SOILS NEWSLETTER

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
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Vienna, Austria

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ISSN 1011-2650

A. TO OUR READERS

The potential for interdisciplinary research activities within the Joint Division was highlighted recently at a Consultant' Meeting on identification of crop species/cultivars for drought and salinity tolerance for sustained crop yields using carbon isotope discrimination. The meeting was organized by the Soil and Water Management & Crop Nutrition sub-programme in co-operation with the Plant Breeding and Genetics sub-programme. The Meeting served to heighten awareness of the important role that isotopic marker techniques can play in selection and breeding of germplasm with superior plant physiological traits. In particular, the use of the $\delta^{13}C$ isotope discrimination technique to select for improved yield and agronomic water use efficiency in cereal and legume crops under conditions of abiotic stress was discussed and critically analysed. Five internationally recognized scientists reviewed the current state-of the-art and formulated recommendations and conclusions for a future Co-ordinated Research Project (CRP) on the further validation of the $\delta^{13}C$ technique for wheat and rice under a range of environmental conditions.

Yield plateaux for both wheat and rice are being approached through established breeding programmes in favourable as well as water-limited environments. However, recent advances in the understanding of physiological traits that contribute to yield has created new opportunities to increase yield through genetic improvement. Carbon isotope discrimination has been shown to have substantial potential application as a screening tool in breeding programmes to increase the rate of genetic increase in yield. This approach is attractive because it provides both temporal and spatial integration of the important traits influencing carbon gain and water use by plants. A milestone was reached recently in Australia with the release of a new wheat variety, Drysdale, with increased yield under stored soil moisture conditions in the northern summer rainfall zone. This variety was bred for low carbon isotope discrimination. However, many important questions remain unanswered, e.g.:

- The relationship between yield and carbon isotope discrimination in other environments, including well watered, water limited and saline.
- The influence of genetic background.
- The efficiency of different breeding methods.
- The plant part to be sampled.

The Consultants concluded that the sub-programme was well positioned to mount an experimental programme to answer these and related questions, with comparative advantages in managing and funding international research networks and the capacity to carry out numerous, precise measurements of carbon isotope discrimination. The Consultants provided a framework for future activities through formulation of a project document that included overall and specific objectives, work plan, expected research outputs and potential sites and partner selection.

The sub-programme looks forward to further planning this initiative in 2002 with implementation of a new CRP in 2003. The involvement of scientists from NARS, CIMMYT, IRRI and CSIRO is foreseen. The Soil Science Unit, Seibersdorf, will play a key role in supporting the CRP through provision of analytical services for $\delta^{13}C$ analyses, the cost of which is often a deterrent to the wider use of the technique in crop breeding programmes.

With my very best wishes for 2002.

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

B. STAFF

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3. Staff Changes

Mr. Pierre Moutonnet retired on 30 June, after serving with distinction for 7.5 years as a Technical Officer in the Section. He has returned to his former home in southern France near Cadarache. Pierre was a valued and trusted colleague, one who could be described as a quiet achiever. His will be greatly missed in the Section. Pierre filled an important post within the sub-programme, having prime responsibility for the management of co-ordinated research projects (CRPs) and technical co-operation projects concerned with the use of nuclear techniques in the assessment of soil water status, in the conservation of scarce water resources and in the efficient management of water through deficit and drip irrigation practices in crop production. He was a recognized authority on the soil moisture neutron probe and tensionics. He was responsible for several important sub-programme publications including a book "Crop Yield Response to Deficit Irrigation" (Eds. C. Kirda, P. Moutonnet, C. Hera and D.R. Nielsen), Kluwer Academic Publishers (1999), and "Deficit Irrigation Practices", FAO Water Report Series (2002). He successfully co-ordinated a regional technical co-operation project for 6 years in West Asia on fertigation, demonstrating that large savings in water and nitrogen fertilizer could be achieved through drip irrigation practices. Due to his perseverance, this project has been followed by a similar regional project in Europe. His colleagues in the sub-programme wish him all the very best for his retirement.

Dr. Graeme Blair, an internationally recognized plant nutrition specialist, left the Agency on June 30 after a 1-year sabbatical at the Soil Science Unit, Seibersdorf. Graeme made a major contribution to the work of the Unit, through his written contributions and editing of the new edition of the Laboratory Manual, and his introduction of multiple labelling strategies to follow the dynamics of several plant nutrients simultaneously. His particular research interest was the relationship between the chemical characteristics of organic residues and rates of decomposition, including effects on soil chemical and physical properties. Graeme returned to his teaching and research position at the University of New England, Armidale, New South Wales, Australia, with his wife Nellie, who also undertook research for her Ph.D at the Austrian Research Centre, Seibersdorf, under the guidance of Prof. Dr. Martin Gerzabek.

C. FUTURE EVENTS

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

⇒ **First RCM and Training Workshop of CRP on "Integrated Soil, Water and Nutrient Management for Sustainable Rice-Wheat Cropping Systems in Asia", 4 – 8 March 2002, Vienna and Seibersdorf, Austria**

Seven research contract holders from Bangladesh, China, India, Nepal and Pakistan, and four agreement holders from Australia, India, Philippines and USA are expected to attend the meeting. The objective of the RCM (first 3 days) is to present on-going work in Rice-Wheat Cropping systems in China and the Indo-Gangetic Plain, with reference to activities co-ordinated under the aegis of the Rice-Wheat Consortium and other bilateral agreements. Research objectives, approaches and protocols will be discussed and agreed upon. P.M. Chalk is the Project Officer and will serve as the Scientific Secretary. The last two days will involve a training workshop at the Soil Science Unit, Seibersdorf, on measurement of soil water status and water balance and the use of ^{15}N labelling techniques to follow the movement and fate of soil, fertilizer and crop residue N in the multiple cropping system.

⇒ **Second 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", 11 – 15 March 2002, Brasilia, Brazil**

Eight research contractors, one technical contractor and four agreement holders will participate in the second RCM. Mr. Segundo Urquiaga, EMBRAPA-Seropedica, is the local organizer. The participants are expected to present their results covering the period 1999-2001. Progress made in implementation of the experimental plans will be reviewed and the plan for future work updated in accordance with the project objectives. F. Zapata is the Project Officer and will serve as the Scientific Secretary.

CO-OPERATION MEETING

⇒ **Symposium 59, 17th World Congress of Soil Science, 14 – 21 August 2002, Bangkok, Thailand**

The Joint Division is co-operating with the Congress in organising and sponsoring a 1-day symposium "Towards Integrated Soil, Water and Nutrient Management in Cropping Systems: the Role of Nuclear Techniques". The Symposium is being co-sponsored by the Australian Nuclear Science and Technology Organisation (ANSTO). There will be 14 oral presentations and approximately 80 poster presentations. Mr. Phillip Chalk, Head of the Soil and Water Management & Crop Nutrition Section, is the Symposium convenor. More information on the Congress can be obtained at http://www.17wcss.ku.ac.th.

NON-FAO/IAEA MEETINGS

⇒ **Stable Isotope Mass Spectrometer Users Group (SIMSUG) Meeting, 17 – 18 January 2002, Belfast, Northern Ireland**

SIMSUG 2002 will be hosted by the Environmental Engineering Research Centre (EERC) at the Queen's University of Belfast. SIMSUG provides an informal forum where applications and developments in the use of stable isotopes from all research disciplines can be presented and discussed. More information can be obtained at http://www.simsug.qub.ac.uk.

⇒ **Meetings of the Regional Steering Committee and the Regional Technical Coordination Committee of the Rice Wheat Consortium (RWC) of the Indo-Gangetic Plain, 11 – 15 February 2002, New Delhi, India**

Senior technical personnel from participating regional and international organisations will meet to review progress in national research efforts in rice-wheat systems, and plan future activities. The FAO/IAEA CRP on "Integrated Soil, Water and Nutrient Management for Sustainable Rice-Wheat Cropping Systems in Asia" is directly linked to the activities of the RWC through research being conducted by the contract and agreement holders. The CRP Project Officer, Mr. P.M. Chalk, has been invited to participate in the Meetings.

⇒ **European Congress of the Society of Environmental Toxicology and Chemistry (SETAC), 12 – 16 May, Vienna, Austria**

The Congress theme is "Challenges in Environmental Risk Assessment and Modelling: Linking Basic and Applied Research" organized around 6 general topics. Within the topic *Pollution at Regional and Global Scales: Sources, Indicators and Implications,* a session on Radioecology (8 – 10 oral presentations) is scheduled under the Chairmanship of Prof. Dr. Martin Gerzabek. More information on the Congress can be obtained at http://www.setac.org/vienna.html.

⇒ **12th International Soil Conservation Organisation Conference (ISCO-2002), 26 – 31 May 2002, Beijing, China**

The main theme of the conference is: Sustainable Utilisation of Global Soil and Water Resources. For more information visit the website: http://www.swcc.org.cn/isco2002 or write to isco2002@swcc.org.cn.

⇒ **13th International Symposium of the International Scientific Centre of Fertilizers (CIEC), 10 – 13 June, 2002, Tokat, Turkey**

This symposium is jointly organized by Gaziosmanpaşa University under the theme "Fertilizers in Context with Resource Management in Agriculture". Further information can be obtained from the Secretariat at ciec2002@gop.edu.tr or at http://ozel.gop.edu.tr/ciec2002.

⇒ **9th International Symposium on Nitrogen Fixation with Non-Legumes, 1 – 5 September 2002, Leuven, Belgium**

This symposium, held every two years, will be hosted by the Centre of Microbial and Plant Genetics, Katholieke Universiteit Leuven. More information can be obtained from the contact person, Anita Vermassen, at cmpg@agr.kuleuven.ac.be.

⇒ **International Colloquium: Land Use Management, Erosion and Carbon Sequestration, 24 – 28 September 2002, Montpellier, France**

Participants may select either one or both scheduled symposia.

- The biological approach to soil and water conservation.
- Soil erosion and carbon sequestration.

For more information please contact Dr. Eric Roose, e-mail: roose@mpl.ird.fr.

TECHNICAL CO-OPERATION PROJECTS (TCPs)

⇒ **FAO/IAEA Regional TC Project for Africa " Combating Desertification in the Sahel" (RAF/5/048)**

Implementation of this regional TC project commenced in 2001. The overall objective is to sustainably intensify food production in the rainfed agriculture of Sahelian countries, in order to enhance food security while combating desertification. The specific objective is to develop, pilot-test and promote the adoption of improved and integrated soil, water and nutrient management technologies in cropping systems through the use of nuclear and related techniques. The short-term goal is to improve the productivity of the system, while the long term goal is to restore and maintain the soil fertility to effectively combat dry-land degradation. The target area is the West African Sahel and includes Burkina Faso, Mali, Niger and Senegal.

- **Regional workshop on the "Use of Nuclear Techniques in Soil, Water and Nutrient Management in Rainfed Arid and Semi-arid Areas", 18 – 22 March 2002, Vienna and Seibersdorf, Austria**

This regional workshop is organized for the national co-ordinators of Burkina Faso, Mali, Niger and Senegal (one from each country). The main objectives of this workshop are: a) to assess the progress made in implementing the first year's activities, to identify constraints and to review/modify the activity plan for 2002, b) to acquaint the participants with the use of nuclear techniques in developing integrated soil, water and nutrient management practices, and c) to establish contacts with relevant staff of the Department of Technical Co-operation and become familiar with the administrative procedures for implementing the project. Mr. F. Zapata is the Technical Officer and organizer of the workshop.

- **Group Training on the "Use of Nuclear Techniques in Nitrogen and Water Dynamics Studies in Rainfed Arid and Semi-arid Areas", 8 – 12 April 2002, Dakar, Senegal**

The main objective of the training course is to provide basic knowledge and skills on the use of relevant nuclear techniques for studying nitrogen and water dynamics in rainfed

cropping systems in arid and semi-arid areas. The course is open to technical staff from Burkina Faso, Mali, Niger and Senegal with relevant experience in rainfed agriculture of the West African Sahel and currently involved in the implementation of the experimental work of the regional TC project. Fourteen successful candidates will be selected as participants in this training event.

⇒ **FAO/IAEA Regional TCP for East Asia and the Pacific (RCA) on "Restoration of Soil Fertility and Sustenance of Agricultural Productivity" (RAS/5/039)**

In East Asia and the Pacific region the conversion of agricultural land into other uses (urbanisation, infrastructure and industrial development) and a series of soil degradation processes are factors contributing to reduced productivity. The principal degradation processes are nutrient depletion, acidification, salinisation and soil erosion. The effects of human-induced degradation are exacerbated by inappropriate land use, soil management and cultivation practices. Excessive use of agrochemicals in some areas affects both water and soil quality. Enhancing sustainable food production will require the combined use of the following strategies: a) agricultural intensification on the best arable land, b) rational utilisation of marginal lands, and c) prevention and restoration of soil degradation.

The overall objective of this project is to develop improved soil, water, nutrient and crop management practices while counteracting predominant soil degradation processes in order to increase and sustain crop productivity. Two complementary approaches will be utilized to achieve this main objective. Part 1 of this project deals with the restoration of soil fertility, and implementation commenced during the 2001-2002 cycle (refer to past events). The specific objective of Part 2 of this project will be to measure soil erosion/ sedimentation and associated pesticide contamination. For this purpose, the fallout radionuclide ^{137}Cs and related techniques will be utilized to measure erosion/sedimentation rates and to define soil redistribution patterns in the landscape. Also, radiotracer and conventional techniques will be applied to determine pesticide contamination levels in soil, water and crops. This part of the project will start in 2002 and be implemented through 2004.

- **First Co-ordination Meeting of Part 2 of the Project, 25 February – 1 March 2002, Beijing, China**

A detailed work plan of the project will be prepared at this meeting with the participating countries. The foreseen work plan includes future co-ordination meetings, training workshops, preparation of field and laboratory protocols, implementation of field and laboratory studies, technical and administrative support, and preparation of a users manual on the new technologies developed.

- **Regional training course on "Use of ^{15}N Techniques for Identifying Management Practices for Efficient Use of Nitrogen Fertilizers in Wetland Rice Soils", 8 – 12 April 2002, Kuala Lumpur, Malaysia**

The training course, which belongs to Part 1 of the project, will be conducted at the Malaysian Institute for Nuclear Technology Research (MINT). The local organizer is Dr. Khairuddin Abdul Rahim and the Technical Officer for the Project is Mr. Gamini Keerthisinghe. It is anticipated that representatives from all the participating countries in the project (Bangladesh, China, India, Malaysia, Myanmar, Mongolia, Pakistan, Philippines, Sri Lanka, Thailand and Viet Nam) will attend this training course. The main purpose of this

activity will be to provide training to the local staff directly involved in the implementation of laboratory and field investigations of the project on the use of ^{15}N techniques to follow the fate of nitrogen fertilizers applied to rice based cropping systems.

D. PAST EVENTS

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

⇒ **Final RCM of CRP on "Management of Nutrients and Water in Rainfed Arid and Semi-arid Areas for Increasing Crop Production", 24 – 28 September 2001, Vienna, Austria**

This third and final RCM was held at the IAEA Headquarters. Twelve contract holders, five agreement holders and one consultant (Mr. Pierre Moutonnet, former Project Officer) participated in this RCM. Mr. Gamini Keerthisinghe, SWMCN Section, and Ms. Lee Heng, SSU, Seibersdorf Laboratories, served as Scientific Secretaries. A total of six Technical Sessions were held during which the participants presented the major results and conclusions of their research. The Technical Sessions were followed by a Session in which participants were divided into five working groups to review the progress towards achieving CRP objectives, collate information and formulate conclusions. The conclusions were presented by the leader of each working group in the final session.

The results presented clearly demonstrated the benefits of using nuclear techniques to obtain quantitative information on water and nitrogen use efficiency for identifying soil, crop, fertilizer and water management practices for increasing crop production and sustaining soil fertility under rainfed conditions. Judicious choice of crop rotations combined with appropriate land preparation methods such as zero tillage showed promising results in conservation of soil moisture, an important factor influencing the establishment and growth of crops during the dry season. Crop simulation models will be used to evaluate the data collected from different agro-ecological regions for extrapolation of research results from the benchmark sites. A report of the RCM is available from the Scientific Secretary upon request.

CONSULTANTS MEETINGS

⇒ **FAO/IAEA Consultants Meeting on "Identification of Crop Species/Cultivars for Drought and Salinity Tolerance for Sustained Crop Yields by Using Nuclear Techniques, in Particular the Carbon Isotope Discrimination" 12 – 16 November 2001, Vienna, Austria**

This meeting was conducted in conjunction with a Group Meeting on "Novel Approaches for Improving Crop Tolerance to Salinity and Drought". Five consultants from Australia, Mexico, Pakistan, UK and the USA and one representative from FAO attended the Consultants Meeting and nine participants from Australia, Canada, China, Germany, India, Israel, Pakistan, South Africa and the USA attended the Group Meeting. Mr. Gamini Keerthisinghe (Soil and Water Management & Crop Nutrition Section) and Ms. Karin Nichterlein (Plant Breeding and Genetics Section) served as Scientific Secretaries of the Consultants Meeting and the Group Meeting, respectively.

Mr. Jihui Qian, Deputy Director General, Department of Technical Co-operation and Mr. James Dargie, Director, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, welcomed the participants to the Joint Meeting and highlighted the problems associated with increasing crop and food production under saline and drought conditions. The first two days of the Joint Meeting consisted of five technical sessions during which the participants presented papers on various approaches for improving crop tolerance to salinity and drought, and the role of nuclear techniques in identification of plants tolerant to abiotic stresses. After the presentations, two working groups were formed: one consisting of the participants of the Consultants Meeting and the other the participants of the Group Meeting. The consultants proposed various strategies for using the carbon isotope discrimination technique as a selection tool for identifying higher yielding crop genotypes, especially in wheat and rice cropping systems under drought and saline conditions. A proposal was formulated to address the above issues in the framework of a CRP. The participants of the Group Meeting reviewed conventional and molecular approaches for improving crop tolerance to salinity and drought, and research priorities were identified for future work on crop productivity improvement under the above stress factors. Recommendations of both working groups were presented at the final session of the Joint Meeting. A report of the Consultants Meeting is being prepared by the Scientific Secretary, Mr. G. Keerthisinghe.

TECHNICAL CO-OPERATION PROJECTS (TCPs)

⇒ **FAO/IAEA Regional TCP for Europe on "Fertigation for Improved Crop Production and Environmental Protection" (RER/5/011)**

- **Regional Training Course on "The Application of Neutron Probe and ^{15}Nitrogen Under Fertigation" 2 – 6 July 2001, Ankara, Turkey**

The training course was held at the Ankara Nuclear Agriculture and Animal Sciences Research Center (ANAASR), Turkish Atomic Energy Authority. Dr. M.B. Halitligil was the local Course Director while the Technical Officer, Ms. Lee K. Heng, was one of the course instructors. Participants of the training course were selected from counterpart institutions in Bulgaria, Cyprus, Greece, Hungary, The former Yugoslav Republic of Macedonia, Romania, Slovenia and Turkey. Topics included: Fertigation-Drip Irrigation (Principles and Management); Injectors & ^{15}N Fertilizer Preparation; Chemistry of Fertilizer Solutions and Water Quality; Analysis of ^{15}N with the NOI7 optical emission spectrometer; Soil Moisture Measurement (Neutron Probe & other techniques).

⇒ **FAO/IAEA TCP on "Biofertilizers for Increased Legume Production" (BGD/5/017)**

This project has been operational since 1995 with the main objective of assisting the country in establishing technologies for pilot-scale production of *Rhizobium* inoculants for grain (pulse) legumes. Tasks and activities have been implemented by the Bangladesh Institute of Nuclear Agriculture (BINA) and the Department of Agricultural Extension (DAE) of the Ministry of Agriculture working in close partnership. The latter was included to create awareness among farmers and establish a market for the inoculants through field demonstrations.

- **Workshop on "Integrated Crop, Soil, Water and Nutrient Management in Rice-based Cropping Systems with Emphasis on Biofertilizer Technologies", 19 – 23 August 2001, Mymensingh and Dhaka, Bangladesh**

With the financial support of OPEC this workshop was organized with the following objectives: a) to review the work done on rhizobial biofertilizers for legumes and to examine other potential biofertilizer technologies, constraints/limitations and ways/means to overcome them, b) to integrate biofertilizer technologies and crop, soil, water and nutrient management practices in rice-based cropping systems for improving soil fertility and sustaining rice production in Bangladesh. According to these objectives, the workshop consisted of two parts: the first part was conducted at the Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, and the second was held at the Cotton Development Board, Dhaka. The local organizer was Dr. M. Idris Ali, Director General BINA, ably assisted by Dr. A. Sattar, Head, Division of Soil Science, BINA. F. Zapata was the Technical Officer. Twenty local scientists from BINA and other institutions participated. In addition to local lecturers from BINA and DAE, the followings scientists were invited by the IAEA as lecturers: Prof. Kaushik, Dr.Sachdev and Dr. Tilak, from IARI, India and Dr. S. Urquiaga, from EMBRAPA, Brazil.

The programme included lectures and practical sessions on biofertilizers, conferences, discussion sessions and a wrap-up session to elaborate a work plan for future studies. The objectives of the meeting were achieved.

⇒ **FAO/IAEA TCP on "Studying the Fate of Nitrate in Soil and Water under Intensive Vegetable Production Systems" (MAR/5/011)**

- **Group Training, 3 – 7 September 2001, St Paul, Mauritius**

This training activity was organized by the Agency with support from the Agricultural Research and Extension Unit (AREU) and the Central Water Authority (CWA). Seven participants from AREU and three from CWA attended the Training. The Technical Officer, Mr. Gamini Keerthsinghe conducted the training with support from Dr. Bernard Vanlauwe from the Tropical Soil Biology and Fertility Programme (TSBF), Kenya, who participated as an Agency Expert. The main aim of the training was to provide basic information on the use of isotopes in agricultural research, especially on the use of ^{15}N in estimating nitrogen fertilizer use efficiency and biological nitrogen fixation in vegetable production systems. The training was in line with the main aim of this project, which is to minimize the excessive use nitrogen fertilizer inputs by increasing the efficiency of nitrogen fertilizers and optimising biological nitrogen fixation. For this purpose ^{15}N techniques will be used to obtain quantitative information on the fate of applied nitrogen, so that appropriate management practices can be identified to reduce nitrogen loss and increase nitrogen uptake by plants. The training included lectures, as well as laboratory and field demonstrations. The acquired experience will be beneficial in the implementation of project activities.

NON-FAO/IAEA MEETINGS

⇒ **International Meeting on Direct Application of Phosphate Rock and Related Appropriate Technology – Latest Developments and Practical Experiences, 16 – 20 July 2001, Kuala Lumpur, Malaysia**

Ms. Lee Heng participated in the meeting which was attended by more than 100 participants from more than thirty countries, including representatives from fertilizer companies and associations, research institutions, international organisations and governments. The meeting was jointly organized by the International Fertilizer Development Center (IFDC), the Malaysian Society of Soil Science (MSSS), the Potash & Phosphate Institute (PPI) and the Potash & Phosphate Institute of Canada (PPIC), East and Southeast Asia Program (ESEAP).

The objectives of the meeting were:

- To present and discuss the latest agronomic research results on the use of natural phosphate rocks and modified products as influenced by origin and characteristics, soil type, management practices, and cropping systems.
- To gain updated information on the production and the agronomic use of phosphate rock from the producers, dealers, and users in different countries.
- To provide an international forum for an objective discussion on the potential use of either indigenous or imported phosphate rocks for direct application to increase crop production or lower crop production costs in the future.

Topics/activities of the conference included:

- Overview of phosphate rock use and related appropriate technology.
- International research network on phosphate rock.
- National research network on phosphate rock.
- Isotopic technique and modelling in phosphate rock research.
- Reports from phosphate rock producers, users and researchers.
- Field trip to an oil palm estate where trials on various sources of phosphate rock were carried out.

Ms. Lee Heng gave two oral presentations on "Towards Developing a Decision Support System for Phosphate Rock Direct Application in Agriculture" and "FAO/IAEA Research Activities on Direct Application of Phosphate Rock for Sustainable Crop Production", the latter on behalf of Dr. Felipe Zapata who was unable to attend the meeting.

⇒ **12th World Fertilizer Congress, 3 – 9 August 2001, Beijing, China**

Mr. P.M. Chalk was an invited keynote speaker at the Congress. The tile of his half-hour presentation in Plenary Session was "Nitrogen Fertilization and Its Environmental Impact" with co-authors Lee Heng and Pierre Moutonnet. The talk was based on the results of an FAO/IAEA Co-ordinated Research Project on N fertilization of irrigated wheat, using the CERES-wheat crop simulation model of the Decision Support System for Agrotechnology Transfer (DSSAT) as a predictive tool for increasing N and water use efficiency. This presentation was of particular relevance to the Congress host country, China, which participated in the CRP. The consumption of fertilizer N in China (22 m t) represents more

than 25 % of global consumption, which increased 8-fold in a linear fashion from 10 million tones in 60/61 to 80 million tones in 88/89. China together with East and South Asia account for approximately 50 % of world consumption of fertilizer N, with urea being the dominant form used.

The International Fertilizer Association (IFA) predicts that production and consumption of urea will increase in the future to meet the increased demand for cereal grains, oilseeds and fibres. A recent international study has predicted that the world population will peak at 9 billion in 2070 from the present population of 6 billion (50 % increase in the next 70 years). Serious environmental problems are becoming more and more evident in China due to excessive use of N fertilizer and irrigation water, and other nutrient inputs from urban, industrial and rural sources. The incidence of eutrophication of surface waters (lakes, rivers) and pollution of groundwater with nitrate is increasing. The predicted increase in the use of N fertilizer in agriculture will exacerbate these problems unless corrective measures are taken. Many of the papers presented at the Congress addressed the issue of increasing N fertilizer use efficiency through new product development and improved management practices.

⇒ 11th Nitrogen Workshop, 9 – 12 September 2001, Reims, France

Ms. Rebecca Hood participated in the workshop which was attended by more than 300 participants from 45 countries. The meeting included a selected number of oral presentations and approximately 228 poster presentations. The programme and poster titles are available on the internet, http://www.inra.fr/Internet/Projets/11Nworkshop/.

The meeting focused on the latest findings in nitrogen research with particular emphasis on:

- Decomposition of added organic matter (plant residues and agricultural wastes): concepts, methods and models related to C & N cycling.
- Residue quality and location, interactions with soil structure, organic/inorganic interactions, gross N transformations, gaseous losses associated with organic matter transformations.
- Long-term evolution of C & N in agroecosystems as affected by organic matter management, N fertilisation and soil tillage.
- Carbon sequestration, mineralisable nitrogen, soil quality indices, environmental impacts.
- Management of nitrogen at field, catchment and regional scales. Decision support system for N fertilisation, crop and soil diagnostic tools, agroecological indicators, precision agriculture.

There were additional thematic working groups to discuss the following issues in more detail:

- Inputs and turnover of C and N through root systems: how should these be quantified? Chaired by I.R.P. Fillery & E.S. Jensen.
- Evaluating N availability in organic wastes. Chaired by H. Kirchmann & S. Houot.
- Where is the 'missing' N in grassland budgets? Chaired by S. Ledgard & C. Watson.
- Organic resource quality and integrated soil fertility management. Chaired by B. Vanlauwe & L.S. Jensen.
- Modelling carbon and nitrogen in the soil/plant system. Chaired by J. Smith & P. Garnier.

- Advances in the measurement of gross and net N fluxes. Chaired by J. Luxhoi & D. Hatch.
- Physical and chemical controls over C and N cycling in soils. Chaired by D. Angers & C. Chenu.
- The use of plant N-status indicators as quick tools to manage in-season N-fertilisation for arable crops. Chaired by J.P. Goffart & M.H. Jeuffroy.
- Measuring, modelling and mitigating nitrous oxide production - What's new? Chaired by J. Stevens & P. Boeckx.

Highlights of the conference were:

- Results from a ^{15}N based field trial showed that application of slurry and N fertilizer simultaneously could lead to high denitrification losses. This could be overcome by applying the slurry four days prior to the fertilizer to lower the available carbon in the soil. Presented by Jim Stevens, Belfast, UK.
- A novel way to measure nitrate concentrations using fibre optics and infra red sensors was presented by A Kenny, Israel.
- Results from foliar labelling studies using ^{15}N showed that below ground nitrogen has been a neglected nitrogen pool. Presented by Ian Fillery and Ann McNeill, Australia.
- Ratios of gross nitrification/immobilisation identified using ^{15}N techniques could provide a tool for estimating leaching potentials. The results showed that under a variety of climates this premise holds true. Presented by Liz Stockdale, UK and Dan Murphy, Australia.
- Two posters were presented by the FAO/IAEA Soils sub-programme on "The effect of polyphenols on gross mineralisation and nitrification" by X.M. Videla and R.C. Hood, and "The effect of soluble organic carbon on gross mineralisation and nitrification processes." by J.P. Bonetto and R.C. Hood. The posters were one of the outcomes of the training of the research fellows Ximena Videla (Chile) and Juan Pablo Bonneto (Argentina) in the Soil Science Unit, FAO/IAEA Agriculture and Biotechnology Laboratory. Both posters were selected for special presentation in the Thematic working groups, highlighting the interest in this area.

⇒ **International Conference on "Soil Science: Past, Present and Future", 16 – 20 September 2001, Prague, Czech Republic**

Mr. P.M. Chalk chaired a Session at the Conference, which was jointly sponsored by the Czech Society of Soil Science and the Soil Science Society of America. The conference was organized into two days of oral and poster presentations at the Czech University of Agriculture and two days of field excursions. Topics covered in the oral and poster presentations included: (1) Soil geographic information systems, (2) Intepretation of soil data and different scales in time and space, (3) Heavy metals and organic pollutants in soils, (4) Transport processes in soil with special reference to preferential flow. The first 1-day field excursion was to southern Bohemia to examine soil limitations to forest and agricultural enterprises. Poor stands of *Pinus* spp. were seen on highly acidic sandy soils (Podzols) with low retention capacities for water and nutrients. Waterlogged cultivated soils following weeks of rain were observed although internal tile drainage had been installed, illustrating the problems of maintenance due to clogging from the high mica content in the soil and the changed system of land tenure/ownership. The second 1-day excursion to northern Bohemia illustrated the potentials and problems of reclaiming open cut coal mining dumpsites for forestry, agriculture and recreation.

The conference highlighted the enormous progress that has been made in the Czech Republic in digitizing GIS-referenced databases to provide information to students, decision makers and farmers on land use capability and pollution hazards, including acid rain and heavy metal contamination of soils. Much of this information has been retrieved from soil surveys, land capability assessments and resource inventories that previously had limited dissemination. Moves are underway to make this material more widely available through the internet. The conference provided an overview of problems in soil, nutrient and water management both in terms of crop and timber production and sustainability. The detrimental effects of acid rain on stands of spruce are evident long after the source has been removed. The conference provided an opportunity for small groups of participants actively involved in natural resource management to interact.

⇒ **3rd Viennese Workshop on Stable Isotopes in Biological and Ecological Research, 8 – 9 November 2001, Vienna, Austria**

Ms. Rebecca Hood assisted in the organization of this workshop, whose aim was to bring together scientists working with stable isotopes and to encourage communication across disciplines and institutions in Austria. The workshop provided the opportunity to discuss theoretical and methodological difficulties of using isotopic techniques and to exchange information and ideas. This workshop took place at the University of Vienna and was organized by the Department of Chemical Physiology of Plants, Institute of Ecology and Conservation Biology, University of Vienna in collaboration with the Soils Science Unit, Seibersdorf. There were about 50 participants from a range of academic institutes from within Austria and representatives from the major isotope-ratio mass spectrometer manufacturers. The lectures covered many aspects of stable isotope technology demonstrating the increasing use of isotopes in biological, ecological, geological and archaeological studies.

The programme was as outlined below:

- Welcome Address & Introduction. H. Bolhàr-Nordenkampf, Institute of Ecology and Conservation Biology, University of Vienna.
- Stable C and O isotopes in cave deposits: an important proxy for environmental change. Spötl, Tooth & Burns, Institute of Geology and Palaeontology, University of Innsbruck.
- Carbon isotope record of the Permo/Triassic Boundary and the Lower Triassic. Horacek, Abart & Brandner, Institute of Mineralogy, University of Graz.
- High precision soil and atmospheric trace gas stable isotopic measurements in the investigation of sources of environmental contaminants. Hertle, Davis & Drimmie, Micromass GmbH, Eschborn, Germany.
- Nitrogen partitioning and ^{15}N natural abundances in soil particle size fractions. Gerzabek, Haberhauer & Kirchmann, ARC Seibersdorf, Department of Environmental Research.
- Application of natural ^{15}N abundance in nitrogen cycling. Studies of tropical rain forests. Wania, Wanek & Hietz, Institute of Ecology and Conservation Biology, University of Vienna.
- Stable isotopes as indicators of management intensity in montane grasslands. Watzka & Wanek, Institute of Ecology and Conservation Biology, University of Vienna.
- A comparison of mass spectrometry and FANci techniques for measuring $\delta^{13}C$. Hood, Haque, El Kadir & Khan, FAO/IAEA Agriculture and Biotechnology Laboratory, Seibersdorf.

- Stable isotopes: a powerful tool to elucidate ecological processes in floodplains. Peduzzi & Hein, Institute of Ecology and Conservation Biology, University of Vienna.

A number of posters were also presented.

It was concluded in the meeting that this was a useful forum for researchers in the area of stable isotopes. It was highlighted that the eclectic approach, of covering many areas linked by using stable isotopes brought together scientists with similar interests from different disciplines, which is particularly important in a country with a relatively small scientific community such as Austria. There is a growing interest in stable isotopes from a range of fields and these types of meetings, which are easy to organize, are an excellent opportunity to network with scientists sharing similar ideas and enthusiasm. We proposed to set up a web site to link the groups and give the workshop a profile and provide an information resource for interested scientists. Several of the staff of the Soil Science Unit participated in this workshop.

E. STATUS OF CO-ORDINATED RESEARCH PROJECTS

⇒ **Use of Nuclear Techniques for Developing Integrated Nutrient and Water Management Practices for Agroforestry Systems**
Project Officer: G. Keerthisinghe

Participating in this CRP are nine contract holders: K. Aihou (Benin), B. Zhang (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), L. Verchot (ICRAF-Kenya), N. Sanginga (IITA-Nigeria) and M. Smith (UK). All contract holders have on-station and on-farm experiments under way and the results presented at the second RCM showed that the experimental work is progressing according to the work plan and experimental guidelines established at the first RCM. Isotope techniques are being used to quantify nutrient and water dynamics in agroforestry systems in order to modify management practices for better utilisation. Linkages with CG centers and other agroforestry projects have been established for effective implementation of project activities. The project is well positioned for significant contributions in understanding the role of trees in agricultural systems and in contributing to the development of improved agroforestry systems.

⇒ **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**
Project Officers: G. Keerthisinghe and L. Heng

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 third and the final RCM was held in Vienna, 24 - 28 September 2001 at which the overall progress and significant achievements of the project were reviewed and discussed. Instructions and guidelines were provided to all the participants for

preparation of final reports and manuscripts for publication in an IAEA-TECDOC. Data collected will be evaluated using different crop growth simulation models such as DSSAT and APSIM.

⇒ **Assessment of Soil Erosion Through the Use of Cesium-137 and Related Techniques as a Basis for Soil Conservation, Sustainable Production and Environmental Protection**
Project Officer: F. Zapata

The final RCM was held from 21 - 25 May 2001, in Vienna, Austria. The final report of the CRP is available upon request from the Project Officer. The peer review of manuscripts submitted for the production of a special issue of the journal Soil and Tillage Research is in progress.

All draft chapters for the production of a handbook on the Cs-137 technique have been received. The IAEA Publications Committee has approved the external publication by Kluwer Academic Publishers, on condition that a contract agreeable to both parties (IAEA and Publisher) is drawn up.

⇒ **Development of Management Practices for Sustainable Crop Production Systems on Tropical Acid Soils through the Use of Nuclear and Related Techniques**
Project Officer: F. Zapata

This CRP was implemented at the end of 1999 and the first RCM was held in Vienna in June 2000. Eight research contract holders: P. Houngnandan (Benin), 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); one technical contract holder: P. Randall (Australia), and five agreement holders: W. Horst (Germany), S.H. Chien (IFDC-USA), B. Vanlauwe (TSBF-Kenya), and J. Diels (IITA, Nigeria) are participating. Most contract holders have submitted an annual progress report and have applied for the first renewal of contract. Guidelines and research protocols are available in the report of the first RCM. The second RCM is scheduled for March 2002 in Brasilia, Brazil. The project will undergo a mid-term review immediately after the second RCM.

⇒ **Use of Nuclear and Related Techniques for Evaluating the Agronomic Effectiveness of P fertilizers, in particular Rock Phosphates**
Project Officer: F. Zapata

Several outputs have been obtained from this project. The IAEA Publications Committee approved the IAEA TECDOC containing some 46 manuscripts and it is now in press. The peer review of 11 manuscripts submitted for the production of a special issue of the journal Nutrient Cycling in Agro-ecosystems has been completed. The IAEA Publications Committee approved the external publication. The Editorial Office of the journal has approved the publication of the special issue for the first quarter of 2002. The joint initiative of two FAO Divisions (AGE/AGL) for the production of a FAO Technical Bulletin on "Use of local phosphate rocks in sustainable agriculture" is being implemented. The first drafts of the chapters will be ready by the end of 2001, and the target date for printing is September 2002.

The sub-programme is planning to collaborate with IFDC to develop a database on phosphate rocks and a decision support system for direct application of phosphate rocks (PR-DSS) during the 2002-2003 biennium. For this purpose, F. Zapata recently visited IFDC at Muscle Shoals, Alabama, USA, to work out an agreement for future co-operation. The PR-DSS will be a useful research and extension tool for scientists, extension workers, progressive farmers, planners and agribusiness dealers, thus contributing to promote the use of phosphate rock resources in tropical and subtropical Member States. At a recent meeting of the Joint FAO/IAEA Division on Information Technology, the PR-DSS was considered as a pilot project for future initiatives on expert systems.

⇒ **Integrated Soil, Water and Nutrient Management for Sustainable Rice-Wheat Cropping Systems in Asia**
Project Officer: P. Chalk

This CRP was approved in February 2001 and the project commenced on October 1, 2001, with an anticipated duration of 5 years. Seven research contract holders from Bangladesh, China (2), India (2), Nepal and Pakistan, and four agreement holders from Australia, Philippines, India and the USA will participate in the CRP. The overall objective is to improve the productivity and sustainability of rice-wheat cropping systems through increased efficiency of water and nutrient use. The specific research objective is to modify existing water and nutrient management systems, and improve soil management in both traditional and emerging (raised beds, non-puddled soil, direct seeding) tillage systems, for sustainable intensification of cereal production. The first RCM and training workshop will be held 4 – 8 March 2002, in Vienna and Seibersdorf, Austria.

F. NEW FAO/IAEA CO-ORDINATED RESEARCH PROJECT

1. Title: Using fallout radionuclides to evaluate the effectiveness of soil conservation measures for sustainable crop production.

2. Proposed duration: 5 years (2003-2007)

3. Introduction:

Estimates from a Global Assessment of Soil Degradation (GLASOD) made by UNEP in 1992 revealed that one third of the agricultural soils or 2 billion ha are affected by several forms of soil degradation, the most important of which are wind and water erosion. Measuring soil erosion and productivity loss is essential to indicate priorities for action in land rehabilitation for sustainable productivity.

As there is an urgent need to arrest soil erosion and associated sedimentation worldwide the Joint FAO/IAEA Division plans to develop further initiatives in this field. In particular, there is considerable scope for the wider application of the ^{137}Cs technique as well as other fallout radionuclides to obtain temporal and spatially integrated estimates of erosion rates, and to evaluate the efficacy of soil conservation measures.

4. Overall objectives:

To develop improved land use and management strategies for sustainable crop production through effective soil erosion control practices.

5. Specific research objective:

- To further develop fallout radionuclide methodologies, with particular emphasis on the combined use of ^{137}Cs, ^{210}Pb and ^{7}Be for measuring soil erosion over several spatial and time scales.
- To establish standardized protocols for the combined application of the above techniques.
- To utilize these techniques to assess the impact of short-term changes in land use practices and the effectiveness of specific soil conservation measures.

6. Expected research outputs:

- Standardized methodologies and guidelines for the use of fallout radionuclides for the assessment of the impact of short-term changes in land use practices and the effectiveness of specific soil conservation measures.
- Reliable data on short-term soil erosion rates and soil redistribution under different land use practices in a range of agro-ecological zones.
- Better understanding of the effectiveness of specific soil conservation measures in controlling soil erosion for sustainable crop production.
- Strengthening the capacity of national institutions to measure and control soil erosion through training, workshops and other activities.
- Publication of the methodologies, guidelines and research results.

7. Work plan:

7.1. Target topics

- Selection of a representative study area in relation to the land use types/management and specific soil conservation measures to be assessed.

- Further development of fallout radionuclide methodologies for measuring soil erosion and redistribution over several spatial and time scales. Particular emphasis should be given to the combined use of ^{137}Cs, ^{210}Pb and ^{7}Be.

- Establishment of standardized procedures and guidelines for the application of the developed methodologies.

- Utilisation of the developed methodologies to assess the impact of short-term changes in land use/management practices and the effectiveness of specific soil conservation measures.

7.2. Sites and partner selection

The proposed CRP will be conducted through the establishment of a network of National Agricultural Research Systems (NARS) and International Agricultural Research Centres (IARCs) and Advanced Research Institutes (ARIs). Appropriate co-ordination will be established with other related projects such as the CRP on Isotope Techniques for Sediment Tracing (F3.10.03, Isotope Hydrology Section) and the IAEA Technical Co-operation Programme. Close collaboration will be established with FAO, Land and Water Development Division, UNEP and other institutions through the World Overview of Conservation Approaches and Technologies (WOCAT). In implementing the project, selected agro-ecological zones will be targeted and specific benchmark areas will be identified as focal points for strategic research and development activities.

The following criteria will be considered in the selection of sites and partners.

Sites should be:

- Well distributed among the main categories of soil conservation measures. (Agronomic, vegetative, management or combined, according to WOCAT).

- Representative of a range of agro-ecological zones and land use types (FAO, UNEP).

- At locations where soil erosion has been identified as a serious problem (according to WOCAT) and conservation measures are being implemented.

- Well characterized in terms of landscape, soil type, and available climate data according to WOCAT.

- Due consideration should be given to other on-going projects of the IAEA Technical Co-operation and Research Contract Programmes.

Partners should represent:

Institutions working on soil conservation programmes and nuclear applications in soil erosion/sedimentation research. They should form multidisciplinary teams, with expertise on:

- nuclear techniques, with experience in measuring fallout radionuclides;
- soil erosion and conservation; and
- other relevant disciplines, including socio-economics.

Collaboration with other UN organisations (UNEP, FAO), CGIAR centres (ICARDA, ICRAF) and other Advanced Research Institutes will be established.

7.3. Isotope techniques for use in the target topics

Fallout radionuclides, with particular emphasis on the combined use of ^{137}Cs, ^{210}Pb and ^{7}Be for measuring soil erosion rates and establishing patterns of soil

redistribution at several spatial and time scales. In addition, other nuclear techniques, such as the soil moisture neutron probe and isotopic tracers can be utilized to study water storage and nutrient cycling processes, respectively.

7.4. Other resources required

Laboratory support from the Agency's Laboratories at Seibersdorf, as well as from the Agreement Holders will be essential to implement the activities of this CRP. It is also envisaged that strategic support through technical contracts will be required.

8. Call for proposals:

Proposal forms for research contracts and agreements can be obtained from the web at http://www.iaea.org/programmes/ri/uc.html. They must be countersigned by the Director of the Institution and submitted to the Head, Research Contract Administration Section, IAEA, Vienna. Please note that **they should be received before the deadline of 30 August 2002.** Further information can be obtained from the Project Officer, Mr. F. Zapata at F.Zapata@iaea.org.

G. LABORATORY ACTIVITIES

RESEARCH AND TRAINING

⇒ **Fellowships**

Training of research fellows started in March this year with a two-week series of lectures on "The use of nuclear techniques in soil, water and nutrient management". The lectures were presented by the staff of the Soil and Water Management & Crop Nutrition sub-programme. This year the Soil Science Unit trained 10 research fellows for periods from 3 months up to 1 year. The fellows received training in the use of nuclear technique in soil science from experimental design, to the collection, interpretation and presentation of data. Most of the fellows were scientists with university/agricultural background who were interested in expanding into nuclear techniques to answer specific problems in their research area.

The following research fellows were trained by the Soil Science Unit in 2001:

Mr. Abdulhafied Ellafi came from Libya for training in soil water management. He set up a field experiment with a tomato crop to study the performance of the soil moisture neutron probe and to compare it with TDR and capacitance sensors such as the Diviner 2000 and EnviroSCAN. He also made comparisons of leaching with different rates of nitrogen fertilizer between fertigation and furrow systems. Supervised by Ms. Lee Heng.

Mr. Ali Khorasani came from Iran. Mr. Ellafi worked on the same project as described above. The results show that the two capacitance sensors have very similar performance and give much higher soil moisture measurements than the neutron probe or TDR. Also, a larger error tends to be associated with these capacitance sensors due to the small volume measured.

Their results also show a substantial saving of water and fertilizer under the fertigation system. Supervised by Ms. Lee Heng.

Mr. Nejat Piervali Bieranvand from Iran performed experiments on the use of ^{15}N to quantify biological nitrogen fixation, i.e. the effect of nutrient deficiency on BNF in soybean and the effect of *Bradyrhizobium* strains to enhance BNF during early growth stages of soybean. Supervised by Mr. Gudni Hardarson.

Mr. M'Hamed El Khadir from Morroco was trained in the use of ^{15}N and ^{13}C techniques to study organic matter turnover and nutrient release in salt affected soils. The research focused on labelling of plant material and following the fate of nutrients through the soil crop continuum. His work may lead to the development of better residue management strategies and increased crop production. Some of the results of Mr. El Khadir's work are shown in an abstract below. Supervised by Ms. Rebecca Hood.

Mr. Aime Lala Razafinjara from Madagascar
and
Mr. Patrick Abis Ndakidemi from Tanzania
worked on the same project as Mr. El Khadir and performed several experiment on the use of ^{15}N to quantify biological nitrogen fixation, including studies on the below ground N accumulation in mixed cropping of soybean/common bean and wheat. Both fellows were supervised by Mr. Gudni Hardarson.

Ms. Elvira Bautista from the Phillipines was trained in measurement of N mineralisation from organic manures using gross and net mineralisation techniques in the field, and in the use of the new indirect approach for measuring N release from organic residues. She also received additional training in the use of the FANci gas analyser and in measuring plant residue quality characteristics. Some of the results of her experiments are shown in an abstract below. Ms. Bautista will use the techniques in her home country, to develop management strategies for poultry manure with local farmers. Supervised by Ms. Rebecca Hood.

Mr. Md Azizul Haque from Bangladesh was trained in using the tree ^{15}N injection technique and chamber techniques for ^{13}C labelling. Various modifications of the technique were also tested. Mr. Haque was also involved in the development and testing of the FANci gas analyzer for ^{13}C analyses. He was also trained in the measurement of plant residue quality characteristics. Declining soil organic matter is a major issue in Bangladesh and agroforestry could be one of the solutions to that problem. The research techniques studied by Mr. Haque will help him develop sustainable management research strategies to increase crop production in his home country. Some of the results of his research work are shown in an abstract below. Supervised by Ms. Rebecca Hood.

Mr. Muhammad Athan Khan from Pakistan was trained in the use of ^{13}C discrimination for identifying isolines tolerant to saline conditions. In collaboration with the Plant Breeding Unit he investigated the relationship between conventional screening techniques and ^{13}C discrimination. He was also trained in the use of the FANci analyser and tested and developed preparation techniques for ^{13}C analysis of plant material. The results from Mr. Khan's studies showed a strong relationship between field observed yields under saline conditions and ^{13}C discrimination measured in short term screening experiments in the laboratory. It is hoped that these techniques will be used to improve the selection of salt

tolerant cultivars in Pakistan and thus lead to increased wheat production in saline environments. Supervised by Ms. Rebecca Hood.

Ms. Jovanka Katarzyna Petrevska from Macedonia carried out a greenhouse fertigation experiment comparing water and nutrient use efficiency of lettuce under two water management (the same amount of water in different portions) and three nitrogen treatments (0, 80 and 160 kg N ha^{-1}). ^{15}N (10% enriched as KNO_3) was also applied to trace the applied N and to estimate its use efficiency. Lettuce reacted positively to less frequent application of water with higher rates per application, and the best results, were obtained when greenhouse lettuce grown in pots was watered on a weekly basis and when 50% of the fertilizers was applied. Supervised by Ms. Lee Heng

In addition to the research fellows a group training on total N and ^{15}N analyses was conducted during October – December 2001. A detailed report will be made in the next Newsletter.

⇒ **Experimental work**

- **Salinity and N fertilizer levels on growth, N uptake and water use efficiency of young tomato plants**

C. Kütük[1], G. Çaycı[1] and L.K. Heng.
[1]IAEA Fellows from the Department of Soil Science, Faculty of Agriculture, University of Ankara, Turkey.

A greenhouse experiment was carried out to investigate the interactive response of nitrogen fertilizer and salinity. Tomato plants were grown in pots and saline treatments were imposed by irrigation water having electrical conductivity (EC) of 0, 3, 6, 9 and 12 dSm^{-1}. Four levels of fertilizer (0, 80, 160 and 240 mg N kg^{-1}) as urea and ^{15}N (10 % atom excess) were also applied.

Preliminary results showed that salinity did not have a negative effect on the dry weights of shoots and roots at zero N treatment, as N was probably the limiting factor. Application of nitrogen significantly increased shoot growth, and the highest shoot weight was obtained at 160 mg kg^{-1} N treatment.

Increasing the levels of salinity decreased the dry weights of shoots and roots in the N treatments. Major decreases occurred only at 6 dS m^{-1} or more salinity, indicating the relatively high tolerance of young tomato plants. Also, there was no significant difference in shoot dry weight in all N treatments at 12 dS m^{-1}.

The fertilizer use efficiency was lowest (28.2 %) in the 80 mg Nkg^{-1} and non-saline water treatment, while maximum efficiency (37.9 %), was obtained at 240 mg kg^{-1} N and 3 dSm^{-1} saline water treatment. Irrespective of saline water levels, the highest efficiency was observed at 240 mg Nkg^{-1} treatment, followed by 160 and 80 mg Nkg^{-1} treatments.

A positive correlation was obtained between water use efficiency (WUE) and N application. In contrast, WUE decreases with salinity levels, showing salinity inhibiting water absorption. Interaction between salinity and N levels was not found to be significant.

Many studies have shown that the carbon isotope discrimination (Δ) technique provides a means of ranking WUE in C_3 plants and have been used as a tool to select plants for drought and salinity tolerance. A negative correlation between Δ and EC was observed in this experiment, but there was no significant difference in the Δ values between the various N treatments. While salinity had no effect on shoot yield at zero N treatment, increasing salinity had a significant effect on the Δ values.

A negative correlation was also obtained between the WUE and Δ at all salinity levels. Also, there was a significant decrease in Δ values as salinity increased ($P<0.01$), suggesting the possibility of using Δ for screening for salinity tolerance.

- **Plant residue quality characteristics and crop N uptake from tropical tree residues under non-N-limiting conditions**

M.E. Khadir[1], M.A. Haque[2], M. Heiling and R. Hood.
[1]IAEA Fellow from Institut National de la Recherche Agronomique, BP 415, Rabat, Morroco, [2]IAEA Fellow from Soil Science Division, Bangladesh Institute of Nuclear Agriculture, P.O. Box 4, Mymensingh 2200, Bangladesh.

One of the problems of residue management is the unpredictability of residue breakdown. By using ^{15}N labelled residues it is possible to determine the rate of plant N uptake from the decomposing residues over time. The amount of N derived from the residue (Ndfr) is determined by soil and climatic conditions and plant residue quality. By understanding the plant residue quality characteristics which determine residue breakdown and subsequent crop uptake, N demand may be synchronized with residue N mineralisation.

It has been shown that initial N, lignin and polyphenol concentrations are the main factors that which determine N mineralisation from residues (Palm and Sanchez, 1991). These experiments were carried out under N limiting conditions as they did not use isotopes. However, using isotopes, as was done in the present investigation, it is possible to investigate the breakdown of residues under non-N-limiting conditions. The present experiment was set up to determine the effect of plant quality characteristics on Ndfr under non-N-limiting conditions in maize.

The following five ^{15}N labelled crop residues were added to Seibersdorf soil at the rate of 50 mg N kg^{-1} (100 kg N ha^{-1}) in addition to 100 mg N kg^{-1} as unlabelled ammonium sulphate: alfalfa, common bean, *Acacia, Glyricidia,* and *Albizia*. Control (no N application), unlabelled fertilizer $(NH_4)_2S0_4$ (100 mg N kg^{-1}) and labelled fertilizer $(^{15}NH_4)_2S0_4$ (100 mg N kg^{-1} at 2 atom % excess ^{15}N) treatments were also included. The maize was harvested 6 weeks after sowing. Total extractable phenol, acid detergent fiber, lignin and cellulose were determined in all residue samples. They were analyzed for total N and atom % ^{15}N excess using mass spectrometry.

There were no significant differences in plant height, total chlorophyll content or leaf area between treatments which had received N fertilizer amendment. However, the control showed significantly lower values in all parameters. Nitrogen derived from residue ranged from 9.87 mg pot^{-1} to 23.59 mg pot^{-1} in the *Acacia* and alfalfa treatments, respectively. Plant residue quality characteristics were significantly correlated to Ndfr, whereas there was no significant influence on dry matter yield. A highly significant ($P<0.001$) relationship was observed between Ndfr and polyphenol concentration of the residues ($r^2 =0.96$).

Polyphenol content of the residue was the main factor, which determined Ndfr under non-N-limiting conditions. Nitrogen use efficiency was relatively high in all treatments and it was greater than 10%, a value commonly reported in the literature. This was probably due to the non-N-limiting conditions.

Palm CA and Sanchez PA (1991) Nitrogen release from the leaves of some tropical legumes as affected by their lignin and polyphenolic contents. Soil Biology & Biochemistry 23:83-88.

- **Gross and net N mineralisation of manures in the field and under glasshouse conditions**

E. Bautista[1] and R.C. Hood.
[1]IAEA Fellow from Bureau of Soil and Water Management, Soil Research Division, SRDC Building, Visayas Avenue, Diliman, Quezon City, Philippines.

Organic materials are potentially important sources of N in crop production, especially for resource poor farmers. In order to successfully manage organic materials as nutrient sources the parameters that determine the release and uptake of N by crops must be identified. Therefore it is important to understand the nutrient dynamics of the processes which lead to the release of nitrogen from organic materials.

Experiments were conducted in both the glasshouse and the field in which the nitrogen dynamics were studied. In the glasshouse measurements of plant N uptake from manure was undertaken using the new approach to the isotope dilution technique (Hood et al., 2000). Two types of organic material were assessed, sewage sludge and turkey manure, under non-N-limiting conditions. Maize was used as the test crop grown and it was grown in Seibersdorf soil.

In the field both net and gross mineralisation were measured using the soil incubation method and the isotope dilution gross mineralisation method (Barraclough, 1991). Soil cores were injected with ^{15}N and sampled analyses of inorganic N and ^{15}N, 24 and 96 hours after injection.

The manure and fertilizer had highly significant ($P<0.005$) positive effects on maize yield. Turkey manure gave the highest dry matter and N yields, significantly greater than sewage sludge and ammonium sulphate alone, which in turn produced greater yields than the no-N-control. Nitrogen derived from manure in the maize crop (Ndfm) was 35 % and 17 % in the turkey manure and sewage sludge treatments, respectively. Manure use efficiency (MUE) was 25 % and 10% in the turkey manure and sewage sludge treatments, respectively. Net mineralisation rates were highest after 14 days of incubation and declined to negative values during the remaining period of the experiment. It was hypothesized that the negative values were attributable to gaseous N losses or immobilisation, as N leaching determined using resin bags was found to be minimal. Gross mineralisation rates were highest in the turkey manure treatment followed by the sewage sludge and ammonium sulphate treatments, with extremely low rates observed in the no-N-control (Table 1). Gross mineralisation rates declined dramatically over the experimental period.

In conclusion it was possible to measure Ndfm under non-N-limiting conditions using the new approach to the isotope dilution technique. It was furthermore possible to trace the

dynamics of N release from manure under field conditions using gross and net mineralisation procedures. These measurements showed that there is an initial flush of N mineralisation followed by a period of immobilisation. Manure N can contribute significantly to the crop N requirement even under non-N-limiting conditions.

Table 1. Gross mineralisation rates

	Gross mineralisation rate mg^{-1} kg soil day^{-1}		
Treatment	**14 days**	**28 days**	**42 days**
1 Sewage sludge	11.63	0.40	0.16
2 Turkey manure	28.00	6.48	0.54
3 Ammonium sulphate	2.75	0.08	0.22
4 No N control	0.24	0.38	0.00

Hood, R., Merckx, R., Jensen, E.S., Powlson, D., Matijevic, M. and Hardarson, G., 2000. Estimating crop N uptake from organic residues using a new approach to the ^{15}N isotope dilution technique. Plant and Soil 223, 33-44.
Barraclough, D. (1991). The use of mean pool abundances to interpret ^{15}N tracer – experiments. Plant and Soil 131, 89–96.

- **Dual labelling of cowpeas and nitrogen fixing tree species using simple chamber technologies**

M.A. Haque[1], M. El Khadir[2] and R.C. Hood.
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Nitrogen and carbon cycling have been shown to be intrinsically linked in soils. Thus to study the turnover of organic matter and nutrient dynamics in soils it is often necessary to investigate the fate of both nitrogen and carbon. Dual labelling with ^{15}N and ^{13}C allows the fate of both elements to be traced and accounted for. ^{13}C labelling was achieved using an extremely simple system. Plants were grown in the greenhouse from seed in PVC tubes. The plants were pulse labelled with ^{13}C in a CO_2 tight plastic tent three weeks after planting. The labelling procedure was repeated twice weekly for two weeks and the plants were harvested 3 days after the last injection. Plant material was separated into leaves and shoots, dried at 70°C and ground for ^{13}C mass spectrometric analysis (Optima, Micromass, UK). The cowpea residue contained 35.53% carbon, 1022.59 ‰ $\delta^{13}C$ and 1.99 % N.

The aim of the experiment was to compare the values of $\delta^{13}C$ of respired CO_2 using the mass spectrometer and FANci analyser, from $SrCO_3$ samples derived from the CO_2 traps (Experiment 1) and directly from respired CO_2 gas using the FANci analyser (Experiment 2). Two parallel experiments were set up with identical soil treatments replicated four times. Soil treatments included: 1) Soil only control with no residue added; 2) Cowpea residue added at a rate equivalent to 890 mg C kg^{-1}soil, 50 mg N kg^{-1} soil to 300 g of soil (dry weight equivalent) and 50ml of water was mixed according to treatment and packed into PVC incubation tubes.

In experiment 1 the samples were placed in a gas tight jar with a NaOH CO_2 trap. The trap was changed every week for 4 weeks. NaOH was back titrated with HCl after precipitation with $SrCl_2$ to determine the amount of CO_2 respired. Sufficient $SrCl_2$ was added to the remaining trap solution and HCl added to neutralize the solution. For FANci analysis the resultant $SrCO_3$ samples were acidified with phosphoric acid to release CO_2. For mass spectrometric analysis the $SrCO_3$ samples were combusted with vanadium pentoxide.

In experiment 2 the samples were placed in a gas tight 1 L Kilner jar with two gas sampling ports. 100 mL of CO_2 was sampled from the jar and analysed using the FANci analyser at 12, 19, 26 and 33 days. The jars were aired and resealed after each sampling.

The ^{13}C labeling was successful and ^{13}C enriched residues were obtained simply and cheaply. ^{13}C measurements by FANci and mass spectrometer were highly significantly correlated (r^2=0.977). CO_2 production from residue amended soil was significantly greater than from un-amended soil, and decreased exponentially with time. Less than 25 % of the carbon added as residue was mineralized over the four week period. %C derived from residue calculated using direct CO_2 measurements and data from the traps compared well although sampled over different time periods. Non isotopic data suggested that there was a positive priming effect of adding residues, but caution should be taken in interpreting this data due to pool substitution effects.

- **Early screening of wheat cultivars for salinity tolerance using carbon isotope discrimination**

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Selection of wheat cultivars for salt tolerance has been largely unsuccessful. Carbon isotope discrimination (Δ) may provide a useful screening tool for salt tolerant varieties, as it is an integrated measure of the response of photosynthetic gas exchange to environmental variables such as water availability, light, humidity and salinity (Farqauhar et al.,1987).

Despite some of the similarities between the effect of water and salt stress on plant growth, few attempts have been made to quantify the effect of salinity on Δ, and its potential as a breeding selection characteristic. Initial studies carried out under this project showed that there was a significant linear decrease in Δ with increasing salinity (Shaheen and Hood, 2001).

Experiments were conducted in the greenhouse to determine the effect of salinity treatments on plant Δ values. The results from the glasshouse experiments were compared with field data obtained in Pakistan. It was shown that there was a very strong correlation between the Δ values of the wheat seedlings at four weeks after germination in the 16 dS/m treatment and the observed yields under saline field conditions. This suggested that carbon isotope discrimination is very useful for early selection of salt tolerant cultivars.

Farquhar, G.D., Masle, J., Hubick, K.T., Caemmerer, S.V. and Terashima, I., 1987. Effect of drought, salinity and soil compaction on photosynthesis, transpiration and carbon isotope composition of plants. In: Current Topics in Plant Biochemistry and Physiology, 6: 147-155.

Shaheen, R. and Hood, R.C. The use of carbon isotope discrimination to screen wheat cultivars for salinity and drought tolerance. In: The proceedings of the International Symposium on Nuclear Techniques in Integrated Plant Nutrient, Water and Soil Management, 16 - 20 October 2000, Vienna, Austria (in press).

- **Use of carbon isotope discrimination (Δ) as a potential tool for salt tolerance selection in plant breeding**

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Several experiments focusing on methodology were conducted at the FAO/IAEA Agriculture and Biotechnology Laboratory, Seibersdorf, in wheat, rice, lentil and chickpea. Initial experiments were performed using wheat cultivars obtained from CIMMYT, to determine the influence of water stress and salinity on Δ. A factorial experiment was set up, with four cultivars, wet (75% plant available water) and dry (35% PAW) conditions and 4 levels of salinity (0, 8, 12 and 16 dSm^{-1}); imposed following germination and monitored using micro soil water samplers. At harvest it was shown that Δ decreased significantly and linearly with increasing salinity under both wet and dry conditions in all cultivars. Furthermore there was a significant interaction of cultivar and salinity level on harvest index and Δ, under both wet and dry condition, suggesting differential cultivar response to salinity. There was a significant positive correlation between harvest index and Δ under dry conditions in the salt tolerant cultivars.

In second series of experiments leaf sap sampling was tested as a means to determine Δ response to short term water stress. Using a simple microwave, freezing, centrifuging procedure, sap samples were collected from 5-week old lentil plants, which had been under water stress for one week. Sap Δ values decreased linearly and significantly with increasing water stress, demonstrating the rapid response of the isotopic composition of sap, to changes in environmental stress.

In a third set of experiments eight wheat cultivars from Pakistan were grown in the greenhouse under 3 post-germination salinity levels (0, 8 and 16 dSm^{-1}). A hole punch technique was used to obtain leaf disc samples for ^{13}C analysis. These values were compared with field yield data obtained in Pakistan, of the same cultivars grown under saline and non-saline conditions. Again under laboratory conditions Δ decreased with increasing salinity. There was a significant positive correlation (r^2=0.62) between the leaf disc Δ value of the wheat grown in the green house at 16 dSm^{-1} and field yield of cultivars grown under saline conditions, suggesting that the simple early-non-destructive hole punch technique and carbon isotope discrimination could be used as screening tools for salinity tolerance.

Work is being performed to develop plant sample preparation techniques for ^{13}C analysis using the FANci breath test analyser. This is a low cost, simple apparatus, which requires minimal training and expertise. Initial results from the tests are promising suggesting that the FANci could be used in discrimination type studies, but further development and testing are required.

In conclusion there was a significant correlation between Δ and the field yields. Δ decreased with increasing salinity. It appears that salinity tolerance is a trait that is correlated to Δ and thus Δ could be used as a screening tool for plant breeding. Sampling techniques using the soil water samplers allowed simple monitoring and adjustment of salinity levels. Plant sap analysis could provide a rapid tool for determining plant tolerance to short-term drought stress. The hole punch technique proved to be a simple and effective non-destructive

sampling strategy. With some development the FANci apparatus may be used as a simple method for ^{13}C analysis.

SUPPORTIVE SERVICES

⇒ **Isotope Analyses**
Coordination: L. Mayr

The Soil Science Unit performed the following elemental and isotope analyses during the period January to October 2001:

Number of samples received:

CRP	4,057	50.3%
TC	644	8.0%
Seibersdorf	3,362	41.7%
Total	8,063	100.0%

Number of measurements carried out:

	^{15}N	^{13}C	^{18}O	Sum
Reported results	8,249	2,932	129	11,310
Analysis overhead (calibration, blank, QA-std, reps, test)	4,617	1,679	230	6,526
Total	12,866	4,611	359	17,836

⇒ **External Quality Assurance. Annual proficiency testing exercises on total N and ^{15}N abundance in plant materials (EQA2001)**
Coordination: M Aigner

The fifth interregional proficiency testing exercise ("EQA2001") on total N and ^{15}N analysis of plant materials was performed during the period January to October 2001 by the Soil Science Unit.

Each laboratory received a test panel consisting of three dry powdered ^{15}N-labeled plant materials to be analyzed for both total N-content and ^{15}N abundance. The choice of analytical instruments and methods was given to the participant. Five institutes performed the ^{15}N analysis by mass spectrometer; the others used optical emission spectrometers.

Twenty-seven ^{15}N analytical laboratories from Member States in five regions expressed their interest to participate and received the test panel. Nineteen laboratories submitted a full set of results in time. Six laboratories reported problems with their instrument and promised to send the data after repair. Two laboratories did not report and gave no explanation. Very good results were received from institutes in Argentina (CNEA), Belgium, Chile, Cuba, Ivory Coast, Syria, Thailand, Turkey, Uzbekistan and Venezuela. Satisfactory results were received

from institutes in Argentina (LANAIS), China, Mexico and Vietnam. The other participants provided data not fully complying with the control limits established by the Soil Science Unit, but it should be stressed that the participation and submission of results is highly appreciated although the analytical performance was not yet satisfactory. This gives the IAEA the possibility to support these laboratories in correcting their deficiencies.

An interesting development was that Cuba (INIFAT) provided data of very high quality after 3 years of technical problems with the instrument.

Mode of evaluation and results

The results are expressed in "z-scores". The z-score is calculated as follows:

z = (measured value – reference value) / s

where ***s*** is the standard deviation set by the Soil Science Unit, being derived from the assessment of the Soil Science Unit's analytical uncertainty in total N- and ^{15}N-analysis performed on various different plant materials with different N- and ^{15}N-contents. (1) Total N-analysis (c.v = 3%): ***s*** = 0.03 x total N [%] in plant material for Kjeldahl analysis. (2) Isotope ratio analysis by optical emission spectrometry (NOI6, FAN, Germany): ***s*** = 0.025.

From this year onward the standard deviation ***s*** used for the z-score evaluation of ^{15}N measured by mass spectrometer will be reduced from ***s***= 0.025 to ***s***=0.010. The z-score for mass spectrometer users will from now on be calculated using the following equation:

z = (measured abundance – reference abundance) / 0.010

Above ***s*** was obtained by measuring the ^{15}N abundance of plant materials with different N- and ^{15}N contents under variable climatic conditions using two different mass spectrometers (*Optima* from Micromass and *Integra-N* from PDZ Europa) in the Seibersdorf Laboratories. This value was defined to be the maximum acceptable ***s*** in ^{15}N- analytical measurements by mass spectrometry.

Reported values more than 2 standard deviations (i.e. $z > \pm 2$) from the reference value are considered to be *questionable* (*"warning limit"*), values being more than 3 standard deviations from the reference value (i.e. $z > \pm 3$) are unsatisfactory (*"action limit"*).

Classification of analytical results

Class I: All three ^{15}N results within the 2-s-limits ($z < \pm 2$) and all total N-results within the 3-s-limits ($z < \pm 3$).
Class II: All three ^{15}N results within the 3-s-limits ($z < \pm 3$), total N-data not considered.
Class III: Some or all results outside action limits ($z > \pm 3$).

To guarantee a high quality routine operation of analytical laboratories the regular and successful participation in QA-exercises, i.e. proficiency tests and intercomparison runs is a pre-requisite. In addition the availability of technical support, funds for reagents, spare parts as well as a well trained, local "trouble shooter" is essential. To provide evidence of regular participation and to monitor the development of the analytical performance over the years individual graphs were prepared for each participant.

A report of the results without laboratory identification was sent to the participants after evaluation.

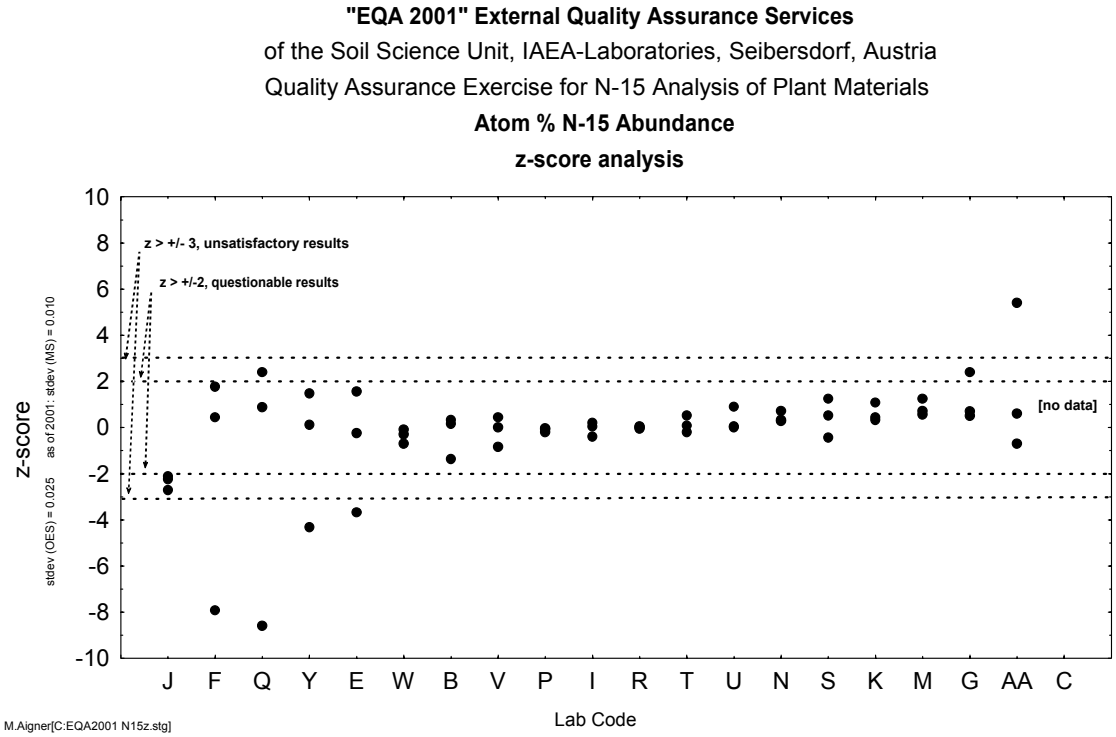
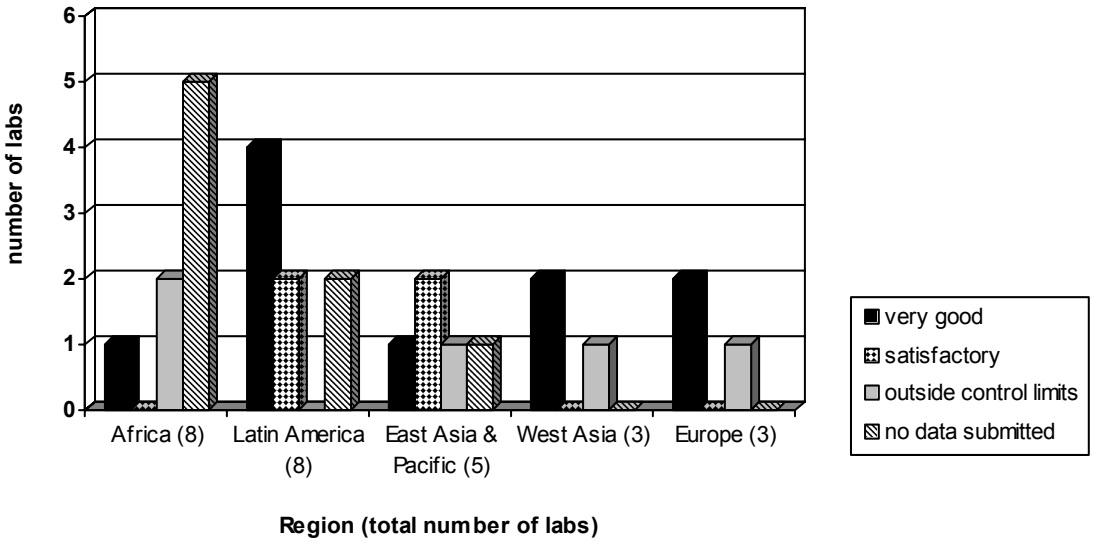


Fig.1: Evaluation of ^{15}N analytical performance of participating laboratories.

Fig.2: Regional distribution of analytical performance.



H. PUBLICATIONS

⇒ **Printed**

- Heng, L.K., Towards developing a decision support system for phosphate rock direct application in agriculture. In Proc. IFDC Int. Meeting "Direct Application of Phosphate Rock and Related Appropriate Technology - Latest Developments and Practical Experiences", 16 - 20 July 2001, Kuala Lumpur, Malaysia, CD ROM (2001), 18 pp.
- Hood, R.C., Field estimation of crop N uptake from organic residues using a new approach to the ^{15}N isotope dilution technique, Biology and Fertility of Soils 34:156-161 (2001).
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- Keerthisinghe, G., Zapata, F., Chalk, P. and Hocking, P., Integrated approach for improved P nutrition of plants in tropical acid soils. In: Food Security and Sustainability of Agro-Ecosystems through Basic and Applied Research, (W.J. Horst, M.K. Schenk, A. Bürkert, N. Classen, H. Flessa, W.B. Frommer, H. Goldbach, H.W. Olfs, V. Römheld, B. Sattelmacher, U. Schmidhalter, S. Schubert, N. v. Wiren and L. Wittenmayer, Eds.). Proceedings of the XIV International Plant Nutrition Colloquium, Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 974-975 (2001).
- Zaharah, A.R. and Zapata, F., The use of ^{32}P isotope techniques to study soil P dynamics and to evaluate the agronomic effectiveness of phosphatic fertilizers. In: Proc. IFDC Int. Meeting "Direct Application of Phosphate Rock and Related Appropriate Technology - Latest Developments and Practical Experiences", 16 – 20 July 2001, Kuala Lumpur, Malaysia, CD ROM (2001), 22 pp.
- Zapata, F., FAO/IAEA research activities on direct application of phosphate rocks for sustainable crop production. In: Proc. IFDC Int. Meeting "Direct Application of Phosphate Rock and Related Appropriate Technology - Latest Developments and Practical Experiences", 16 – 20 July 2001, Kuala Lumpur, Malaysia, CD ROM (2001), 12 pp.

Soils Newsletter

Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture
International Atomic Energy Agency
P. O. Box 100, A-1400 Vienna, Austria

Printed by the IAEA in Austria

December 2001

01-04697