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 International Atomic Energy Agency Vienna, Austria

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A. To Our Readers

It is 12 months since I wrote my first message to the readers of the Soils Newsletter as the new Head of the Soil and Water Management & Crop Nutrition Section. As we approach the end of 1998, it is an opportune time to review the year's work of the Sub-programme and to look ahead to the tasks planned for 1999.

The professional staff of the Section have been very active during the past year in both research co-ordination and support to technical co-operation projects. A total of six Research Co-ordination Meetings (RCMs) were held during 1998, four at HQ in Vienna, one in Bucharest, Romania, and one in Oeiras, Portugal. Of the meetings held at HQ, two were final meetings (CRPs on "Irrigated Wheat" and "Phosphatic Fertilizers"), while another was the first (CRP on "Rainfed Agriculture"). A Consultants' Meeting was also held at HQ on "The Comparison of Three Soil Water Content Assessment Methods". Another significant meeting in 1998 was Workshop D at the 16th World Congress of Soil Science in Montpellier, France ("The Use of Nuclear Techniques for Developing Sustainable Soil, Water and Nutrient Management Practices") which was sponsored by the Joint FAO/IAEA Division. A Workshop or Symposium convened by the Sub-programme has become a regular event at the World Congress of Soil Science which is held every four years. Details of all Meetings are given in the Newsletter.

Four RCMs are planned for 1999, one at HQ (first RCM in "Agroforestry"), one in Barcelona, Spain (third RCM in "Soil Erosion"), one in Rabat, Morocco (third RCM in "Organic Matter") and one in Kuala Lumpur, Malaysia (final RCM in "Irradiated Sewage Sludge"). In addition, a Consultants' Meeting to plan for a new CRP on "Acid Soils" will be held in Vienna early in 1999. Detailed planning for an International Symposium on *Nuclear Techniques for Developing Sustainable Soil, Water and Nutrient Management Practice,* to be held at HQ in October 2000, will also be initiated early in 1999.

During the 1997-98 biennium, the Section provided support to 25 Technical Co-operation Projects. Seven of these projects will continue during 1999. Details of Projects completed in 1998 are given in the Newsletter. A total of 22 Projects in Technical Co-operation will be supported by the Section in the 1999-2000 biennium. These Projects are valued at US $ 2.1 million in 1999 and $ 2.2 million in 2000.

Several significant additions to the professional staff of the Soil Science Unit, Seibersdorf, occurred during 1998. An important gap in the area of Soil Physics was filled by the appointment of Lee Heng. Her expertise in modelling nutrient and water dynamics will be invaluable in future CRPs. The appointment of Shawel Haile-Mariam, Michigan State University, to a 4-month Consultancy, acted as a catalyst for developing the analytical capability to support research on organic matter dynamics in agroforestry and cropping systems using ^{13}C. A 6-month sabbatical for Professor Craig Atkins, University of Western Australia, has greatly assisted the Sub-programme in the preparation of an FAO Bulletin on "Biological Nitrogen Fixation by Legumes in Farming Systems", in planning future activities on the use of natural variations in deuterium and ^{18}O to study soil water dynamics, and in developing a medium-term (6 year) Strategic Plan for the Sub-programme.

Four TECDOCS and two books were published by the Sub-programme in 1998. Three TECDOCS and two FAO Bulletins will be prepared for publication in 1999. Details of all publications are given in the Newsletter.

With best wishes for the Christmas season and for the new year.

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

B. Staff

1. IAEA Headquarters, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Vienna International Centre, Wagramer Strasse 5, P. O. Box 100, A-1400 Vienna, Austria, Fax: +43 1 26007, Telephone: +43 1 2600

James D. DARGIE	Director
Manase P. SALEMA	Deputy Director

Soil and Water Management & Crop Nutrition Section

Phillip M. CHALK, Head of the Section	(Soil Fertility, Plant Nutrition)
Pierre MOUTONNET, Technical Officer	(Soil Physics, Irrigation Management)
Felipe ZAPATA, Technical Officer	(Soil Fertility, Plant Nutrition, Agronomy)
Gamini KEERTHISINGHE, Technical Officer	(Soil Fertility, Plant Nutrition)
Mujtaba NAQVI, Technical Officer	(Soil Salinity, Plant Physiology)

Secretarial staff: Seta BALIAN
Ruth ROSSI

2. FAO/IAEA Agriculture and Biotechnology Laboratory, A-2444, Seibersdorf, Austria, Fax: (02254) 73951222, Telephone (02254) 72251

Chris J. RIGNEY	Head, FAO/IAEA Agriculture and Biotechnology Laboratory

Soil Science Unit

Gudni HARDARSON, Head of the Unit	(Soil Microbiology, Plant Nutrition)
Lee K. HENG (Soil Scientist)	(Soil Physics)
Rebecca C. HOOD (Soil Scientist)	(Plant Nutrition)
Craig ATKINS	(Sabbatical)
Martina AIGNER	(Senior Laboratory Technician) (50%)
Leopold MAYR	(")
José Luis ARRILLAGA	(Laboratory Technician)
Stefan BOROVITS	(")
Gerhard ECKHARDT	(")
Mirta MATIJEVIC	(")
Maria HEILING	(") (50%)
Christine FICKER	(Laboratory Attendant)
Norbert JAGODITSCH	(")

Secretarial Staff: Muriel WEINREICH

3. Staff Changes

Prof. Craig Atkins, University of Western Australia, joined the Soil Science Unit in mid-July for a 6-month Sabbatical. He is working on an FAO Bulletin on Biological Nitrogen Fixation and on the use of stable isotopes tracing water movement in soil/plant systems. He is also advising the Sub-programme on Strategic Planning.

Shawel Haile-Mariam, Research Associate at Michigan State University, left the Soil Science Unit at the end of July after a 4-month Consultancy. His work focused on the effects of soil organic matter on soil aggregation and physical fractionation of the soil and the use of tracers such as ^{13}C to determine the dynamics of the soil organic carbon pools.

C. Future Events

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

* **First RCM of CRP on "Use of Nuclear Techniques for Developing Integrated Nutrient and Water Management Practices for Agroforestry Systems" (D1.20.07), Vienna, Austria, 15-19 March 1999**

A new CRP was approved in 1998 for an estimated duration of seven years. Research contract and agreement holders are under selection; it is expected that ten contracts and five agreements will be awarded. A meeting is anticipated in the Headquarters, 19-23 April 1999, for finalizing the guidelines as suggested earlier by the Consultants' Meeting. Gamini Keerthisinghe is the Project Officer, and will serve as Scientific Secretary for the meeting.

* **Third 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), Rabat, Morocco, 6-10 September 1999**

Ten contract holders and five agreement holders are expected to participate in this RCM. Gamini Keerthisinghe is the Project Officer, and will serve as the Scientific Secretary for the meeting. Ismaili Mohammed, Universite Moulay Ismail, Meknes, Morocco, is the local organizer. Each participant will present the major results and conclusions of their research. The presented data will be fully discussed, and the implications for enhancing sustainable agricultural production will be examined.

* **Final RCM of CRP on "The Use of Irradiated Sewage Sludge to Increase Soil Fertility and Crop Yields and to Preserve the Environment" (D1.50.04), Serdang, Malaysia, 20-24 September 1999**

Eleven contract holders and five agreement holders are expected to participate. Phillip Chalk is the Project Officer, and will serve as the Scientific Secretary. Che Fauziah Ishak, Universiti Putra Malaysia, is the local organizer. Each participant will make a presentation on the results achieved and conclusions drawn on the research conducted within the framework of the CRP. The meeting will then synthesize the results of all presentations and formulate general conclusions and recommendations. The results of the CRP will be published as a TECDOC. All participants are kindly requested to prepare manuscripts for the TECDOC according to IAEA instructions and submit them to the Project Officer by June 30, 1999.

* **Third 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" (D1.50.05), Barcelona, Spain, 4-8 October 1999**

Eleven contract holders and four agreement holders are expected to participate in this RCM. In addition, 10 participants of the Sedimentation CRP co-ordinated by the Isotope Hydrology Section will also attend the meeting. F. Zapata and E. García Agudo will serve as the Scientific Secretaries. Ignasi Queralt Mitjans, Institute of Earth Sciences, CSIC, Spain will be the local organizer. It should be noted that both CRPs are implemented together because of the similarities in documentation techniques and both processes (erosion and sedimentation) are strongly inter-related when working at the watershed scale.

CO-ORDINATED RESEARCH PROJECT (CRP)

* New CRP on the "Use of Nuclear Techniques to Develop Management Practices for Increasing Crop Production and Soil Fertility in Acid Soils" (Provisional title)

The Phosphate CRP which focused on the use of rock phosphates in acid soils is coming to an end in 1998. In order to continue this research in a broader perspective, plans are underway to develop a new CRP on the sustainable development of acid soils along three main lines of investigation:

1. Utilising acid-tolerant and phosphate-efficient plant genotypes.
2. Addressing issues of acid soil infertility.
3. Management/Conservation of acid soils.

As acid soils are widespread all over the world, the target area will be the humid/sub-humid savannah ecosystem, which shows the highest agricultural potential in Africa and Latin America. It is also intended to create linkages to ongoing networks in acid soils (CGIAR and IBSRAM) to enhance synergism between projects.

A Consultants' Meeting will be convened during the first quarter of 1999 to formulate the work plan and guidelines of the project. Immediately after approval of the CRP by the IAEA Contractual Committee, the selection procedure of contractors and agreement holders will be made. It is expected to have 8 to 10 contractors with good scientific calibre and four to five agreement holders. It is envisaged to hold the first Research Co-ordination Meeting (RCM) of this CRP in the last quarter of 1999.

TECHNICAL CO-OPERATION PROJECTS (TCPs)

● FAO/IAEA Interregional Model Project on "Sustainable Utilisation of Saline Groundwater and Wastelands for Plant Production" (INT/5/144)

- **Group Activity**

The National Co-ordinators from 6 participating countries will spend a week each in Pakistan, Tunisia and Morocco, visiting the counterpart institutions and Demonstration Sites in those countries. The activity will facilitate exchange of information and will enhance TCDC. The activity will start in Pakistan on 16 November and end in Morocco on 4 December 1998.

- **Co-ordination Meeting**

A 3-day Co-ordination Meeting of the project will be held in Tunis, Tunisia, from 25 to 27 November 1999. The National Co-ordinators will present detailed reports on the status of work in their respective countries and three experts will review the progress and make suggestions for future work.

● 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, China, Indonesia, Malaysia, Myanmar, Pakistan, Philippines, Sri Lanka, Thailand and Viet Nam. It is in the second phase of implementation, with Gamini Keerthisinghe as the Technical Officer.

- **Regional Seminar on "Extension Aspects of Agroforestry Practices", Kandy, Sri Lanka, 28 June-2 July 1999**

The main purpose of this meeting will be to discuss the extension activities of the project. All country representatives will present their work related to the transfer of promising agroforestry practices to the farmers. Lionel Gunaratne, Department of Export Agriculture, Sri Lanka, will be the local organizer of the seminar.

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

This regional project is approaching mid-term and the Secretariat has reviewed its implementation to ensure effectiveness, relevance and impact. As a result, the following guidelines have been written and sent to the project co-ordinators in the participating countries.

- **Phase II (1999-2000)**

The activities initiated in the first phase (please refer to Past Events Section) will continue during phase II until completion, and new initiatives will start such as the phosphate studies to ensure the sustainability of the technological package being developed.

The achieved project will be evaluated not only by its effectiveness (outputs, specific objectives) but also its impact (positive changes arising from the project) on the beneficiaries: the target farmers. Therefore, it is advisable to identify and to strengthen mechanisms that facilitate the transfer of the results obtained in the first phase to the farmers. Among the strategies to be considered: demonstration trials in farmers' fields, workshops of extension service personnel, field days for farmers, extension leaflets/bulletins, press releases to daily newspapers, other audio-visual communication media, etc. These aspects will be discussed in detail during the Third Co-ordination Meeting to be held in January 2000 in Mexico.

- **Preparation of a New Project Proposal for the 2001-2002 biennium**

During the Second Co-ordination Meeting held in Chile, a Working Group consisting of the project co-ordinators of Argentina, Brazil and Venezuela was established to elaborate a proposal for a new project. Technical information as well as guidelines for the preparation of the proposal have been provided to the members of the working group.

The project proposal will be prepared according to the following schedule of activities:

Formulation of the project idea	11 December 1998
First draft of the project proposal	29 January 1999
First corrected version	26 February 1999
Distribution IAEA/ARCAL Member States	2 March 1999
Final corrected version	31 March 1999
Submission of the project proposal to the IAEA	Before 15 April 1999

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

Under a previous project, RAW/5/002, a group of scientists from six countries in the West Asia region (Iran, Jordan, Lebanon, Saudi Arabia, Syria, United Arab Emirates) were introduced to the concept and practice of fertigation, i.e., fertilization through irrigation, an approach of great relevance for the arid and semi-arid conditions of the region. Fieldwork for a variety of crops and soil conditions was undertaken during 1995-1998. This involved the use of ^{15}N-labelled fertilizers, applied through drip irrigation, and monitoring of soil moisture through the use of neutron probes. Positive results have

been achieved for most of the crops studied under these conditions. In the case of cotton in Syria, a saving of 36% in water use was achieved under drip irrigation, coupled with an increase of 22% in seed yield. The current project will further promote the use of these techniques at the farm level by bringing together "on-station" work and "on-farm" trials. Close collaboration will be established between agricultural scientists and farmers for the monitoring of soil-water balance and nutrient uptake from mineral fertilizers under farm conditions.

The overall objective is to increase crop yields through the use of improved fertigation technologies and to develop strategies for increasing water use efficiency in countries in West Asia. Facilities and staff of the Soil Science Departments and Ministries of Agriculture of the respective participating countries will be available. The IAEA will provide expert services; training; ^{15}N- and ^{32}P-labelled fertilizers; equipment for fertigation under drip irrigation or mini-spray; ^{15}N analytical services in plant and soil samples; external QA services on ^{15}N analysis. The large-scale adoption of the successful fertigation techniques will promote the efficient use of scarce water resources for agriculture, and enhance food production, while reducing fertilizer costs and pollution risks.

D. Past Events

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

* **Second RCM of CRP on "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), Bucharest, Romania, 25-29 May 1998**

Felipe Zapata and Edmundo García Agudo, Project Officers of the Soil Erosion and Sedimentation CRPs, respectively, have prepared a full report of this RCM. This report contains the revised and updated protocols for field and laboratory application of the Cs-137 technique, guidelines for interpretation of Cs-137 data and practical applications of the technique and a preliminary report of the analytical intercomparison exercise for Cs-137 measurements. The abstracts of the presentations by the participants are included as an Annex. This report has been distributed to all participants of both CRPs. Copies may be obtained from the Project Officers upon request.

* **Third RCM of CRP on "The Use of Irradiated Sewage Sludge to Increase Soil Fertility and Crop Yields and to Preserve the Environment" (D1.50.04), Oeiras, Portugal, 22-26 June 1998**

Eleven contract holders and five agreement holders participated in this RCM. Phillip Chalk, the Project Officer, served as the Scientific Secretary. Eugénio Mendez Ferreira, Estação Agronómica Nacional, was the local organizer. All participants made presentations of the results of their research activities. Progress towards achieving project objectives was thoroughly reviewed and analyzed. A set of 11 recommendations was formulated for future activities. The Report of the RCM is available from the Scientific Secretary upon request. The Project was formally reviewed by the Research Contract Sub-Committee and approved for extension until the end of October, 1999.

* **First RCM of CRP on "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), Vienna, Austria, 6-10 July 1998**

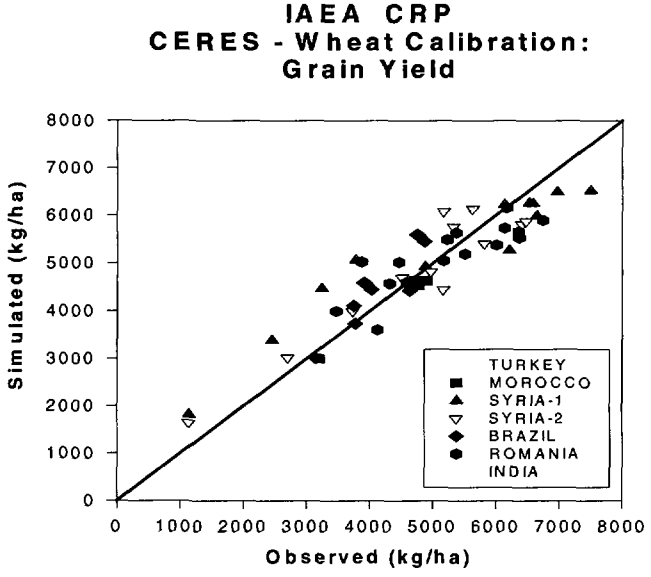
This new CRP was approved in 1997 for an estimated duration of five years. Pierre Moutonnet is its Project Officer, and served as the Scientific Secretary for the meeting. At present eleven research contract and four agreement holders have been selected; additionally, two research contracts are in the pipeline. Out of this group, seven contract holders and all the agreement holders met in the Headquarters, 6-10 July 1998. Staff of the Section and Soil Science Unit participated in the debates. This RCM was organized within the first semester of implementation of the CRP, with the following objectives:

- to present the rationale and overall workplan of the CRP;
- to design experiments to be conducted "on-station" and "on-farm" between now and the next RCM;
- to formulate guidelines for implementing the CRP.

The RCM was very successful in achieving its objectives; the first field experiments are being implemented. The main nuclear techniques involved are: i) ^{15}N-labelled fertilizer, ii) soil moisture neutron probe, iii) delta ^{13}C measurement on plant samples. The report of this RCM is available from the Section through the Project Officer.

* **Final RCM of CRP on "The Use of Nuclear Techniques for Optimizing Fertilizer Applications under Irrigated Wheat to Increase the Efficient Use of Fertilizers and Consequently Reduce Environmental Pollution" (D1.40.07), Vienna, Austria, 28 September to 2 October 1998**

Twelve contract holders and four agreement holders participated in this final RCM which was held at the IAEA Headquarters. P. Moutonnet, the Project Officer, served as the Scientific Secretary for the meeting. Each participant produced a final report dealing with the results obtained during the period 1994-1998. These reports were submitted according to the "Instructions for formatting A4 manuscripts using Microsoft Word" for IAEA TECDOC publications. These texts are being edited prior to publication. Additionally, a questionnaire on project data was prepared, completed by the contract holders, and collected by the Project Officer. A data base is being built up; it will be soon available, as Excel/PowerPoint files, upon request to the Section. W. Baethgen summarized some data: the figure below is an example of the collective data.



* **Final RCM of CRP on "The Use of Nuclear and Related Techniques for Evaluating the Agronomic Effectiveness of Phosphate Fertilizers, in Particular Rock Phosphates" (D1.50.03), Vienna, Austria, 16-20 November 1998**

Twenty four scientists participated in this final RCM which was held at IAEA Headquarters, six as agreement holders: J.M. Barea (Spain), S.H. Chien (USA), J.C. Fardeau (France), D. Montange (France), F. Sikora (USA) and D. Stevens (Australia), and fifteen as contract holders or their representatives: E. Casanova (Venezuela), J. Herrera-Altuve (Cuba), K. Mwendwa (Kenya), J. Mahisarakul (Thailand), T. Muraoka (Brazil), I. Pino (Chile), Z. Borlan (Romania), Zaharah Rahman (Malaysia), E. Sisworo (Indonesia), Li Ming Xiong (China), R. Alexakhin (Russia), I. Bogdevitch (Belarus), M. Fotyma (Poland), T. Nemeth (Hungary), and V. Sidlauskas (Lithuania). In addition, R.N. Roy (FAO-AGL), A. Benjelloun (IMPHOS) and Truong Binh (Consultant) participated. F. Zapata was the Scientific Secretary of the meeting. After the Official Opening by P.M. Chalk, the Section Head, and remarks by the Scientific Secretary, the contract and agreement holders presented their final reports. The formulation of conclusions and recommendations was made in four working groups, i.e.: i) phosphate availability studies including environmental issues, ii) agronomic effectiveness of phosphatic fertilizers, iii) field trials and practical recommendations for the application of P fertilizers, and iv) phosphate studies in Eastern Europe. Final reports including the summaries were compiled and edited. The manuscripts for the preparation of the final publication of the CRP were also compiled and revised. The results generated from this CRP were highly relevant to improve the knowledge and understanding of the chemistry of P in soils, soil P testing, P nutrition by crops, and P fertilizer recommendations, with particular emphasis on the utilization of phosphate rocks. Due consideration was also given to environmental issues. Special thanks are given to all participants for their untiring efforts to achieve the objectives of the CRP and to ensure a successful completion. A task lies ahead to disseminate the scientific and technical information generated in the participants' countries for the benefit of farmers.

NON-FAO/IAEA MEETING

● **Workshop on "The Use of Nuclear Techniques for Developing Sustainable Soil, Water and Nutrient Management Practice", 16th World Congress of Soil Science, Montpellier, France, 21 August 1998**

This half-day Workshop was sponsored by the Joint FAO/IAEA Division. The Workshop was opened by P.M. Chalk, Head of the Soil and Water Management & Crop Nutrition Section, who presented a brief introduction to the work of the Sub-programme. Five keynote papers were presented at the Workshop which was very well attended. The papers described recent advances in a range of topics relevant to the sustainable management of the soil and water resource base.

1. Analytical Determination of Concentric Carbon Gradients Within Stable Soil Aggregates. (A. J. M. Smucker and E. A. Paul)
2. Use of The Stable Isotope of N to Quantify Below-ground N Inputs and N Turnover by Crop and Pasture Plants. (A. McNeill, I. Fillery, D. Murphy and C. Russell)
3. Managing Nitrogen and Its Use Efficiency in Alley Cropping Systems. (N. Sanginga, B. Vanlauwe, J. Diels and R. Merckx)
4. Nuclear Techniques in Sustainable Management of Soil Water and Mineral Nitrogen. (M. Bazza and P. Moutonnet)

5. The Use of Fallout Radionuclides as Tracers in Soil Erosion and Sedimentation Investigations.
(F. Zapata, E. Garcia Agudo and D.E. Walling)

The use of natural variations in the distribution of the stable isotope, ^{13}C, is a powerful tool for studying the dynamics of carbon in the soil-plant system. It relies on measurement of the shift in the ^{13}C signature of the soil when the dominant vegetation changes from a C-3 to a C-4 photosynthetic pathway, or vice-versa. The role of organic matter in soil aggregation is being studied by measuring the distribution of ^{13}C within soil aggregates by mechanical fractionation of larger aggregates into more biophysically meaningful components.

The fallout radionuclide Cs-137 is being used to study rates and patterns of soil redistribution at the watershed level. An international research network, co-ordinated by the Joint FAO/IAEA Division, is refining and standardizing the methodologies, including sampling, analysis, calibration and extrapolation. The potential use of other fallout radionuclides such as lead-210 and beryllium-7 has also been demonstrated. The data are being used to validate existing models of soil erosion.

Estimation of root biomass and nutrient content by excavation and sieving is a tedious and inaccurate methodology. New techniques in ^{15}N foliar labelling and improved soil sampling procedures now permit a more accurate estimation of the below-ground component of the plant. Results obtained with a range of annual cereals and legumes show that below-ground plant-derived N has been previously underestimated by as much as 50 %. This has important implications with respect to the role of grain legumes in the N balance of cereal-legume rotations.

The following scientists received financial support from the Joint FAO/IAEA Division to attend the 16th World Congress: S. Ahmed (Bangladesh); S.M. Rahman (Bangladesh); M. Bazza (Morocco); J. Diels (Nigeria); M. Nasyrov (Uzbekistan); J. Sattorov (Uzbekistan); E. Kvasnikova (Russia).

CONSULTANTS' MEETING

- **Consultants' Meeting on "The Comparison of Three Soil Water Content Assessment Methods", Vienna, Austria, 23-25 November 1998**

The three soil water content assessment methods were: Neutron Scattering (sub-surface measurement), Time Domain Reflectrometry (TDR) principle, and Electric Capacitance Technique.

Five international experts, with relevant experience and knowledge in this area, participated in the 3-day meeting: G.C. Topp (Canada), C.T. Hignett (Australia), J.-P. Laurent (France), F. Moreno-Luca (Spain) and S.R. Evett (USA). The proceedings of the meeting will be published as an IAEA-TECDOC booklet. The Consultants formulated a series of recommendations to FAO and IAEA on these topics. Some manufacturers involved in producing/selling equipment dealing with the above-mentioned methods were represented as observers during the meeting: I.S.E.~Gabel Corporation (Canada), S.D.E.C. (France), IMKO-Micromodulelectronic (Germany), Pessl Instruments (Austria), SENTEK (Australia).

TECHNICAL CO-OPERATION PROJECTS (TCPs)

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

  - **Phase I (1997-1998)**

This phase was designed to gather results obtained by national institutes with past IAEA technical assistance and apply the most relevant in a Regional Network of field trials to demonstrate their technical and economic feasibility. For this purpose, it was recommended that these trials be located in farmers' fields.

The detailed Activity Plan of this phase was prepared during the first co-ordination meeting held in Irapuato, Mexico, in November 1996.

The main activities of this phase were the organization of several workshops and the publication of technical manuals on specialized topics in the use of nuclear techniques in soil/plant research. In addition, national events have been organized to train young local scientists in the use of nuclear techniques and promote their use at the national level.

The second co-ordination meeting was held in March 1998 in Santiago, Chile, to review the progress made in the overall implementation of the Activity Plan of the first phase, to make an assessment of the progress in the conduct of the Regional Network of field trials, and to prepare a work plan for the 1999-2000 biennium.

Most field studies focused on the use of nuclear techniques for evaluating the efficient use of fertilizer N, and to a lesser extent on water use efficiency by crops. The following recommendations were made to ensure the achievement of the project objectives: i) to give more relevance to the field trials, ii) to adjust objectives and methodologies used in the field trials, and iii) to integrate water and fertilizer N use efficiency studies in the field trials and to relate them to production and environmental protection issues.

  - **Advanced Regional Training Workshop on "Quality Assurance for N-15 Analysis", Montevideo, Uruguay, 8-12 June 1998**

The need to establish Quality Assurance and Control Systems in the isotopic laboratories of the region to generate precise and accurate analytical data was one of the most relevant conclusions of the Regional Workshop on Strengthening Analytical Laboratories carried out in Chile, from 11 to 15 November 1996. To achieve this goal the following two recommendations were adopted:

1. To create the Regional Latin American Network of Isotopic Analytical Laboratories in Soil/Plant as a means to co-ordinate the activities indicated below. This network, through a co-ordinator in Uruguay, has been actively involved in the exchange of information among the participating laboratories: Argentina, Brazil, Chile, Cuba, Guatemala, Mexico, Uruguay and Venezuela.

2. To elaborate an Activity Plan for the period 1996-1998 for the regional network including the write up of analytical protocols, introduction of elements of quality control systems in the laboratories, production of Internal Reference Materials (IRM) and the validation of analytical methods.

FAO and IAEA have supported the implementation of these activities on N-15 Quality Assurance in the region through several mechanisms: the characterization of the IRM, the conduct of External Quality Assurance Exercises and the organization of two workshops with different scope, one interregional held in Mexico and another regional in Uruguay.

This advanced workshop was, therefore organized with the following specific objectives: i) to assess the progress made in the implementation of the Activity Plan prepared in Chile for the period 1996-98; ii) to improve and harmonize concepts and practical guidelines on Quality Assurance and Control measures in the laboratories; iii) to evaluate the results of the participating laboratories in the Quality Assurance Exercise organized by the IAEA in 1997; and iv) to plan future activities in the region to continue further the process of Quality Assurance in the isotopic laboratories. R. Goyenola was the local organizer. A full report is available in Spanish. The main conclusion was that the regional network of participating laboratories has made significant progress in the implementation of Quality Assurance measures adopted in the Chile meeting. This was confirmed by the good general performance of the same laboratories in the External Quality Assurance Programmes for total N and N-15 analysis run by the IAEA Seibersdorf Laboratories. Overall, this achievement means a substantial improvement in the quality of the total N and N-15 data produced by these laboratories and a high degree of confidence of the staff responsible for the analytical services.

Recommendations were also made for further implementation of Quality Assurance measures in the isotopic laboratories of the countries participating in the project ARCAL XXII. These include activities for N-15 analysis as well as for P-32 assay, following the guide ISO-IEC 25.

- **National Training Course on the "Use of Nuclear Techniques in Studies of Soil Fertility, Fertilizers and Water Management", Guatemala City, Guatemala, 12-16 October 1998**

This was the first course of this nature organized in Guatemala for professional staff of the agricultural sector working in the fields of soil fertility, fertilization and water management. The course was held in the "Instituto de Ciencia y Tecnologia Agrícolas" (ICTA), Bárcenas, Villa Nueva. Twenty two professionals from several institutions participated. The event included lectures by local and invited scientists, practical demonstrations, sessions in working groups and discussion sessions. The local organizer and Director was Maritza García-Chaclán of the Soils Laboratory, ICTA. Segundo Urquiaga (EMBRAPA) and Paulo Libardi (CENA,USP) participated as invited lecturers. It is hoped that this course will promote the creation of inter-disciplinary projects on the use of nuclear techniques in fertilizer and water management studies.

- **National Course/Workshop on "The Use of Nuclear Techniques to Evaluate the Dynamics of Nutrients and Water in Cropping and Tillage Systems", Maracay, Venezuela, 2-6 November 1998.**

This event was organized to train and acquaint investigators and postgraduate students from several national institutions on the use of nuclear techniques in studies of the dynamics of carbon and nitrogen in field trials on tillage and associated soil management practices (crop rotation, cover crops, etc.) to achieve and maintain sustainable agricultural production.

The land areas with the highest potential for agricultural use in Venezuela have serious limitations of aridity and soil infertility. One of the key issues to develop sustainable agricultural systems in those areas is the management of the soil organic matter.

The venue of the course was the "Centro Nacional de Investigaciones Agropecuarias" in Maracay, Aragua, Venezuela. The local co-ordinators were Evelin Cabrera de Bisbal (CENIAP-FONAIAP) and Adriana Florentino de Andreu (FAGRO-UCV). The core lectures were delivered by S. Urquiaga (Embrapa, Brazil), IAEA invited speaker and seminars on specific topics were given by local staff. In round table discussion sessions, the participants elaborated a proposal for a national project on the main topics of the course. This proposal will be submitted to the IAEA for consideration.

- **Technical Manuals**

Two technical manuals were completed this year. The first one entitled "Manejo Eficiente de los Fertilizantes Fosfatados con énfasis en Rocas Fosfóricas de Aplicación Directa" was edited by Eduardo Casanova, Faculty of Agronomy, Universidad Central de Venezuela, Maracay, Venezuela. 200 copies of the manual have been printed and distributed to the particpating countries in the project through the co-ordinators. The Manual contains eight sections: introduction, isotopic methodologies (F. Zapata and J.C. Fardeau), and the contributions of Argentina (N. Barbaro), Brazil (T. Muraoka and E. Tzi), Chile (I. Pino), Cuba (A. Garcia, A. Nuviola, G. Hernandez and C. Alvarez), Mexico (J.J. Peña Cabriales, R. Nuñez-Escobar and J.D. Etchevers Barra), and Venezuela (E. Casanova, A.M. Salas and M. Toro). This publication has set the basis for future phosphate studies in the region using P-32 isotope techniques.

The second publication is related to the use of neutron moisture probes and their application in agriculture. It was prepared by O. Bacchi, K. Reichardt and M. Calvache in Spanish as a training document on the subject, in support of the integrated approach on nutrient and water management adopted by this regional project. The IAEA Publications Committee found that it is a very comprehensive document. It was therefore decided to publish it in the IAEA Training Manual series. The initial version has been translated into English and French. In addition these versions have been peer reviewed by D. Nielsen and G. Vachaud, respectively. The final versions will be published after the approval of the IAEA Publications Committee.

- **FAO/IAEA Regional TCP for West Asia on "Water Balance and Fertigation for Crop Improvement" (RAW/5/002)**

  - **Fourth Co-ordination Meeting, Karaj, Iran, 31 October - 04 November 1998**

This regional TCP was initiated for two years in 1995, and then extended for a 2-year period in 1997. It was a follow-up of another Regional TC Project on "Nuclear Methods for Plant Nutrients and Water Balance Studies under Legume-Cereal on Fallow-Cereal Crop Rotation Systems" (1991-1994), the results of which were published in the IAEA-TECDOC-875 (1996). Seven countries participated in the meeting: Lebanon , Jordan, Syria, Iran, Saudi Arabia, United Arab Emirates and Turkey with a total of 22 attendees. The Agency was represented by A. Habjouqa (Project Officer) and P. Moutonnet (Technical Officer). Furthermore, O. van Cleemput (Belgium) was contracted for the period as an Expert. Each counterpart had the opportunity to show the latest results obtained in his country, as well as synthesis of data obtained during the period 1995-1998. The final reports provided by each counterpart will be edited and then published as an IAEA-TECDOC by the end of 1998. It has been decided that RAW/5/002 will be closed at the end of 1998; it has been very successful in its achievements which constituted "Phase I" of the regional TCP.

The following data from the Atomic Energy Commission of Syria show that fertigation of cotton is a very efficient technique for conserving both water and N fertilizer.

Fig.1 displays a saving of 36% of irrigation water under drip irrigation when compared to surface irrigation.

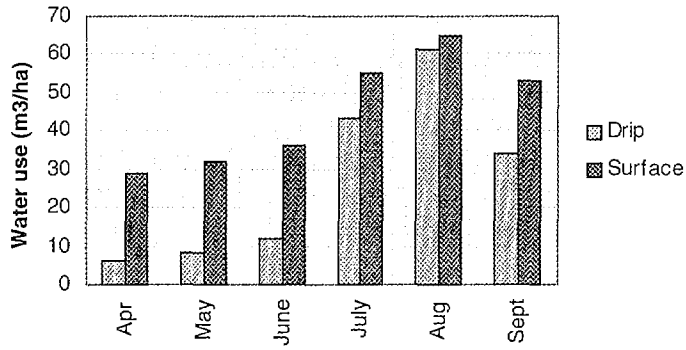


Fig. 1. *Average daily evapo-transpiration (m^3/ha) during the growing season of cotton under drip and surface irrigation. Total water consumption was 4, 900 m^3/ha (drip) and 7, 600 m^3/ha (surface).*

Fig.2 shows a 22 % increase in seed-cotton yield for fertigation compared with traditional fertilizer and water management practices.

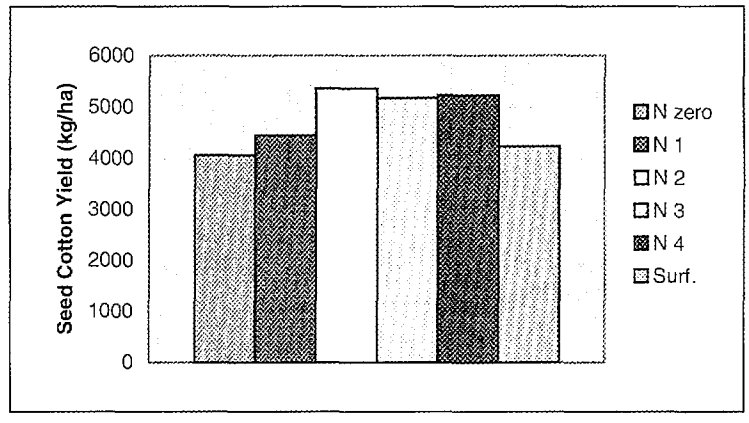


Fig. 2. *Yield of seed-cotton for fertigation with 0, 60 (N1), 120 (N2), 180 (N3), and 240 (N4) kg N/ha and traditional surface irrigation with 180 kg N/ha (compare N3 and Surf.).*

The reduced consumption of irrigation water and the increased yield under fertigation boosted water use efficiency. A 93 % increase in water use efficiency was found when comparing N_3 and surface irrigation (Fig. 3).

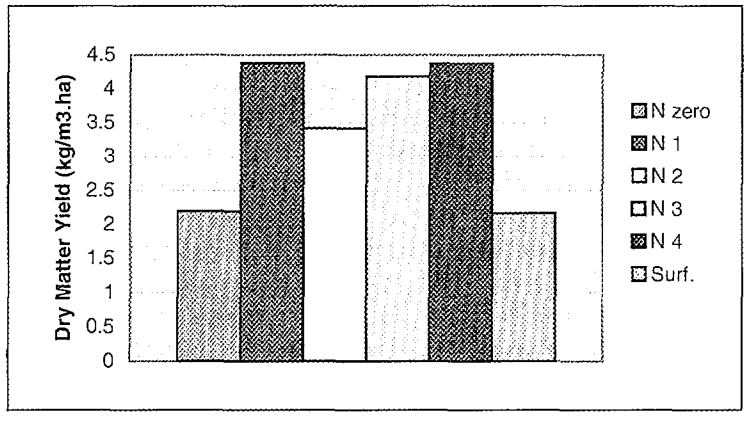


Fig. 3. *Water use efficiency (kg dry matter/m^3/ha) of cotton under drip and surface irrigation.*

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, China, Indonesia, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand and Viet Nam. It is in the second phase of implementation, with Gamini Keerthisinghe as the Technical Officer.

• Third Co-ordination Meeting, Serdang, Malaysia, 20-24 July 1998

This co-ordination meeting was held at the Department of Soil Science, Universiti Putra Malaysia. Zaharah Abdul Rahman was the local organizer. Roland Buresh of the International Centre for Research in Agroforestry (ICRAF) served as a Consultant in the review of the project. The main purpose of the meeting was to review the overall progress and to discuss the future activities of the project. The project co-ordinators of Bangladesh, China, Indonesia, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand and Viet Nam participated in the meeting.

All countries have successfully completed Phase I of the project on the selection of trees to be used in agroforestry systems. Selection of trees was mainly based on their adaptability to the local conditions and their potential benefits to the entire cropping system. Activities of Phase II are in progress in all participating countries. Incorporation of trees in various cropping systems have been tested and evaluated. Experiments have demonstrated that when the competition for growth resources between the tree and crop components is well managed the agroforestry systems increase nutrient inputs, improve soil physical properties and increase crop yields. A report has been published highlighting the major achievements of the project.

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

• In-Country Workshops

Workshops were held during the latter part of 1998 in Iran (June), Pakistan (July), Syria (September), and Egypt (October); individuals from different institutions taking part in the project activities in these countries presented their work and visited the Demonstration Sites together. Detailed discussions on the ongoing and future work were held and continued during the visits to field sites. Such workshops are a regular feature and are held at the time of the Project Manager's visit. They help catalyse co-operation among the different institutions and provide a chance for monitoring and evaluation of the project work and for assessment of individuals that are to be accepted for training or fellowships.

• Status of Project Implementation

Objective: To demonstrate sustainable utilisation of saline groundwater and wastelands by growing salt tolerant plant species to provide green cover, improve environment, and obtain biomass for use as food, forage, fuel wood, manure and for processing in agro-based industry.

Present Status: The two-phased 6-year Model Project was initiated in January 1997; seven countries, Morocco, Tunisia, Egypt, Syria, Iran, Pakistan and Myanmar are participating. Six countries have established Demonstration Sites, each consisting of about 10 hectares of arid, semi-arid wasteland provided with saline groundwater (5 to 12 ds/m). A number of salt tolerant plant species from within the country and abroad have been introduced on these sites. Those showing promise are: *Acacia spp., A. ampliceps, A. saligna*; *Prosopis chilensis, P. juliflora*; *Eucalyptus camaldulensis*; *Tamarix aphylla*; *Atriplex spp.*; *Kochia indica; Leptochloa fusca*

(kallar grass); *Hordeum vulgare* (a barley line selected for high salt tolerance in Pakistan); *Sesbania aculeata* and a few others. Irrigation is to be managed by using neutron moisture meters. Groundwater from several points around a 1-2 kilometer radius of the Site is collected periodically and analysed for isotopes of hydrogen and oxygen.

Salient Results: It has been shown that it is possible to grow some useful plant species using the available saline groundwater on salt affected lands in arid areas. Isotopic analyses of groundwater samples have provided some indications of its origin and possible source and cause of salinity. Efforts will now be made to cover larger areas of land with a few of the tried plant species to be selected on economic and other criteria. Some of these will also be passed on to the farmers. In Pakistan, the technology is being passed through practical training workshops and supply of some seed and plantlets to the farmers. Management of irrigation is also explained using neutron moisture probes on farmers' fields.

Five Group Training Courses have been held and 55 persons trained in the use of nuclear and other techniques relevant to the project. In addition, 8 persons have been trained through three-month fellowships.

A Report on the project activities will be published early in 1999.

● National Projects Completed During the 1997-1998 biennium

• Soil Fertility Studies in the Pampa Region (ARG/5/008)

Objectives: To develop management practices to improve the efficiency of applied N and P fertilizers in wheat-based cropping systems.
Counterparts: N. Barbaro and S. Lopez, Soil Fertility Group, Centro Atomico Ezeiza, National Atomic Energy Commission (CNEA), Buenos Aires, Argentina.
Duration: 3 years (1996-98).
Outcomes: Local staff have been trained on the use of isotope techniques in fertilizer studies. An Atomic Absorption Spectrophotometer was supplied to the "Instituto Nacional de Tecnología Agropecuaria" (INTA) in Balcarce to increase analytical capabilities for routine soil and plant analysis. A N-15 laboratory, that is fully functional and producing high quality data was established. N-15 aided studies were carried out within the network of field fertilization studies of INTA. A significant response (grain yield increases of 500 to 1600 kg/ha) was obtained in the locations. No differences in grain yield were observed in applying all the fertilizer N at planting or at tillering or in two-splits. The fertilizer N recoveries by wheat ranged from 53 to 63%, depending on the locality.
Equipment was provided to conduct the P-32 exchange kinetics technique to study the soil P dynamics. Preliminary studies were carried out to adjust/modify the technique for use in the predominant Mollisols.
Initial studies were undertaken to follow the dynamics of organic matter and nutrient (N and P bioavailability) in wheat-based cropping systems.
Impact: Accelerated adoption of the N-15 technology for fertilizer N studies and leadership of the Soil Fertility Group in this field to the benefit of the agricultural research in Argentina. This has been possible due to the close collaborative links established with INTA and the Ministry of Production of the province of Buenos Aires. This collaboration will also enable the transfer and dissemination of the technologies generated to the farmers.

• Biofertilizers for Increased Legume Production (BGD/5/017) MODEL PROJECT

Objectives: To assist in establishing technology for large scale production of biofertilizers (*Rhizobium* inoculant) in order to increase and sustain pulse production.
Counterparts: I. Ali, Bangladesh Institute of Nuclear Agriculture (BINA), Mymesingh and S. Ahmed, Department of Agricultural Extension (DAE), Ministry of Agriculture, Dhaka.
Duration: 4 years (1995-98)

Outcomes: During the first phase (1995-96) of this model project the biofertilizer technology was introduced on a pilot scale basis. Production of biofertilizers started in 1995 on a limited scale and a distribution system to the farmers was developed. Field demonstrations (some 1,500 with 6 legume crops and country-wide distribution) and training of extension personnel and progressive farmers on biofertilizer use were also carried out in the seasons 1995-96; 1996-97; and 1997-98. In 1996 additional funding was provided by the Government of Bangladesh under a Pilot Project on Biofertilizer to construct a two-storey building (550 sq m.) and recruit manpower for the production of rhizobial inoculants. These activities have been successfully implemented this year with continuing support of the IAEA and OPEC. 10,000 copies of a training manual entitled "Microbial fertilizer: Acquaintance and Application" were printed in Bengali for use by the extension personnel to train block supervisors and farmers. Production targets of biofertilizer were achieved in 1997 and the quality of the inoculant produced will improve substantially with the introduction of quality control measures recommended by an IAEA expert. Arrangements are underway for the involvement of a private entrepreneur in the large scale production and marketing of biofertilizers.
Impact: The IAEA assistance has been instrumental in establishing a pilot scale facility for the production of rhizobial inoculants, and demonstrating their effectiveness in increasing legume production through field trials, training sessions of extension personnel and farmers and other mechanisms. All this will contribute to increase grain legume (the meat protein substitute of the poor) production in the country while saving valuable foreign currency needed to import the ever increasing demand of pulses. Currently import costs are of the order of US $ 23 million. Another added benefit results from the savings in chemical fertilizer N and the associated environmental protection. Costs of chemical fertilizer N for grain legume production amount to about US $ 6 million.

- **Plant Nutrient Management in Traditional Crops (GUA/5/011)**

Objectives: To increase the inputs of biological nitrogen fixation and improve the efficiency of applied nitrogen and phosphate fertilizers in the maize-common bean traditional cropping system.
Counterpart: M. Garcia Chaclan, "Instituto de Ciencia y Tecnología Agropecuarias" (ICTA), Guatemala City.
Duration: 4 years (1995-98).
Outcomes: During the first biennium (1995-96), the counterpart staff was located at the Agriculture Section, General Directorate of Nuclear Energy, Ministry of Energy and Mines, and the activities of the project were closely related to a large scale regional EU-funded project on "Strengthening agricultural research in basic grains" implemented in Central America, which focused on the traditional bean-maize cropping system. The N supply from the green manures "mucuna" and "canavalia", the yield and nitrogen uptake by maize and nitrogen fixation in common bean grown in monoculture or in association with maize were measured.
As a result of a re-organization in the public sector of the country, the counterpart staff was transferred to ICTA. Field trials using N-15 labelled materials were carried out to evaluate the effect of applying green manure and fertilizer N in different proportions on grain yield and N uptake by maize. Highest yields were obtained when fertilizer N, or green manure in combination with fertilizer N, were applied at a rate of 100 kg N/ha. All fertilized treatments were superior to the check.
Local staff were trained, as requested and the equipment has been provisionally installed in the soil laboratories of ICTA. Expert services were provided to integrate nitrogen and water management studies in traditional and export crops. A national training course was organized to demonstrate these integrated studies with support of the regional project ARCAL XXII.
Impact: Guidelines on these improved nutrient management practices will be published for dissemination to the extension personnel. They will contribute substantially to increased production of the most essential staple foods of the rural population and the sustainability of these production systems.

- **Identifying Nitrogen-Fixing Trees in Low Phosphate Soils (MOR/5/022)**

Objectives: To conduct nitrogen and phosphate fertilizer studies by using N-15 and P-32 isotope techniques to identify tree species suitable for soils low in phosphorus.
This project has two components: one dealing with the improvement of peanut cropping systems in the Larache area, Northern Morocco, and the other with the development of improved nutrient and water

management practices for N-fixing tree species for the rehabilitation of degraded rangelands in the Errachidia area, Southern Morocco.
Counterparts: N. El Mourabit, "Institut Nationale de la Recherche Agronomique" (INRA), Programme des techniques nucleaires, Tanger and M. Ismaili, Faculté des Sciences, Université Moulay Ismail, Meknes, Morocco.
Duration: 4 years (1995-98).
Outcomes: A functional laboratory for *Rhizobium* inoculant production was established and personnel were trained on microbiological techniques. *Rhizobium* native strains for peanut are more effective in terms of nodulation and nitrogen fixation than the imported ones in the cultivated areas. From the field fertilization trials it may be inferred that no high rates of chemical fertilizer N are needed, and irrigation water management is a key issue for sustainable production of peanut in this area.
Training of local staff on the use of N-15 and P-32 techniques was made.
An Atomic Absorption Spectrophotometer for elemental plant and soil analysis and additional equipment for N-15 assay were purchased to strengthen the analytical capability of the Soils Laboratory in INRA, Tanger. A P-32 laboratory was set up in Meknes to conduct studies on mycorrhizal associations for increasing acquisition of nitrogen and phosphorus in promising nitrogen-fixing tree species. Studies on further exploitation of plant genotypic differences adapted to arid and semi-arid conditions and also tolerant to salinity are underway.
Impact: These studies are laying the foundation for the development of sustainable agricultural production in two targets areas of the country. In view of the socio-economic importance of peanut production, the creation of a National Peanut Programme at INRA is under consideration. Preliminary arrangements have been made to create linkages to existing networks of peanut germplasm and elite rhizobial strains, in order to improve the peanut cropping system in the country. This will contribute to substantial savings in fertilizer N while avoiding contamination of the groundwater with nitrates. On the other hand, the studies on the identification of trees and shrubs adapted to arid and semi-arid conditions have evolved into the development of a sustainable agro-sylvopastoral system, that is best suited to these conditions, predominant in the southern part of the country. Collaborative links have been established with the activities of another IAEA Interregional TC project (INT/5/144) in which Morocco is participating, with the focus on the utilization of saline wasteland and groundwater for plant production.

- **Field Performance of Selected Mutants of Sorghum and African Rice (MLI/5/014) MODEL PROJECT**

Objectives: To contribute using nuclear-based techniques to the development of sustainable sorghum and African rice production through the selection of improved varieties and soil fertility and water management practices.
The specific objective of the plant breeding component was to select improved varieties generated by mutation breeding of local varieties while the soils component was to develop a package of agronomic practices based on nutrient and water management to realise the full potential of the released mutant varieties.
Counterparts: Project co-ordinator and counterpart of the plant breeding component was A. Bretaudeau, "Institut Polytechnique Rurale", Katibougou; and the counterpart of the soils component was B. Traore, "Institut d'Economie Rurale", Bamako.
Duration: 4 years (1995-98).
Outcomes: After a country-wide field evaluation in multilocation trials, the plant breeders released 8 mutants varieties of sorghum with higher grain yield potential, tall-statured plants, long panicles and resistant to lodging. The release of two promising mutants of African rice is under consideration.
A functional tissue culture laboratory was established and personnel were trained to integrate micropropagation techniques in the production of disease-free planting material of vegetatively propagated crops.
N-15 aided field experiments were carried out over three consecutive seasons in several locations to evaluate the performance of the selected mutants against their parents, in terms of yield production,

nitrogen uptake and utilization. Experiments were also conducted to study their adaptability to dryland conditions. Local staff were trained on the use of N-15 and P-32 techniques in soil/plant research. The Soils Laboratory at Sotuba was re-conditioned to host the equipment provided by the IAEA for sample preparation for isotope analysis.
Guidelines for N fertilization of the mutants and their suitability to the various agro-ecologies predominant in Mali were developed.
Impact: Further work is needed to fully achieve the targets set for the two components, to see their visible impact on the farmers' livlihood and to assess their contribution to sustainable food security in the Sub-Saharan countries. It is envisaged that the IAEA assistance will continue through the next biennium: the breeding component under a regional project for Africa for further dissemination and evaluation of the new varieties among interested countries, while the soils component will focus on the assessment of phosphorus use efficiency by the new sorghum varieties, in particular those with high P utilization from the locally available Tilemsi rock phosphate.

- **Improvement of Soil Fertility (IRQ/5/012)**

Objectives: To strengthen research and development for food production in saline soils through the application of radioisotopes and radiation technology.
Counterparts: A. Fahad, Iraqi Atomic Energy Commission, Nuclear Research Centre, Baghdad.
Duration: 4 years (1995-98).
Outcomes: New equipment and spare parts have been provided, after clearance by the UN Sanctions Committee: two soil moisture neutron probes, a Kjeldahl apparatus, tensiometers and spare parts for a flame photometer, conductivity meter, pH meter and spectrometer. On the other hand, it was not possible to buy some other equipment: EM-38 soil salinity meter, computer and software. We were much more efficient in Fellowships Training; ten fellows undertook their training for a total of 49 months abroad. Owing to the prevalent situation in Iraq, this kind of support was judged as the most effective one. One expert mission was undertaken, one national consultant visit, as well as one scientific visit.

- **Isotopes in Optimizing Mineral/Water Inputs in Agriculture (IVC/5/022)**

Objectives: To increase soil fertility through the optimal use of fertilizers and nitrogen fixing trees.
Counterparts: A. Zakra, N. Koffi, Institute of Forestry; Dept. Coffee & Cacao Research, Abidjan.
Duration: 4 years (1995-98).
Outcomes: In the framework of the "Institut des Forêts" (IDEFOR) research activities several field trials were installed aiming at assessing Biological Nitrogen Fixation (BNF) of legume plants/trees associated with tree crops (rubber, coconut palm, banana, coffee, cocoa). To make the N-15 analysis locally, an Optical Emission Spectrometer NOI-6 PC was supplied and a technician was trained in Seibersdorf Laboratories ^{15}N-labelled fertilizer was provided as well as a soil moisture neutron probe for soil water balance evaluation. Results have shown a good impact of legume trees associated with tree crop plantations. In particular, coconut palm grown on sandy soils along the littoral, showed a strong response to N input from the *Acacia* associated crop. Therefore, a model project on this theme will be implemented from 1999 to 2002.
Impact: The integration of selected nitrogen fixing trees into small scale farms supplements scarce and expensive commercial nitrogen fertilizer and contributes significantly to maintaining soil fertility and increasing crop yields. Improvements in the small scale farming sector will lead to economic and environmental benefits nation-wide.

- **Increasing Nitrogen Fixation Potential of Cowpea (SEN/5/024)**

Objectives: To assess the biological nitrogen fixation of several varieties of cowpea already available or selected; to produce new mutants obtained after irradiation or other chemical/physical treatments; and to screen the indigenous germplasm of these mutants using genetic marker techniques.
Counterparts: M. Barreto, University Cheikh Anta Diop of Dakar, Dakar.
Duration: 2 years (1997-98).

Outcomes: Equipment, chemical products and ^{15}N-labelled fertilizers were provided according to the work programme and the University Chuk Anta Diop (Biotechnology Laboratory) requirements. Even the most perishable biological products (Buffer DNA polymerase, Marker Lambda/Bst, dNTP polymerisation kit) were provided and used successfully. Under greenhouse conditions a set of 16 varieties of cowpea have been tested for their Biological Nitrogen Fixation (BNF) potential. Out of these varieties the 4 best ones for BNF have been characterized by DNA Amplification Fingerprinting (DAF). Different cultivars will be screened for drought resistance. It is expected that the genome characterization will enable scientists to screen and identify genetic markers related to high BNF potential. Later on, the small farmers will take advantage of elite cultivars.

- **Improving Crop Productivity in Arid Areas (PAK/5/036)**

Objectives: To develop drought-tolerant varieties of wheat and to improve fertilizer use efficiency (FUE) under rainfed conditions.
Counterparts: N. Nawaz, Pakistan Atomic Energy Commission, Peshawar.
Duration: 2 years (1997-98).
Outcomes: Equipment, chemical products and ^{15}N-labelled fertilizers were provided to conduct FUE studies. A new vacuum line for preparing discharge tubes for an old Jasco OES and a digital plant water potential apparatus were also supplied. Field experiments were carried out for assessing the mulch efficiency of plant residues, plastic sheets, waste paper and soil mulch. Soil moisture conservation (neutron probe) and crop yield were affected by mulches in the order: plastic > wheat straw > waste paper > soil mulch > control (no mulch). One fellowship and two scientific visits were implemented as well as one short expert mission.

- **Nitrogen Fixation Through Rhizobium Inoculation (GHA/5/024)**

Objectives: The main objective was the introduction of effective *Bradyrhizobium* strains for promoting nitrogen fixation and yield of cowpea and soybean in Ghana. Cowpea is an important grain legume providing a substantial portion of the daily dietary protein requirement of the peoples of West Africa. Soybean on the other hand is an introduced oil legume that is assuming great commercial importance.
Counterpart: S. Danso, Dept. of Soil Science, Faculty of Agriculture, University of Ghana, Legon-Accra.
Duration: 2 years (1997-98).
Outcomes: Under this project more than 100 indigenous *Bradyrhizobium* strains were isolated from 20 different soils. These strains have been characterized for their effectiveness in nitrogen fixation; 6% were ineffective, 79% were moderately effective and 15% were highly effective. The highly effective strains are now being used to prepare peat-based inoculants for field testing. Preliminary investigations have shown that mixed-strain inoculants are even more effective than highly effective single strains. The yield increase due to inoculation was mainly dependent on the type of strain, plant genotype, soil and the ecological zone. For example, yield increases due to inoculation ranged from 20-60% in soybean. Rhizobial inoculants have never been marketed in Ghana and farmers are unaware of the benefits of *Bradyrhizobium* inoculation. With the support of the Ministry of Agriculture field demonstration trials are being planned to highlight the importance of *Bradyrhizobium* inoculation in increasing yield of grain legumes.
The Agency provided training and expert missions (two expert missions and a training fellowship for 6 months) to assist the counterpart in establishing basic molecular biology techniques for selecting effective and competitive indigenous strains for inoculation of legumes. Basic equipment needed for the implementation of the project was supplied by the Agency.

- **Effective Use of Fertilizers in Rice Cultivation (INS/5/024)**

Objective: The main objective was to study soil-plant relationships, and to improve nutrient management practices for sustaining and enhancing soil fertility and rice production. Rice is the most important staple food in Indonesia. The soil degradation in rice-based cropping systems is a major concern mainly due to high output oriented agricultural practices without consideration of unfavourable long term effects.

Counterpart: E. Sisworo, National Atomic Energy Agency, Centre for the Application of Isotopes and Radiation, Jakarta.
Duration: 4 years (1995-98)
Outcomes: With the Agency's support a series of field experiments were established to investigate nitrogen use efficiency from fertilizers and green manures in different rice-based cropping systems. On-going experiments in farmers' fields have clearly demonstrated that *Azolla* can be successfully used as a source of nitrogen for lowland rice. *Azolla* inoculation with or without fertilizer increased rice yields by about 15%. Field experiments on intercropping of *Sesbania* with direct seeded lowland rice in South Sumatra showed that application of *Sesbania* green manure increased the nitrogen fertilizer use efficiency by about 25%. In crop rotation experiments (rice-soybean-cowpea; rice-corn-cowpea) a progressive increase in grain yield of all crops has been observed due to incorporation of crop residues. This project is providing useful information on management practices that can be adopted by farmers to increase crop yields and sustain soil fertility.

The Agency has fulfilled its obligations in terms of providing expert assistance, equipment and training. Six expert missions were funded by the Agency to assist the counterpart on the use of isotope techniques to investigate fertilizer use efficiency and identify appropriate fertilizer management practices for different cropping systems. Six fellowships were awarded to train the local staff on the use of isotope techniques (^{15}N, ^{32}P, ^{65}Zn) in soil-plant studies, which included sample preparation methods, radio-assay techniques and radiation protection measures.

- **Nitrogen Fixation by Multipurpose Tree Species (KEN/5/015)**

Objective: This project was initiated with the main aim of exploiting the potential of several multipurpose trees and shrubs in Kenya to improve nitrogen fixation and determine their contribution to improving soil fertility. Multipurpose trees and shrubs act as a source of green manure, animal feed and fuel wood among other benefits to the small farmers. The project was funded by the Agency and the United Kingdom.
Counterpart: D. Nyamai, Kenya Forestry Research Institute, Kikuyu.
Duration: 8 years (1991-98)
Outcomes: Multipurpose tree experiments were established at Kenya Forestry Research Institute (KEFRI) to evaluate the nitrogen fixation ability of a number of tree species and their contribution to the nitrogen nutrition of crops. The Agency provided expert missions and training programmes to support the studies on nitrogen fixation by multipurpose trees, soil and fertiliser nitrogen use efficiency by food crops and the use of ^{15}N methodology to investigate the above parameters. All requested equipment was provided for the successful implementation of the project. Experts assisted the counterparts in installing, testing and operation of major equipment such as the NOI 6PC Emission Spectrometer and the Liquid Scintillation Analyzer supplied by the Agency.
This project has been useful in identifying promising nitrogen fixing tree species such as *Calliandra calothyrsus, Leucaena leucocephala* and *Gliricidia sepium* which can be successfully integrated into agroforestry systems to promote crop production and sustain soil fertility in Kenya. The study also revealed the importance of selecting effective rhizobia strains to optimize nitrogen fixation as the nitrogen fixation by trees varied both between and within species depending upon the type of strains used. The use of green manures or mulches of *Albizia* and *Gliricidia* was effective in providing nutrients to sustain crop growth but was less effective in maintaining soil organic matter due to their rapid decomposition. The release of nutrients from *Acacia* and *Eucalyptus* residues was slow but contributed positively to the maintenance of soil organic matter content. The results demonstrated that the selection of leaf litter is important to identify appropriate combination of mulches that can be used to provide adequate nutrients to crops as well as to manage soil organic matter content. This project has also been successful in establishing the isotope laboratory at KEFRI to strengthen the local capability to carry out studies related to the efficient use of plant nutrients for sustainable crop production.

- **ZIM/5/009 - BNF For Increased Crop Production For Smallholders (ZIM/5/009)**

Objective: The objective of this Model Project is to promote, through on-farm demonstration trials, the use of rhizobial inoculants (biofertilizers) to increase legume production and improve soil nitrogen economy through use of legumes in smallholder farming systems.
Counterpart: L. Mukurumbira, Ministry of Lands, Soil Productivity Research Lab., Marondera.
Duration: 2 years (1997-98).
Outcomes: The project involves close collaboration between the Biofertilizer Production Factory within the Soil Productivity Research Laboratory and the Extension Service (Agritex) of the Ministry of Lands, Agriculture and Rural Resettlement. The research and the extension units of the Ministry are involved in all stages of the project cycle. The main activities of the project are (i) production of quality biofertilizers for important legumes, particularly soybean; (ii) carrying out biofertilizer demonstration trials on smallholder farmers' fields. The N-15 isotope dilution technique is used to select efficient strains for biofertilizer production, and for measuring the performance of the biofertilizer on farmers' fields.
During the first year the project concentrated on soybean. Biofertilizer use demonstrations on farmers' fields were conducted in three provinces, Mashonaland East, Mashonaland West and Mashonaland Central. In each province 5 districts, and in each district 5 demonstration sites, were chosen. Over 2000 farmers were reached. Due to logistics problems, final harvests were only done in 3 districts in each province. The benefit of biofertilizer use was clearly demonstrated. In all districts except one, grain yield increases ranged between 72 and 502% (see Table below). Yields on communal farms are now comparable to those obtained in commercial farms. Results of the second year of the project are not yet available and will be reported in the next issue of the Soils Newsletter. Meanwhile, the excellent results of the first year have led to the decision by the IAEA Department of Technical Co-operation to initiate similar activities in five other African countries, viz. Kenya, Senegal, Tanzania, Uganda and Zambia in the next biennium, 1999-2000.

Benefit of biofertilizer use on farmers' fields in three provinces of Zimbabwe in the 1996/1997 season (Yield in t/ha)

District	Without biofertilizer	With biofertilizer	Yield increase due to biofertilizer	% increase due to biofertilizer
MASHONALAND EAST PROVINCE				
Marondera	1.41	2.42	1.01	72
Murewa	2.36	4.10	1.74	74
Wedza	2.82	4.83	2.01	92
MASHONALAND WEST PROVINCE				
Hurungwe East	1.37	1.43	0.06	4
Hurungwe West	0.40	1.19	0.79	98
Kariba	0.98	1.96	0.98	100
MASHONALAND CENTRAL PROVINCE				
Bindura	0.58	1.21	0.63	109
Guruve	0.47	2.83	2.36	502
Shamva	0.89	2.00	1.11	125

E. Status of Co-ordinated Research Projects

- **Use of Nuclear Techniques for Optimizing Fertilizer Applications under Irrigated Wheat to Increase the Efficient Use of Fertilizers and Consequently Reduce Environmental Pollution (D1.40.07)**

  Project Officer: P. Moutonnet

  The fourth and final RCM was held in Vienna, 28 September to 02 October 1998. All but one final report was delivered; they are being edited for an IAEA-TECDOC. A data base is being built up as Excel/Power Point files which will be available through the Section or the Project Officer. The CRP will be closed by the end of 1998.

- **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

  This project has presently fifteen participants, four of whom are research agreement holders: F. Maraux (France), R.J.K. Myers (ICRISAT-India), A. Bationo (IFDC/ICRISAT-Niger), J. Ryan (ICARDA-Syria), and eleven are research contract holders: D.R. Prieto (Argentina), G.X. Cai (China), D.L. Deb (India), V.R. Maparla (India), M.J.M. Rusan (Jordan), I. V. Sijali (Kenya), K. El Mejahed (Morocco), M.M. Iqbal (Pakistan), N.E.D. Sharabi (Syria), M. Mechergui (Tunisia), T. Sithole (Zimbabwe). The first RCM was held in Vienna, 6-10 July 1998. The research programme was discussed and the guidelines established for the next cropping seasons. The first field experiments are being implemented during the 1998/1999 agricultural season. The second RCM is envisaged in February 2000 in Tunisia.

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

  Project Officer: G. Keerthisinghe

  This CRP has been approved by the Nuclear Applications Research Contract Sub-Committee. Research contract and agreement holders have been selected and submitted to the Research Contract Administration Section for approval. The first RCM is scheduled for 15-19 March, 1999, in Vienna.

- **Use of Nuclear and Related Techniques for Evaluating the Agronomic Effectiveness of Phosphate Fertilizers, in Particular Rock Phosphates (D1.50.03)**

  Project Officer: F. Zapata

  The fourth and final RCM was held in Vienna, 16-20 November 1998 and the project will be terminated in 1998. The results generated from this CRP will be published in several ways, as recommended by the participants in the final meeting. In addition to the manuscripts prepared by the participants, papers on methodological and other issues will be prepared for inclusion in the final publication. All manuscripts will undergo technical editing.

- **Use of Irradiated Sewage Sludge to Increase Soil Fertility and Crop Yields and to Preserve the Environment (D1.50.04)**

  Project Officer: P.M. Chalk

  Participating in this CRP are eleven contract holders, C. Magnavacca (Argentina), S. Ahmed (Bangladesh), T. Jiang (China), R. El-Motaium (Egypt), V.V. Athalye (India), M. Mitrosuhardjo (Indonesia), F. Ishak (Malaysia), F. Azam (Pakistan), E.M. Ferreira (Portugal), M. Dumitru (Romania), P. Chaiwanakupt (Thailand), and five Agreement Holders, F. Kock (Austria), H. Harms (Germany), K. Kumazawa (Japan), A.C. Chang (USA), and S. McGrath (UK). The third RCM was held from 22-26 June 1998 in Oeiras, Portugal. The report on this meeting is available on request from the Project Officer. This CRP was formally reviewed by the Research Contracts Committee in October 1998. A 1-year extension was approved. The final RCM will be held in Serdang, Malaysia, from 20-24 September 1999.

- **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

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

- **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

  This project is implemented together with another Project on Sedimentation co-ordinated by the Isotope Hydrology Section, Division of Physical and Chemical Sciences (Project Officer: E. García Agudo). This joint implementation is based on the similarities of the techniques used and the inter-relationship between erosion and sedimentation at the watershed level. While the first phase of implementation of this project is completed, the Sedimentation project is starting its second phase. A full up-to-date description of the ongoing and future activities of both projects is given in the report of the Second RCM held in Bucharest, 25-29 May 1998.
  The Soil Erosion CRP has 15 participants, of whom ten are research contract holders: A. Buján (Argentina), O. Bacchi (Brazil), A. Ellies (Chile), X. Zhang (China), L. Hua (China), S. Terachopoulos (Greece), I. Ionita (Romania), V. Golosov (Russian Federation), E. Fulajtar (Slovakia), and L. Mukurumbira (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).

In order to derive quantitative estimates of rates of soil erosion and sediment deposition from Cs-137 measurements, it is necessary to establish a relationship often called calibration, between the magnitude of the deviation from the reference inventory and the extent of soil loss or gain. In view of the large number of different calibration methods available, investigators initiating studies on the use of the Cs-137 technique will face difficulties in selecting an appropriate calibration model and interpreting the model correctly. In order to promote the use of standardised calibration procedures in the CRPs, D.E. Walling and Q.He have selected several models which vary in complexity and applicability to estimate soil redistribution rates in both cultivated and uncultivated soils. The models can be retrieved from: ftp://ftp.iaea.or.at/dist/gnip/ripc_his/.
Participants have been requested to implement several of the available models in order to become familiar with the trade-offs between the model complexity and data requirement, and the reliability and consistency of the results obtained.

F. Laboratory Activities

- **Research and Development on Water and Nutrient Interactions**

A new research project in collaboration with the Isotope Hydrology Section of the IAEA using stable isotopes (deuterium and ^{18}O) to trace water movement, plant-plant interactions and the history of water use in the soil/plant/atmosphere system was initiated by Lee Heng at the Soil Science Unit with visiting scientist, Craig Atkins of the University of Western Australia.

It has been observed in recent years that tree roots can extract water at night from depth in the soil profile (water table in the case of deep tree roots) and release it from the roots into more xeric layers of the soil profile, close to the surface. This phenomenon is termed hydraulic lift. The water so-lifted is re-absorbed by the roots and transpired via xylem in the shoots when the demands of transpiration exceed the rate of water movement from depth. Such a process can have several beneficial consequences:

1. The water status of the deep-rooting plant in an arid environment can be enhanced.
2. The water status of nearby plants that are not rooted at depth is also improved, as they can make use of this hydraulically-lifted water.
3. The water table can be kept lower than it would have otherwise been. This has relevance to the development of salinity due to rising water tables.
4. Leaching of nutrients (e.g. NO_3 that might be regarded as a pollutant of ground water) can be reduced; instead it is transported for use in upper layers.
5. The availability of nutrients in the upper soil layers is enhanced.

Nevertheless, few studies have been conducted on the extent and significance of this process. Nor has much work been carried out on the genetic variation of plants to exploit such benefits. Some preliminary work was performed, which was aimed to answer some of those questions.

The first experiment was carried out on a variety of plants (shallow and deep-rooted) in the vicinity of Seibersdorf Laboratory. The signatures of the isotopes in plant sap, rainwater, ground water and soil water were analysed. Sap was taken before and after a 22-mm rainfall event. Variations in the deuterium and ^{18}O signatures before and after rainfall, and between the different plant species and groundwater which was only 2 m deep, were observed in the data. There was also a good relationship between the delta deuterium and delta ^{18}O values.

A second experiment was carried out in an experimental site belonging to the Institute of Forest Ecology, The Agricultural University, Vienna. Plant sap samples were taken from stems of trees of various species. Leaves, soil samples, groundwater and rainwater were also collected. Preliminary results show that there was less variation between the deuterium signature from the sap of

different plants, probably because of dilution of the signature due to rainfall which occurred just before field sampling. For further information contact Lee Heng.

All diazotrophs produce H_2 gas as a consequence of the activity of nitrogenase. However, in many rhizobia little or no H_2 is evolved because it is oxidised by an uptake hydrogenase (*hup*) also expressed in the *Rhizobium*. Because H_2 production is apparently a waste of plant assimilates it is believed that more effective symbioses are achieved by having rhizobial inoculants with the *hup* gene, i.e. hup^+ symbioses, thus retrieving some of the energy expended in forming H_2 in the first place. However, the impact of having H_2 gas produced in the rhizosphere on the microflora and their metabolism has not been considered, especially in relation to the effect on a subsequent non-legume crop. Experiments have been initiated to assess the impact of growing nodulated soybean with a hup^+ or a hup^- *Rhizobium* symbiont on the subsequent growth of corn, barley, beans and canola. The two *Sinorhizobium* strains chosen differ only in a Tn5 insertion in the *hup* gene. The production of H_2 by the symbioses will be assessed using a novel flow-through H_2 detector. For further information contact Craig Atkins.

- **Training**

Four fellows were trained at the Soil Science Unit during 1998:

A.H.W. Ali (IRQ/97006) received training in crop nutrition under the supervision of Rebecca Hood. **R. Shaheen** (PAK/98026) received training on water management and the use of stable isotopes under the supervision of Rebecca Hood and Lee Heng. **M. Beqqali**, (MOR/98008) and **F. Hussain** (PAK/98028) were trained in water management under the supervision of Lee Heng and Pierre Moutonnet.

- **Scientific visits**

The following scientists visited the Soil Science Unit in the second half of 1998:

R. J. Rennie, Vice President of Agrium Inc., Calgary, Canada.
B. Guritno, (INS/98019), Indonesia.
P. Saffigna, Griffith University, Queensland, Australia.
M.T. Razzak, National Atomic Energy Agency, Indonesia.
E. Stockdale and D. Murphy, Soil Science Department, Rothamsted, UK.
G.K. King'oriah (KEN/98003), Kenya.
Jamal Ibijbijen (MOR/98016PV), Morocco.

- **Consultants and Cost Free Experts/Interns**

J.C. Fardeau, Consultant, 1998-11-02 to 1998-11-06
S. Gosek, Consultant, 1998-11-02 to 1998-11-06
C. Videla, Cost free expert, 1998-10-28 to 1998-12-27
J. Ortiz, Cost free intern, 1998-11-02 to 1999-04-01

- **Supportive Services**

During 1998 (January - October) the Soil Science Unit analysed 6986 samples for total N and ^{15}N abundance of which 3069 were for Co-ordinated Research Projects, 931 for Technical Co-

operation Projects and 2986 for Research and Development within the Unit. In addition 5457 analyses were performed for N-15 Quality Assurance projects implemented by the Unit.

The Unit also made 114 total C and ^{13}C analyses as well as 310 total P and 460 ^{32}P analyses. The Isotope Hydrology Section made 96 ^{2}H and ^{18}O analyses in support of the collaborative R & D on water dynamics in the unsaturated zone.

G. Publications

● Printed

"Crop Yield Response to Deficit Irrigation"; Report on FAO/IAEA Co-ordinated Research Program by Using Nuclear Techniques. 1998. Edited by C. Kirda, P. Moutonnet, C. Hera and D.R. Nielsen. Developments in Plant and Soil Sciences, Vol. 84. Kluwer Academic Publishers, Dordrecht.

"Management of Nutrients and Water in Rainfed Arid and Semi-arid Areas". Proceedings of a Consultants Meeting organized by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture and held in Vienna, 26-29 May 1997. IAEA-TECDOC-1026. July 1998, IAEA, Vienna, Austria.

"Improving Yield and Nitrogen Fixation of Grain Legumes in the Tropics and Sub-tropics of Asia". Results of a CRP organized by the Soil and Water Management & Crop Nutrition Section, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. IAEA-TECDOC-1027. July 1998, IAEA, Vienna, Austria.

"Use of ^{137}Cs in the Study of Soil Erosion and Sedimentation". Proceedings of a Consultants' Meeting organized by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture and held in Vienna, 13-16 November 1995. IAEA-TECDOC-1028. July 1998, IAEA, Vienna, Austria.

"The Use of Nuclear Techniques in the Management of Nitrogen Fixation by Trees to Enhance Fertility of Fragile Tropical Soils". Results of a CRP organized by the Soil and Water Management & Crop Nutrition Section, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. IAEA-TECDOC-1053. November 1998, IAEA, Vienna, Austria.

Zapata, F. and Fardeau, J.C. 1998. "Metodologías isotópicas en estudios sobre el fósforo". In: Manejo Eficiente de los Fertilizantes Fosfatados con énfasis en Rocas Fosfóricas de Aplicación Directa", Ed. E. Casanova, pp. 4-11. ARCAL (Arreglos Regionales Coperativos Para La Promocion de la Ciencia y la Tecnologia Nucleares en America Latina), Maracay, Venezuela.

Hardarson, G. and Broughton, W.J. (1998). FAO/IAEA Co-ordinated Research Project on Enhancement of Nitrogen Fixation in Leguminous Crops. Proceedings of the 16th World Congress of Soil Science, Montpellier, Volume 1, p.207.

Fardeau, J.C., Aigner, M. and Morel, C. (1998). How to forecast P fertilizer efficiency using isotopic methods: their application to replenish soil P fertility. Proceedings of the 16th World Congress of Soil Science, Montpellier, Volume 2, p.265.

Zapata, F., Garcia Agudo, E., and Walling, D.E. (1998). The use of fallout radionuclides as tracers in soil erosion and sedimentation investigations. Proceedings of the 16th World Congress of Soil Science, Montpellier, Volume 2, p. 846.

- **Under Peer Review**

Zapata, F., Garcia Agudo, E. and Walling, D.E. The use of fallout radionuclides as tracers in soil erosion and sedimentation investigations: A review. Submitted for publication to Catena.

Bacchi, O., Reichardt, K. and Calvache, M. The Use of Neutron Moisture Meters and Their Application in Agriculture. Training Manual Series (English and French versions).

- **In Press**

Arslan, A., Zapata, F. and Kumarasinghe, K.S. Carbon isotope discrimination as an indicator of water use efficiency of spring wheat as affected by salinity and gypsum addition. Commun. Soil Sci.Plant Anal.

H. From Our Readers

- **Report of the Co-ordinator, Excursion (A4), 16th World Congress of Soil Science, Tunisia, 11-18 August 1998**

The excursion, which took place prior to the Congress in Montpellier (France), was organized by the Tunisian Society of Soil Science (**TSSS**), whose president Amor Mtimet (also director of the Department of Soils in the Ministry of Agriculture) was the co-ordinator. Nineteen Tunisian colleagues collaborated on the organization of the excursion, mainly researchers and engineers from the Department of Soils of Tunisia and the District Soils Services of the CRDA (regional departments for agricultural development) of the regions visited, as well as researchers and professors of several institutes, notably: Mrs. Nadira Ben Aissa (INAT), Pr. Boubaker Houmène (Faculty of Science of Tunis), Mohamed Hachicha (INRGREF), and two French researchers from ORSTOM: Drs Eric Braudeau and Jean Collinet.

The 16 participants were from eight countries: South Africa, Germany, Canada, Spain, USA, France, Japan and Switzerland.

In only six days (12-17 August) we covered about 2000 km, from North to South, and from East to West. It was an ambitious, but successful venture, in accordance with the purpose of the 16th World Congress on Soil Science, **"Man and Soil'.** The excursion permitted us to discover the best parts of Tunisia: Mediterranean country, cross-roads of civilizations, evidence of several climatic changes between the Mediterranean Sea and the Sahara; it was subject to successive transformations of landscapes and soils under the combined effects of man and of climate change. Too often, the negative effects of man were evident, erosion, salinization and desertification. During the last decade, there has been a considerable effort to arrest soil degradation, with the promotion of economically and socially sustainable agricultural development. The two main objectives of the scientific research in this domain have been better management of water and soil resources.

The itinerary of the excursion was chosen to observe the range of landscapes and agricultural ecosystems allowing the semi-arid Mediterranean climate (xeric) in the North, the arid in the Centre and the lower arid in the South up to the limit of the Sahara desert.

- In the North of Tunis, in the Mejerda estuary, intensive irrigated horticulture on saline and alkali alluvial soils; the problem of irrigation with low-salinity waters (Ca>Na): the control of the water

table with high Na content (Na>Ca). Considerable efforts have been made for improvement and reclamation (irrigation and drainage networks, cultivation).

- In the South East of Tunis, from Zaghouan to Siliana, through Jebel Bargou, a sequence of soils on which are grown cereals and olive-trees, and a forest of pine; a general survey of the hydraulic management system of the small dams (Mrichet and El-Gattar) installed on slopes in order to hold back the run off water and stop gully erosion; the visit to a big dam (El-Howreb) at the outlet of a large catchment area, built for developing intensive irrigated agriculture in the plain of Kairouan; (IAEA - Project TUN/5/017) on the higher slope of Mrichet, a good example of a topo-litho-sequence: from Rendizinas on limestone to vertisols on marls.

- In the Centre-West, in the high plateaux, from Kairouan to Kasserine, with a climate more arid in summer and colder in winter: up hill, near Kasserine, the steppe of Esparto (*Stipa tenacissima*) and the control of its exploitation for the production of paper pulp downhill, near Sidi Bouzid, the development of fruit-tree-cultivation (almonds, olive trees, apple trees) made possible by hydraulic management: spreading of floods by deviation to Oued El-Fekka, and surface wells; the problem of semi-arid soils with calcareous accumulations, eroded or with colluvium, and having a dense horizon near the surface (even in alluvial plains).

- In the South, in the large tectonic ditch of the Gulf of Gabès, up to Chott El-Jerid, which marks the Sahara limit, can be observed in an east-west alignment: seasonal saline lakes (SO_4 and Cl, Ca and Na) where gypsous and chlorides crusts form; ancient fixed dunes and recent live dunes; as well as ancient oases (Tozeur, Douz, Gabès) of date palms around artesian wells, and new palm groves irrigated with bore-water (El Hamma), which permitted three levels of vegetation (date palms, apple-trees and horticulture) and even an intensive horticulture in every season. Away from the oasis, a very sparse steppe covering vast glacis and hills, whose soils are nearly sterile. Around the Chotts and Sebkats (saline lakes) the saline substratum of clay and sand is covered with a veil of aeolian quartz sand, gypsum, calcite, chlorides, etc. almost sterile (Glacis of Methouia).

In the face of the extension of the recent live dunes in the west of Gabès, considerable works are undertaken in order to stop the progression of desertification (area of Menzel Habib).

- In the desiccated high plateau of Matmata, north of Gabès: a sparse steppe and soils with calcareous encrustings, which are very eroded and covered with loess, sometimes saline, probably originating from saline lakes and the Eastern Erg; an ancient form of management in terraces in the small valleys, "the Jessours" is practised, permitting water and soil to accumulate in the wet season behind packed down earthen works, and spaced out plantations of olive-trees and date palms and some rainfed crops.

- Then, in the Sahel and the coast, from Gabès to Tunis and from south to north, the most agricultural and touristic regions of Tunisia: in the region of Sfax, under an arid climate, (annual rainfall: 200 mm), vast plantations of olive trees on Serozems, alluvial sandy soils with low calcareous accumulations and moderate alkalinity; near the city of Sousse, under a semi-arid climate (rainfall: 330 mm), ancient olive groves on chestnut brown soils are managed in "meskats", which are ingenious systems partitioned by earthen levees ("tabias"), with an impluvium uphill for retaining water and sediments.

- Finally, south of Tunis, in the Cap Bon, under a markedly more humid climate (annual rainfall: 550 mm at the summit and 450 mm in the littoral), we observed a good toposequence (climatic and lithodependant: at the summit, a forest and leached red ferrallitic soils on sandstone; on the hills, cereal crops and vertic and red brown soils on marls; on the calcarous coastal terraces, intensive irrigated arboriculture and horticulture on brown calcarous or red ferralitic soils with a calcareous encrusting near the surface. It is on this terrace, between Lebna and Menzel Temime, that we visited an ultra-modern farm (granted by the government to a private firm), in which are being tried out ultramodern techniques for the management of water, soil and crops (devoted for

exportation to Europe), and which represents an ultimate model of intensification of Tunisian agriculture.

Soil science in Tunisia has gone through three periods during the last five decades: in the fifties and sixties, selective studies on saline soils and irrigation management; then in the 70-80's, soil surveying and pedologic and applied soil cartography; finally, in the 80-90's, especially detailed studies concerning soil and water management in the irrigated areas, hydropedological monitoring of watersheds in several climatic zones and the fight against desertification and intensification of agriculture.

As far as pedology *"stricto sensu"*, the contribution of classification systems such as the French, American, south-African, or even FAO to the characterization and cartography of soils in Tunisia, seems to me disappointing (except for the case of the better known saline and alkali soils) with regard to scientific knowledge and its agronomic application. Tunisian soils are often "out of norms" on account of a complex history resulting from climatic changes in the Quaternary, erosion or superficial deposits (alluvial and eolian) and strong anthropic impacts. Furthermore, we should better take into account geomorphology and the close relation in the same catchment area, between upland soils and those of the lowlands. Thus, alluvial or colluvial soils keep some mineral constituents of the soils of the slope but they differ from these in their physical and hydro-geochemical properties; whereas eroded upland soils conserve in an arid climate only a part of the former formation, or generate new horizons if the climate has changed.

A. Mtimet
Director of Soils
Ministry of Agriculture
Tunis, Tunisia

● Report, XXVIIIth Annual Meeting of ESNA, Working Group Soil-Plant Relationships and International Union of Radioecolgy (IUR) Working Group Soil-plant Transfer

The annual meeting was held in Brno, Czech Republic, from 26-29 August 1998. The working group was well attended with the active participation of 41 scientists from 20 countries in oral or poster presentations. Besides the sessions, which focused mainly on radioecology, soil science and plant nutrition, the Working Group held one joint session with WG 5 (Quality of Agro-Ecosystems) on stable isotope techniques and a special session dedicated to protocols in soil-plant transfer studies.

The majority of oral presentations (18) focused on radionuclide behaviour in the soil-plant system. The papers described e.g. surface versus water table contamination with respect to migration of Cs (Wadey et at., Marchant et al.). A series of papers focused on the behaviour of radiocesium in seminatural environments including modelling (Drissner et al.), and the effect of countermeasures like liming (Konoplev et al.) and potassium fertilization (Nikolova and Johanson), diminishing soil-plant transfer of ^{137}Cs by factors of 8-20 and 2-4, respectively.

Concepts of radionuclide soil-to-plant transfer were addressed by five presentations. Frissel showed an approach using characterization of the ecosystem, Herren and Riesen discussed alternatives to the Kd-concept (ratio between dissolved and sorbed radiocesium) while Tompkins et al. highlighted the main influencing factors, which should be taken into account for uptake models. Waegeneers et al., and Roca Jove and Vallejo Calzada demonstrated the impact of K concentration in the soil solution on Cs uptake models. Additional papers focused on soil-tree transfer of Cs (Skarlou et al.), the translocation of Sr and Cs from contaminated leaves to fruits (Carini et al.), the impact of physiological factors and stress on ^{137}Cs absorption by plants (Kravets), the impact of elevated

radionuclide levels on chromosomal aberrations in plants of the exclusion zone (Goncharova et al.), ^{137}Cs transfer as influenced by contamination level (Cojocaru et al.) and the use of zeolites as a countermeasure (Oncsik Bíróne). Additionally 5 posters were presented in the field of radioecology (Todorovic et al., Kravets, Grodzinsky et al., Tsyganov et al.). The work of Wright et al. on identifying vulnerable regions in Europe concerning Cs-deposition load based on the soil map of Western Europe was deemed to be of high relevance.

The working group held a special session to discuss a draft document (FAO/IAEA/IUR) on protocols in soil-plant transfer studies (Frissel). Many suggestions were made and the revised protocol will be published in the proceedings of the Working Group.

Eleven oral presentations were given in the field of Soil Science and Plant Nutrition. Esteban-Mozo presented results on the impact of sewage sludge on soil fertility and nutrient movement. A valuable data set from a 30-year (NPK) fertilizer experiment was presented by Nankova and Kirchev. These data might provide a sound basis for production models. Two papers by Brohi et al. and Hejnak and Lippold dealt with N fertilization. In the latter paper leaching of ^{15}N under different soil conditions and the priming effect of mineral nitrogen on initial soil N was quantified. In a joint session with Working Group 5 the use of stable isotope techniques was discussed. Gerzabek began with a review on the use of stable isotopes in soil organic matter studies. Grego and Megusar highlighted the mechanisms of N immobilisation in biomass, the role of the rhizosphere in this respect and the fixation of N in clay minerals. Moutonnet described fertigation experiments in horticulture using ^{15}N as tracer and the tensionic device for sampling the soil solution.

The last session focused on the use of fertilizers in general. Zeleny et al. discussed the sulfur supply of Czech soils considering plant demand, fertilizer input and SO_2-emissions. Esengün and Akay evaluated the fertilizer effect on crop yields in Tokat/Turkey. Gürler et al. provided data from the fertilizer industry.

Six posters were presented in the field of Soil Science and Plant Nutrition. Topics ranged from the mineralization of organic fertilizers (Budoi et al.), different aspects of plant nutrition (Budoi et al., Stanica et al., Draga et al.) to the uptake of Be by plants and its effect on crop growth (Hlusek and Richter).

The extended summaries of the presentations will be published in the proceedings in late 1998. The next annual meeting of ESNA and the IUR Working Group Soil-to-plant Transfer will be held in Wye College, U.K., 8-12 September 1999. Further links to the soil science community will be established in the future. M. Gerzabek was appointed by the Council of the International Union of Soil Sciences (IUSS) during the 16th World Congress of Soil Science in Montpellier as Liaison Officer to the IUR to stimulate exchange of information between the two Unions.

Martin H. Gerzabek
Working Group Chairman
Seibersdorf, Austria

SOIL AND WATER MANAGEMENT & CROP NUTRITION SECTION

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Mr. Phillip Chalk
Head, Soil and Water Management
& Crop Nutrition Section
Joint FAO/IAEA Division of Nuclear
Techniques in Food and Agriculture
P.O. Box 100, Wagrammer Strasse 5
A-1400 Vienna, Austria

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