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
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Vienna, Austria

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Vol. 23, No.2 January 2001

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ISSN 1011-2650

A. TO OUR READERS

As we go into 2001, it is an opportune time to review the work of the Sub-programme in 2000 and to look ahead to the tasks and activities planned for 2001 and beyond.

Two Research Co-ordination Meetings (RCMs) were held in 2000, one in Vienna and one in Tunis, Tunisia. The Vienna RCM was the first meeting of the "acid soils" Co-ordinated Research Project (CRP) while the Tunis RCM was the 2nd meeting of the "rainfed" CRP. A Consultants' meeting on "Integrated Soil, Water and Nutrient Management for Sustainable Rice-Wheat Cropping Systems in Asia" was held in FAO, Rome, to plan for a future CRP. FAO Headquarters staff from the Plant Production and Protection Division (AGP) and the Land and Water Development Division (AGL) as well staff from Regional Offices in Asia participated fully in the meeting. A major event for the Sub-programme in 2000 was the FAO/IAEA International Symposium on "Nuclear Techniques in Integrated Plant Nutrient, Water and Soil Management" which is held in Vienna once every five years. Presentations were of a high standard and highlighted recent advances in the development and applications of nuclear techniques in agronomic and environmental studies.

Four RCMs are planned for 2001. Final RCMs are scheduled for the "organic matter" CRP (Kuala Lumpur, Malaysia) and the "soil erosion" CRP (Vienna). The 2nd RCM of the "agroforestry" CRP and the 3rd RCM of the "rainfed" CRP will be held in Kuala Lumpur and Vienna, respectively. Initial contracts for the "rice-wheat" CRP will be awarded in 2001 with the first RCM to be held early in 2002 in Vienna in conjunction with a training workshop. A Consultants' Meeting on biological nitrogen fixation is being jointly organised with AGL in early 2001 in Rome and planning has already commenced for a half-day Symposium titled "Towards integrated soil, water and nutrient management in cropping systems: the role of nuclear techniques" to be held under the aegis of the 17th World Congress of Soil Science in Bangkok in 2002.

The Sub-programme provided support to 22 Technical Co-operation Projects worth more than US $ 4 million during 1999-2000 compared with 23 projects in 1997-98. Four projects in the current biennium were regional and one was interregional. The projection for 2001-02 is 25 projects, including 3 regional and one interregional. Thus, the Sub-programme's portfolio of TC projects has remained relatively stable during the 1997-2002 period. The regional projects for 2001-02 include fertigation (Europe), desertification (Africa) and nutrient management (Asia).

Sub-programme inputs to the FAO Medium Term Plan (2001-07) and to the IAEA and FAO Programmes of Work and Budget (2002-03 biennium) were finalised during 2000. Two new CRPs will commence in 2003. One project will be concerned with the practical application of the Cs-137 technique to assess soil conservation measures and the other is targeted at improved irrigation practices. Three TECDOCS and a range of articles were published by the Sub-programme in 2000, details of which can be found in the current and the previous Newsletters.

In July, Professor Graeme Blair, School of Rural Science and Natural Resources, University of New England, Armidale, NSW, Australia, joined the Soil Science Unit, Seibersdorf for a 12-month sabbatical. Graeme is an eminent scientist who has extensive experience in developing country agriculture, particularly in tropical regions of Asia and Latin America. He has served as a senior scientific advisor on several committees funding rural research in Australia and the Australian Center for International Agricultural Research. In 2000, he was the recipient of the prestigious International Fertiliser Award of the International Fertiliser Association, in honor of a career dedicated to research in the field of soil fertility and plant nutrition. His work at the Soil Science Unit will involve research on C and S dynamics using the stable isotopes ^{13}C and ^{34}S, and he will develop guidelines on the application of S isotopes in agronomy and soil science. He will also assist the Sub-programme in planning future CRP activities in sustainable rice/wheat cropping systems in Asia. His wife, Nellie Blair, is continuing her Ph.D research at the Austrian Research Centre, Seibersdorf, under the guidance of Prof. M. Gerzabek.

With my very best wishes for the Christmas season and for 2001.

Phillip Chalk
Head, Soil and Water Management
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C. FUTURE EVENTS

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

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

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

⇒ **Second RCM of CRP on "The Use of Nuclear Techniques for Developing Integrated Nutrient and Water Management Practices for Agroforestry Systems", 7 - 11 May 2001, Kuala Lumpur, Malaysia**

Nine contract holders and five agreement holders are expected to participate. Ms. Zaharah Rahman, University Putra Malaysia, is the local organiser. The participants will present the major results and conclusions of their research covering the period from 1999-2001. Deadline for the submission of progress report has been set for 6 April 2001. The presented data will be fully discussed and work plan for future work will be updated in line with the project objectives. Gamini Keerthisinghe is the Project Officer and will be the Scientific Secretary.

⇒ **Final RCM of CRP on "The Assessment of Soil Erosion Through the Use of Cesium-137 and Related Techniques as a Basis for Soil Conservation, Sustainable Production and Environmental Protection", 21 - 25 May 2001, Vienna, Austria**

Twelve contractors and four agreement holders will participate in the final RCM. The participants are expected to present their main research results and conclusions. The results obtained during the implementation of the CRP (1996-2000) will be reviewed and discussed, and the achievements will be evaluated in accordance with the project objectives. The effectiveness, relevance and impact of the project will be evaluated. Deadline for the submission of the final reports and summaries has been set by 30 April 2001 (about three weeks before the date of the meeting). In addition, all participants are requested to prepare manuscripts for publication in "Soil and Tillage Research" as a special issue. Details on "Instructions to Authors" will be sent to the participants in due course. Mr. F. Zapata is the Project Officer, and will serve as the Scientific Secretary.

⇒ **Third RCM of CRP on "Management of Nutrients and Water in Rainfed Arid and Semi-arid Areas for Increasing Crop Production", 17 - 21 September 2001, Vienna, Austria**

Twelve contract holders and five agreement holders will participate in this RCM. Ms. Lee Heng, Soil Science Unit, Seibersdorf Laboratories, will serve as the Scientific Secretary as the present Project Officer, Mr. Pierre Moutonnet, will be leaving the IAEA on 30 June 2000. The participants will present the major results and conclusions of their research covering the period from 1998-2001. General conclusions and recommendations will be formulated and guidelines updated accordingly. Data sets for running the plant growth simulation models of DSSAT and APSIM will be collected. A detailed report on the meeting will be available, upon request, to the Soil and Water Management & Crop Nutrition Section Office or the Soil Science Unit in Seibersdorf Laboratories.

CONSULTANTS MEETINGS

⇒ **FAO/IAEA Consultants Meeting on "Increasing the Use of Biological Nitrogen Fixation (BNF) in Agriculture", 13 – 15 March 2001, FAO, Rome, Italy**

A Consultants' Meeting on "Increasing the Use of Biological Nitrogen Fixation (BNF) in Agriculture" will be organised by AGE (Vienna), AGL and AGP (Rome) in March 2001. The main objective of this meeting is to review current knowledge and research on BNF for identifying research priorities to enhance the effectiveness of BNF in crop production in developing Member States. The possibilities of obtaining external funding for such activities will be explored.

⇒ **FAO/IAEA Consultants Meeting on "The Comparison of Soil Moisture Neutron Probe with Time Domain Reflectometry and Capacitance Methods", 21 – 23 March 2001, Vienna, Austria**

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

⇒ **FAO/IAEA Consultants Meeting on "Assessment of Soil Conservation Technologies for Sustainable Agricultural Production", 28 - 30 May 2001, Vienna, Austria**

In connection with the final meeting of the CRP on Soil Erosion, a consultants meeting will be organised to review ongoing work in soil/water conservation technologies to control soil erosion and associated sedimentation and recent developments in nuclear and related

techniques for measuring soil erosion. Five consultants are expected to participate at this meeting and they will identify priority areas of research in soil and water conservation and make recommendations to the IAEA, in particular the development and implementation of a new Co-ordinated Research Project and Technical Co-operation projects. This would be a logical follow-up of the CRP on soil erosion and thus, further refinement of the Cs-137 technique to assess soil erosion and sedimentation will also be discussed. Mr. F. Zapata will be the Scientific Secretary.

TECHNICAL CO-OPERATION PROJECTS (TCPs)

⇒ **Workshop on "Integrated Nutrient and Pest Management Practices for Crop Mutants in Rice-Based Cropping Systems" (BGD/5/022), 11 - 15 March 2001, Dhaka, Bangladesh**

The Agency has provided substantial support to Bangladesh for a number TC-projects related to increasing crop production and sustaining soil fertility. The main aim of this workshop will be to critically review the major achievements of the past and on-going TC-projects to formulate a package of technologies to promote crop production in rice-based cropping systems, as they play an important role in food security and alleviating hunger and poverty in Bangladesh. One of the main task of this workshop will be to formulate a realistic work plan to identify integrated fertiliser, water and pest management practices to increase crop production. Representatives from Bangladesh Institute for Nuclear Agriculture (BINA), Department of Agricultural Extension (DAE) and counterparts of related projects funded by other international organisations such as IFAD, CARE and DANIDA will be participating at this workshop. Mr. Gamini Keerthisinghe will be the Technical Officer.

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

This regional project was initiated at the end of 1996 involving eight countries of the Latin American region. Current participating countries are: Argentina, Brazil, Chile, Cuba, Mexico, Uruguay and Venezuela. It is in the final phase of implementation, with Felipe Zapata as the Technical Officer.

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

The purpose of the meeting is to evaluate the results achieved in accordance with the project objectives. Mr. Juan José Peña Cabriales, "Centro de Investigaciones y Estudios Avanzados del Instituto Politécnico Nacional", Irapuato, Mexico will be the local organiser of the meeting. The project coordinators are requested to send him their final reports by 1 March 2001. The reports of the regional workshops, national training courses, seminars, and other events should be submitted at the meeting. The participants will present their final reports describing major activities during the implementation of the project, highlighting results from the field trials and dissemination of promising technologies generated from the project to the end-users. The impact of the project on the development of integrated nutrient, water and soil management practices of the participating countries will be evaluated.

⇒ **Technical Co-operation Programme - New Cycle 2001-2002**

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

Desertification or dry-land degradation caused by wind and water erosion, and chemical and physical processes is exacerbated by human interventions that eliminate the sparse vegetation cover through overgrazing and firewood collection. Estimates of African desertification show that 74% of rangeland, 61% of rainfed cropland and 18% of irrigated land are severely affected in 33 countries of the region. With the ever-decreasing potential to expand the cultivated land areas in many countries of the region, future increases in agricultural production will have to come from more intensive use of land and water resources and external agricultural inputs.

A prosperous agriculture sector in Africa is important for future development without which poverty cannot be reduced, natural resources cannot be managed in sustainable manner, and food security cannot be assured.

Three main strategies which require a concerted action by all parties are postulated to combat desertification: 1) sustainable agricultural intensification on the most suitable arable land, 2) conversion of marginal lands to appropriate land uses, reducing and/or eliminating the extensive grazing of low-productive rangelands, and 3) restoration of degraded lands and ecosystems.

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

Coordination with other desertification initiatives will be pursued at international, regional and national levels.

Consultations at the national and regional level have already started. A first regional co-ordination meeting is envisaged for the week 19 - 23 February 2001 in Ougadougou, Burkina Faso to formulate the First Regional Activity Plan.

- **FAO/IAEA Regional TC Project for East Asia and Pacific "Restoration of Soil Fertility and Sustenance of Agricultural Productivity" (RAS/5/039)**

The Asia and the Pacific region has a very rapidly increasing population and the RCA has two of the most populous countries in the world among its Member States, namely India and China. The population of China is expected to reach 1.6 billion in 2030, and the present population growth rate of India is nearly 2.4%. Along with increase in the population, many countries in this region are experiencing a progressive shortage of land available for cultivation, due to industrialisation, urbanisation and gradual erosion of the ecosystem. Thus,

there is an urgent need to identify management practices to improve soil fertility and increase crop production. However, improper use of fertilisers and pesticides, coupled with intensive cropping without adequate replenishment of nutrients have resulted in the decrease in soil fertility and soil productivity, and decreased efficiency of chemicals fertilisers in many countries of this region.

The overall objective of this project is to develop improved soil, water, nutrient and crop management practices while counteracting predominant soil degradation processes like nutrient depletion, soil acidification and soil erosion in order to increase crop productivity. The specific objectives are to a) improve fertiliser management practices to increase the efficiency of chemical and bio-fertilisers to optimise the cost-effectiveness of fertiliser inputs, b) identify crop residue management practices to enhance the nutrient availability to crops and improve soil fertility, and c) develop agronomic practices to minimise soil degradation processes such as soil erosion, acidification, etc., relevant to each participating country. The focus will be on rice based cropping systems which play an important role in food security of the region. With regard to the fertiliser efficiency, the emphasis will be on nitrogen, as it is the most costly input and it is not efficiently used in rice based cropping systems (only about 30-40 % of applied N is utilised by crops). Labelled fertilisers will be used to obtain quantitative information on the fate and efficiency of applied fertilisers to crops for identifying appropriate management practices for improved utilisation of fertiliser inputs.

The participating countries are Bangladesh, China, Malaysia, Myanmar, Mongolia, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam. A project co-ordination meeting will be held during the first quarter of 2001 to establish a regional activity plan.

NON-FAO/IAEA MEETINGS

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

This meeting is organised by the International Fertiliser Development Center (IFDC), in collaboration with the Malaysian Society of Soil Science (MSSS) and with the support from the Potash & Phosphorus Institute (PPI) and the World Phosphate Institute (IMPHOS). The objectives of the meeting include the following:

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

The programme content will focus the following main topics:

1) Overview of phosphate rock use and related appropriate technology.
2) International research networks on phosphate rocks.
3) National research networks on phosphate rocks.

4) Isotope techniques and modelling in phosphate rock research.
5) Latest research reports on phosphate rock.
6) Reports from phosphate rock producers, dealers, and users.

F. Zapata and Lee K. Heng have been invited to participate with contributions of the FAO/IAEA Programme to main topics 2, 4 and 5 of the meeting.

⇒ **XIV International Plant Nutrition Colloquium, 27 July – 3 August 2001, Hanover, Germany**

The main objective of this colloquium is to provide opportunities for researchers studying all aspects of plant nutrition to review recent advances in plant nutrition and to exchange new knowledge, information, ideas, and techniques. The Colloquium will cover research work on physiological aspects, plant soil relationships, plant quality, plant health, soil nutrient dynamics and nutrient management in relation to the environment. Gamini Keerthisinghe will participate from the Sub-programme and present a paper on "Integrated approach for improved phosphorus nutrition of plants in tropical acid soils".

⇒ **12th World Fertiliser Congress, 3 – 9 August 2001, Beijing, People's Republic of China**

The theme of this Congress, which is being jointly organised by the Chinese Academy of Sciences (CAS) and the International Scientific Center of Fertilisers (CIEC), is *Fertilisation in the Third Millennium – Fertiliser, Food Security and Environmental Protection.* Mr. Phillip Chalk, Head of the Soil and Water Management & Crop Nutrition Section, and co-authors, will present a keynote lecture on *Nitrogen Fertilisation and Its Environmental Impact*. More information can be obtained by e-mail CIEC2001@iae.syb.cn or the web http://www.pb.fal.de

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

The workshop is being organised by the Unité d'agronomie de Reims et de Laon, INRA. It will emphasise the understanding of organic matter cycling in soils (C and N) and recent developments in tools for managing soil and fertiliser nitrogen. Contributions from intensive, low-input and organic agricultures (including forests) are welcome. More information can be obtained by e-mail Nworkshop@reims.inra.fr or the web http://www.inra.fr/Internet/Projects/11Nworkshop.

⇒ **Towards Integrated Soil, Water and Nutrient Management in Cropping Systems: the Role of Nuclear Techniques, Symposium 59, 17th World Congress of Soil Science, 14 – 21 August 2002, Bangkok, Thailand**

A half-day Symposium will be convened within the 17th World Congress of Soil Science, which has as its theme, *Soil Science: Confronting New Realities in the 21st Century*. Mr. Phillip Chalk, Head of the Soil and Water Management & Crop Nutrition Section, is the convenor of Symposium 59 and Dr. Sakorn Phongpan, Senior Scientist, Nuclear Research in Agriculture Section, Agricultural Chemistry Division, Department of Agriculture, Chatuchak, Bangkok, is the Thai Co-convenor. The Symposium will focus on the application of nuclear techniques in studies of soil organic matter dynamics and nutrient cycling, evaluation and management of nutrient sources, water management and conservation, soil erosion and

sedimentation, plant tolerance to environmental stress, environmental and pollution studies and advances in nuclear-based methodologies and instrumentation. April 30, 2001, is the closing date for the submission of 500-word abstracts that will form the basis for selection of oral and poster presentations. Detailed information on the Congress can be obtained at http://www.17wcss.ku.ac.th. Financial support will be provided by the Agency to assist scientists from developing countries to participate in the Congress.

D. PAST EVENTS

CONSULTANTS MEETING

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

A Consultants' Meeting was convened at FAO Headquarters to review on-going activities in the rice-wheat cropping system of South Asia and China, identify research needs and provide recommendations on a future Co-ordinated Research Project. Mr. Phillip Chalk (AGE, Vienna) and Ms. Helena Gomez-MacPherson (AGP, Rome) jointly organised the Meeting. Five international Consultants attended the Meeting: Messrs. D. Connor (Australia), J.K. Ladha (IRRI, Philippines), J. Gaunt (UK), R. Gupta (CIMMYT, India) and J. Duxbury (USA). Mr. T. Fischer (ACIAR, Australia) and Ms. J. Lauren (USA) attended as observers. Participants from IAEA were Messrs. P. Chalk (Scientific Secretary) and G. Blair, Seibersdorf Laboratories. Participants from FAO Headquarters were Ms. GomezMacpherson and Messrs D. van Tran, N. Nguyen, T. Bachmann, H. Nabhan, M. Porto and E. Kueneman. Mr. K. Pillai, FAO Bangladesh and Mr. F. Thiery, FAO Regional Asia and Pacific also participated in the Meeting. The Consultants presented state-of-the-art reviews of on-going work within bilateral and multilateral programmes, particularly those funded by USAID and ACIAR and those falling within the umbrella of the Rice-Wheat Consortium. A Project document has been prepared for a new Co-ordinated Research Project based on the recommendations of the Consultants. A report of the Consultants' Meeting is available upon request to the Scientific Secretary.

INTERNATIONAL SYMPOSIUM

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

This symposium was a major event for the Sub-programme in 2000. One hundred and seventeen participants representing 43 countries and 5 organisations participated in the symposium. The Opening Session, chaired by Mr. J. Dargie, Director of the Joint FAO/IAEA Division, was officially opened by Mr. W. Burkart, Deputy Director General, Department of Nuclear Sciences and Applications. Opening statements were given by Prof. C. Hera, President of the International Scientific Center of Fertilisers (CIEC), Prof. W. Blum, Secretary-General of the International Union of Soil Sciences (IUSS), and Mr. P. Chalk, Section Head.

The programme was organised into seven technical sessions, each beginning with a keynote address:

- Evaluation and management of natural and manufactured nutrient sources.
- Soil organic matter dynamics and nutrient cycling.
- Soil water management and conservation.
- Plant tolerance to environmental stress.
- Environmental and pollution studies.
- Assessment of soil erosion and sedimentation.

– Recent advances in isotope analytical methodologies and related instrumentation.

The technical sessions covered a total of 4 days. In addition, one afternoon was devoted to a poster session and another afternoon to an excursion to the Soil Science Unit, Seibersdorf Laboratories. A total of 46 oral presentations were made and 38 posters were displayed. The proceedings of the Symposium will be published as a CD ROM in 2001.

TECHNICAL CO-OPERATION PROJECTS (TCPs)

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

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

This meeting was held at the Philippine Nuclear Research Institute (PNRI) in Manila. Ms. Crispina M. Rosales of PNRI was the local organiser. The meeting was attended by the project co-ordinators of the nine participating countries (Bangladesh, China, Indonesia, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand and Viet Nam), Mr. Roland Buresh from IRRI, Philippines, as the external reviewer and the Technical Officer, Mr. Gamini Keerthisinghe. The following activities were carried out:

– Assessed the overall achievements of the project in line with the project objectives, based on the progress reports and the presentations given at the meeting.

– Discussed the outputs of the project and their impacts on sustaining soil fertility and increasing crop production of participating countries.

– Discussed the economic benefits of promising agroforestry practices emanating from the project for each participating country.

The counterparts reported significant progress, during the five year span of this project, in (i) selection of promising tree species for agroforestry systems based on their adaptability to the local conditions and their potential benefits to the entire cropping system, (ii) promoting agroforestry, and (iii) working together with extension workers and farmers to disseminate promising agroforestry technologies to the end-users. A report will be published highlighting the major achievements of the project.

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

This project was initiated in 1999 for a period of two years. The participating Member States are Iran, Jordan, Lebanon, Saudi Arabia, Syria, United Arab Emirates and Yemen. This project follows on from a previous project (RAW/5/002) which was implemented as Phase I during the period 1995-1998 (an IAEA-TECDOC is under preparation). Pierre Moutonnet is the Technical Officer. The final co-ordination meeting was organised in Austria (IAEA Headquarters and Seibersdorf Laboratories) from 20 – 24 November 2000. The meeting was attended by fifteen participants from West Asia. During the first two days of the meeting results obtained by the different counterparts over the period 1999-2000 were discussed in line with project objectives. On the third day a scientific visit was organised to the Seibersdorf Laboratories and a field trip to Burgenland to see a field experiment on sub-surface drip irrigation. During the last two days, a workshop was organised on "Phosphorus Fertilisers in Fertigation". Dr. Truong Binh attended as an expert and presented papers on 1) ^{32}P as a tracer

for studying kinetics of exchanges from soil solution to soil matrix, 2) ^{32}P as a tool for assessing P-fertiliser recovery in pot experiments, 3) ^{32}P as a tool for assessing P-fertiliser recovery in field experiments under fertigation. Some of the counterparts and staff of the Sub-programme also presented papers. A number of scientists from West Asian countries have expressed a keen interest on initiating a new regional TC project (2003-04) on fertigation with special emphasis on phosphorous fertilisation.

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

Following the conclusions and recommendations adopted in the Third Co-ordination Meeting held in Oaxaca, Mexico, 20 - 24 March 2000 the following activities were carried out:

a) Preparation of the country dissemination plans of the generated technologies by the project coordinators. These have been since approved for implementation by the ARCAL national coordinators and the IAEA.

   Several mechanisms are being utilised in the participating countries to disseminate the results obtained in the project. Ms. Silvia Lopez, project co-ordinator of Argentina distributed a leaflet on the activities of the project, in particular those carried out in Argentina during the recently held 11th International Soil Conservation Conference (ISCO), Buenos Aires, 22 - 27 October 2000.

b) Procurement of equipment requested by the project coordinators was finalised. Requests for additional N-15 labelled materials were discussed.

c) The requested expert missions to assist local staff in interpreting the results and generating practical recommendations have been fielded to Chile, Venezuela and Mexico.

d) Project coordinators have prepared individual web pages describing the field activities carried out in each participating country. The Technical Officer has collated them and added an overall description and achievements obtained so far in this regional project. The responsible co-ordinator of this activity was Carlos Perdomo of Uruguay. The full project description can be found on our web site.

e) Project coordinators and counterpart staff have written manuscripts based on the results obtained from the field trials for publication in a special issue (in Spanish) of the journal TERRA of the Mexican Society of Soil Science. This activity is being coordinated by Juan José Peña Cabriales, project co-ordinator of Mexico.

f) The present status of the following publications is as follows:

   1) Manual on N fertilisation of annual crops in Latin America and the Caribe. Co-ordinator: Segundo Urquiaga, EMBRAPA-CNPAB, RJ, Brazil. Printed and ready for distribution.
   2) Manual on Biological Nitrogen Fixation in Latin America and the Caribe: the contribution of the nuclear techniques. Co-ordinator: Juan José Peña Cabriales, CINVESTAV-IPN, Irapuato, Mexico. In press.
   3) Manual on Improvement of Water Use in Agriculture: the role of the nuclear techniques. Co-ordinator: Takashi Muraoka, CENA, Piracicaba, Brazil. Final editing.

g) Preparatory work has been initiated for the Final Project Evaluation Meeting to be held in Irapuato, Mexico, 26 - 30 March 2001. In this regard, project co-ordinators are requested to prepare their final reports describing all activities performed during the total duration of the project (1996-2000) and attach all relevant supporting information of the main activities and outputs of the project.

NON-FAO/IAEA MEETINGS

⇒ **International Summer School on the Environment, hosted by the University of Girona, 10 – 15 July 2000, Figueres, Spain**

Rebecca Hood participated at the International Summer School on the Environment hosted by the University of Girona, Figueres, Spain and presented lectures on "Nitrogen use in agricultural and agroforestry ecosystems; Problems and perspectives, "The role of stable isotopes in achieving sustainability." and " The use of stable isotopes in agricultural and environmental research". The theme of the Summer School was "The nitrogen cycle and sustainability: A multidisciplinary approach". Many issues related to nitrogen transformation and their effects on sustainable crop production were presented and discussed.

The main issues raised at the meeting were:

- Problems associated with increasing crop production to meet the growing demand for food due to rapid increase of population in developing countries.
- The impact of increased animal production on global food supply and the effective management of animal waste.
- Reduction of nitrogen losses from agricultural systems and their detrimental impact on the environment.
- 1.2% of global fuel consumption is for nitrogen fertiliser production. Nitrogen fertiliser use efficiency in crop production is often less than 50%, and the nitrogen conversion efficiency of feed to protein is about 33%. In many European countries, the use of denitrification tanks to eliminate nitrogen from the animal waste is being discussed. The question was raised whether the nitrogen resource is being efficiently used.

The main recommendations that came out of the conference were:

- Nitrogen losses have a major impact on the environment and overall crop production. Methods to minimise nitrogen losses should be developed and integrated into all farming practices.
- Using nitrogen-fixing crops food production can be enhanced. Nitrogen fixing crops can be easily integrated into the mixed farming systems. Further research to enhance biological nitrogen fixation and to modify plants for specific cropping-systems is required.

⇒ **The Fourth European Nitrogen Fixation Conference, 16 - 20 September 2000, Sevilla, Spain**

Gudni Hardarson participated at the Fourth European Nitrogen Fixation Conference and presented recent research findings on "Nitrogen Transfer from Legumes to Non-legumes" of the Soil Science Unit.

The European Nitrogen Fixation Conference is held every four years. The conference this year was attended by approximately 400 participants from developed and developing countries. The programme of the Conference included eight symposia on:

- Chemistry and biochemistry of nitrogen fixation
- Functional plant genomics
- Functional bacterial genomics
- Physiology and regulation of nitrogen fixation
- Free living nitrogen fixers
- Molecular *Rhizobium*-legume interaction
- Cooperation between the European Union and developing countries in the field of nitrogen fixation research
- Nitrogen fixation in sustainable agriculture and environment

Short analysis of trends in BNF Research

This analysis of trends in BNF research is based on the presentations of the conference and special issue published in Field Crop Research, Vol. 65, Issues 2-3, March 2000, on "*Applied Technologies in Biological Nitrogen Fixation*". The conference provided a good overview on the use of basic research, mostly molecular biology techniques, to understand the BNF process, whereas the FCR Issue summarised the applied aspects of the use of BNF.

It is appropriate to start with the words of Professors P. Graham and C.P. Vance of the University of Minnesota. *"Scientific discoveries over the last 30 years have revolutionised our knowledge of the basis for legume nodulation and nitrogen fixation. The function for many of the genes involved in these processes has been identified and the entire symbiotic plasmid of the promiscuously-nodulating NGR234 sequenced. The emphasis given this field is reflected in a spate of scientific publications with some 3000 articles on* Rhizobium *published since 1994. Despite this, progress at a field level has been minimal. There are still many parts of the world where inoculant quality is problematic or inoculants simply not available. Whereas plants provide up to 80% of the N used in the human diet of the tropics and subtropics, and beans, cowpea or mung beans are consumed daily when available, few of the studies mentioned above have impacted nodulation and nitrogen fixation by such crops at the field level. Improved N_2 fixation is rarely considered a breeding objective and the impacts of fertilisation, pesticide usage agronomic practice or land deterioration on nodulation and N_2 fixation are grossly understudied. With population increases of 1.4% annually projected, there appears to be a widening gulf between those who will have access to fertiliser N and those who will not. For the latter, applied research to improve nodulation and nitrogen fixation under field conditions will be critical to future agricultural productivity".*

Five of the eight symposia of the Fourth European Nitrogen Fixation Conference dealt with the chemistry, biochemistry, physiology, genetics and regulation of BNF. Molecular biology methods have made a major impact on our understanding of symbiotic nitrogen fixation. Most of the work done in this field could be considered as basic research, but the knowledge acquired can be used to make a concise effort to modify the symbionts with the main aim of enhancing BNF.

Some of the important findings reported at the meeting are mentioned below:

- Nodule development is governed by signal exchange between the two symbionts. Flavonoids exuded by the roots induce the expression of the *Rhizobium* nodulation genes whose product are involved in the synthesis and excretion of a family of structurally related lipochitooligosaccharides. These Nod factors induce Ca^{++} influx in root hairs which act as secondary messengers, evoking root hair deformation, cortical cell division and nodule organogenesis. Recently, several plant genes controlling nodule development were identified and described (Kondorosi *et al,* France).

- The broad host range *Rhizobium* sp NGR234 contains three replicons – a 536 kb symbiotic plasmid, a 2.2 Mb mega plasmid and a 3.5 Mb chromosome. The 536 kb plasmid has been completely sequenced and random sequence data exists for the other two replicons (Broughton *et al*, Switzerland).
- In soybeans, more than 30 nitrogen fixation and nodulation genes have been characterised. Physical and genetic maps of the chromosome reveal that they are clustered within a region of about 400 kb. Because of the complex interactions between the bacterium and plant, the chromosomal sector may contain additional genes that are involved in the maintenance of an efficient symbiosis. Therefore, its nucleotide sequence was determined (Gottfert, Hennecke *et al*, Germany and Switzerland).
- The improved genetic map of diploid alfalfa has been developed by analyzing the inheritance of more than 1500 genetic markers on 137 plant individuals of a F2 population. The genetic map of alfalfa in its present form contains eight morphological, 2 SSCP, 10 isozyme, 26 seed protein, more than 400 RFLP, more than 700 RAPD and 200 specific PCR markers in eight linkage groups (Kiss *et al*, Hungary).
- Grass-endophytic bacteria of the genus *Azoarcus* spp. were recently found to be naturally associated with rice. They were found most frequently and abundantly in wild rice species and land races of *Oryza sativa* mostly flooded from Nepal, where a high genetic diversity of rice in rather undisturbed environments can be found. The new isolates allowed the reamendment of the genus *Azoarcus sensus lato*, leading to the description of three new genera: *Azovibro restrictur, Azonexus fungiphilus* and *Azovibro oryzae*, the latter being most frequent in rice (Reinhold *et al*, Germany).
- Due to homologous recombination between reiterated rhizobial DNA sequences, the bacterial genomes are subject to different type of rearrangements, including deletions, amplifications, inversions and cointegration of different replicons (Palacios *et al*, Mexico).
- Maize and bean have been traditionally grown in association for thousands of years in Mesoamerica. *Rhizobium etli* strains which constitute the main symbiont nodulating beans are highly diverse and may harbor distinct symbiotic plasmids. Over 60 *Rhizobium* strains have been isolated from within maize plants grown in association with beans. These strains have been characterised as *R. etli* bv. *phaseoli* on the basis of several molecular patterns. The isolates were shown to recolonise maize plants in numbers ten-fold greater than those isolates normally recovered from bean nodules (Martinez-Romero *et al,* Mexico).

In short, there are plenty of new findings in the field of BNF research. However, the main task of FAO/IAEA would be to identify areas of research and development in BNF needed to increase sustainable crop production in developing countries, and this depends on the objectives to be achieved.

1. If the objective is to use BNF effectively to increase crop production in developing countries, this can certainly be done with present technology. The conditions for growing legumes are well known. Often inoculation with effective strains is necessary but very few countries produce quality inoculants. Quality assurance is very rarely implemented. Also, the extension people need to be made aware of the benefits of BNF for dissemination of information to the farmers. In this field there is a great need for improvement.
2. If the objective is to enhance BNF in those legumes in which the BNF is low, this can be done with existing technologies. The common bean may be taken as an example. It has a relatively low nitrogen fixation ability but is an important food crop in many developing countries. The FAO/IAEA Programme (1993) showed that there is a great variation among cultivars in their support for BNF. It was shown that BNF could be between 0 and 60% depending on the plant cultivar. There are basically three ways of enhancing BNF in grain legumes, i.e., to manipulate (i) the micro-organisms, (ii) the plant, or (iii) growing condition of the crop. Most of the work in the area of microbiology has shown limited success mainly due to the difficulties in identifying competitive strains which can out-compete indigenous bacteria. The research conducted at the FAO/IAEA using common bean showed that plant genotype or its nitrogen fixation supportive traits contribute more to the difference in BNF than any other factors. This approach was used in Brazil for improving BNF of soybean and now over 25 million tons of soybean are being produced annually on 11 million ha without any N fertiliser. The reason for this success story was that although soybean was bred mainly for criteria such as yield and pest resistance and not necessarily for BNF, inadvertently a selection occurred for efficient nitrogen fixation supportive traits, as the crops were always innoculated with effective rhizobial strains and no nitrogen fertiliser was applied. This approach can be used to improve other legumes in different regions. In addition to conventional breeding approaches, it is beneficial to explore modern molecular biology techniques to enhance BNF in grain legumes. Many of the genes involved in the BNF process have now been identified and can be manipulated to increase BNF. Although enhancement of BNF can be done by conventional methods, molecular approaches accelerate the process.
3. It is also important to explore BNF in other systems. The most promising area is the newly discovered endophytic nitrogen fixation within the stems, leaves and roots of cereals, forage grasses, oil palms and especially sugar cane, which may in the future contribute substantial amounts of fixed N to these crops than associative fixation (max. 10% contribution) in the rhizosphere . It has been reported that in Brazil sugarcane is able to fix 30 –70% of its nitrogen requirement through endophytic nitrogen fixation. This is an area with great potential for research and isotope techniques will be a valuable tool to quantify the contribution of endophytic nitrogen fixation to N nutrition of crops.

Graham and Vance (Field Crop Research Issue, mentioned above) recently reviewed the main research imperatives in the field of N_2 fixation and provided an overview of the following six research areas believed to be critical for the improvement of N_2 fixation:

1. Plant improvement. Significant variation in nitrogen fixation supportive traits has been found in most legumes. Further research is needed to explore these characteristics for improving BNF.
2. Use of acid-tolerant legume cultivars and rhizobia in the management of acid soils in temperate and tropical regions, where liming is not possible to alleviate aluminium and manganese toxicity.

3. Phosphorus supply and utilisation. Considering the importance of adequate P supply for symbiosis, it is important to investigate approaches for improving P acquisition by plants.
4. Crop rotation and N_2 fixation. Alternative approaches for integrating legumes into cropping systems are needed to be investigated to optimise the benefits of BNF to crop nutrition.
5. Soil degradation, desertification and salinisation. Many legumes can be used in the remediation of degraded lands including salt affected soils, or for erosion control, but more research is needed in this area.
6. Strain and inoculant improvement. More work is needed on the production of high quality inoculants.

The same authors have reviewed the role of biotechnology in the improvement of BNF. They summarised that although the direct molecular modification of host plant or microsymbiont has not yet shown any promising results on improvement of N_2 fixation at the field level, several approaches offer promise, including:

1. Host transformation to modify host range for rhizobial nodulation.
2. Host modification to synthesise opines.
3. Genetic transformation of plants for enhanced malate dehydrogenase (MDH) synthesis in roots and nodules.
4. Random amplification of symbiotic plasmid.

Agricultural dependence on N_2 fixation has declined in recent years, probably due to the availability of cheap N fertilisers and other factors. The decline is most obvious under intensive agricultural production in developed countries. However, N_2 fixation will remain as the dominant N input into farming systems in developing countries. It is, and will be, a key to integrated nutrient management in developing Member States.

⇒ **International Symposium on Balanced Nutrient Management Systems for the Moist Savanna, Cotonou, 9 - 12 October 2000, Benin**

Rebecca Hood attended the International symposium on Balanced Nutrient Management Systems for the Moist Savanna, Cotonou, Benin, 9-12 October 2000 and delivered an oral presentation on "Estimating plant N uptake from organic residues using a new approach to the ^{15}N isotope dilution technique". The conference was organised by IITA and Leuven University. Over 100 participants from Africa and Europe attended.

The main themes of the conference were:

- Soil processes determining nutrient dynamics in particular nitrogen and phosphorus, modelling nutrient fluxes in tropical farming systems.
- Interaction between organic and inorganic nutrient sources, functions of soil organic matter.
- Improved utilisation of rock phosphate, capitilisation of soil P.
- Variability in biophysical and socio-economic factors and its consequences for selection of representative areas for nutrient balance experiments, possibilities and techniques for extrapolation.

- Decision support systems to improve fertiliser use efficiency at farm level.
- On farm testing of technologies improving the soil nutrient balance.

Several keynote addresses were presented:

Professor Pedro Sanchez, ICRAF (International Centre for Agroforestry Research), Kenya stated that "Declining soil fertility is the major constraint to attaining agricultural and economic development in Africa." He stressed that many African countries are still strongly dependent on subsistence farming and that the only way out of this poverty cycle is to promote the idea of "Nitrogen from the air (i.e. biological nitrogen fixation) and phosphorus from the bag". The importance of integrated nutrient management practices was highlighted. He showed evidence for many successful programmes of ICRAF, in particular the progress made with the improved fallow systems.

Professor Dudal (Leuven University) detailed the efforts of the FAO's Freedom-from-Hunger Campaign. It has not been as successful as hoped in Sub-Saharan Africa due to low land pressure and lack of economic incentives. He highlighted that this has led to persistent mining of soil nutrients, and stressed the need for an integrated or balanced nutrient management approach. The soil management practices for improving soil fertility must be within the investment horizon of the farmers.

Professor Roel Merckx (Leuven University) highlighted that much of the advancement in our knowledge and improved soil management practices over the past 20 years have been developed with the aid of isotope techniques, in particular in the areas of nitrogen fixation and organic matter studies. He stressed the need for process based studies to investigate the complex soil interactions.

Professor Ken Giller (University of Zimbabwe) introduced the concept of "feeding the rotation" using inorganic fertilisers mainly P, to maximise the N fixation capacity of the legumes within the rotation and thus boosting the overall productivity of the cropping system.

Professor Mokwunye (UN University, Accra) argued that phosphate rocks (PRs) can contribute both in the short and long term to P capital replenishment. He highlighted that West Africa has an excellent potential in supplying of PRs. It was however, highlighted in the discussions that there is a significant lack of availability of rock P throughout Africa, in many cases due to administrative problems or lack of government policy to facilitate the availability of PRs.

Professor Eric Smaling (Wageningen University) stressed that soil nutrient depletion is one of the major constraints to food security in sub-Saharan Africa and the need for sustainable integrated nutrient management systems to secure food production. He proposed the add-save-recycle philosophy, add fertiliser, save nutrients by improved erosion control, reduced nutrient losses etc. and recycle nutrients using manures, no till etc. He highlighted how improved knowledge has led to better management of cropping systems and pointed out further research is required in the areas of nutrient losses and turnover in tropical systems.

The main conclusions from the conference were:

- Integrated soil nutrient management is the only practical way of achieving food security in sub-Saharan Africa.

- Soil fertility re-capitalisation should be based on the concept of "Nitrogen from the air, phosphorus from the bag".
- The strategy of "feed the rotation" to maximise the N input from the legume and maximise the output of the cropping system should be promoted, as well as "add-save-recycle" approach.
- The process based research, in particular using stable isotopes, must be promoted to improve knowledge and understanding of complex soil interactions. The acquired knowledge should be utilized to identify management strategies that can be implemented at farmers' level.

⇒ 11TH Conference of the International Soil Conservation Organisation, ISCO-2000, 27 - 28 October 2000, Buenos Aires, Argentina

This Conference was organised by the National Institute of Agricultural Technology (INTA) and the Faculty of Agronomy of the University of Buenos Aires (FAUBA). Participants representing sixty countries attended the meeting and the total number of participants was 524.

The meeting focused on "Land Conservation and Food Production in the Third Milennium". The programme comprised Plenary sessions, round table, oral and poster presentation sessions with the following main themes:

- **Theme I:** Land degradation processes: extension and intensity. The challenge of the new causes of degradation and desertification.
- **Theme II:** Scientific and technological advances for environmental protection and sustainable land use.
- **Theme III:** Socio-economic factors of human intervention and their consequences on food production and the environment.
- **Theme IV:** Policies for environment conservation in a global society. Scientific co-operation, education and extension. Communication media.

At the plenary session review papers were presented covering a wide range of issues related to land degradation, such as desertification, erosion, climate change, technology and sustainable management of agriculture and agroforestry, carbon sequestration, soil and environmental quality conservation, socio-economic factors and sustainable development, and conservation policies of natural resources.

F. Zapata delivered an oral presentation co-authored with P.M. Chalk entitled "The role of nuclear-based techniques in the development of integrated soil, water and nutrient management for sustainable intensification of agricultural production and arresting soil degradation", highlighting the activities of the Sub-programme. Relevant IAEA publications (TECDOCs, flyers from TCPs, information brochures of the Joint FAO/IAEA Division) were displayed.

Upon request of the Organizing Committee, F. Zapata chaired the session of oral presentations on "Processes of erosion and degradation. Evaluation. Methods of control ".

Dr. Sally Bunning, AGL, FAO was the main speaker at the Special Session on "Sustainable Land Management and Synergies among Diverse Processes and Actions: FAO's Strategy and Thrusts". She stressed the complementarity of several FAO activities such as the Special Programme for Food Security and the Soil Fertility Initiative with those undertaken

under several UN Conventions: Convention for Biodiversity (CBD), Framework to Control Climate Change (CCC), Convention for Combating Desertification (CCC). Proposals were made for co-ordination of operational programmes, exchange of experiences and collaboration, and strengthening of soil and water conservation actions.

The concluding session of the conference was focused on Needs, Options and Constraints for an International Convention on Soil. These points were thoroughly discussed. It was also recalled that chapters 10 through 14 of the Agenda 21 are related to land degradation. In this regard, a working group on "International Actions for Sustainable Use of Soils" that has been constituted by the International Union of Soil Sciences presented an agenda for the preparation of a proposal on Global Soil Convention.

Estimates from the Global Assessment of Human-induced Soil Degradation (GLASOD) revealed that one third of the agricultural soils or 2 billion ha. are affected by several types of soil degradation, of which 84% by wind and water erosion.

According to UNEP, 75% of drylands are affected by desertification. In Africa, this process is exacerbated by human activities such as overgrazing, deforestation, and mismanagement causing a serious threat to food security in many countries of this continent. Most land in Latin America and Asia is becoming unproductive due to increasing desertification.

Summary of the major points discussed at the conference:

- Pressing issues for the 21st Century will be population growth, soil degradation, per capita land and water availability, and climate change due to increasing CO_2 concentration.
- There was a general consensus about the inter-relationship between the several land degradation processes, productivity, sustainable management, soil quality and environmental protection. This calls for synergies between the Conventions mentioned above and the development of common strategies and inter-institutional co-operation with specific objectives.
- An integrated hydrological approach (watershed level) should be adopted for development and application of soil and water conservation technologies.
- New soil and water conservation strategies should also consider environmental issues such as C sequestration, climate change and water quality.
- Development of simulation/prediction models based on climatic factors, including extreme events and replacement of empirical-process based event models.
- Formation of human resources at all levels, capacity building and raising public awareness on aspects of soil degradation and their implications.
- The urgent need for simple and cost-effective methodologies for evaluating soil degradation processes and monitoring the performance of the soil and water conservation technologies. Few papers (1%) were presented on this topic.
- An integrated, participatory approach (farmers, educational and research institutes, industry, government) is required for optimising priorities and harmonising actions. Also, for the development and adoption of technologies, strategies and policies, considering cultural, socio-economic and political factors.
- The International Soil Conservation Organisation decided to reorganise its Committee, and to utilise modern communication media to create public awareness worldwide on the need for soil and water conservation. The next Conference on Sustainable Utilisation of Global

Soil and Water Resources will be held in China, 26-31 May 2002 and the Conference of 2004 is anticipated to be held in Africa.

E. STATUS OF CO-ORDINATED RESEARCH PROJECTS

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

Participating in this CRP are nine contract holders: K. Aihou (Benin), B. Zhang (China), C. Ovalle Molina (Chile), C. Cervantes (Costa Rica), J.M. Ndufa (Kenya), Z. Rahman (Malaysia), S. Nissanka (Sri Lanka), P. Ebanyat (Uganda) and R. Chintu (Zambia); and five agreement holders: M. Adams (Australia), S. Recous (France), L. Verchot (ICRAF-Kenya), N. Sanginga (IITA-Nigeria) and M. Smith (UK). All contract holders have initiated field experiments in accordance with the work plan and experimental guidelines established at the first RCM which was held in Vienna from 19 - 23 April 1999. The second RCM will be held in Kuala Lumpur, Malaysia from 7 – 11 May 2001.

⇒ **Use of Isotope Techniques in Studies on the Management of Organic Matter and Nutrient Turnover for Increased, Sustainable Agricultural Production and Environmental Preservation**
Project Officer: G. Keerthisinghe

This CRP is in the final phase of implementation, 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) and Phan thi Cong (Viet Nam); and five agreement holders: D.F. Herridge (Australia), R. Merckx (Belgium), O.P. Rupela (ICRISAT-India), C. van Kessel (USA) and D.S. Powlson (UK). The progress of the project was evaluated at the third RCM which was held in Rabat, Morocco from 6 - 10 September 1999. All contract holders have field studies under way to determine the role of residue management practices in crop production and soil fertility. Dr. Dourado-Neto, University of São Paulo, has been awarded a technical contract to evaluate the data of the project using different models to obtain information for the development of effective residue management practices for a wide range of environments. The overall progress and significant achievements of the project will be reviewed and discussed at the final RCM which will be held in Seradang, Malaysia from 26 –30 March 2001.

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

Technical editing and proof-reading of the manuscripts submitted for publication are continuing. Currently 50 papers or about 450 pages have already been edited by Frank Sikora, University of Kentucky, USA. A balance of 20 papers remain to be completed by the end of the year. All manuscripts will be collated for the production of an IAEA TECDOC. In addition, 11 selected manuscripts have been submitted to the journal Nutrient Cycling in Agro-Ecosystems to be published as a special issue. They have gone through the process of peer-review and about 50% have been already accepted for publication.

In addition to the collaborative work between IFDC/Joint FAO/IAEA Programme undertaken to test and validate a phosphate model utilizing the data from the Phosphate CRP, work has started to develop a decision support system for direct application of phosphate

rocks (PRs). Ms. L.K. Heng and F. Zapata (from the Sub-programme) and Norman Chien (IFDC) are involved in implementing this task.

Also, within the frame of the Integrated Plant Nutrition Systems promoted by the Land and Water Development Division (AGL), FAO, Rome, and the National Action Plans for soil productivity improvement under the Soil Fertility Initiative (SFI) for Sub-Saharan countries, PRs are considered as an important source of locally available P which can be effectively used for P fertilisation. There is, however, a need for a comprehensive review and assessment to provide practical guidelines for the direct application of PRs as a source of P to soils of the tropics and sub-tropics considering the socio-economic and environmental issues and concerns. With this in mind, AGE and AGL decided to join efforts in the production of a bulletin covering aspects pertaining to promote direct application of PRs. F. Zapata (AGE) and R.N. Roy (AGL) are the coordinators. Extensive research has been carried out worldwide on the agronomic potential and effectiveness of PRs and a wealth of information is available but scattered in several publications and reports. Thus, there is a need for a comprehensive review and assessment to provide practical guidelines for the direct application of PRs as a source of P to soils of the tropics and sub-tropics considering the socio-economic and environmental issues and concerns.

A Consultants' Meeting on "Preparation of a proposal for a Joint AGL/AGE Bulletin on direct application of phosphate rocks" was held at IAEA Headquarters, Vienna from 27 - 29 November 2000. Three leading internationally recognized consultants with expertise in phosphate rock utilization, Dr. S.H. Chien (IFDC), Dr. Truong Binh (formerly CIRAD), and Dr. P. Sale (University La Trobe, Melbourne, Australia) and FAO/IAEA staff (F. Zapata, R.N. Roy and L.K. Heng) attended the meeting. The participants presented reviews of the situation regarding studies on the direct application of phosphate rocks in agriculture, including the activities of the FAO/IAEA Co-ordinated Research Project on "The use of nuclear and related techniques for evaluating the agronomic effectiveness on P fertilizers, in particular phosphate rocks". Thereafter, the panel reviewed the tentative outline of the contents of the Bulletin and developed a full proposal for preparation of a Technical Bulletin on direct application of phosphate rocks. The consultants agreed on the following recommendations:

a) Preparation of a FAO Technical Bulletin on direct application of PRs for sustainable agriculture according to the proposal developed at the meeting.
b) Dissemination of information on the same topic through FAO and IAEA web-pages and preparation of a brochure.

A report on the meeting is available upon request from the Scientific Secretary, F. Zapata.

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

This project is its final phase of implementation and it will be finalised in May 2001 (Refer to future events). This CRP currently has sixteen participants, of whom eleven are research contract holders: A. Buján (Argentina), O. Bacchi (Brazil), A.Ellies (Chile), X. Zhang (People's Republic of China), Yong Li (People's Republic of China), S. Theocharopoulos (Greece), B. Damnati (Morocco), I. Ionita (Romania), V. Golosov (Russian

Federation), F. Fulajtar (Slovakia) and H. Nemasasi (Zimbabwe); two are technical contract holders: D.E. Walling (UK) and P. Wallbrink (Australia); and three are agreement holders: D.Pennock (Canada), J. Ritchie (USA) and F. Penning de Vries (IBSRAM-Thailand).

A general recommendation made during the Third RCM held in Barcelona, October 1999, was to complete the work plan of the project. Activities since then have focused on the following: a) detailed sampling of the reference sites and study areas, b) finalise Cs-137 analyses of samples collected, c) further testing of calibration models, d) gathering relevant information on climate, geology, land use, soil types and management, etc., and e) analysing the agricultural and environmental implications of the work done (soil conservation, sustainable production and environmental protection). The research results will be documented in the manuscripts for publication in a scientific journal. In addition, all participants will be requested to send a final report of the work conducted during the total duration of the project and a summary highlighting the major achievements.

The arrangements for the production of the handbook on the Cs-137 technique have been finalised and the contributing authors have started their work. It is expected that the first draft of all chapters will be ready by March 2001. The final publication will be made by Kluwer Academic Publishers.

In connection with the planning of future activities related to sedimentation and water resources management, the Isotope Hydrology Section organised an Advisory Group Meeting (AGM) on "Sediment tracing (finger-printing) by nuclear techniques and their application to the planning and design of erosion and sedimentation remediation strategies and the assessment of their effectiveness with emphasis on dam sustainability", Vienna, 10 - 12 October 2000. It was recommended to initiate a CRP on the topic with emphasis on sustainable water-shed management. Linkage to the IAEA TC program and other institutions was also recommended. Catchments in China and India have been identified as flagship sites.

The logical continuation of the Soil Erosion CRP will be activities in the field of Soil and Water Conservation. Therefore, a Consultants Meeting is planned to initiate a CRP on Soil Conservation in 2003 (refer to Consultants Meetings). A proposal has been also submitted to the IAEA for a Regional Technical Co-operation Project in Asia and the Pacific for consideration in the biennium 2003-2004.

⇒ **The Use of Nuclear and Related Techniques in the Management of Nutrients and Water in Rainfed Arid and Semi-arid Areas for Increasing Crop Production**
Project Officer: P. Moutonnet
Next Project Officer (1 July 2001): L. Heng

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

Laboratories. Plant and soil samples from the 1999-2000 cropping season were collected and analyzed. The third RCM will be held in Vienna, from 17 – 21 September 2001.

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

The implementation of this CRP started at the end of 1999 and the first RCM was held in Vienna, June 2000 (refer to Past Events). The recruitment process of the project has been completed. Participants in this CRP are eight research contract holders: P. Houngnandan (Benin), S. Urquiaga (Brazil), T. Muraoka (Brazil), V. Bado (Burkina Faso), A. García (Cuba), J.J. Peña-Cabriales (Mexico), E. Iwafuor (Nigeria), and M. Lopez (Venezuela); one technical contract holder: P. Randall (Australia), and five agreement holders: R. Thomas (CIAT-Colombia), W. Horst (Germany), S.H. Chien (IFDC-USA), B. Vanlauwe (IITA-Nigeria), and K. Sahrawat (WARDA-Cote d'Ivoire). All contract holders have initiated their greenhouse and field experiments in accordance with the work plan of the CRP. Guidelines and research protocols were established during the first RCM. All this information is available in the report of the first RCM. The second RCM is scheduled for February 2002 in Brasilia, Brazil.

F. NEW FAO/IAEA CO-ORDINATED RESEARCH PROJECT

⇒ Integrated Soil, Water and Nutrient Management for Sustainable Rice-Wheat Cropping Systems in Asia

Background

The one billion people living in South Asia rely on rice and wheat for a large portion of their daily caloric requirement: about three-fourths of the regional food grain requirement is now supplied by rice and wheat, and that proportion is rising. The rice-wheat production system in the Asian subtropics occupies nearly 12 million ha in South Asia and another 10 million ha in Central China. These two staples are commonly grown in rotation, with rice in the monsoon months and wheat in the cooler winter months. Production of these crops must increase by at least 3% per annum to meet the growing demand due to population increase and rising incomes, while maintaining the integrity of the resource base. During 1960-1990, rice and wheat made a substantial contribution to meeting that increasing food requirement. However, the previous gains in per capita cereal production from this cropping system are now threatened by stagnant yields of both rice and wheat crops and a declining trend in total factor productivity over the last decade. The decline in soil organic matter, the lowering of groundwater tables, and the build up of insect pests and disease are indicators of the threat to the ecological sustainability of the system.

To understand the processes governing the sustainability of the natural resource base and to develop strategies and tools to preserve and improve the system, IRRI, CIMMYT, and NARS commenced joint research (in a consortium mode) to raise the long-term productivity and profitability of rice-wheat systems in South Asia. Production statistics and trends for the region are being collected and synthesised (and data bases and site characterisation captured through GIS), and efforts made to monitor and quantify system sustainability on farmers' land; system constraints are being identified, and ameliorative technologies are being adapted, developed, and evaluated, with a corresponding expansion of knowledge of soil, water, crop, and system management and processes; NARS systems-research teams have been strengthened and have been empowered to interact collectively. In addition to these efforts, national funding agencies and institutions in developed countries (e.g. USAID, ACIAR), recognising the importance of sustainable cereal production in these intensive systems in developing countries, are supporting research through bilateral and multilateral agreements.

In a Rice-Wheat Consortium Workshop on Nutrient Management Research (21 – 23 September 1995) organised by IRRI, the participants cited the following main soil fertility related issues:

- Organic matter (OM) decline
- Residue management
- Decreased nutrient supply capacity
- Declining soil quality/heath
- Micro-nutrient deficiencies
- Nutrient imbalances
- Declining yields

Many of the factors listed above are interrelated. Low and declining organic matter is a characteristic of soils of the rice-wheat belt. Organic matter is important for the supply of N, P and S through mineralisation and the retention of some micronutrient elements, enhanced cation exchange capacity, favourable water relations, and aggregate stability. Although soil physical properties and associated water relations are generally more important for wheat, they are also critical for rice in the lighter-textured soils prevalent in large areas of the R-W system. There is a demonstrated need for research at both strategic and applied levels involving a holistic approach to arrest OM decline and maintain soil fertility on a sustainable basis. Research to improve nutrient management by better matching of soil nutrient supply with crop demand under conditions of fluctuating water availability would result in increased nutrient and water use efficiencies.

Farmers in the rice-wheat area are changing the traditional cultivation practices of bunding and puddling. Direct seeded rice, sown onto leveled fields without puddling, is increasing in popularity throughout the region. This results in savings in both time and labor in the planting of the rice crop and in a better wheat crop that follows rice. It is estimated that no-till wheat was planted on 8 000 ha in India and 5 000 ha in Pakistan this year. Similarly, direct sown wheat saves labour and fuel while at the same time yields increase because the sowing date can be advanced closer to the optimum. The availability of a suitable seed drill has made this possible. In addition, the planting of wheat on raised beds has been made possible by the local manufacture of a dual-purpose bed maker-planter. Farmers report water savings, easier irrigation, less reliance on herbicides for weed control, less lodging and better growth.

Experiments in Nepal have shown considerable benefits from mulching with rice straw and the increase in mechanisation may increase the supply of straw as ruminants consume less. These innovations offer the possibility to improve water, soil and nutrient management to increase productivity and resource use efficiency.

Overall objective

To improve the productivity and sustainability of rice-wheat cropping systems through increased efficiency of water and nutrient use.

Specific research objective

To modify existing water and nutrient management systems, and improve soil management in both traditional and emerging (raised beds, non-puddled soil, direct seeding) tillage systems, for sustainable intensification of cereal production.

Expected research outputs

- Recommendations for improved soil, water and nutrient management in rice-wheat systems.
- Means to extrapolate experimental findings across the system.
- NARS capacity to conduct integrated soil, water and nutrient management studies with the aid of nuclear techniques enhanced.
- Research findings communicated to the wider community.

Site/partner selection

Preference will be given to scientists already conducting research in the rice-wheat system so that the planned activities in the CRP can be integrated into existing experiments. Research will be conducted on the impact of changed soil management practices (direct seeding, bed planting, non-puddled rice soils) on the interaction between soil water and plant nutrients, particularly nitrogen, potassium, sulfur, boron and zinc. Experience in the use of nuclear techniques to study water balance and nutrient dynamics will be required.

It is anticipated that project activities will be closely co-ordinated with those of the Rice-wheat Consortium (RWC) involving multi-institutional collaborators from rice-wheat growing countries and International Agricultural Research Centers (IRRI and CIMMYT). The financial assistance offered by the Agency will enable the NARS to apply both nuclear-based and non-nuclear methodologies to complement and add value to their on-going work through the collection of precise data and information on nutrient, carbon and water dynamics in rice-wheat systems, leading to knowledge-based improvements in soil, water and nutrient management practices. An additional important function is to bring together through research co-ordination meetings the NARS contract holders, and agreement holders drawn from international agencies and advanced research institutes who are actively working in rice-wheat systems supported by various funding agencies.

Research contracts

Contracts with research institutions from developing countries will be awarded for an initial period of one year on the basis of technically sound and innovative proposals from IAEA or FAO Member States. **The deadline for receipt of proposals is 30th June 2001** but applicants are encouraged to apply as soon as possible. Contracts are renewed on an annual basis subject to satisfactory performance. The project duration is normally 5 years. Contracts will provide financial support up to US $ 9 000 per annum. The Soil Science Unit at Seibersdorf, Austria, will provide additional support for isotope analyses if required. The contracts follow an agreed work plan and are awarded on a cost-sharing basis. i.e. the participating institution is expected to provide support to achieve the project objectives. It is anticipated that 7 contracts will be awarded commensurate with areas planted to rice-wheat in South Asia and China. i.e. India (2), China (2), Bangladesh (1), Pakistan (1) and Nepal (1). One Technical Contract of up to US $9,000 may also be awarded each year to respond to specific needs identified at the first or subsequent RCMs.

Research Contract Proposal forms can be obtained from the Research Contracts Administration Section, IAEA, Vienna, National Atomic Energy Authorities, UNDP offices or from the web at http://www.iaea.org/programmes/ri/uc.html They must be countersigned by the Head of the Institution and submitted to the Research Contracts Administration Section, IAEA, Vienna. It is not necessary to route them through any other official channels.

Research agreements

Scientists of international standing who have active research programmes or relevant experience in rice-wheat cropping systems in South Asia and China are invited to apply for participation in the CRP as research Agreement Holders. No financial remuneration will be provided except for paid expenses when invited to participate in Research Co-ordination Meetings. It is anticipated that 5 research agreements will be awarded. Research Agreement

Proposal forms can be obtained from the web at http://www.iaea.org/programmes/ri/uc.html **and should be received before the deadline of 30th June 2001** at the Research Contracts Administration Section, IAEA, Vienna.

Evaluation of proposals

It is essential that high scientific standards be maintained with respect to each contract/agreement. The following major points will be considered when evaluating proposals:

- The relationship of the proposal to the approved CRP.
- The competence of the Chief Scientific Investigator.
- The scientific merit of the proposal, including the experimental design and methods proposed.
- The relationship of the proposal to on-going work in the rice wheat system.
- Links with the rice-wheat consortium, CG Centers and advanced research institutes.
- Institutional support including staffing and facilities.
- The justification for and accuracy of estimates of proposed items of expenditure.

Research Co-ordination Meetings (RCMs)

The first RCM is scheduled for March 2002 in Vienna, and every 18 months thereafter in locations to be determined within the rice-wheat cropping system. A 1-week training workshop for contract holders will be held at the Seibersdorf laboratories immediately following the first RCM. A total of four RCMs are planned during the duration of the project. All contract and agreement holders are expected to participate in each RCM. The cost of attending an RCM will be met by the Agency over and above the amount awarded for research contracts.

Complementary support

Complementary support for developing country partners for the purchase of equipment and supplies, fellowship training, expert missions, scientific visits and training workshops may be obtained from the Agency's Technical Co-operation (TC) Programme. Proposals for TC Projects should be made on the appropriate forms available from the TC Department, IAEA, Vienna, National Atomic Energy Authorities or the web at http://www-tc.iaea.org/tcweb/tcprocedures/projectproposals/tcprefsform_en.htm. Applications for the next biennium (2003-2004) are due at the Agency **no later than 31st December 2001** and must be routed through National Atomic Energy Authorities.

G. LABORATORY ACTIVITIES

RESEARCH

⇒ Experimental Work in Progress

- **From Paddock to Particle**

Nelly Blair, Visiting Scientist at Austrian Research Centers and FAO/IAEA Laboratory, Seibersdorf from Agronomy and Soil Science, University of New England, Armidale, Australia

Grain production is of major agricultural importance in Australia where much of the land has been developed from forest or natural grassland. Agricultural development of native lands has lead to a marked decline in soil organic matter (SOM) throughout the world. This contributes both to global warming via CO_2 evolution from the soil as the SOM mineralises and to a decline in both physical and chemical fertility of the soil. A survey carried out by the Soil Conservation Service of NSW in 1987-88 showed that 18.3% of the state of NSW, Australia suffered from soil structural decline. It is necessary to ensure that Australian agriculture is not only sustainable but also productive. Soil structural decline and aggregate breakdown can result in surface sealing, hardsetting, compaction, reduced water infiltration and increased surface runoff and soil erosion. Plant growth can be affected by structural decline. The most obvious effect is on root growth. If the soil is compacted, with few pores for roots to pass through, root growth can be severely reduced. The development of surface seals through aggregate breakdown can pose considerable mechanical impedance to seedling emergence. Improvement in soil structure can result in increased yields through improved plant growth, better soil water relations, higher infiltration and reduced run-off and erosion risk. This has the potential to reduce the possibility of pesticide and herbicide residues and soil and nutrients leaving the farm and entering waterways and thus lessoning the environmental impact of agriculture.

This study is being funded by the Grains Research and Development Corporation (GRDC) in Australia and by the Australian Institute of Nuclear Science and Engineering (AINSE) with support from the Austrian Research Centers and FAO/IAEA.

It can often be difficult to study the impact of newly added plant materials on the soil system because of the large background of residual soil C. However by using labelled plant residues it is possible to trace these materials through the soil and investigate the effect they have on soil chemical and physical fertility.

A rotation trial was established in 1966 on a Red Clay (Chromic vertisol) and a Black Earth (Pellic vertisol) soils near Tamworth, New South Wales, Australia. Rotations included lucerne/wheat (L), clover/wheat (CV), medic/wheat (M), grain legume/wheat (GL), continuous wheat (CW) and long fallow/wheat (LF). In February 2000, *in situ* hydraulic conductivity (K) was determined for the different rotations and on a nearby pasture soil (reference soil) using automated tension infiltrometers. Following determination of K, soil samples were collected from 0-100 mm from directly under the infiltrometers. A sub-sample of this soil was used for determination of wet aggregate stability using a wet sieving technique

and total C (C_T), labile C (C_L) (by oxidation with 333 mM $KMnO_4$) and total N (N_T) concentrations.

At Seibersdorf soil samples collected from the CV and LF rotations of the Tamworth field trial, and brought from Australia, are being used for an incubation experiment to study the impact of plant residues on soil C dynamics and aggregation. Plant materials (flemingia (*Flemingia macrophylla*), medic (*Medicago trunculata*) and rice (*Oryza sativa*) straw) labelled with $^{14}C/^{13}C$ and ^{15}N were incorporated into the soil at a rate equivalent to 5 t/ha, along with a no residue control. The soil samples are being incubated at 30°C day/20°C night at 75% of field capacity for 10, 20, 60 and 200 days. Following incubation C_T, C_L, N_T, ^{13}C and ^{15}N, along with wet aggregate stability are being determined. These results will enable the determination of the amount of C from the newly added plant material that is in the soil system and how it is influencing soil aggregation. It is also planned to develop a technique to determine the contribution of these newly added plant residues to the labile C as determined by oxidation with 333 mM $KMnO_4$. This work will be conducted in collaboration with Rebecca Hood.

An Agriculex SAE-1 Soil Aggregate Eroding machine located at Seibersdorf is being used to locate the newly added residue C within concentric layers of the soil aggregates. This technique involves slowly eroding the outside off soil aggregates and determining C_T, C_L, N_T, ^{13}C and ^{15}N on the different layers eroded from the aggregates. Thus it will be possible to determine where the labelled plant materials are located within the newly formed soil aggregates.

Investigations will be conducted using Secondary Ion Mass Spectrometry (SIMS) to locate the ^{13}C labelled organic matter within the soil aggregates. Soil aggregates will be set in resin and thin sectioned to study using this technique. This work will be carried out at the SIMS located at the Australian Nuclear Science and Technology Organisation (ANSTO) in collaboration with Dr Katherine Prince. Preliminary investigations have shown the presence of some labeled materials within soil aggregates.

An auto-radiography technique will also be used to determine the presence of ^{14}C within the same soil aggregates as studied using the SIMS. This uses a technique where the same thin sectioned aggregates are dipped in a photo emulsion sensitive to ^{14}C, the emulsion will be developed and the presence of silver grains determined using an electron microprobe which is located at the University of New England, Australia. This will allow the comparison of the two techniques.

The results from this investigation will allow the determination of the influence of newly added plant residues on the soil system, in particular soil C dynamics and soil aggregation.

- **Cycling of carbon, sulfur and nitrogen in animal based systems**

Graeme Blair[1] and Mirta Matijevic
[1] Visiting Scientist at Seibersdorf Laboratory from Agronomy and Soil Science, University of New England, Armidale Australia

Studies using fertilisers, crop residues and/or animal wastes have generally focused on the yield response and nutrient uptake to various combinations of inputs with little or no

measurement of nutrient cycling. To accurately assess the sustainability of the system, carbon and nutrient dynamics must be studied together. It has become apparent that management of residues, manures and fertiliser to optimise the efficiency of nutrient use by crops can only be achieved on the basis of a detailed understanding of the processes regulating nutrient transfer and partitioning between the added materials, the soil, plants and animals. Increasingly studies of interactions between nutrients rather than single nutrient studies are becoming important as systems intensify and a wider range of nutrients are added to systems.

Because of the large background of nutrients present in integrated livestock/crop systems, and the relatively small additions of nutrients made in fertilisers, animal wastes and/or crop residues it is almost impossible to follow the fate of the applied nutrients without the use of tracers.

In order to study the primary and interaction effects of nutrients in the plant/animal/soil system it is necessary to produce multi-labelled plant material. Stable isotopes such as ^{13}C, ^{15}N and ^{34}S offer the prospect of replacing radioactive isotopes, or being used in combination with radioactive isotopes, to minimise the perceived risks and/or to allow the tracing of the components in the system. A protocol to be used in the CRP is being developed at Seibersdorf to produce multi-labelled forage.

Preliminary experiments have been conducted to trial a double-pot nutrient solution system to produce the labelled forage. This system utilises a balanced nutrient solution contained in a lower pot, which is fed to an upper pot via an uncut cigarette filter, which acts as a wick. The potting medium in the upper pot holds the plants. The solution is balanced in terms of cations and anions so the solution pH does not change during the experiment. The advantage of this system is that ^{15}N and ^{34}S can be added to the nutrient solution to maximise uptake and ensure uniform labelling.

The Seibersdorf laboratory has an excellent Conviron S10H controlled environment cabinet fitted with a CO_2 monitor and controller. This cabinet has been successfully trailed to administer $^{13}CO_2$ to plants. Lucerne (*Medicago sativa*) will be grown in sand and a complete nutrient solution, containing ^{15}N and the stable S isotope ^{34}S, will be supplied to the plants via the wick system. Labelled $^{13}CO_2$ will be generated inside the chamber by the reaction of $Na_2{}^{13}CO_3$ with lactic acid and circulated via the air system. The level of CO_2 within the chamber will be monitored by the Horibor monitor installed in the cabinet. The CO_2 concentration inside the chamber will be allowed to drop from 350 to 300 ppm before the $^{13}CO_2$ pulse is introduced. When the CO_2 concentration declines to approximately 180 ppm due to photosynthesis, and becomes steady, $^{12}CO_2$ will be introduced into the chamber from a gas cylinder to return the concentration to 350 ppm. Sequential $^{12}CO_2$ pulsing will be continued for the rest of the day. The frequency of labelling will be increased from once a week, to four times a week as the plant biomass increases. This system of ^{13}C labelling has been used by Pearl Sanchez at the University of New England (see "Production of Labelled Plant Materials to Trace the Fate of Residue Derived Carbon, Nitrogen and Sulfur" Basilio-Sanchez et al (2000), Proceedings of the International Symposium on Nuclear Techniques in Integrated Plant Nutrient, Water and soil Management held at IAEA Vienna, September, 2000).

The lucerne will be harvested and fed to rabbits. The dung and urine will be collected and these, and the original plant material will be applied to pots and the fate of the ^{13}C, ^{34}S and ^{15}N followed in a subsequent crop of wheat.

The protocol developed here will form the basis for the production of larger quantities of multi-labelled forage to be used in subsequent studies.

- **Indirect ^{15}N methodology for measuring N release from manures and complex organic residues**

Field experiments to investigate the N contribution of sewage sludge and other manures to N nutrition of crops have been initiated using the new indirect methodology developed at the Soils Unit, while pilot studies in Kenya and Malaysia to test the indirect methodology for measuring N release from manures and complex organic residues continue.

- **Below ground carbon sequestration**

Maize plants have been grown under different temperature and fertilizer regimes in the glasshouse and C input and carbon breakdown are being measured by the shift in the δ^{13}C signature of the soil. Experiments are in progress to investigate the role of soluble organic carbon in N mineralisation using ^{13}C micro-respiration chambers and ^{15}N gross mineralisation techniques.

- **^{13}C techniques for selecting salt and drought tolerance**

Further experiments for early selection of rice cultivars for salt tolerance using $\delta\ ^{13}$C isotope discrimination are being undertaken. Differences in δ^{13}C signals of metabolically active carbon pools in combination with molecular techniques are being used to assess drought tolerance in peanuts and lentil. The work is being conducted in collaboration with the Plant Breeding Unit.

- **Plant quality characteristics**

Nitrogen uptake by rice from different residues was studied and the results were presented at the recent FAO/IAEA symposium. The role of polyphenols in inhibiting N transformation processes in soil is being investigated using ^{15}N.

- **Root N turnover and below ground N availability**

Stem injection with ^{15}N was used to study below ground N cycling and fixation in cowpea and soybeans. The experiment will continue to assess the transfer of legume N to a following cereal crop.

- **Monitoring of soil water status under different climatic conditions**

Effects of temperature, rainfall and snow-cover on soil water status are being investigated using capacitance sensors and neutron moisture probes.

- **^{18}O and ^{2}H techniques to identify different sources of water to plants**

Soil column studies are in progress to identify the different sources of water (surface water, water at different soil depths) to plants using stable isotopes, ^{18}O and ^{2}H.

⇒ **Synthesis of data from Co-ordinated Research Projects (CRPs)**

A decision support system is being developed for establishing guidelines on direct application of phosphate rocks. The results of the CRP on phosphate rocks and information from other sources will be utilized for this purpose. This activity will be co-ordinated by Ms. Lee Heng in collaboration with IFDC and FAO.

TRAINING

The following training activities were carried out by the Soil Science Unit:

Mr. A.C. Kutuk and **Mr. G. Cayci** carried out several experiments on (a) determination of nitrate leaching using ^{15}N on potato grown in large pots, (b) effect of different nitrogen and salinity levels on water use efficiency and growth of tomato plants, (c) water use efficiency and nitrate leaching under different irrigation systems using ^{15}N under field conditions. To monitor and evaluate water content of soil under different irrigation systems, capacitance sensors, TDR and neutron scattering methods were used. Supervised by Ms. Lee Heng.

Ms. Ximena Videla has been working on the effect of tannic acid on gross mineralisation and nitrification, following the evidence that polyphenols can significantly effect the N turnover in soils. Supervised by Ms. Rebecca Hood.

Mr. Juan Pablo Bonnetto conducted experiments to investigate the effect of soluble organic carbon on gross N and C mineralisation using both isotope dilution techniques and ^{13}C techniques. Supervised by Ms. Rebecca Hood.

Mr. Abdul Kalam Azad performed drought tolerance experiments in peanut and lentil crops using differences in $\delta^{13}C$ signals of metabolically active carbon pools. Parallel assessment of phenotypic traits using molecular techniques was also done. Supervised by Ms. Rebecca Hood.

Ms. Champa Kularatne studied the effect of salinity on nitrogen fixation in a range of legumes (Supervision: Gudni Hardarson) and the effect of residue quality on N release as determined by ^{15}N techniques. Supervised by Ms. Rebecca Hood.

Mr. Nadiruzzaman Mondol conducted experiments to investigate the effects of different fertilisers and salinity on rice production. Also experiments were conducted to investigate root turnover using ^{15}N labelling techniques. Experiments to determine below ground biological N fixation in a variety of leguminous crops have been set up. Supervised by Ms. Rebecca Hood.

A group training on total N and N-15 analyses by Emission Spectrometry was conducted during the period from 9 October to 8 December 2000. The participants were **Ms. C. Kabade, ZIM/97007; Ms. E. Rasovololonomenjanahary, MAG/00009R; Mr H. Sirin, TUR/99009; Mr R. Nurmato, UZB/00004; and Mr H. Al-Halabi, SYR00014.** Supervised by Mr. Leo Mayr and the technical staff of the Soil Science Unit.

SUPPORTIVE SERVICES

The Soil Science Unit performed the following elemental and isotope analyses during the period January – October 2000:

Source of sample	**N and ^{15}N**	**C and ^{13}C**
CRPs	4467	971
TCPs	509	0
Seibersdorf	4068	1205
Quality Assurance	4379	1512
Total	13423	3688

H. PUBLICATIONS

⇒ **Printed**

- Aigner, M. Modified micro-diffusion method for ^{15}N-enriched soil solutions. In: Optimising Nitrogen Fertiliser Application to Irrigated Wheat. IAEA-TECDOC-1164, pp. 191-200. (July 2000).
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- Hocking, P.J., Randall, P., Delhaize, E. and Keerthisinghe, G. The role of organic acids exuded from roots in phosphorus nutrition and aluminium tolerance in acidic soils. In: IAEA-TECDOC-1159, pp. 61-73. (2000).
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- Management and Conservation of Tropical Acid Soils for Sustainable Crop Production. Proceedings of a Consultants Meeting, 1 – 3 March 1999, Vienna, Austria. IAEA-TECDOC-1159, 113 p. (June 2000).
- Optimising Nitrogen Fertiliser Application to Irrigated Wheat. Results of a FAO/IAEA Co-ordinated Research Project. IAEA-TECDOC-1164, 245 p. (July 2000).

I. FROM OUR READERS

⇒ **XXXth Annual Meeting of ESNA (European Society for New Methods in Agricultural Research) and of the Working Group Soil-to-Plant Transfer of UIR, 26 - 30 August 2000, Keszthely, Hungary**

Report of the Chairman of Working Group 3 (Soil-Plant Relationships)

The annual meeting of Working Group 3 dealt with 24 contributions, 14 were presented orally and 10 as posters by scientists from 11 countries.

The first paper by Matin (IAEA) introduced the IAEA co-ordinated research programme "The classification of soil systems on the basis of transfer factors of radionuclides from soil to reference plants" and the principle concepts behind this approach. A couple of talks addressed the time dependent radionuclide transfer into plants and translocation within plants following soil and/or foliar contaminations. Brambilla (Italy) presented a detailed model study on translocation of Cs, Sr and Zn from green plants into tomato fruits. Oncsik (Hungary) demonstrated the seasonality effect with respect to Cs-transfer into rice grain following contamination of rice plants at different growth stages. In a related poster Haak (Sweden) described the reduction half-times of Cs and Sr in grass and cereals during the first weeks after an artificial contamination. The data of both contributions are useful for radiological assessment models, especially concerning the first year after a fallout. Effects of soil characteristics and yearly variations on Cs.-transfer into soybean and sunflower applying the fluxes concept were reported by Skarlou (Greece). Goncharowa (Byelorussia) presented a plant physiological study on the impact of macronutrient cations on the Cs and Sr influx into roots of cereals. Zibold (Germany) presented a well calibrated model of Cs-fluxes in forest ecosystems based on a forest site near Lake Constance. After correction with different parameters it could be concluded that the decrease of the ^{137}Cs-contamination levels of mushrooms at present follows its physical decay.

Soil management and questions of plant nutrition were addressed in several presentations. Gerzabek (Austria) reported on sensitive organic carbon pools in soil which react more rapidly to management changes and are related to soil microbial activity. Hegedüs (Hungary) compared two long-term field experiments in Europe with respect to soil organic matter and biological properties.

Use of mineral fertilisers was discussed in several papers. Budoi (Romania) presented mathematical solutions to the problem to derive optimum complex fertilisers from fertilisers containing more than one macronutrient. The optimum use of phosphorus and complex fertilisers was elaborated in papers presented by Brohi (Turkey) highlighting the issues in Turkey, Stanica (Bulgaria) in orchards and Gavriluta (Romania) on extremely sandy soils. In the latter mentioned poster, it was shown that fertilisers in tablet form decrease nitrogen losses in sandy soils considerably. Budoi (Romania) reported on the optimum pH and base saturation conditions needed to optimise plant growth. The respective recommendations for more than 500 plants will appear in the proceedings. The application of foliar fertilisers was addressed by Özcan (Turkey), Brohi (Turkey), Soare (Romania) and Dana (Romania). The latter paper related the micronutrient content of hybrid maize seeds obtained by foliar fertiliser application to the seed quality. Two presentations focussed on grapevine nutrition. A detailed study on the optimum potassium fertilisation level taking into account cation ratios in soil and

plants and grape juice quality parameters was presented by Licina (Yugoslavia). The plant physiological aspects of lime induced chlorosis was explained by Serdinescu (Romania). It could be concluded – as already shown in literature – that the low Fe-content of grapevine leaves is not the reason for chlorosis, but the inactivation of Fe. Differences between sensitive and tolerant varieties could be shown by simple cation ratios, which might be useful for selection purposes.

Additional posters presented data on e.g. heavy metal adsorption in soil: Madjar (Romania) and micronutrient and heavy metal distribution in soils of Vojvodina: Sekulic (Yugoslavia).

The proceedings of the meeting will be published later this year.

The participants of the working group sessions thank the local organisers Prof.Szabo and Dr.Karpati for their efforts and the warm welcome.

The XXXIth Annual Meeting of ESNA will be held in Chania, Greece during the second week of September 2001.

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Soils Newsletter

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

Printed by the IAEA in Austria

January 2001

01-00011