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# SOILS

A Publication of the Soil and Water Management & Crop Nutrition Sub-Programme of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture and FAO/IAEA Agriculture and Biotechnology Laboratory, Seibersdorf International Atomic Energy Agency Vienna, Austria



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## A. TO OUR READERS

The Soil and Water Management & Crop Nutrition Sub-programme of the Joint FAO/IAEA Division has contributed to the FAO Medium Term Plan (MTP) for 2002-2007. The MTP provides the framework for the detailed planning of the programme of work and budget which is now underway for the 2002-2003 biennium. It is the blueprint for the biennial planning process, which is now moving from output- or activities-based programming to one based on results.

Several staff members from the Sub-programme (myself, Felipe Zapata and Lee Heng) visited FAO, Rome, in February-March to consult with colleagues in the Land and Water Development Division and the Plant Production and Protection Division of the Agriculture Department on the formulation of the PWB and to identify specific tasks on which we could collaborate. Several joint activities have been agreed to:

- Bulletin on deficit irrigation (FAO Water Reports).
- Validation of CROPWAT computer programme for irrigation planning and management.
- Bulletin on utilisation of rock phosphates in agriculture (FAO Fertiliser and Plant Nutrition Series).
- Participation in *ad hoc* Task Force to prepare and co-ordinate inputs into ISCO-2000.
- Information exchange on soil and water conservation, carbon sequestration, biological nitrogen fixation, conservation farming practices.
- Consultants Meeting on Integrated Nutrient and Water Management in Rice-Wheat Cropping Systems in Asia.

A Major Output (MO) of the MTP was identified as *Improved Practices and Capacities for Intensifying Cropping Systems and Conserving Natural Resources through Integrated Management of Soil, Water and Nutrients*. Components of the MO are:

- Methodologies and guidelines for the use of (a) neutron probes, time domain reflectometry and capacitance probes for measuring soil water content in rainfed and irrigated cropping systems, (b) spatial and temporal distribution of  $^{137}\text{Cs}$ ,  $^7\text{Be}$  and unsupported  $^{210}\text{Pb}$  for estimating soil redistribution rates and the efficacy of soil conservation measures in catchments, (c)  $^{13}\text{C}$  and  $^{18}\text{O}$  isotope discrimination for identification of crop genotypes with drought and salinity tolerance, (d) temporal distribution of  $^{13}\text{C}$  natural abundance in soil organic matter to estimate C sequestration and turnover time, (e) foliar labelling with  $^{15}\text{N}$  to estimate below-ground N in crops and trees, and (f)  $^{18}\text{O}$  and  $^2\text{H}$  isotope discrimination to identify sources of water used by plants; disseminated through scientific papers, technical documents, bulletins and training manuals.
- Recommendations for (a) crop genotypes with high P use efficiency and tolerance to drought and Al toxicity in acid tropical soils in savannah agro-ecosystems, (b) crop sequences and combinations and management of fertilisers, legumes and local nutrient sources to optimise nutrient cycling and water use in intensive rice-wheat systems in south and east Asia, savannah agro-ecosystems in Africa and Latin America and agro-forestry systems world-wide.

- Data and information collection for validation and refinement of models of crop growth, nutrient and water dynamics, organic matter turnover and soil erosion for improved prediction of crop yields and to provide decision-support for better management of natural resources and external inputs.
- Enhanced human resource and institutional capacities in NARS for on-station and on-farm research and extension activities in integrated soil, water and nutrient management and natural resource conservation.

Some of these components are presently being addressed through existing co-ordinated research projects (CRPs) and others will be included in a new CRP in 2001 and CRPs being planned for the 2002-03 biennium.

With my very best wishes.

Phillip Chalk  
Head, Soil and Water Management  
& Crop Nutrition Section

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Senior Laboratory Technician (50%)  
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### 3. Staff changes

**Dr. Mujtaba Naqvi**, Project and Technical Officer for Interregional Model Project on *Sustainable Utilisation of Saline Groundwater and Wastelands for Plant Production* (INT/5/144), who was based in the Section, left the IAEA at the end of January after managing the project for the past 3 years. We are indebted to Mujtaba for his wise counsel and willing contribution to the work of the Sub-programme that went beyond his immediate responsibility for INT/5/144. As a mark of appreciation for his long association with the IAEA, Mr. J. Dargie, DIR-NAFA, presented Mujtaba with a certificate of Honorary Staff Membership of the Joint FAO/IAEA Division.

**Ms. Robina Shaheen** worked with the Soil Science Unit, Seibersdorf, as a Junior Professional Officer from 7 March 1999 to 6 March 2000 on the use of  $^{13}\text{C}$  isotope discrimination to screen wheat cultivars for salinity and drought tolerance. The Sub-programme acknowledges her excellent work and wishes her every success in her future PhD studies at the Institute of Mineralogy and Petrography, Lausanne, Switzerland.

## C. FUTURE EVENTS

### ***RESEARCH CO-ORDINATION MEETINGS (RCMs) OF FAO/IAEA CO-ORDINATED RESEARCH PROJECTS (CRPs)***

- ⇒ **Final RCM of CRP on “The Use of Isotope Techniques in Studies on the Management of Organic Matter and Nutrient Turnover for Increased, Sustainable Agricultural Production and Environmental Preservation” (D1.40.08), 26 - 30 March 2001, Serdang, Malaysia**

Ten contract holders and five agreement holders are expected to participate. Ms. Rosenani Abu Bakar, Universiti Putra Malaysia, is the local organiser. Gamini Keerthisinghe is the Project Officer and will serve as the Scientific Secretary. The research carried out during the duration of the CRP (1995-2000) will be reviewed and the major achievements and outputs will be evaluated in accordance with the project objectives. Deadlines for the receipt of manuscript for inclusion in a TECDOC and for the receipt of final reports have been set for 31 January and 28 February, respectively.

- ⇒ **Final RCM of CRP on “The Assessment of Soil Erosion Through the Use of Cesium-137 and Related Techniques as a Basis for Soil Conservation, Sustainable Production and Environmental Protection” (D1.50.03), 21 - 26 May 2001, Vienna, Austria**

Twelve contract holders and four agreement holders are expected to participate. The research results obtained during the implementation of the CRP (1996-2000) will be reviewed and the outputs/achievements will be evaluated in accordance with the logical framework of the project. F. Zapata is the Project Officer, and will serve as the Scientific Secretary. Deadlines for the submission of the final reports and summaries has been set for 30 April 2001. In addition, all participants are kindly requested to prepare manuscripts from their research work for inclusion in an IAEA TECDOC (planned output of the CRP) and submit them (in diskette, Word 95/97 version) to the Project Officer by the final meeting.

### ***CONSULTANTS MEETINGS***

- ⇒ **FAO/IAEA Consultants Meeting on “Integrated Soil, Water and Nutrient Management for Sustainable Rice-Wheat Cropping Systems in Asia”, 23 - 25 August 2000, Rome, Italy**

A group of five internationally-recognised consultants with expertise in soil fertility and cropping systems will review on-going work in the rice-wheat system of Asia, which includes principally Bangladesh, People’s Republic of China, India, Nepal and Pakistan. The consultants will address the issue of sustainability under intensive cereal production with attendant high nutrient removal in grain and crop residues, and high water and fertiliser inputs with the associated risk of environmental pollution. They will have an active research or extension programme in the rice-wheat system and will preferably have strong links with the existing Rice-Wheat Consortium involving NARS, international agricultural research centres and advanced research institutes. Both CIMMYT and IRRI will be represented at the meeting. The consultants will make recommendations to the IAEA with regard to its future research involvement through a CRP, particularly in relation to overall water, carbon and nitrogen budgets in rice/wheat cropping systems which may include a grain legume phase and variable

crop residue/water management treatments. The recommendations will include the role of nuclear techniques in the proposed project. Phillip Chalk is the Scientific Secretary.

⇒ **FAO/IAEA Consultants Meeting on “The Comparison of Soil Moisture Neutron Probe with Time Domain Reflectometry and Capacitance Methods”, March 2001, Vienna, Austria**

A consultants meeting will be organised at IAEA Headquarters with the participation of four individual research contract holders. The researchers involved in this project are: C.T. Hignett (Australia), P. Cepuder (Austria), J.P. Laurent (France) and S.R. Evett (USA). In addition, Ms. L.K. Heng from the Soil Science Unit, Seibersdorf Laboratories, is undertaking complementary field/laboratory experiments. This project was organised following a consultants meeting in Vienna, 23 – 25 November 1998, the results of which are collated in IAEA-TECDOC-1137: “Comparison of soil water measurement using the neutron scattering, time domain reflectometry and capacitance methods”. This document is available upon request to Mr. P. Moutonnet. A selected bibliography on this topic is available from our home page: [http://www.iaea.org/programmes/nafa/d1/public/d1\\_pbl\\_2\\_1.pdf](http://www.iaea.org/programmes/nafa/d1/public/d1_pbl_2_1.pdf).

***TECHNICAL CO-OPERATION PROJECTS (TCPs)***

⇒ **FAO/IAEA Regional TCP for East Asia and the Pacific on "Nuclear Techniques for the Promotion of Agroforestry Systems" (RAS/5/029)**

This Regional TCP was initiated in 1995 involving Bangladesh, People’s Republic of China, Indonesia, Malaysia, Myanmar, Pakistan, Philippines, Sri Lanka, Thailand and Viet Nam. It is in the final phase of implementation, with Gamini Keerthisinghe as the Technical Officer.

• **Final Project Evaluation Meeting, 3 - 7 July 2000, Manila, Philippines**

The main purpose of this meeting will be to evaluate the results achieved in accordance with the project objectives. The counterparts will present reports describing the major achievements and steps taken to disseminate the new information to the end-users. The presentations will be critically evaluated to assess the impact and outputs of the project. Ms. Crispina Rosales, Philippine Nuclear Research Institute, Manila, will be the local organiser of the meeting.

⇒ **FAO/IAEA Regional TCP for West Asia on “Fertigation for Improved Water Use Efficiency and Crop Yield” (RAW/5/007)**

This project was initiated in 1999 for a period of two years. Iran, Jordan, Lebanon, Saudi Arabia, Syria, United Arab Emirates and Yemen are the participating Member States. This project replaces an antecedent project (RAW/5/002) which was implemented as Phase I during the period 1995-1998. Pierre Moutonnet is the Technical Officer.



- **Annual Co-ordination Meeting, November 2000, Vienna, Austria**

A 2-day meeting followed by a 3-day workshop on the utilisation of P-fertilisers in fertigation is proposed.

⇒ **FAO/IAEA Regional TCP for Latin America on “Plant Nutrition, Soil and Water Management” (RLA/5/036), ARCAL XXII**

This regional project was initiated at the end of 1996 with eight participating countries: Argentina, Brazil, Chile, Cuba, Guatemala, Mexico, Uruguay and Venezuela. The project is in its final phase of implementation and will be completed in the year 2000.

- **Final Project Evaluation Meeting, 26 - 30 March 2001, Irapuato, Mexico**

During this meeting the Project Co-ordinators will evaluate the implementation of the project in accordance with the project objectives. The counterparts will present reports on the implementation of the activities during the duration of the project highlighting the achievements/outputs obtained in their countries. Thereafter, participants will assess the impact of the project in their countries and the region. Dr. Juan José Peña-Cabriales, “Centro de Investigaciones y Estudios Avanzados del Instituto Politécnico Nacional”, Irapuato Unit, Mexico, will be the local organiser.

⇒ **Proposal for FAO/IAEA Regional TCP for Africa on “Desertification”**

Desertification and drought are very serious and complex problems with great social, economic and environmental impacts in developing countries located in arid and semi-arid regions world-wide, in particular those of Africa. The IAEA Department of Technical Co-operation through the Africa Section with the technical support of the Sub-programme is considering a new regional project for the next biennium (2001-2002). Planning and consultations have started. It is intended to create strategic linkages to existing networks on desertification such as the Desert Margins Programme, a system-wide eco-regional initiative of the CGIAR/UNEP with the ICRISAT Sahelian Center in Niamey, Niger, as the focal point.

### ***INTERNATIONAL SYMPOSIUM***

⇒ **FAO/IAEA International Symposium on “Nuclear Techniques in Integrated Plant Nutrient, Water and Soil Management”, 16 - 20 October 2000, Vienna, Austria**

Planning for the Symposium is at an advanced stage. The deadline for applications was 19 May 2000. Keynote speakers for the seven principal themes have been selected. Applicants will be informed at the end of June about financial assistance and the format (poster/oral) for presentation of their contributions. The deadline for revision of extended synopses is 1 September 2000.

## ***NON-FAO/IAEA MEETINGS***

- ⇒ **Steering Committee and Global Environment Facility (GEF) Meeting of the Desert Margins Programme (DMP), 13 – 14 June 2000, Niamey, Niger**

Felipe Zapata will participate with a contribution from the Sub-programme and the proposal for the FAO/IAEA TCP for Africa on “Desertification”.

- ⇒ **ISCO-2000, 11<sup>th</sup> Conference of the International Soil Conservation Organization, 22 - 27 October 2000, Buenos Aires, Argentina**

This Conference under the motto “Land Conservation and Food Production in the Third Millennium” will serve as a forum for experts from all over the world in the different disciplines related to the conservation of natural resources, particularly soil and water. As the overall theme of this event relates directly to FAO’s mandate, FAO has created a Task Force to develop a common strategy and position in regard to multi-disciplinary technological and policy issues of sustainable agriculture, addressing land, soil, water, animal, plant, and human resources with a view to enhancing food security. Ms. Sally Bunning, AGLL, is the focal point of the FAO Task Force. Felipe Zapata will participate with a contribution from the Sub-programme to Theme II of the Conference “Scientific and technological advances for environmental protection and sustainable land use”.

## D. PAST EVENTS

### ***RESEARCH CO-ORDINATION MEETINGS (RCMs) OF FAO/IAEA CO-ORDINATED RESEARCH PROJECTS (CRPs)***

- ⇒ **Second RCM of CRP on "Management of Nutrients and Water in Rainfed Arid and Semi-arid Areas for Increasing Crop Production" (D1.20.06), 6 - 10 March 2000, Tunis, Tunisia**

Thirteen contract holders, four agreement holders and Ms. Lee Heng (Soil Science Unit, Seibersdorf Laboratories), participated in this RCM. Only one agreement holder could not participate for personal reasons. Pierre Moutonnet, Project Officer, served as the Scientific Secretary. Professor Mohamad Mechergui, Institut National Agronomique de Tunis, Tunisia, was the local organiser. The participants presented the major results and conclusions of their research covering the period from 1998-2000. General conclusions and recommendations were formulated and guidelines updated accordingly. Data sets for running the plant growth simulation models of DSSAT and APSIM are being collected by Ms. L. Heng. A detailed report on the meeting is available, upon request, to the Soil and Water Management & Crop Nutrition Section Office.

- ⇒ **First RCM of CRP on "Development of Management Practices for Sustainable Crop Production Systems on Tropical Acid Soils Through the Use of Nuclear and Related Techniques" (D1.50.06), 5 - 9 June 2000, Vienna, Austria**

This CRP was approved in March 1999 for a duration of five years (1999-2004). Seven contractors and five agreement holders participated. Felipe Zapata is the Project Officer and served as the Scientific Secretary for the meeting. Participants analysed the main soil constraints to crop production in the savannah ecosystems, established research priorities and finalised experimental protocols as recommended by the Consultants Meeting. They also became fully acquainted with the logical framework of the project as well as technical and administrative procedures for implementation. A one-day workshop on isotope technologies was conducted at the Soil Science Unit, Seibersdorf.

### ***CONSULTANTS MEETING***

- ⇒ **FAO/IAEA Consultants Meeting on "Identification of Research Needs for Quantification of Nutrient Dynamics in Integrated Crop/Livestock Systems with a Focus on Conservation and Sustainability Issues in Developing Countries", 12 - 14 April 2000, Vienna, Austria**

This meeting was jointly organised by the Animal Production and Health Section and the Soil and Water Management & Crop Nutrition Section. The Scientific Secretary was Mr. Harinder Makkar (APH). The consultants were Messrs. S. Jarvis (United Kingdom), E. Smaling (Netherlands), S. Ledgard (New Zealand) and G. Blair (Australia). A report of the meeting is available from the Scientific Secretary upon request.

## **TECHNICAL CO-OPERATION PROJECTS (TCPs)**

⇒ **FAO/IAEA Regional TCP for Latin America on "Plant Nutrition, Soil and Water Management" ARCAL XXII (RLA/5/036)**

• **Third Meeting of Project Co-ordinators, 20 - 24 March 2000, Oaxaca, Mexico**

The meeting was attended by the Technical Officer, Felipe Zapata and project co-ordinators of the eight participating countries: Argentina, Brazil, Chile, Cuba, Guatemala, Mexico, Uruguay and Venezuela. The following activities were carried out:

- (a) A review of the progress made in the implementation of the Activity Plans for 1998 and 1999.
- (b) Detailed assessment of the results obtained during the reporting period by the participating countries in the following main activities: regional network of field trials, regional and national workshops and training events, individual training, expert services and publications. The main difficulties in implementation were identified and recommendations made to overcome them and ensure the proper completion of the project.
- (c) Presentation of the findings of his mission to four countries: Argentina, Brazil, Guatemala and Venezuela by Dr. Pedro de Hegedus, IAEA expert on agricultural extension. This was followed by a critical analysis of the overall project implementation with regard to dissemination and transfer of technologies generated under the project.
- (d) Preparation of the Proposal for a Modified Activity Plan and Budget for the year 2000. Proposal for allocation of the available IAEA financial resources for the year 2000.

Significant progress has been made towards the achievement of the objectives of the project. The overall assessment of the implementation of the project activities is satisfactory. Four participating countries are performing very well due to the inter-institutional links established from the start of the project between investigation and extension institutions and farmers' associations leading to the dissemination of the results to the farmers. Three other countries showed satisfactory performance in conducting the field trials but more effort is needed to disseminate the results. One participating country is facing serious difficulties in implementing the project activities due to the lack of supporting staff and financial resources.

In most cases the results obtained from the field trials need to be properly interpreted and practical recommendations should be developed. It was agreed that the activities of the project during this last year should focus on dissemination and transfer of the generated technologies. It was noted that the dissemination of these practical technologies implies the selection and utilisation of appropriate mechanisms better suited to the particular conditions in each country.

Accordingly, each project co-ordinator will prepare and submit to the IAEA a detailed dissemination plan by 31 May 2000.

⇒ **FAO/IAEA Regional TCP for West Asia on "Fertigation for Improved Water Use Efficiency and Crop Yield" (RAW/5/007)**

- **Group Training, 8 - 15 May 2000, Beirut, Lebanon**

A 2-week event was organised with the collaboration of the National Atomic Energy Commission of Lebanon on “The use of low quality irrigation water in fertigation”. Practical exercises and lectures covered the following topics:

- Physical quality: filtration of suspended solids.
- Chemical quality: problem of plugging related to the composition of water.
- Chemistry of soluble fertilisers: their interactions.
- Biological quality: problems related to the use of marginal water.

⇒ **Interregional Model Project on “Sustainable Utilisation of Saline Groundwater and Wastelands for Plant Production” (INT/5/144)**

- **Co-ordination Meeting, 6 - 8 April 2000, Islamabad, Pakistan**

National co-ordinators from seven participating countries, three IAEA experts dealing with plant, soil and hydrology and Mr. Mujtaba Naqvi, Project Officer, attended the meeting. Written reports and oral presentations were discussed and the overall progress and achievements in individual countries were evaluated. Plans were formulated for Phase II (2000-2002) of the project. Morocco, Tunisia, Egypt, Jordan, Syria, Iran and Pakistan are participating in the project while the United Arab Emirates has made a request for participation. A mission is soon to be fielded to the United Arab Emirates to formulate work plans.

All participating countries have demonstrated that by using highly saline groundwater, salt-tolerant plants can be cultivated on saline and other wastelands. Atriplex species, some Acacia species, salt-tolerant barley, *Brassica napus*, *Sesbania aculeata* from Pakistan and olive trees have been successfully established on the demonstration sites. In Morocco, salt-tolerant barley (*Hordeum vulgare*), rape seed (*Brassica napus*), kallar grass (*Leptochloa fusca*) and Atriplex species have been established on abandoned farmers’ fields using high salinity groundwater for irrigation. In Tunisia, 28 different species, having different economic values, including trees, bushes, grasses, food and forage crops, were successfully field tested. Arrangements are now being made to plant selected species on an additional area of 700 hectares out of the 4,000 hectares of government land lying waste near the El Hicha demonstration site. In Syria, out of more than a dozen species planted, the most successful have been Atriplex, kallar grass, *Sesbania*, *Brassica napus*, *Tamarix aphylla* and olive. Seed for the first four has been multiplied and the area extended. Plans are now underway to pass on seed to the farmers and to provide supervision to successfully transfer the technology. In Iran, plantations of *Tamarix aphylla*, four species of Atriplex, wild olive and *Acacia ampliceps* have been established at Chah Afzal in Yazd province. Barley has also performed well. Plans are being formulated to increase the plantation from the present 15 hectares to 100 hectares and to recommend *Sesbania aculeata* to farmers as a summer forage, barley as a winter crop and Atriplex as a perennial bush for forage. In Pakistan, kallar grass is now being extensively grown by farmers as a forage, as well as a strategy for soil rehabilitation. Some Eucalyptus and Acacia species have been passed on to some farmers. They have also been asked to extend the plantations over the entire 1,000 acres of wasteland, only part of which is being used as the demonstration site for this project. Jordan is a new entrant to the project and two sites have been selected for future demonstrations.

In most cases, some indications on the sources of groundwater and its dynamics are now available. Even though these do not indicate the size of the aquifer, in some cases they do reveal that the agricultural activity can be extended to areas much larger than the 10 hectare demonstration sites. For example, in Tunisia it is estimated that there is sufficient groundwater available for extension of the activity on 700 to 1,000 hectares around the El Hicha site.

In Phase II of the project, the activities of Phase I will continue and some additional activities will be initiated on assessing comparative advantages of different salt-tolerant species for their biomass production, value as food and forage, etc., and to assess end user preferences. Transfer of technology to the end user will receive much greater emphasis and so will the assessment of sustainability of the activity over larger areas to have economic impact.

## E. STATUS OF CO-ORDINATED RESEARCH PROJECTS

⇒ **Use of Nuclear Techniques for Developing Integrated Nutrient and Water Management Practices for Agroforestry Systems (D1.20.07)**

Project Officer: G. Keerthisinghe

1998-2005

Participating in this CRP are nine contract holders: K. Aihou (Benin), B. Zhang (People's Republic of China), C. Ovalle Molina (Chile), C. Cervantes (Costa Rica), J.M. Ndufa (Kenya), Z. Rahman (Malaysia), S. Nissanka (Sri Lanka), P. Ebanyat (Uganda) and R. Chintu (Zambia); and five agreement holders: M. Adams (Australia), S. Recous (France), R. Buresh (ICRAF-Kenya), N. Sanginga (IITA-Nigeria) and M. Smith (UK). All contract holders have initiated field trials in accordance with the work plan and experimental guidelines established at the first RCM which was held in Vienna from 19 - 23 April 1999. The second RCM is scheduled for May 2001 and the exact dates and location are now under consideration.

⇒ **Use of Isotope Techniques in Studies on the Management of Organic Matter and Nutrient Turnover for Increased, Sustainable Agricultural Production and Environmental Preservation (D1.40.08)**

Project Officer: G. Keerthisinghe

95-00

This CRP is in an advanced stage of implementation, with ten contract holders: S.M. Rahman (Bangladesh), K. Reichardt (Brazil), E. Zagal (Chile), J.Y. Wang (People's Republic of China), M.S.A. Safwat (Egypt), R. Abu Bakar (Malaysia), M. Ismaili (Morocco), J.Z. Castellanos (Mexico), R. Sangakkara (Sri Lanka) and Phan thi Cong (Viet Nam); and five agreement holders: D.F. Herridge (Australia), R. Merckx (Belgium), O.P. Rupela (ICRISAT-India), C. van Kessel (USA) and D.S. Powlson (UK). The progress of the project was evaluated at the third RCM which was held in Rabat, Morocco from 6 - 10 September 1999. All contract holders have field studies under way to determine the role of residue management practices in crop production and soil fertility. A minimum data set will be collected from each experimental site for validation of models to obtain information for the development of effective residue management practices for a wide range of environments. The final RCM is scheduled for March 2001 in Kuala Lumpur, Malaysia.

⇒ **Use of Nuclear and Related Techniques for Evaluating the Agronomic Effectiveness of Phosphate Fertilisers, in particular Rock Phosphates (D1.50.03)**

Project Officer: F. Zapata

93-99

The fourth and final RCM was held in Vienna, 16 - 20 November 1998. The final report of the project is available upon request to the Project Officer. The administrative procedures to terminate the project have been completed. Participating scientists have been very effective in developing manuscripts from the research work carried out in the CRP. By the end of June 1999, a total of 52 manuscripts (or 634 pages A-4 format) had been received from the participants for inclusion in the final publication. Twelve manuscripts have been selected for an external peer-reviewed publication in a scientific journal and the remaining 40 manuscripts will be included in the IAEA TECDOC of the CRP. Dr. Frank Sikora, University of Kentucky, USA is responsible for the technical editing of the manuscripts. Ms. Lee Heng, Soil Science Unit, Seibersdorf, is creating a database with the available information to test and validate the P submodel of DSSAT. Progress has been made in collecting information on the standard characterisation of soils and phosphate rocks as part of a report to IMPHOS, who

provided extrabudgetary funding for the project. These data need to be related to the response obtained in the field and greenhouse trials. Messrs. A. Benjelloun, J.C. Fardeau, D. Montange, Truong Binh and F. Zapata are involved in this task. If and when necessary, participants will be requested to provide additional information.

⇒ **Assessment of Soil Erosion through the Use of Cesium-137 and Related Techniques as a Basis for Soil Conservation, Sustainable Production and Environmental Protection (D1.50.05)**

Project Officer: F. Zapata

95-01

This project is being implemented together with another project on sedimentation coordinated by the Isotope Hydrology Section, Division of Physical and Chemical Sciences (Project Officer: E. García Agudo). The sedimentation CRP will terminate in July 2000 whereas the soil erosion CRP is expected to terminate in May 2001 (See Future Events).

The soil erosion CRP has currently sixteen participants, of whom eleven are contract holders: A. Buján (Argentina), O. Bacchi (Brazil), A. Ellies (Chile), X. Zhang (People's Republic of China), L. Hua (People's Republic of China), S. Theocharopoulos (Greece), B. Damnati (Morocco), I. Ionita (Romania), V. Golosov (Russian Federation), E. Fulajtar (Slovakia) and H. Nemasasi (Zimbabwe); one is a technical contract holder: D.E. Walling (UK); and four are agreement holders: P. Wallbrink (Australia), D. Pennock (Canada), J.C. Ritchie (USA) and F. Penning de Vries (IBSRAM-Thailand).

The Third RCM was held from 4 - 8 October 1999 in Barcelona, Spain. The report on this meeting is available upon request to the Project Officer. Significant progress has been made towards a harmonised application of the  $^{137}\text{Cs}$  techniques by the participants of the CRP, and increased human and institutional capacities for soil erosion and sedimentation studies have been established. The work of the participants has greatly broadened the range of environments in which the technique has been successfully applied, and a considerable amount of data on erosion and sedimentation rates have been generated for these areas. Participating scientists were urged to continue to publish their results in peer-reviewed journals. It was also agreed that this progress will be further consolidated through the preparation of a handbook on "Nuclear Techniques for the Assessment of Soil Erosion and Sedimentation".

Further testing of the calibration models for calculating soil loss or gain was recommended. In this regard, an updated (revised) version of the software Csmode11.exe for the calibration models developed by Walling and He is available at the following website: [ftp://ftp.iaea.org/dist/gnip/ripc\\_ihs/csmode1/](ftp://ftp.iaea.org/dist/gnip/ripc_ihs/csmode1/) or on diskette upon request.

The work "Bibliography of publications of Cs-137 studies related to erosion and sediment deposition" by Jerry C. and Carole A. Ritchie which is available on the Internet at the following location <<http://hydrolab.arsusda.gov/cesium137bib.htm>> has been updated as of February 2000. It can be viewed with an Acrobat Reader. Corrections/additions, etc. are most welcome. Please send them to J. Ritchie at <[jritchie@hydrolab.arsusda.gov](mailto:jritchie@hydrolab.arsusda.gov)> for incorporation into the next version, which will be updated periodically.

The final RCM will be held in Vienna, Austria from 21 - 26 May 2001 (see Future Events).



⇒ **The Use of Nuclear and Related Techniques in the Management of Nutrients and Water in Rainfed Arid and Semi-arid Areas for Increasing Crop Production (D1.20.06)**

Project Officer: P. Moutonnet

97-2002

This project has presently seventeen participants, twelve of whom are contract holders: D.R. Prieto (Argentina), G.X. Cai (People's Republic of China), M.S. Sachdev (India), V.R. Maparla (India), M.J.M. Rusan (Jordan), I.V. Sijali (Kenya), K. El Mejahed (Morocco), I. Mahaman (Niger), M.M. Iqbal (Pakistan), M. Sene (Senegal), M. Mechergui (Tunisia) and T. Sithole (Zimbabwe); and five agreement holders: F. Maraux (France), R.J.K. Myers (ICRISAT-Zimbabwe), A. Bationo (IFDC/ICRISAT-Niger), S. Asseng (Australia) and J. Ryan (ICARDA-Syria). The second RCM was held in Tunis, 6 - 10 March 2000. The research programme was discussed and guidelines established for the next cropping season. The first field experiments were implemented during the 1998-1999 agricultural season; analyses have been carried out in the FAO/IAEA Seibersdorf Laboratories on samples from these trials. At present, plant and soil samples from the 1999-2000 cropping season are being collected. The third RCM is scheduled for the second half of 2001 in Vienna.

⇒ **Development of Management Practices for Sustainable Crop Production Systems on Tropical Acid Soils through the Use of Nuclear and Related Techniques (D1.50.06)**

Project Officer: F. Zapata

99-04

The focus of this project is the development of improved and integrated soil, water and nutrient management practices to increase and sustain the productivity of acid soils in the savannah ecosystems of Africa and Latin America. Participants in this CRP are seven contract holders: S. Urquiaga (Brazil), T. Muraoka (Brazil), V. Bado (Burkina Faso), A. García (Cuba), J.J. Peña-Cabriales (Mexico), E. Iwafuor (Nigeria) and M. Lopez (Venezuela); and five agreement holders: R. Thomas (CIAT-Colombia), W. Horst (Germany), S.H. Chien (IFDC-USA), B. Vanlauwe (IITA-Nigeria) and K. Sahrawat (WARDA-Côte d'Ivoire). It is envisaged that the three main areas of investigation will be: (i) identifying acid-tolerant and P-efficient plant genotypes, (ii) addressing acid soil infertility factors, and (iii) developing appropriate soil management and conservation practices. It should be noted that this grouping is arbitrary and in most cases integrated approaches will be required. A detailed work plan and experimental protocols were established at the first RCM which was held in Vienna from 5 - 9 June 2000.

## F. LABORATORY ACTIVITIES

### RESEARCH

#### ⇒ Experimental work in progress

- *Movement of nitrogen and water use efficiency under drip irrigation*

Potatoes are being grown under various soil water regimes in large pots in the glasshouse. TDR and rhizon mini soil solution samplers were installed to monitor soil moisture and to collect the soil solution, respectively. The  $^{15}\text{N}$  and  $^{13}\text{C}$  content of the soil, water and plant materials will be analysed and correlated with various parameters. The experiment is part of the training programme for two fellows from Turkey, Messrs. Cayci and Kutuk.

- *Interaction of nitrogen fertiliser and salinity*

Tomato is being grown in the glasshouse under various N and salinity regimes.  $^{15}\text{N}$  and  $^{13}\text{C}$  of the plant and soil samples will be analysed. This experiment is part of the training of the two fellows from Turkey mentioned above. In Turkey, tomato crops are often grown using large amounts of nitrogen fertiliser, and saline water is sometimes used to irrigate the crop.

- *Leaching of nitrogen fertiliser under drip and furrow irrigation systems*

Four different rates of urea were applied to tomatoes in the field, and the movement of nitrate will be monitored using tensionic, suction cups, neutron probe, TDR and Diviner 2000 capacitance sensors.

- *Below-ground carbon sequestration*

Maize plants are being grown under different temperature and fertiliser regimes in the glasshouse and C inputs are being measured by the shift in the  $\delta^{13}\text{C}$  signature of the soil.

- *Organic versus inorganic fertiliser*

$^{15}\text{N}$  labelled inorganic fertiliser and  $^{15}\text{N}$  labelled plant residues have been added to soil subjected to different salinity regimes. Rhizon mini soil solution samplers are being used to monitor the soil nitrate and salt concentration. Initial results suggest that addition of organic matter to the soil reduces salt stress whilst maintaining yield of wheat.

- *Drought tolerant lentil and peanut*

Genotype selection is based on differences in  $\delta^{13}\text{C}$  signals of metabolically active carbon pools. Parallel assessment of phenotypic traits using molecular techniques is also being made in collaboration with the Plant Breeding Unit. This work is being conducted as part of the training of a fellow from Bangladesh, Mr Azad.

- *Root N turnover*  
 $^{15}\text{N}$  foliar labelling techniques are being used to assess below-ground N.
- *Acid detergent fibre, cellulose and lignin in residues*  
Rapid, reliable and low-cost techniques are being developed as well as a low-cost simple field method to measure polyphenols.
- *Photosynthesis in the tissue culture systems*  
Collaborative work with the Plant Breeding Unit using  $^{13}\text{C}$  is in progress.
- *Indirect  $^{15}\text{N}$  methodology for measuring N release from manures and complex organic residues*  
Pilot studies in Kenya and Malaysia to further test the methodology are underway.
- *The contribution of sewage sludge and manures to crop N nutrition*  
Field experiments have been initiated using the modified indirect  $^{15}\text{N}$  methodology.
- *Early selection of rice cultivars for salt tolerance*  
 $\delta^{13}\text{C}$  discrimination is being investigated as a selection criterion in collaboration with the Plant Breeding Unit.
- *The source and turnover of soluble organic carbon*  
A total organic carbon analyser coupled to the mass spectrometer is being used to study  $\delta^{13}\text{C}$  signatures.
- *N transfer from leguminous crops to associated cereal crops*  
The direct method of stem injection of the legume with  $^{15}\text{N}$  is being pilot tested.
- *N dynamic in legume cereal rotations*  
The movement of biologically-fixed N is being studied under field conditions using  $^{15}\text{N}$  isotope dilution.

⇒ **The utilisation of datasets collected from Co-ordinated Research Projects (CRPs)**  
Co-ordinator: Ms. L.K. Heng

Part of the activities in the Soil Science Unit is the collection of experimental data from various CRPs and the creation of databases from this information. Decision support systems/models are then used to analyse the impact of management practices (e.g. sowing dates, fertiliser rates, residue management, rotation selection) to improve yield, reduce variability in food supply, and enhance system sustainability.

Three datasets have been collected to date, but only one is reported here. This dataset is from the CRP on “The use of nuclear techniques for optimising fertiliser application under irrigated wheat to increase the efficient use of nitrogen fertilisers and consequently reduce environmental pollution” (P. Moutonnet is the Scientific Secretary). The dataset contains information on soil characteristics, yield, nitrogen (fertiliser, soil, leaching), water (soil moisture, irrigation, WUE), economics, chlorophyll meter readings, etc.

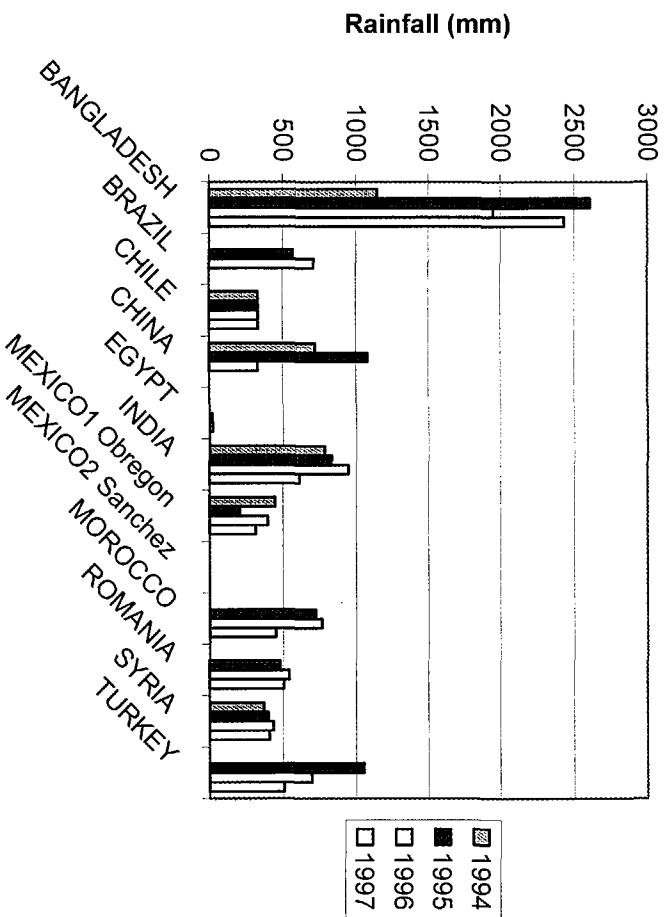
The participating countries were Bangladesh, Brazil, Chile, China, Egypt, India, Mexico, Morocco, Romania, Syria and Turkey. The soil texture at the experimental sites ranged from very sandy (India) to very heavy clays in Chile and Egypt. The amount of rainfall gives an indication of the availability of water and hence the success or failure of a crop, although it is the distribution over the season that is more important. A wide range of rainfall was recorded for different countries; annual rainfall between 1000-2500 mm was common in Bangladesh whereas as little as 300 mm was recorded in Chile, and near zero rainfall in Egypt (Fig. 1). The majority of the countries received rainfall of less than 500 mm, and consequently supplemental irrigation was needed for adequate crop growth (Fig. 2). China and Egypt applied the most irrigation (over 450 mm per year) and some countries such as India and Mexico applied pre-season irrigation (not shown).

The average grain yield obtained during the four-year study and the average expected yield for the region, are shown in Fig. 3. Despite receiving the highest rainfall, Bangladesh did not produce the highest grain yield. Yield was highest in Chile and China with values above 6 tonnes/ha.

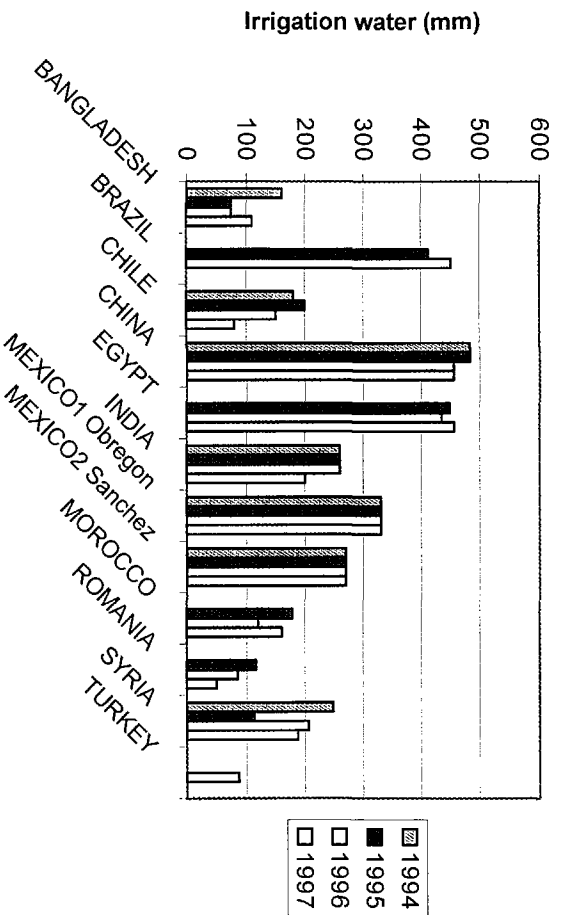
The data was used to test CERES-Wheat model within DSSAT (Decision Support System for Agrotechnology Transfer) which is capable of simulating various processes of crop growth and development such as timing of phenological events, yield, yield component characteristics and their interactions with weather, cultivar variations in plant ontogeny, soil water balance and leaching. Good agreement was found between observed and predicted grain yield (Fig. 4). Good agreement was also observed for other parameters. The ability of the model to predict these parameters implies that it is possible to use this as a tool in facilitating the screening of cultivars for selecting those that are best adapted to specific target environments. This can help in optimising the use of resources and quantifying risks associated with plant, soil and weather variation.

Detailed simulations on individual countries were also carried out. These will be presented in two papers currently being prepared.

**Annual rainfall for years 1994-1997**



*FIG. 1. Annual rainfall between 1994-97*



*FIG. 2. Irrigation water applied in each country*

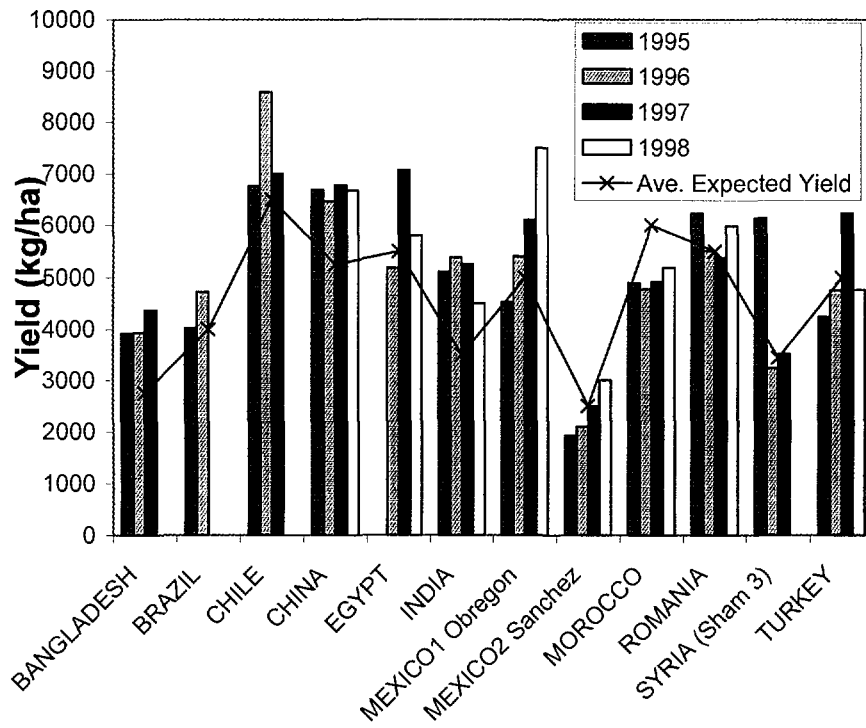


FIG. 3. Grain yield obtained from the various countries

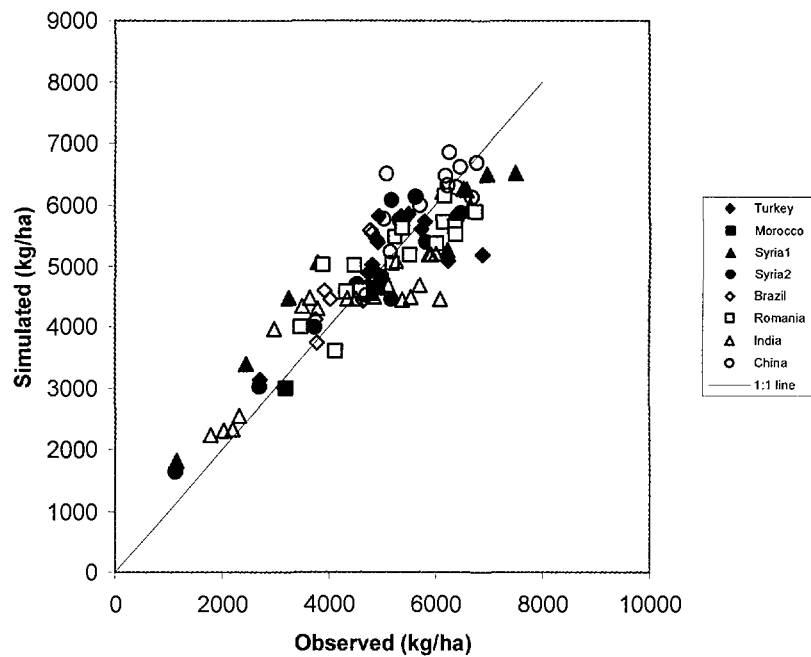


FIG. 4. The observed grain yield and that simulated using CERES-Wheat

## ***TRAINING***

A course of 16 lectures on “The use of nuclear techniques for plant nutrient and water management studies” was given by the staff of the Sub-programme for the four fellows. All aspects of  $^{15}\text{N}$  and  $^{13}\text{C}$  techniques from the setting up of experiments to the preparation of samples for analysis and mathematical interpretation of isotope data were covered. In addition, the fellows received training in the use of neutron probes in water management, and conducted individual or group research projects as outlined below.

**Ms. D.C.K. Kularatne** (SRL/99016P) has been working on the effects of salinity on nitrogen fixation in a range of legumes and the effect of plant quality characteristics on N release from organic residues as determined by  $^{15}\text{N}$  in wetland rice. Supervised by Gudni Hardarson and Rebecca Hood.

**Mr. Md. A.K. Azad** (BGD/00016P) has been working on a modification of the  $\delta^{13}\text{C}$  technique for selecting drought and salt tolerance. In addition, he has been working with Ranwak Afza of the Plant Breeding Unit to assess the genetic diversity of the selected mutants using RAPD markers and its physiological traits. Supervised by Rebecca Hood.

**Mr. G. Cayci** (TUR/99007P) and **Mr. A.C. Kutuk** (TUR/9906P) have been carrying out several experiments including: (1) determination of nitrogen leaching using  $^{15}\text{N}$  on potato plants grown in large pots; (2) effect of different nitrogen and salinity levels on water use efficiency and growth of tomato plants; (3) estimation of nitrogen losses under different irrigation systems using  $^{15}\text{N}$  under field conditions. Supervised by Lee Heng, Pierre Moutonnet and Jose Luis Arrillaga.

## ***SUPPORTIVE SERVICES***

⇒ **Quality System in the Soil Science Unit**  
Quality Co-ordinator: Mirta Matijevic

The quality system of the laboratory for the Soil Science Unit (SSU) has been developed according to the reference guides ISO/IEC 25, ISO 9000 series and good laboratory practice (GLP).

The Unit operates and maintains the following stable isotope analytical instruments for routine analyses:

- Micromass OPTIMA continuous flow isotope ratio mass spectrometer (CF-IRMS) coupled with CARLO ERBA elemental analyser.
- PDZ Europa INTEGRA-N (CF-IRMS).
- PDZ Europa ANCA SL 20-20 (CF-IRMS).

This equipment is used for the measurement of stable isotope ratios of carbon and nitrogen. In future it is planned to expand the QA capabilities to include isotopes of hydrogen and oxygen.

Analytical quality assurance involves checking the instruments as well as the chemical processes, including sample preparation, handling and documentation. Various techniques, statistical, investigative, preventive, administrative, and corrective, including regular checks on sample preparation system, mass spectrometer performances, and the use of internal standards, have been utilised to maximise the reliability of the data.

Quality management requires administrative management of equipment and laboratory tools including recording of all settings. Several manuals (SOP, standard operation procedure) have been written as part of the work in the Unit including:

- Initiation of sample analysis
- Sample receipt
- Sample storage
- Balance calibration
- Preparation of fresh plant material for analysis
- Weighing in samples
- Preparation of inorganic nitrogen solutions for analysis
- Analysis and daily calibration using the Carlo Erba and Isogas Optima set up
- Analysis and daily calibration using the Europa Scientific ANCA SL 20:20 set up
- Data management
- Preparation of laboratory standards
- Kjeldahl digestion
- Preparation of ammonium sulphate solution  $^{15}\text{N}$  laboratory standard
- Day to day maintenance of the mass spectrometer
- Long term maintenance of the mass spectrometer
- Shut down of the nitrogen analyser and mass spectrometer
- Installation of the nitrogen analyser-mass spectrometer unit
- Sample preparation guidelines for C, N stable isotope analysis
- Arabic, Chinese, French, Russian and Spanish version of sample preparation guidelines for C, N stable isotope analysis

The following forms have also been written and are being used in the routine analyses:

- Sample receiving reports
- Data reporting sheet
- Logbook for Carlo Erba Optima MS
- Control charts for routine mass spectrometer analysis
- Balance check
- Instrument Logbook-mill
- Instrument Logbook-Balance
- Logbook for Integra MS

Chemical compounds for calibration and reference materials are being coded and their origin and use, including name of user, is being recorded. Certified reference material is stored in a locked cabinet and can only be accessed by authorised users.



Reports, including sample preparation guidelines for  $^{15}\text{N}$ ,  $^{13}\text{C}$ ; sample receiving reports and data reporting sheets are being prepared and sent to counterparts. Attention is given to complaints and corrective action is taken when needed.

Balances are routinely tested using certified OIML class E2 calibration and test weights. The laboratory is also conducting routine balance maintenance on a regular basis.

The number of samples analysed by the Soil Science Unit in the past five years is shown in Table 1. Control charts have been produced and they are regularly checked for outliers. Statistical treatment including summary statistics, significance testing, control charts (Shewart, CuSum), error analysis, uncertainty of the CF-IRMS system have been established.

The precision for isotope analyses are  $\pm 0.002$  atom percent  $^{15}\text{N}$  excess for tracer studies and  $\pm 0.1\%$   $\delta^{13}\text{C}$  for natural abundance measurements.

**Table 1:** Summary of samples analysed for total N, total C,  $^{15}\text{N}$  and  $^{13}\text{C}$  in the Soil Science Unit, 1995-1999

	1999 C, $^{13}\text{C}$	N, $^{15}\text{N}$	1998 N, $^{15}\text{N}$	1997 N, $^{15}\text{N}$	1996 N, $^{15}\text{N}$	1995 N, $^{15}\text{N}$
Seibersdorf	1162	3579	4269	2726	1668	2316
T.C.	-	497	1080	1287	2910	513
C.R.P.	1193	5625	3214	3361	4309	4079
$\Sigma$ (Seib, TC, CRP)	2355	9701	8563	7374	8887	6908
QA (B+Std+Rep)	1149	4790	5789	3751	1113	1242
	3504	14491				
Total	17995		14352	11125	10000	8150

## MEETINGS

⇒ **SIMSUG 2000, Annual Conference of the Stable Isotope Mass Spectrometers Users Group, 18 – 19 January 2000, Grange Over Sands, UK**

Two posters were presented by Rebecca Hood: "Isotopic signatures in water soluble organic carbon. How, why and where from?", by Rebecca Hood, Kevin Mc Tiernan and Leo Mayer and "The use of carbon isotope discrimination to screen wheat cultivars for drought tolerance", by Robina Shaheen, Mujtaba Naqvi and Rebecca Hood.

⇒ **2<sup>nd</sup> Viennese Workshop on "Stable Isotopes in Biological and Ecological Research", 27 January 2000, Seibersdorf, Austria**

The aim of the workshop was to bring together scientists working with stable isotopes and to encourage communication across disciplines and institutions within Austria. The workshop provided the opportunity to discuss theoretical and methodological difficulties of using stable isotopic techniques and to exchange ideas. This workshop was organised by the Soil Science Unit in collaboration with the Department of Chemical Physiology of Plants,

Institute of Ecology and Conservation Biology, University of Vienna. There were 41 participants from the various academic institutes in Vienna. The lectures covered many aspects of stable isotope technology demonstrating the increasing use of stable isotopes in biological and ecological studies.

Martin Gerzabek and Georg Haberhauer, Department for Environmental Research, Austrian Research Centers, Seibersdorf	The use of stable isotopes in element dynamic studies.
Wolfgang Wanek, Institute of Ecology and Conservation Biology, University of Vienna	Searching for isolation procedures of nitrogen species for $^{15}\text{N}$ natural abundance studies.
Mark Adams, UWA, Perth, Australia	Carbon stable isotopes and conifers.
Sonja Heintel, Institute of Ecology and Conservation Biology, University of Vienna	Use of $^{13}\text{C}$ natural abundance of leaf carbon fractions in assessing short-term water deficit situations.
Stefan Arndt, Institute of Ecology and Conservation Biology, University of Vienna	Ecological basis for a sustainable management of desert vegetation - stable isotope approaches.
Robina Shaheen, FAO/IAEA Laboratory, Seibersdorf	The use of carbon isotope discrimination to screen wheat cultivars for salinity and drought tolerance.
Thomas Franz, Institute of Ecology and Conservation Biology, University of Vienna	Carbon transfer from plants into the soil and microorganismal use of rhizodeposition.
Rebecca Hood, FAO/IAEA Laboratory, Seibersdorf	Isotopic signatures in water-soluble organic carbon. Why and where from?
Leo Mayr, FAO/IAEA Laboratory, Seibersdorf	Isotopic signatures in water-soluble organic carbon. How?
Thomas Hein, Institute of Ecology and Conservation Biology, University of Vienna	Hydrological connectivity: Driving force for the dynamics, composition and sources of particulate organic matter (POM) in floodplains of the River Danube, Austria
Johanna Lippmann, Hydrology Section, IAEA	Determination of a pore water system by means of tritium, C-14, deltaD, deltaO-18, S-34 and noble gases: A case study.
Mirta Matijevic, FAO/IAEA Laboratory, Seibersdorf	Quality assurance of isotope measurements.

⇒ **2<sup>nd</sup> Conference on the Applications of Stable Isotope Techniques to Ecological Studies, 7 – 10 May 2000, Braunschweig, Germany**

Rebecca Hood gave an oral presentation on “The effect of soil temperature and moisture on organic matter decomposition and plant growth”.

## G. PUBLICATIONS

### ⇒ Printed

- Chalk, P.M. Integrated effects of mineral nutrition on legume performance. *Soil Biol. Biochem.* 32, 577-579 (2000).
- Heng, L.K., White, R.E. and Chen, D. Soil water status under perennial and annual pastures. In: *Comparison of Soil Water Measurement Using the Neutron Scattering, Time Domain Reflectometry and Capacitance Methods*. IAEA-TECDOC-1137. pp. 125-137 (2000).
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### ⇒ In press

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- Hocking, P.J., Randall, P.J., Delhaize, E. and Keerthisinghe, G. The role of organic acids exuded from roots in phosphorus nutrition and aluminium tolerance in acid soils. In: *Management and Conservation of Tropical Acid Soils for Sustainable Crop Production*. Proceedings of a Consultants Meeting, 1 - 3 March 1999, Vienna, Austria. IAEA-TECDOC Series.
- Zapata, F. Evaluating the agronomic effectiveness of phosphate rocks using nuclear and related techniques: Results from a past FAO/IAEA co-ordinated research project. In: *Management and Conservation of Tropical Acid Soils for Sustainable Crop Production*. Proceedings of a Consultants Meeting, 1 - 3 March 1999, Vienna, Austria. IAEA-TECDOC Series.
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- Urquiaga, S. and Zapata, F. Manejo eficiente de la fertilización nitrogenada de cultivos anuales en América Latina y el Caribe. EMBRAPA/ARCAL Technical Manual (in Spanish).

⇒ **In preparation**

- Water Balance and Fertigation for Crop Improvement in West Asia. Results of a FAO/IAEA Technical Co-operation Project. IAEA-TECDOC Series.
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- Isotopic Methods in Soil Fertility and Water Management: A Manual. IAEA Training Course Series.
- The Use of Nuclear and Related Techniques for Evaluating the Agronomic Effectiveness of Phosphate Fertilisers, in particular Rock Phosphate. Results of a FAO/IAEA Co-ordinated Research Project. IAEA-TECDOC Series.
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## H. FROM OUR READERS

⇒ **2<sup>nd</sup> Conference on the Applications of Stable Isotope Techniques to Ecological Studies, 7 - 10 May 2000, Braunschweig, Germany**

The aim of the meeting was to provide an international forum for the reporting and discussion of developments in all aspects of the applications of stable isotopes in ecological studies. The meeting included a selected number of oral presentations and approximately 60 poster presentations on wide-ranging issues from insect ecology to the environmental effects of sewage sludge outflows on marine ecosystems.

The main topics of the conference were:

- Plant, soil and sediment ecology.
- New methods and applications.
- Dietary and trophic studies.
- Applications of molecular isotope analysis.
- Contamination pathways and impacts.
- Wildlife research.
- Variable scale and ecosystem studies.

The general impression from the meeting was that stable isotopes have revolutionised ecological/environmental research in the past 5-10 years. They enable food web studies to be undertaken both in the terrestrial and marine environments. Stable isotopes have also been used to track migration patterns of birds, bats and butterflies, allowing interventions to protect species and habitats. In addition, stable isotopes are playing a major role in the modelling and prediction of climate change.

Key new areas appear to be pyrolysis techniques for deuterium and oxygen-18 bulk samples and compound-specific studies.

Full abstracts from the conference are available on: <http://204.83.154.70/isoecol/>

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