity, accuracy and feasibility of these tools, together with a more accurate definition of the optimal framework of use and application procedures. Prospects for the future were identified as: (i) the potential combination/integration of quick tools with decision support systems should be investigated more, and (ii) it is essential to take into account more efficiently the economical return of new equipment associated with quick tools in order to help facilitate the diffusion of such techniques towards farmers and advisors.

TWG9, “**Measuring, modelling and mitigating nitrous oxide production – what’s new?**” was organised and presented by Dr. J. Stevens (Queen’s University of Belfast, Northern Ireland) and Dr. P. Boeckx (Gent University, Belgium). The discussion was organised around three questions: (i) measuring nitrous oxide fluxes and how we cope with temporal and spatial variability; (ii) modelling nitrous oxide fluxes, and are there user-friendly models that have been independently tested for predicting fluxes on the lab, plot and field scales, and (iii) mitigating nitrous oxide production and how advances in combined microbial techniques and measurements of fluxes help us to identify better the processes that need mitigation. Emphasis was given to the rapid progress of technological innovation (use of isotopes, automated measuring systems), the increasing numbers of studies that link nitrous oxide production with C dynamics and the growing attention that is given to modelling.

The next 12th Nitrogen Workshop will be hosted by the Institute of Grassland and Environmental Research (IGER) and will take place from the 21st-24th September 2003, at the University of Exeter, Devon, UK. The main theme will be “Controlling N flows and losses” and will be likely to include the following points: (i) drivers towards sustainability – why change?; (ii) matching supply with demand; (iii) controlling losses, and (iv) reconciling productivity within environmental constraints. More information will be available on the website (http://www.iger.bbsrc.ac.uk/igerweb/confs/N_Workshop/12th_N_Workshop.html).