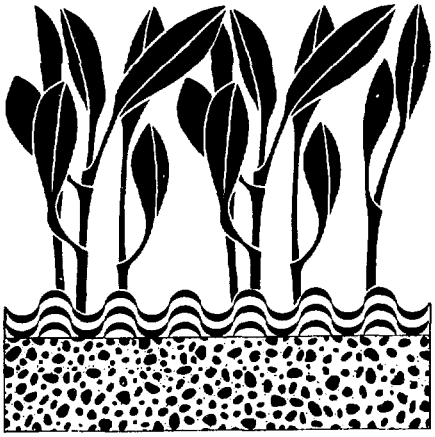

Soils Newsletter

JOINT FAO/IAEA DIVISION
OF NUCLEAR TECHNIQUES IN FOOD AND AGRICULTURE
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA

Vol. 16, No. 2
December 1993

ISSN 1011-2650

CONTENTS

TO OUR READERS

Here we are at the end of another successful year and the beginning of a new one. On behalf of all the staff of the Soil Fertility, Irrigation and Crop Production Section and the Soils Science Unit at the Seibersdorf Laboratory, may I take this opportunity to send you our greetings and all best wishes for the New Year 1994.

I am pleased to inform you that the main new development in 1993 was the initiation of two Co-ordinated Research Programmes (CRPs), one on "The Use of Nuclear and Related Techniques for Evaluating the Agronomic Effectiveness of Phosphate Fertilizers, in particular, Rock Phosphate", kindly financed by the French Government, and the other one on "the Use of Nuclear Techniques for Optimizing Fertilizer Applications under Irrigated Wheat to Increase the Efficient Use of Nitrogen and consequently Reduce Environmental Pollution". In connection with the Phosphate CRP, a Consultants Meeting was held at the IAEA Headquarters in Vienna, from 10 - 12 May 1993, and the first Research Co-ordination Meeting (RCM) was held also in Vienna, from 1 - 5 November 1993. For the initiation of the second programme, a Consultants Meeting on "Irrigated Wheat and Environmental Preservation" was held in Vienna, Austria, from 29 November - 2 December 1993, with the participation of experts in this area.

Four other RCMs were held in 1993 in connection with the implementation of the CRPs on "Enhancing Soil Fertility and Crop Production by better Management of *Rhizobium*" (Vienna, Austria), "The Use of Nuclear Techniques to Improve Crop Production on Salt-affected Soils " (Vienna, Austria), "The Use of Nuclear and Related Techniques in Assessment of Irrigation Schedules of Field Crops to Increase Effective Use of Water in Irrigation Projects" (Fundulea, Romania), and "The Use of Isotopes in Studies to Improve Yield and N_2 Fixation of Grain Legumes with the Aim of Increasing Food Production and Saving N-Fertilizer in the Tropics and Sub-tropics of Asia" (Tamworth, Australia). It is with pleasure that I inform our readers that the results of two completed CRPs were published in 1993, in collaboration with Kluwer Academic Publishers, Dordrecht, The Netherlands. They are: (1) Enhancement of Biological Nitrogen Fixation of Common Bean in Latin America. Eds. F.A. Bliss and G. Hardarson, and (2) Isotopic Studies of *Azolla* and Nitrogen Fertilization of Rice. Eds. K.S. Kumarasinghe and D.L. Eskew. Presently we are preparing the results of the CRP on Salt-affected Soils to be published in 1994.

An FAO/IAEA Regional Seminar for Asia and the Pacific on Nuclear Related Methods in Soil/Plant Aspects of Sustainable Agriculture was held in Colombo, Sri Lanka. The second Co-ordination Meeting of the FAO/IAEA Regional Middle East and Europe Technical Co-operation Project on "The Use of Nuclear and Related Techniques in Plant Nutrition and Water Balance Studies in Legume-Cereal Crop Rotation Systems" was held in Amman, Jordan, in October 1993. The meeting was followed by a one-week workshop, organized for young scientists who would be involved in a future Middle East project on "The Use of Nuclear and Related Techniques in Plant Nutrient and Water Balance Studies in Legume-cereal Crop Rotation Systems, with Emphasis on Fertigation Practices".

In the year 1993, the Soil Fertility, Irrigation and Crop Production Section was responsible for the execution of 78 Technical Co-operation (TC) projects in Africa, Asia and the Pacific, Latin America, and the Middle East and Europe regions. In four countries (Algeria, Kenya, Myanmar and the Philippines), this year marked the first year of implementation of TC projects.

As reported later in this Newsletter, we plan to hold two symposia in 1994. Participants for the one in Acapulco, Mexico to be held from 10-16 July have already been selected. The deadline for receipt of participation forms and extended synopsis for the Vienna symposium (17-21 October) is 10 April 1994. We welcome your applications for this symposium.

Finally, I would like to thank you all for the valuable contributions and continued interest in our Soils Newsletter. As always, we welcome any comments or suggestions for the improvement of this Newsletter. Also, please make sure that you notify us promptly of any change in your mailing address. This issue of the Soils Newsletter was compiled and partially edited by Saliya Kumarasinghe and myself, with the contributions from our colleagues, and the manuscript typed by Ingrid Puschnig.

We wish you a Merry Christmas and a Happy New Year 1994.

Christian HERA
Head, Soil Fertility, Irrigation and
Crop Production Section

STAFF

1. IAEA Headquarters, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Vienna International Centre, Wagramerstrasse 5, P.O.B. 100, A-1400 Vienna, Austria, FAX: +43 1 234564, TELEPHONE: +43 1 2360

   Björn SIGURBJÖRNSSON, Director
   Waldemar KLASSEN, Deputy Director

   Soil Fertility, Irrigation and Crop Production Section

Christian HERA, Head of the Section	(Soil Fertility, Plant Nutrition)
Seth K.A. DANSO, First Officer	(Microbiology, Soil Fertility)
K. Saliya KUMARASINGHE, Second Officer	(Plant Physiology, Soil Fertility)
Manase P. SALEMA, Regional Expert	(Microbiology, Soil Fertility)

   Secretarial staff: Ruth ROSSI
   Ingrid PUSCHNIG

2. Soil Science Unit, Joint FAO/IAEA Programme, Agency's Laboratories A-2444 Seibersdorf, Austria

Felipe ZAPATA, Head of the Unit	(Soil fertility, plant nutrition)
Gudni HARDARSON, Research Officer	(Soil microbiology)
Helga AXMANN, Head Analyst	(Analytical chemistry)
K.Olufemi AWONAIKE, Soil Scientist	(Nitrogen fixing trees)
Marius W.QUIST, Associate Professional Officer	(Forestry research)

   Technical Staff:

José Luis ARRILLAGA	(Laboratory technician)
Leopold MAYR	(")
J. Aldo SEBASTIANELLI	(")
Angela SESSITSCH	(")
Stefan BOROVITS	(Laboratory assistant)
Gerhard ECKHARDT	(")
Christine FICKER	(")
Norbert JAGODITSCH	(")

   Secretarial Staff: Marie-Andrée ABLÖSCHER

3. Staff Changes

Mr. Naoto KATO, the visiting scientist from the National Institute of Agro-Environmental Science, Ministry of Agriculture, Forestry and Fisheries, Tokyo, Japan, who was attached to the Soil Science Unit of the Agency's Laboratories in Seibersdorf, left on 14 November after a stay of one year. During this period, he was involved in back-up research in support of the newly initiated CRP on "The Use of Nuclear and Related Techniques for Evaluating the Agronomic Effectiveness of Phosphate Fertilizers, in particular Rock Phosphates". He also completed successfully a series of laboratory and greenhouse experiments using the ^{32}P isotopic technique, the results of which will be published in the near future. Before his departure, he spent two weeks as a visiting scientist at the Centre des Etudes Nucleaires at Cadarache, France. Mr. Kato is a hard working and a dedicated scientist. We wish him all the best in his future endeavours.

CO-ORDINATED RESEARCH PROGRAMMES

1. FAO/IAEA/SIDA CRP on "The Use of Isotope Studies on Increasing and Stabilizing Plant Productivity in Low Phosphate and Semi-arid and Sub-humid Soils of the Tropics and Sub-tropics"

(Project Officer: K. Saliya KUMARASINGHE)

This CRP, funded by the Swedish International Development Authority (SIDA) has just entered its fifth and final year. The present contract holders (9) are: Messrs. M. Abdou (Egypt), I. Ofori (Ghana), D.O. Nyamai (Kenya), M. Bazza (Morocco), N. Afolabi (Nigeria), D. Amara (Sierra Leone), K.H. Elamin (Sudan), M. Mechergui (Tunisia) and Ms. Bui Thi Hong Thanh (Viet Nam). The five agreement holders include: Messrs. W. Horst (Germany), N. Sanginga (Nigeria), A. Haystead (New Zealand), P. Högberg and K. Johanson (Sweden). In November 1993, the project officer visited the counterparts in Sudan to review progress and to advise on follow-up research. The programme is being implemented as scheduled and the last RCM is planned to be held in Vienna from 10 - 14 October 1994. All contractors are kindly requested to return the completed contract renewal forms as soon as possible. As you are aware, without a valid contract, participation at the RCM will not be possible.

2. FAO/IAEA/UNDP CRP on "The Use of Isotopes in Studies to Improve Yield and N_2 Fixation of Grain Legumes with the Aim of Increasing Food Production and Saving N-Fertilizer in the Tropics and Sub-tropics of Asia"

(Project Officer: Seth K.A. DANSO)

The fourth RCM of this CRP was held in Tamworth, Australia, from 30 August to 3 September 1993. Our host was Dr. D. Herridge, an agreement holder in the CRP. The present contractors are: M.S. Sattar (Bangladesh), L. Haixian and Y. Chongbiao (People's Republic of China), F. Yusuf (Pakistan), N. Boonkerd (Thailand), F. Abdul Wahab and I. Rusli (Malaysia), R. Senaratne (Sri Lanka), C.M. Rosales (Philippines), Xuan Hong Nguyen (Viet Nam). The two agreement holders are: D. Herridge (Australia), O.P. Rupela (India). Excerpts of this RCM are given elsewhere in this Newsletter.

3. FAO/IAEA/OPEC CRP on "The Use of Nuclear Techniques in the Management of Nitrogen Fixing Trees for Enhancing Soil Fertility and Soil Conservation"

(Project Officer: Seth K.A. DANSO)

There has not been any significant changes in the running of this CRP since the July 1993 report in the Soils Newsletter. The objectives remain the same, to use the ^{15}N methodology to quantity N_2 fixation in trees of importance in agroforestry and/or the provision of fuelwood and the prevention of soil deterioration, including soil erosion. Data coming in have shown that genotypic differences in N_2 fixation can be demonstrated in field-grown trees. However, in some cases N_2 fixation has been very low, and whether this is methodology-induced or not remains to be verified. Studies on the decomposition of organic matter, and the effect of pruning intensity on N_2 fixation are going on.

One participant of the CRP, Dr.K. Mulongoy has left his post at IITA, and unless IITA nominates someone to fill Dr. Mulongoy's place, the participation of the CRP will consist of: C. Ovalle-Molina (Chile), C. Yuehua (People's Republic of China), E.Y. Safo (Ghana), S. Hj. Abdul Hamid (Malaysia), K.A. Malik (Pakistan), M. de S. Liyanage (Sri Lanka), B. Sougoufara and M. Gueye (Senegal), P. Wadisirisuk (Thailand), M.A. Bekunda (Uganda), and N. Mbaya (Zaire). The three remaining Agreement Holders are: J.K. Ladha (IRRI, Philippines), C. Van Kessel (Canada), and D. Baker (USA).

4. FAO/IAEA CRP on "The Use of Nuclear and Related Techniques in Assessment of Irrigation Schedules of Field Crops to Increase Effective Use of Water in Irrigation Projects"

(Project Officer: Christian HERA)

This programme includes eighteen participants: C. Angueira (Argentina), P.L. Libardi (Brazil), W. Fujun (People's Republic of China), B.G. Pene (Cote d'Ivoire), M. Calvache (Ecuador), M. El-Haris (Egypt), G. Vachaud (France), S. Adiku (Ghana), T. Kovacs (Hungary), A. Ahmad (Malaysia), M. Tayaa (Morocco), M. Iqbal and R. Waheed (Pakistan), I. Craciun (Romania), F. Moreno (Spain), M.S. Anac and C. Kirda (Turkey) and J. Hopmans (USA).

The second RCM was held from 24 - 28 August 1993 in Fundulea, Romania. Excerpts from this meeting are given elsewhere in this report.

Prof. M. Bazza has kindly offered to host the next RCM in Morocco in March/April 1995.

5. FAO/IAEA CRP on "Enhancing Soil Fertility and Crop Production by better Management of *Rhizobium*"

(Project Officer: Gudni HARDARSON)

At present, there are eleven participants in this programme. They are: A. Akkermans (The Netherlands), W.J. Broughton (Switzerland), J.E. Cooper (UK), D. Gareth Jones (UK), W. Ludwig (Germany), E. Martinez (Mexico), H. Moawad (Egypt), A. Popescu (Romania), J.A. Qureshi (Pakistan), S.M. Tsai (Brazil), J.P.W. Young (UK).

The next RCM is planned to be held from 15 - 19 August 1994. Prof. W.J. Broughton has kindly offered to host the meeting at his institute at the University of Geneva, Switzerland.

6. FAO/IAEA/French Government CRP on "The Use of Nuclear and Related Techniques for Evaluating the Agronomic Effectiveness of Phosphate Fertilizers, in particular, Rock Phosphates"

(Project Officer: Felipe ZAPATA)

This CRP, funded by the French Government, is in its first year of operation. A Consultants' Meeting was held in Vienna from 10-12 May 1993, a brief report of which is

given elsewhere (Meetings) in this issue. The programme is being implemented as recommended by the Consultants and the first RCM was held in Vienna, Austria, from 1 - 5 November 1993.

The programme has 12 contractors: T. Muraoka (Brazil), L.M. .Xiong (People's Republic of China), C. Herrera-Altuve (Cuba), I. Pino (Chile), E. Owusu-Bennoah (Ghana), E. Sisworo (Indonesia), N. Karanja (Kenya), Z. Rahman (Malaysia), Z. Borlan (Romania), J. Mahisarakul (Thailand), E. Casanova (Venezuela) and Sat Cong Doan (Viet Nam). The six agreement holders are: T. McLaughlin (Australia), J.C. Fardeau (France), Truong Binh (France), J.M. Barea (Spain), S.H. Chien (USA) and F. Sikora (USA). Excerpts from this RCM will be published in the next issue of this Newsletter.

7. FAO/IAEA CRP on "The Use of Nuclear Techniques for Optimizing Fertilizer Applications under Irrigated Wheat to Increase the Efficient Use of Nitrogen and to Reduce Environmental Pollution"

(Project Officer: Christian HERA)

This CRP will come into operation in 1994. A Consultants Meeting was held in Vienna, Austria, from 29 November to 2 December 1993. A brief report on the recommendations of the meeting is given in this Newsletter (Meetings).

FAO/IAEA TRAINING COURSES

Completed

1. The FAO/IAEA Interregional Training Course on the Use of Isotope and Radiation Techniques in Studies on Soil/Plant Relationships with Emphasis on Soil Water Management (C7-INT-5.127), 1 June - 9 July 1993, Seibersdorf, Austria

Technical Officer: Christian HERA: Course Director: Felipe ZAPATA

The Annual Interregional Training Course on the Use of Isotope and Radiation Techniques in Studies on Soil-Plant Relationships, was held at the IAEA Laboratories, Seibersdorf, from 1 June - 9 July 1993. This year, special emphasis was given to topics related to crop water requirements in different cropping systems for optimizing the efficient and rational use of soil water and the interactions between irrigation and fertilizer practices for maximizing crop productivity.

A Selection Panel met to consider 119 official nominations from 53 countries. Several late nominations, received after the meeting of the Selection Panel, were not considered. Twenty-two participants representing 22 Member States successfully concluded the training: M.F. Ahmed (Bangladesh), O.O.S. Bacchi (Brazil), B.I. Kolev (Bulgaria), M. Qi (P.R. China), B.G. Pene (Côte d'Ivoire), A. Ravelo Sanchez (Cuba), R.M.R. Hedia (Egypt), A. Garcia Granados (El Salvador), M. Syafiuddin (Indonesia), M.S. Hobbi (Iran), A. Ahmed (Malaysia), G. Montesinos Silva (Mexico), K. Barhmi (Morocco), F.T. Talavera Siles (Nicaragua), E. Ocampo (Philippines), C. Paltineanu (Romania), M.S. Tejan-Kella (Sierra

Leone), M.M. Ahmed (Sudan), A.K. Razzouk (Syria), M.A. Ul (Turkey), S.J. Torres Pernalete (Venezuela), T.B. Do (Viet Nam). This year, the duration of the course was 6 weeks. Instructions were carried out by IAEA staff members supported by invited lecturers specialized in particular fields of soil-water-plant relationships research. The following scientists were recruited as invited lecturers: K. Buchtela (Austria), E. Haunold (Austria), M. Bazza (Morroco), M. de Boodt (Belgium), W. Horst (Germany), C. Kirda (Turkey), D. R. Nielsen (USA), G. Vachaud (France), D.E. Walling (UK) and D.W. Lawlor (UK).

A two-day field trip (14-15 June) to Innsbruck provided an insight into soil water management practices in the sub-alpine regions of Austria at selected sites of the Federal Forestry Research Institute. Another field excursion (30 June) was organized to visit the Experimental Station of the Faculty of Agriculture and other installations where participants received information on agricultural activities in Austria. Dr. J. Sagardoy, Senior Technical Officer, AGL, FAO, presented the computer programme CROPWAT and guided a computer practical session on the same subject. The good co-operation and motivation of participants, dedication of the IAEA staff and the valuable collaboration of invited lecturers all contributed *to ensure successful implementation of the course. We thank them all.*

2. The FAO/IAEA Regional Training Course on the Use of Isotopes and Radiation Techniques in Studies on Soil/Plant Relationships with Emphasis on Salt-affected Soils (RER/5/007), 6 September - 1 October 1993, Ankara, Turkey

Technical Officer: Christian HERA

The course was organized in co-operation with the Turkish Atomic Energy Authority and held at the Nuclear Research and Training Centre of the Nuclear Agriculture Research Institute in Saraykoy, Ankara. Eighteen participants from 14 member states of the IAEA and the FAO in the Middle East and Europe attended the course. They included: S. Golovatyi (Belarus), Ch. Photiou (Cyprus), M. Zaki Hassan Ali (Egypt), M.H. Mostafaviy (Iran), A. Bulad (Jordan), A. Al-Mondhri (Oman), S. Al-Mumari (Oman), C.M. de Arruda Pacheco (Portugal), A.H. Al-Yousef (Qatar), E. Banica (Romania), A. Al-Sughayer (Saudi Arabia), F. Al-ein (Syria), G. Bilgehan (Turkey), A.F. Dorsan (Turkey), A. Ilbeyi (Turkey), H. Ustun (Ankara), A.I. Dutov (Ukraine), O.A. Abu Bakr (UAE). The lecturers included: K. Buchtela (Austria), W.E.H. Blum (Austria), G. Vachaud (France), K.A. Malik (Pakistan), and D.R. Nielson (USA), C. Kirda, O. Tekinel, S. Yesilsoy, R. Derici and R. Kanber (Turkey), and Ch. Hera, H. Axmann and K.S. Kumarasinghe (Joint FAO/IAEA Division). The course consisted of lectures, laboratory and field practical sessions and a field excursion to the Mediterranean region in Adana, including the University of Cukurova and the South Anatolian irrigation project. The training course was a success.

3. The FAO/IAEA Workshop on "The Use of Nuclear and Related Techniques in Plant Nutrient and Water Balance Studies in Legume-Cereal Crop Rotation Systems with Special Emphasis on Fertigation Practices", 23 - 27 October 1993, Amman, Jordan

Technical Officer: Christian HERA

In this workshop, training was given to junior scientists from Jordan (4), Saudi Arabia (1), Syria (1), Turkey (2), UAE (1), and also to 7 senior scientists from Jordan. During the workshop, subjects concerning soil fertility, plant nutrition, soil/plant/water relationships, and

the use of nuclear technique and fertigation aspects were covered by Drs. Ch. Hera, C. Kirda, and I. Papadopoulos. The discussions during the workshop indicated the interest and the good understanding of the participants. With the assistance provided by Dr. I. Ghawi from the Faculty of Agriculture at the University of Jordan, a field demonstration on calibration and on the use of neutron moisture gauges was organized. The theoretical basis of neutron moisture and gama density gauges, access tube installation, and their use in agricultural research was discussed.

Planned

FAO/IAEA Advanced Fellowship Group Training on "Modern Nuclear Techniques in Soil-Plant Research for Sustainable Agriculture Development and Environmental Conservation", 26 September - 21 October 1994, IAEA Laboratories, Seibersdorf, Vienna, Austria

Technical Officer: Christian HERA; Course Director: Felipe ZAPATA

This group training is open to soil scientists, local counterparts of the IAEA Technical Co-operation projects and/or former participants of FAO/IAEA Interregional Training Courses engaged in soil science research and actively involved in FAO/IAEA research programmes. Some 12 - 15 participants from all geographical areas will be selected.

General topics on the FAO/IAEA programmes as well as specific aspects of the use of nuclear and related techniques in soil/plant relationship studies will be covered over a period of 4 weeks. The training will provide a critical evaluation of the potentiality of the nuclear techniques as well as guidelines for further applications in the various fields of soil-plant research. In-depth coverage of the techniques will be given through overview lectures, practical sessions, calculation and interpretation of data, and group discussions. The group is expected to actively participate in all activities and to make suggestions for further improvement of the FAO/IAEA programmes. **The language of the training course is English.** A prospectus has already been dispatched to the national authorities responsible for IAEA matters in the respective member states.

MEETINGS/WORKSHOPS

Completed

1. The FAO/IAEA Consultants Meeting on "The Evaluation of the Agronomic Effectiveness of Phosphate Fertilizers through the Use of Nuclear and Related Techniques", 10 - 12 May 1993, Vienna International Centre, Vienna, Austria.

   Scientific Secretary: Felipe ZAPATA

The FAO/IAEA Consultants Meeting on "The Evaluation of the Agronomic Effectiveness of Phosphate Fertilizers through the Use of Nuclear and Related Techniques" was held in Vienna at the IAEA Headquarters from 10 to 12 May 1993. The meeting was attended by 7 consultants from 5 Member States and staff members of the Joint FAO/IAEA Programme and was organized in connection with the forthcoming FAO/IAEA CRP on "The Use of Nuclear and Related Techniques for Evaluating the Agronomic Effectiveness of

Phosphate Fertilizers, in particular Rock Phosphates". The main objectives were to review the current status and future trends of the application of tracer techniques in phosphate research and to provide a critical evaluation of the topics to be investigated using nuclear techniques as well as guidelines for the implementation of the aforementioned CRP.

The meeting started with an overview of phosphorus research in agriculture. Thereafter, presentations were grouped into 4 sessions each addressing a main topic of phosphate research as follows:

Session I - Monitoring soil phosphorus availability (3 papers).
Session II - Evaluation of the agronomic effectiveness of phosphate fertilizers (5 papers).
Session III - Technological and biological processes for enhancing the agronomic effectiveness of rock phosphate (3 papers).
Session IV - Environmental issues about phosphate sources (3 papers).

The last two sessions (Sessions V and VII) were devoted to a general discussion of topics related to planing and implementation of the CRP.

The meeting recommended the initiation of a networked research programme to assess P availability in soils amended with indigenous and modified phosphate rock products and water soluble P fertilizers in diverse soils and climatic conditions. Research should also focus on ways and means to enhance the agronomic effectiveness of rock phosphate-based products. Isotopic tracer techniques would be the most appropriate approach for assessing both the dynamics of "available" P in soils and the availability of P from rock phosphate-based products to crops. Other important recommendations were (i) to establish close co-operation with other research networks on rock phosphate utilization, and (ii) to validate selected models to predict soil P bioavailability in rock phosphate-amended soils. A full report of the meeting is available upon request.

2. The FAO/IAEA Consultants Meeting on "The Use of Nuclear Techniques for Optimizing Fertilizer Applications under Irrigated Wheat to Increase the Use of Nitrogen and Consequently Reduce Environmental Pollution", 29 November - 2 December 1993, Vienna, Austria

Scientific Secretary: Christian HERA

This meeting was organized in connection with the forthcomming FAO/IAEA CRP on the above subject and was attended by 5 consultants and also by staff members of the Soil Fertility, Irrigation and Crop Production Section, and the Soil Science Unit of the Seibersdorf Laboratory. The main objectives were to review the current status and future trends of fertilizer application under irrigated wheat to increase the yield and to avoid environmental pollution, by using nuclear techniques.

Irrigated wheat accounts for about 40 % of wheat production in developing countries but the efficiency of nutrient use is thought to be quite low by international standards. The availability of irrigation greatly reduces the potential of crop failure caused by drought. Therefore, producers are more likely to allocate their resources of time, labour, seed and fertilizer to irrigated areas where profitability is likely to be most stable. Poor management of one or more material inputs (water, nutrients, etc.) can easily reduce the effectiveness of the

others. In the case of inefficient N use by crops, the unused N can harm the environment through NO_3^- leaching into ground water or volatile N losses to the atmosphere. The use of isotopes and neutron moisture gauges represent an invaluable tool for maximizing nutrient and water utilization by crops in order to produce more and better food, to avoid pollutuion and to protect the environment.

The specific objectives recommended by the participants are as follows: to investigate various aspects of nitrogen use efficiency of the wheat crop under irrigation through an interregional research network of experimental sites in the countries with large area of irrigated wheat; to use all results to develop further and to refine various relationships in the CERES-wheat simulation model; to use the knowledge generated to validate the CERES model and produce a nitrogen recommendation expert system to refine specific management strategies with respect to fertilizer applications, expected yield and other parameters; use ^{15}N techniques and neutron moisture gauges to determine the fate of applied N fertilizer and organic N as well as water movement in the soil, and water use efficiency in wheat cropping systems.

The programme will be implemented in collaboration with CIMMYT (Mexico) and IFDC (USA). Eight to ten contract holders and four agreement holders will be selected.

3. The FAO/IAEA Research Co-ordination Meeting on Assessment of Irrigation Schedules of Field Crops to Increase Effective Use of Water in Irrigation Projects, 24 - 28 August 1993, Fundulea, Romania

Scientific Secretary: Christian HERA

The meeting was organized in co-operation with the Research Institute for Cereals and Industrial Crops in Fundulea. Seventeen scientists from 14 countries including contractors and agreement holders participated at this meeting. Results of the first phase of this programme were presented and follow-up experiments planned.

Excerpts from presented reports:

G. Vachaud, J.L. Thony, L. Kengi, R. Laty
Laboratoire d'Etudes des Transferts en Hydrologie et Environment
Grenoble, France

B. Garino
Lycée Agricole
St. André, France

An experiment is continuing since 1990 at the site of La Cote St. André, close to Grenoble, in order to characterize the importance of soil and groundwater pollution induced by intensive agricultural practices, and to advise on new alternative techniques. This is done in very close collaboration between the University, research teams, the agricultural community (Agricultural School and the Experimental Farm of La Cote St. André, together with farmers' unions), and local and regional authorities. One of the most important aspect is to gather information at 3 different scales: (1) experimental field (2 ha) and lysimeter; (2) a zone of 50 km^2; and (3) the regional scale (5000 km^2).

Research done in relation to this CRP concerns the first scale where an intensive experimentation has been developed to determine the water, nutrient and pesticide balance for cultivation of maize. In order to account for spatial variability and for an effect of two levels of fertilization, 8 sites have been used, each one with a neutron access tube, tensiometers and soil solution suction cups. Two lysimeters with the same kind of instrumentation have also been installed in 1992. Measurements have been obtained on the basis of weekly determination for soil moisture and soil solution concentration, and of a daily determination for soil suction at 5 different depths for each site. Hourly measurements with corresponding data acquisition were also done in terms of classical bioclimatological values, soil temperature at 8 depths, rainfall and irrigation on 8 rain recorders. On each site, the hydraulic conductivity and the soil moisture retention curves have been determined in situ at different depths. The water flux beyond the root zone, as well as the mass flow of nitrate-N have been characterized during the 3 continuous years, on the basis of Darcy's and convective transport equations. Characterization of the irrigation pattern (distribution above the canopy, and distribution at soil surface) is also under study. The method of mass flux estimation (use of Darcy's law) has been fully validated from the use of lysimeters where it was possible to obtain total mass flux at the output as well as mass flux from internal measurements.

It has been demonstrated that irrigation is not responsible for the high level of nitrate pollution found in the groundwater. During the crop growing period, the amount of drainage beyond the root zone is indeed nil, all the irrigation supply being used by the maize. It is the mismanagement of fertilization which is by far the biggest problem, in particular the high amount of nitrogen residues which can be found in the root zone layer after harvest in case of surplus of supply. This is typically the case with the traditional farming practices corresponding to an application of 250 kgN/ha just after sowing. It was shown that the unused surplus at harvest can reach 150 kgN/ha, the total being leached by winter rain. It has also been clearly demonstrated that with a decrease of supply of approximately 100 kgN/ha, the incidence on yield was negligible, whereas the risk of leaching during winter was totally withdrawn. This study received strong support from EEC (DGXII, Programme STEP), from the French Ministries of Agriculture, Environment and Research, and from the local authorities (Conseil Général de l'Isère, Region Rhône-Alpes).

J.W. Hopmans
University of California
Davis, USA

At the first meeting held in Vienna (February, 1992), it was concluded that an accurate determination of crop evapotranspiration (ET) requires knowledge of soil drainage, since ET would be estimated using the water balance approach. In this regard, soil water retention and unsaturated hydraulic conductivity data are needed. Both, a fast laboratory and an in-situ field method were developed to obtain these soil hydraulic characteristics. The laboratory method is based on the inverse solution of the soil water flow equation by parameter optimization of the soil hydraulic functions for pressurized initially saturated soil cores. For the field, a combination of the inverse method with a scaling approach was used to infer field-representative soil hydraulic functions from initially near saturated soil profiles. The agreement between the field and laboratory soil hydraulic functions was good. For conditions with shallow water tables also as occurring in the central valley of California, the contribution of groundwater to ET can be important. Groundwater contribution to ET was estimated from a field water balance and field drainage volume and drainage water salinity measurements. We found that for the particular field under condsideration, 15 - 20 % of total ET originated from the groundwater. The EC of saturation extracts of soil samples from this field varied between 1-3 dS m^{-1}, with the higher salinity values near the groundwater.

M.M. Iqbal, S.M. Shah and W. Muhammad
Nuclear Institute for Food & Agriculture
Peshawar, Pakistan

Field experiments were conducted with potato (during autumn 1992 and spring 1993) and rapeseed (during Rabi 1992-93) to study their yield response to irrigation stress imposed at different growth stages. For potato, the effect of 7 irrigation treatments and two fertilization treatments in all possible combinations was studied. For rapeseed, the effect of 10 irrigation treatments only was studied. The results obtained showed that for both crops of potato, the highest tuber yield was produced by all-normal and the lowest by all-stress watering. The relative reduction in yield was the least when ripening stage was stressed (11 - 14 %), followed by flowering stage (19 - 24 %) and the greatest when tuber formation (30 - 32 %) and establishment stages (31 - 35 %) were stressed. This indicates that the former stages were less sensitive to water stress whereas the latter were more sensitive. The field water use efficiencies (Ef) of different treatments were low (< 3.0 kg/m^3). The all-normal and ripening stress treatments gave Ef values which were higher compared to other treatments. In rapeseed, the effect of imposed irrigation treatments was vitiated because of intermittent rains coinciding with the flowering and seed setting stages.

Q. Mengwen, W. Huaguo, W. Fujun, Z. Changjiu
Beijing Agricultural University
Beijing, P.R. China

The results showed that the sensitivity of winter wheat to water stress was different at different growth stages. The most sensitive stage was the period from booting to flowering and then milking to ripening. The results of ^{15}N analysis showed that soil water deficiency significantly affects nitrogen use efficiency. In later growth stages, the effect is less pronounced and reflected mainly in the ratio of nitrogen use efficiency between grain and straw. The yields at two fertilizer levels was not significantly different. Lower water use efficiency and higher loss of nitrogen fertilizer showed that local practices were not very efficient.

C. Kirda, University of Cukurova, Adana, Turkey
S. Anaç, University of Ege, Izmir, Turkey
H. Güngör, Rural Affairs Research Institute, Eskisehir, Turkey

Results of several field experiments on deficit irrigation programmes in Turkey are discussed. Deficit irrigation of sugarbeet with water stress imposed (i.e., irrigation omitted) during ripening stage saved nearly 22 % water, yet with no significant yield decrease. An experiment conducted in the Trakya region (the European part of Turkey), aimed at studying water production functions of sunflower (i.e., yield vs. water consumption), revealed that water stress imposed at either head forming or seed filling stages influence yield the least and 40 % savings of irrigation water supply compared with traditional practices in the region can be achieved without significant yield reduction. Water stress imposed at vegetative and flowering stages of corn hindered the yield most significantly. The results showed that deficit irrigation can be a feasible option under limited supply of irrigation if stress occurs during yield formation stage. A four year field experiment aiming at developing deficit irrigation strategies for soybean showed that soybean was the most sensitive to water stress during flowering and pod filling stages, and irrigation during these stages would ensure high yields.

B. Pene, N. Kouassi, D. Coulibally
Institut des Savannes (IDESSA)
Bouaké, Côte d'Ivoire

K. Edi
Sodesucre Experimental Station
Ferkessédougou, Côte d'Ivoire

A field study on sugar cane yield response to deficit irrigation practices was carried out at IDESSA experimental station of Ferkessédougou, in the northern part of the country. The crop material tested was Co 449, an early-season variety. Planting and harvest were done on November 1991 and December 1992 respectively. The experimental design was a randomized complete block with 10 treatments in 4 replicates. Two vegetative growth stages, i.e. tillering and stem elongation, were studied in all different irrigation treatments. Water was applied through a furrow irrigation system. Water allocation during tillering was not successful because of a failure in the pumping unit. However, irrigation scheduling was successfully achieved at stem elongation stage. Crop water consumption was computed according to a water balance model, because of the delay of receipt of the equipment provided by the Agency (neutron moisture gauge and access tubes). The study shows that sugarcane crop is more sensitive to water deficit during stem elongation than during tillering. In terms of water management strategy, irrigation efficiency may be improved by saving water at tillering for the elongation stage as far as an early maturing cane crop is concerned. It is shown that the practice of irrigation at the elongation stage can improve cane and sugar yields by 30 %. Accordingly, an improved practice may consist of omitting irrigation at tillering stage.

M.K. El-Harris
Alexandria University
Alexandria, Egypt

Field experiments were conducted with local varieties of maize (*Zea mays* var. Giza 2) and with wheat (*Triticum aestivum* L. var. Skha 8 and 69) at three experimental stations (Abis, El-Hammam and W. Nubaria). Since the summer of 1991, the first site represents high water table areas (ranging from 65 to 120 cm depth). Irrigation treatments (factor 1) were randomly assigned to plots and N fertilizer levels (factor 2) were randomly assigned to the sub-plots within the blocks. Furrow irrigation was used for corn and surface irrigation for wheat. The irrigation treatments were selected to impose single or combined water stress at one or more of the four growth stages (vegetative, flowering, heading and ripening stages) of both corn and wheat compared to full irrigation or severe stress throughout the growth season. The aim of the study is to investigate the effect of deficit-irrigation on yield and yield components. Data showed that several water regimes of low water application gave grain yields which were not different from the full irrigation treatment. The plots which were exposed to single or combined stress at flowering or yield formation stage showed a higher yield reduction. Nitrogen fertilizer levels had no effect on grain yield and there was no significant interaction between irrigation treatments and N fertilization. Some significant effects of N levels were observed with other yield characteristics.

F. Moreno, F. Cabrera, L. Andreu, R. Vaz and J. Martin-Aranda
Instituto de Recursos Naturales y Agrobiología
Sevilla, Spain

The Guadalquivir river marshes (SW Spain), situated in the old estuary extend to some 140,000 ha. Soils formed in this zone are alluvial, very clayey, saline-sodic with a shallow very saline water table. Part of these marshes, reclaimed since 1979, were selected for this

study. In the present work, a detailed study has been carried out on some physical and chemical properties of soil and the influence of irrigation (sprinkler and furrow irrigation) on the drainage characteristics and salt leaching during the crop periods of 1988, 1989, and 1990. Experiments using surge-flow irrigation were also carried out. A 1 ha experimental plot has been used for this purpose. It is situated within the area being used for agricultural practices equipped with a drainage system of ceramic pipes buried at 1 m depth and 10 m spacing, ending at an open ditch collector perpendicular to them.

The results obtained show that after approximately 10 years in reclamation, the electrical conductivity and exchangeable sodium percentage decreased in the 0-90 cm layer of this soil, particularly in the top 50 cm. During irrigation, a rapid response of the drain pipes was observed as a consequence of the particular soil fissure and crack network due to the shrinking and swelling processes. Maximum drainage outflow was reached when the irrigation stopped. Water movement in this soil is characterized by a first rapid phase due to the soil fissures and cracks and a second slow one controlled by the soil matrix. The efficiency of irrigation in salt leaching was higher in the case of furrow irrigation (16 g of salt leached per L of applied water) than in the case of sprinkling irrigation (10 g L^{-1}). Salinity of soil and soil solution decreases after irrigation starts, the length of time to reach a minimum value for the different soil layers and irrigation method used, being different. In 1989, due to water restrictions in some time of the crop period, the irrigation schedule was different to that normally used and the crop was affected by severe stress. Water distribution in the soil was more uniform under surge-flow irrigation than under traditional furrow irrigation. Although the efficiency in the salt leaching was less in surge-flow irrigation than in sprinkler and furrow irrigation, the rise in the water table level was less, which could diminish the risks of resalinization of the profile.

It can be deduced from the results obtained in this work that smaller amounts and more frequent applications of water should be applied in order to prevent soil deterioration and to maintain an adequate crop yield.

M. Calvache
Ecuadorian Atomic Energy Commission
Quito, Ecuador

K. Reichardt
CENA/USP
Piracicaba, Brazil

Common bean (*Phaseolus vulgaris L.*) is an important crop in Ecuador for its grain protein content. It has relatively shallow rooting depth, is a poor nodulator, requires frequent irrigation and large supplies of N fertilizers. The increasing demands for limited water supplies and rising costs of nitrogenous fertilizers requires its rational application without adversely affecting production.

The purpose of this study was to identify specific growth stages of the common bean crop, at which the plant is less sensitive to water stress so that irrigation can be omitted or decreased without significant decrease in biological nitrogen fixation and grain yield. The field experiment was conducted at "La Tola" University experiment station, Tumbaco, Pichincha, Ecuador, during July - October 1992. The soil was a sandy loam (Typic Durustoll). The climate was warm and dry (mean air temperature 16°C and mean relative humidity 74 %), and a rainfall of 123 mm was recorded during the cropping period. The treatments consisted of combinations of 7 irrigation regimes (I1 = all normal watering; I2 = all stress; I3 = traditional practice; I4 = single stress at vegetation; I5 = flowering; I6 =

yield formation and 17 = ripening stages) and 2 levels of applied N (20 and 80 kg/ha). These 14 treatment combinations were arranged and analysed in a split-plot design with 4 replications. The plot size was 33.6 m^2 (8 rows, 7 m long) and a plant population of 120,000 plants/ha was maintained. Differential irrigation was given after 3 uniform irrigations for germination and establishment. Soil moisture was monitored with a neutron probe down to 0.70 m depth, before and 24 hours after each irrigation. The actual evapotranspiration (ETa) of the crop was estimated by the water-balance technique. Field water efficiency (Ef = kg/m^3) and crop water use efficiency (Ec = kg/m^3) were calculated by dividing actual grain yield (10 % humidity) by irrigation and by ETa, respectively. Biological Nitrogen Fixation was calculated using ^{15}N methodology in the 20 kg N/ha treatment.

From the yield data, it can be concluded that treatments which had irrigation deficits had lower yield than those that had supplementary irrigation. The flowering stage was the most sensitive to moisture stress. Nitrogen fertilization significantly increased the number of pods and grain yield. Biological Nitrogen Fixation was significantly affected by water stress at flowering and pod formation stages. The crop water use efficiency (kg/m^3) was the lowest at flowering period and the yield response factor (Ky) was higher in treatments 12 (all stress) and 15 (stress at flowering). When compared with traditional practice by farmers of the region, only treatments 11 and 17 had 13 and 10 % higher crop water use efficiencies.

I. and M. Craciun
Research Institute for Cereals and Industrial Crops
Fundulea, Romania

The purpose of this study is to report the effects of water deficits on growth and yield components of maize and to determine the seasonal evapotranspiration requirements in order to obtain information regarding the adaptation of maize for limited irrigation in a region of normally high evaporative demand. The experiments were conducted in the field during the 1987 and 1992 seasons at the Research Institute for Cereals and Industrial Crops. Irrigated maize yield response to water deficit, and potential for limited irrigation were evaluated during a 6 year cycle.

In 1992, (a dry year) seasonal evapotranspiration (ET) was 372 to 443 mm, seasonal irrigation water applied was 74 to 220 mm, grain yields were 7039 to 12849 kg/ha, and seasonal water use efficiencies were 15 to 41 kg/mm. Water deficits reduced average grain yield by 22 to 41 %. Water deficit during late vegetative growth had no effect on weight per kernel and maize yield, but water deficit at grain filling caused a 22 % reduction in yield, and that during pollination caused a 41 % reduction in yield.

D.R. Prieto and M.C. Angueira
INTA-EEA
Santiago del Estero, Chile

During the 1990/91 and 1991/92 growing periods, we conducted at INTA-EEASE (Instituto Nacional de Tecnología Agropecuaria, Estación Experimental Agropecuaria Santiago del Estero) a field evaluation of the response of cotton (*Gossypium hirsutum*) to water stress. Two of the most important cotton varieties of the country, Guazuncho II-INTA and Quebracho-INTA were studied. The experiment was arranged in a randomized block and the eight treatments were: (T1) without water stress; (T2) with water stress on vegetative period and early bud formation; (T3) with water stress during flowering stage; (T4) with water stress in ripening; (T5) non-irrigated; (T6) with water stress in late ripening; (T7) with water stress during vegetative and ripening stages; and (T8) with water stress in all the periods except the ripening.

In the 1990/91 growing season, the Guazuncho II yields attained in the T1, T3, T4 and T6 treatments according to the Turkey test were not significantly different from each other, but were significantly different from T2, T5, T7 and T8. Results indicated that to avoid irrigation during ripening (T4 and T6) could be as effective as the T1 strategy. Water stress on vegetative and bud formation (T2, T7 and T8) provoke permanent effects that cannot be overcome by better moisture levels in later periods. In the 1991/92 experiment, significant differences between treatments were not found. After the preceeding irrigation (approx. 240 mm), there was enough rainfall (474 mm) and it was well distributed, so the planned water stress was not achieved. Due to the good conditions for cotton growth, high yields were obtained in all treatments and both varieties. Results confirmed that: (1) it is important to keep soil moisture during the vegetative and flowering stage, higher than 17 % and 13 % by volume for Guazuncho II and Quebracho respectively; (2) high soil moisture level during the whole season did not increase yield significantly and has negeative effects - longer growing periods, excessive vegetative growth and 30 % of reduction of the water use efficiency; (3) it is possible to control the height of the plants by shortage of water in short periods. This is important for mechanical harvest.

T. Kovacs and G. Kovacs
Irrigation Research Institute
Szarvas, Hungary

A field experiment was conducted with maize using 7 irrigation treatments at two fertilizer levels (F_1=N80 : P40 : K40 and F_2=N160 : P80 : K80). Ammonium sulphate labelled with ^{15}N was used to examine the effect of irrigation on fertilizer use efficiency. The aim of the study was to compare deficit irrigation (i.e. the water stress imposed during one growth stage) with normal irrigation practice.

Two watering regimes were established: (1) normal watering when available water was within the range of 80 - 100 %, and (2) deficit irrigation when the available water was at 25 to 40 %. Neutron moisture gauge was used for measuring the soil water status and evapotranspiration. The range of applied water was within 240 to 430 mm. According to data from isotope plots, 17 - 32 % of N was derived from fertilizer at F_1 level, and the fertilizer use efficiency was 12 - 35 %. The corresponding figures for F_2 level are 24 to 33 % and 12 to 27 % respectively.

Water use efficiency for maize dry matter yield in different irrigation treatments was 4.6 to 14.4 kg/ha/mm at F_1 level and 5.4 to 15.7 kg/ha/mm at F_2 level. The relationship between the yield and the applied irrigation water showed that 1 mm of water resulted in 15.8 kg of yield at F_1 level. This was 14.6 kg for F_2 level.

P.L. Libardi
Universidad de Sao Paulo
Piracicaba, Brazil

The experiment was carried out in Guaira, State of Sao Paulo, Brazil, the country's major region of mechanized sprinkler irrigation with 11 thousand hectares irrigated by 180 center-pivots. The experimental design was a randomized block design with six treatments (two extreme treatments (IIII and 0000) and four intermediate treatments (0III, I0II, II0I and III0) to verify the effect of water stress on the yield of common bean (*Phaseolus vulgaris*, L.). In treatment IIII, the available soil water was not limited. In treatment 0000, all growth stages received 50 % of the amount of water applied in treatment IIII. For the intermediate treatments 0III, I0II, II0I and III0, only one stage received water stress. Since four replications and six treatments were considered, the total number of experimental plots was

24. In order to evaluate the crop water balance, one neutron probe access tube was installed in the center of each of the 24 experimental plots to a depth of 1 m. Three mercury manometer tensiometers were also installed beside each access tube at the depths of 10, 20 and 30 cm. The neutron probe used was the 503 Hydroprobe (CPN Corporation). Tensiometer readings were made every day while readings with the neutron probe at the depths of 15, 30, 45 and 60 cm were made just before and after the irrigation. The irrigation control was done by means of tensiometer and neutron probe readings, using a minimum value of - 0.006 MPa for matric potential at the depth of 15 cm. The water to be applied was calculated by taking into account the value of -0.008 MPa for the soil at field capacity. So far, a total of 10 irrigations have been made. The experiment is still underway and no final conclusion is therefore possible at this stage. However, results so far obtained have shown that the neutron probe and tensiometers can be conveniently used for irrigation water control.

4. The Fourth FAO/IAEA RCM of the CRP on "The Improvement and Yield of Grain Legumes with the Aim of Increasing Food Production and Saving N Fertilizer in the Tropics and Sub-Tropics of Asia", 30 August to 3 September, Tamworth, Australia.

Scientific Secretary: Seth K.A. DANSO

The RCM was attended by the following participants: M.A. Sattar (Bangladesh), Li Haixian and Y. Chongbiao (People's Republic of China), F. Yusuf (Pakistan), N. Boonkerd (Thailand), N. Moris (Malaysia), G.A. Dayatilake (Sri Lanka), C. Rosales (Philippines), Nguyen Xuan Hong (Viet Nam), O.P. Rupela (India) and the host D. Herridge (Australia).

The following, largely plant breeders collaborating with the participants of the CRP, were invited as consultants: M.L. Das (Bangladesh), Y. Baishuang and L. Xinmin (People's Republic of China), I. Malik (Pakistan), R. Hautea (Philippines) and T.D. Long (Viet Nam).

At the RCM, both participants and consultants reported on research performed since the third RCM in Harbin, China. The data presented showed once more the potential to select from existing cultivars and mutant lines for higher N_2 fixation in various grain legumes, and the depressing effect of inorganic N on N_2 fixation. After a thorough discussion, it was agreed that the abilities of various cultivars to fix large quantities of N should be confirmed, and after harvest, a cereal should be planted in their places, to quantify the residual benefit of previous N_2 fixing crops to succeeding cereals in a rotation study.

Excerpts from presented reports:

N. Boonkerd and P. Wadisirisuk
Department of Agriculture
Bangkok, Thailand

Mungbean (*Vigna radiata*) is a nitrogen fixing crop. To be most useful to farmers the recommended mungbean should obtain nitrogen from atmosphere through symbiotic fixation with rhizobia. The objective of this study was to select mungbean lines and rhizobial strains for high nitrogen fixation. Results obtained from screening of 423 mungbean lines indicated that there were variation in nitrogen fixation, nodulation, nitrogenase activity and growth of mungbean lines. The mungbean lines VA 1948, VC 1776, VC 3128, VC 1830, VC 1693 and VC 2335 were higher in nitrogen fixation than the recommended cultivars. Using ^{15}N natural abundance technique to quantify the amount of nitrogen fixed, it has been found that

mungbean lines fixed nitrogen ranging from 0-300 mg N per plant in 35 days. It was interesting to find that the hybrid line F7 of VC 2768 A/1560 D which was the highest fixing line could fix N up to 120 kg per ha. A farmer could get an additional profit of 1468-1875 baht/ha using this line. In estimating seasonal fixing of nitrogen, it was found that mungbean start fixing N in small amounts at early stage and gradually increased until it reached maximum at pod filling stage or about 41-45 days. N fixation then gradually declined until it ceased at maturity. Investigation of rhizobial strains infecting mungbean cultivars revealed that some strains were specific to a mungbean cultivar. However, most mungbean rhizobia were effective. There were high correlation among nodule number, nodule mass, ARA and plant biomass. To quantify nitrogen fixation in mungbean under field condition it is necessary to find a suitable reference or non-fixing crop. It was found that sorghum was the most suitable reference plant for measuring N_2 fixation in mungbean. Under normal field conditions the selected mungbean line could derive up to 70% of its N from fixation.

Li Haixian, and Yu Baishuang
Heilongjiang Academy of Agricultural Sciences
Heilongjiang, P.R. China

This paper reports our investigation of using ^{15}N dilution method for screening soybean lines with high yield and high nitrogen fixation ability.

Different varieties of soybean have different levels of nitrogen fixing ability. Nitrogen fixation ability is related to its maturity period. The longer the maturity period of soybean variety, the greater is its nitrogen fixation ability. The average of % Ndfa of early maturing varieties is 36 %. Suinong 5377 (51%), and Suinong 6003 (41%) are high nitrogen fixation varieties of this group. The average of % Ndfa of medium-maturity varieties is 50 %. 8-1173 (62%), 87-1004 (60%), Heinong -26 (59) and , 88-1218(59) are high nitrogen fixation varieties of this group. The average of % Ndfa of late maturing varieties is 57%. Jilin-25 (71%) and Jilin-26 (61) are high nitrogen fixation varieties of this group. The yield of soybean is not related to its % Ndfa. 88-1173, 88-1148, 88-1218, Sheng-1067, Suinong-5377, Kenda 4, Donnong-39 and Nenfong-14 are soybean lines with both high yield and high nitrogen fixing ability.

Yu Baishuang, and Li Haixian
Soybean Research Institute
Heilongjiang, P.R. China

Crossbreeding is an effective method to have many traits recombined. According to local natural condition and production demand, parents of crossing should have better traits, such as high yielding, spread in large area, strong combining ability, etc.

In 1992, 7 crosses were made in our field experiment and 315 seeds were obtained. They were planted in a nursery in 1993. From F2, progenies will be handled with picking pod method. It is hoped that good lines will be obtained in F5 generation.

I. A. Malik
Nuclear Institute for Agrciuture
and Biology (NIAB)
Faisalabad, Pakistan

The work on improvement of mungbean, blackgram (mashbean) and lentil in yield, plant type, disease resistance and enhanced nitrogen fixation capacity was initiated in 1977 by creating the genetic variability through induced mutations and hybridization.

In mungbean, through gamma ray breeding, several high yielding and early maturing mutants with higher degree of resistance to mungbean yellow mosaic virus (MYMV) were developed from local cultivars. Of these NM 28 was released in 1983. Its yield is higher and matures a week early than the parent st. Pak 17. The mutant was found to fix about 40 kg/ha of N_2; 30% higher than the parental type. Four more mutants NM 121-25, NM 19-19, NM 20-21 and NM 13-1 were released as commercial varieties in 1986. These mutants yield 1300-1400 kg/ha; 30-45% higher and mature 3-4 weeks earlier than the parents. Through hybridization and irradiation of hybrid seed, bold seed size and resistance to cercospora leaf spot (CLS) disease was incorporated in local varieties/mutants resistant to MYMV. This led to the development of several bold-seeded, high yielding disease resistant lines which thrive in both spring and summer. Of these, two lines NM 51 and NM 54 were released as commercial varieties in 1990. These lines yield 20-25 % (1500-1550 kg/ha) higher than the national standard NM 121-25, mature early (65-70 days) and uniformly and resist diseases. Through the introduction of new varieties, mungbean production in the country has increased by about 80% from 1982 to 1990. The derivatives of three-way crosses are expected to produce even higher yielding disease resistant varieties of mungbean. The elite lines compare favourably with parental types in traits related to nitrogen fixation capacity.

In blackgram (mashbean), several high yielding mutants having early maturity, short and upright growth were induced in local cultivars. Of these, mutants 5-60 and 33-40 yield 30-45% (1450-1650 kg/ha) higher and mature 2-3 weeks earlier than the parent strain Mash 217. They are expected to be released as commercial varieties in the near future. Through hybridization and irradiation of hybrids a large number of recombinants with even higher yield, early maturity and disease resistance characteristics were selected.

In lentil, a large number of putative mutants/varieties with higher yield potentials, (2600-3200 kg/ha) 2 - 5 weeks earliness in maturity, short compact and erect growth habit were identified in microsperma group of local varieties. A wide range of morphological mutants with changes in almost all plant parts, some of them resembling wild species were isolated. The crosses between microsperma and macrosperma varietal groups displayed transgressive segregation for days to flower and several other quantitative traits.

C. M. Rosales
Philippine Nuclear Research Institute (PNRI)
Quezon City, Philippines

Seventeen mungbean and 19 groundnut cultivars were grown in the field at the Institute of Plant Breeding (IPB), University of the Philippines at Los Baños (UPLB). It aimed to quantify the amount of atmospheric N_2 fixed, screen superior mungbean/groundnut genotypes with high nitrogen fixation potential and finally incorporate these characteristics into high yielding recommended varieties.

Two trials were done with mungbean. Dry matter and seed yields, and nitrogen content showed significant differences among cultivars. The % Ndfa in both trials were not significant but the total N yield and N-fixed showed highly significant differences. PAEC 3, PAEC 10, Pag-asa 5, Taiwan Green, Acc 867 and Acc 58 were among the varieties that showed high values of % Ndfa but not significantly different from other varieties except for Acc 174.

In the groundnut field evaluation, DMY, nodule number and weight, pod and seed yields showed significant differences among cultivars. Varieties EG Pn 3, IPB Pn 85-14-60 and IPB

Pn 85-3-86 gave the highest values in DMY, nodule number and weight, and pod and seed yield data, respectively. IPB Pri 85-10-68, IPB Pn 87-24-39, BPI Pn 2 and UPL Pn 8 showed the lowest value for DMY, nodule number, nodule weight, pod and seed yields, respectively. Total N yield and N-fixed showed significant differences among varieties but the % Ndfa showed no significant differences among cultivars. Backcrossing of the F_1 plants to recommended cultivars will be done in October 1993.

G.A. Dayatilake, S. Subasinghe, and S.R. Senaratne
University of Ruhuna
Kamburupitiya, Sri Lanka

Advanced field screening of 18 cowpea genotypes from early accessions was done under low (no fertilizer-N) and high (40 kg N/ha) nitrogen regimes. Following genotypes i.e., IT-82 D-504-4, JT-85D-3428-4, IT-81D-994, IT-86D-1054 and CV Bombay were marked as the best in terms of nodulation parameters, dry matter production and yield, in the treatment without fertilizer-N. In the other treatment, the following genotypes, IT 769, IT 3139 and IT 899 showed higher response to fertilizer in terms of yield. Three mungbean genotypes, selected from screening trials of last year were tested further for yield together with two recommended varieties. Genotypes V1378 and VC 3580 B were identified as best yielders.

Effects of fertilizer-N level and inoculation on N_2 fixation capacity and yield of cowpea were studied by using ^{15}N dilution technique for two recommended cowpea cvs. i.e., MI-35 and Bombay. Inoculation increased nodule number and mass, total phytomass production, % Ndfa and pod yield in cv. Bombay compared to cv MI-35. The increase in fertilizer-N has resulted in a decrease in nodulation and % Ndfa significantly.

Effects of micro-nutrients (Mo, Co and B) on cowpea and groundnut were studied with reference to nodulation, growth and yield. Mo, at 2 ppm level increased total dry matter production but the effect on nodulation is not significant. Further increase in Mo level clearly reduced the total dry matter production. Co increased nodule mass and total dry matter production up to 6 ppm and a further increase affected both parameters adversely. B significantly reduced nodule no/plant and total dry matter production. This trend was clearly seen in groundnut too. Co decreased the nodulation in groundnut, but the effects on dry matter production and yield were not prominent. An enhanced nodulation, dry matter production and yield were observed in groundnut with increased levels of Mo, up to 4 ppm.

F.A. Wahab
Rubber Research Institute of Malaysia
Kuala Lumpur, Malaysia

Preliminary glasshouse screening of 100 varieties of groundnut (*Arachis hypogea*) inclusive of mutant lines developed by gamma irradiation was carried out in 1987-1989. Field evaluation of 60 selected varieties was carried out in 1990 at the Rubber Research Institute of Malaysia Experimental Station.

At the second stage screening, 13 varieties selected were tested in the field. ^{15}N was added by incorporation of ^{15}N enriched organic matter. Results obtained showed that the varieties tested did not perform significantly better than the established varieties, V13 and Matjam, in terms of yield and biological nitrogen fixation. Inoculation of legume seeds with selected *Bradyrhizobium* strain 32H1 resulted only in about 25% of the nodules being formed

by inoculant strain at 50 days. The amount of N fixed by groundnut varieties calculated using okra and capsicum as reference crops did not differ significantly.

Final stage screening of 6 varieties was carried out in 1992. Capsicum and upland rice were grown as reference crops. Two levels of N were applied viz. 20 and 100 kg/ha. Dry matter production and seed yield at high N level were very much higher compared to the treatment at low N level. Inoculation with 32H1 was not able to substitute for large application of fertilizer N.

L. Xinmin, D. Xintian, W. Yufeng, and L. Haixian
Soil and Fertilizer Research Institute and
Research Institute of HAAS
Harbin, P.R. China

Nitrogen fixation of 19 soybean varieties (lines) grown in the field were evaluated using ^{15}N labelling technique. Significant variation in nodule weight, total N yield, the amount of N_2 fixed and the proportion of N derived from fixation (% Ndfa) was found in different varieties. They were highly and positively correlated with each other in total dry matter yield, total N, Ndfa and % Ndfa. N_2 fixed ranged from 67-140 kg N/ha, and the % Ndfa from 35 - 60%. The varieties with higher amount of N_2 fixed and % Ndfa also had higher total dry matter yield and grain yield. It seems that direct selection for yield improvement in soybean has indirectly included improved capacity to fix N_2. The varieties of ha 88-7704, Dong 9674 and Heilong 26 were in the top group in most characteristics and would seem to merit further study and testing in the nitrate tolerant nodulation and N_2-fixing characteristics.

Nguyen Xuan Hong
National Atomic Energy Commission and
University of Hanoi
Hanoi, Viet Nam

Several mutant varieties and bred lines of groundnut and soybean were tested for varietal differences in BNF using AR assay and ^{15}N dilution technique under greenhouse and field conditions in the spring of 1992. Results have shown that the % Ndfa and N fixed for some groundnut and soybean lines were rather high using upland rice strains "CH1-NG90" and "CH1-Ng92" as reference crops. In the greenhouse the % Ndfa ranged from 10 to 63% for groundnut and from 10 to 79 % for soybean, respectively. The field experiments were conducted in the autumn-winter season of 1992. Significant varietal differences were found between varieties. The % Ndfa ranged from 20 to 32 % for groundnut and from 18 to 46 % for soybean.

Y. Chongbiao, P. Shuzhen, W. Zhidong, and Y. Fenyi
Institute for Application of Atomic Energy, CAAS
Beijing, P.R. China

100 soybean varieties were selected. From this, 10 varieties (with good growth) were taken for further study. 3 N levels, (20 kg N, 80 kg N and 160 kg N/ha) were used. The results showed that in the low N level, and even in the medium N level conditions, the nodules tend
to be large, concentrated in the upper root system but in the high N level, the nodules are small and widely scattered throughout the root system. The % Ndfa in the low N level is higher than that in medium and high N levels. A positive correction was found between

photosynthetic efficiency and % Ndfa in some varieties in the low and medium N levels. In the high N level, the results are variable. High N level inhibits the nodulation and the % Ndfa. ^{13}C discrimination was also measured and these values (Δ) were negatively correlated with dinitrogen fixation.

F. Y. Hafeez, S. Asad and K.A. Malik
National Institute for Biotechnology and Genetic Engineering
Faisalabad, Pakistan

^{15}N isotope methodology was used to select higher nitrogen fixing genotypes. Two reference crops wheat and barley, were used to estimate N_2 fixation in 20 advanced chickpea mutants/cultivars in the field (1991-1992). ^{15}N was applied at a rate of 30 kg ha^{-1} in the form of ammonium sulphate enriched with 5% ^{15}N excess in ^{15}N sub-plot. Plants were not inoculated because there is no response to inoculation of chickpea genotypes (Hafeez et al., 1987). The indigenous rhizobial population was $2x10^2$ cells g^{-1} soil (Hafeez et al., in press). The % Ndfa of chickpea genotypes were calculated using wheat as the reference crop. Among 20 chickpea genotypes, variety MB-75 has the highest dry biomass yield, total nitrogen concentration and highest estimates of total nitrogen fixed while genotype 35 and E 2034 have the lowest values. In some cases, a positive correlation was observed between N concentration, biomass yield and total nitrogen fixed. No clear correlation was found between number/mass of nodules and total nitrogen fixed.

F. Y. Hafeez, Nasim-ul, H. Shah and K.A. Malik
NIBGE
Faisalabad, Pakistan

An experiment was conducted in 1992-1993 to see the effect of *Rhizobium* strains and genotypes on growth and nodulation using ^{15}N isotope dilution technique. Three local strains, Lc6, Lc 26 and Lc 33 (Shah et al., in preparation) and one NifTAL strain 1397 were used for rhizobial inoculation. The indigenous population of rhizobia ranged from 20-100 cells g^{-1} of soil throughout the season (Shah et al., in press). The genotypes included three varieties, one mutant and two hybrid progenies (obtained from NIAB with courtesy of Dr. I.A. Malik). Nodulation data was taken at 50% flowering stage. Sub-samples of ground plant material (shoot + grain) were prepared at maturity for ^{15}N analyses.

There was a significant effect of inoculation and genotypes on the growth and nodulation of lentil plants. Locally isolated and characterized strain Lc 26 gave the best results in almost every aspect like, nodule number and dry weight, biomass and grain yield, followed by TAL 1397. The genotypes M-85, PL-406 and PL 406/M7-10-62 were significantly different from Precoz and its hybrid genotypes which without inoculation always gave the poorest results. Various genotypes have different genetic potential for the same strain.

F. Y. Hafeez, Nasim-ul, H. Shah and K.A. Malik
NIBGE
Faisalabad, Pakistan

A factorial experiment was conducted with lentil genotypes in the experimental area of NIAB, Faisalabad, Pakistan to find the best suited nitrogen and phosphorus fertilizer dose in combination with highly effective *Rhizobium* strains in the presence of native soil rhizobial population. It was found that all the fertilizer treatments and rhizobial strains significantly affected nodulation and biomass yield. Fertilizer treatments 40:40 and 40:60 ($N:P_2O_5$) kg ha^{-1} gave the highest shoot weight. Fertilizer treatment 40:80 kg ha^{-1} resulted in the highest

nodule number, nodule weight and grain weight while the control treatment without any fertilizer gave the lowest. All the fertilizer treatments were statistically different from control. From our results it can be concluded that the inoculation with a highly nitrogen fixing *Rhizobium* strain is imperative for high biomass and grain yield. But along with inoculation, judicious use of nitrogenous and phosphatic fertilizer is also very helpful in enhancing nodulation and biomass yield.

5. The Second FAO/IAEA Co-ordination Meeting on "The Use of Nuclear and Related Techniques in Plant Nutrient and Water Balance Studies with Special Emphasis on Fertigation Practices", 18 - 20 October, Amman, Jordan

Technical Officer: Christian HERA

This meeting was organized in collaboration with the Faculty of Agriculture of the University of Jordan and the Ministry of Energy and Mineral Resources (MEMR), and was mainly for senior research scientists who were the designated country co-ordinators of the above regional project. There were 20 participants from Cyprus (1), Jordan (9), Saudi Arabia (1), Syria (4), Turkey (4) and UAE (1).

At the official opening ceremony, Mr. Abdul Wahab Zubi, the Secretary General of the Jordanian MEMR delivered an opening address. Christian Hera gave a brief chronological summary of the activities implemented under the TC regional project RER/5/004. During the meeting, the scientists presented the results on biological nitrogen fixation, and nutrients and water balance studies in different cropping system, received under this project. Highlights of the results are given below:

The most interesting results were received from **Cyprus**. The project counterpart, Dr. Papastylianu, pointed out that excess nitrogen fertilizer application, will reduce barley yield and increase N losses if rainfall is 250 mm or below. If rainfall is 350 mm or more, 60 kg N/ha would still give good yield response for barley cultivated after fallow or after vetch. However, because the whether cannot be predicted, the optimal rate recommended is 30 kg N/ha. If there is enough rain during the winter period, some extra fertilizer can be applied as a top dressing. The results achieved in Cyprus clearly demonstrated the benefit of including vetch in the rotation. After harvesting vetch for hay, 31 kg N/ha was removed by the subsequent crop and 93 kg/ha was still left in the soil organic matter.

The results from **Jordan** were presented by Dr. D. Badarneh, of the Faculty of Agriculture, University of Jordan. In his case, plant sample analysis for ^{15}N were not complete and therefore no conclusion could be drawn concerning the contribution of lentil to the crop rotation system. The results were to be finalized by the end of 1993.

In **Syria**, the two year cycle on crop rotation experiments has ended. Data presented by Dr. Asfari and Dr. Khalifa, clearly indicated that an inclusion of chickpea in rotation increases wheat yield significantly, with a difference of about 1000 kg/ha. Although a similar trend was observed when the preceding crop for wheat was groundnut, the yield difference was not significant when compared with cereal-cereal rotation. Soil water data presented indicated that fallow practice has no significant benefit over legume-cereal rotation regarding extra water conservation. The data suggest that traditional fallow practice should be abandoned.

Mr. M.Al-Wabel mentioned that similar research work on crop rotation was initiated in **Saudi Arabia**, but under irrigation conditions, using fababean as the leguminous crop in rotation with cereal. Additional data are necessary to demonstrate nutritional benefit of leguminous crops included in crop rotation.

Dr. M.B. Halitligil reported that in **Turkey**, the crop rotation experiments were located in three different regions: Ankara, Konya and Eskisehir. Two years data showed that wheat yield increased significantly if the preceding crop was lentil or vetch, demonstrating clearly the nutritional benefits of including a leguminous crop in the rotation. Soil water data has not yet been evaluated thoroughly to reach a meaningful conclusion if the traditional fallow treatment has any beneficial effect on water conservation.

The representive from the **United Arab Emirate**, Mr. M.A. Ahmad was not involved in the activities of the regional project RER/5/004 and therefore no presentation was made during the meeting.

The last day of the meeting was devoted to the new emphasis of the project - fertigation. Dr. I. Papadopoulos (invited expert on fertigation) presented an excellent paper on the use of nuclear technique in plant nutrients and water balance studies with particular emphasis on fertigation. After useful discussions, Drs. Ch. Hera, C. Kirda and I. Papadopoulos prepared a research proposal on fertigation. This was accepted by all participants. It was recommended that under the existing regional project the new emphasis in 1994 should be on fertigation which is a new innovation to increase efficient and effective use of scarce water resources in the region, as well as for increasing fertilizer use efficiency, better yields and high quality crops, and at the same time to diminish environment pollution to a maximum. The new emphasis on fertigation is particularly important for the countries of the region since irrigated agriculture is expanding rapidly and modern irrigation technology is taking over in almost all countries in the region.

Planned

Fourth FAO/IAEA Research Workshop of the Regional Africa Project on Biological Nitrogen Fixation, RAF/5/010, 14-26 March 1994, Nairobi, Kenya

Technical Officer: Manase P. SALEMA

The Regional Africa Project on Biological Nitrogen Fixation was initiated in 1987 with the overall objective to increase and sustain agricultural production and hence the standard of living of the people through exploitation of biological nitrogen fixation in grain, tree and pasture legumes. The regional project operates as a network involving various Member State institutions aimed at promoting collaboration between scientists in the Africa Region for exchange of information and scientific experience. Research workshops are held periodically in different Member State laboratories to discuss results of previous experiments and plan follow up research, as well as discuss ways of enhancing collaboration. The third workshop was held in Meknes, Morocco in September 1992.

TECHNICAL CO-OPERATION PROGRAMMES

The Soil Fertility, Irrigation and Crop Production Section presently has the responsibility for 78 Technical Co-operation projects. In the December 1992 issue and the July 1993 issue, we gave summaries of projects in Africa. In this issue, we highlight the activities of TC projects in Latin America.

Brazil

Studies on Green Manure and Crop Residue Utilization (BRA/5/029)

Centre for Nuclear Energy in Agriculture (CENA), Piracicaba
Counterparts: T. Muraoka and A. Boaretto

This new project is operational for the biennium 1993-94. The objective is to evaluate the possible replacement of mineral nitrogen fertilizers with nitrogen released from green manuring and crop residues for maintaining soil productivity. The need for search for alternative sources to inorganic nitrogen fertilizers has been brought about not only by their high price but also by the need to maintain long-term soil productivity and ecological sustainability (reduce nitrogen pollution). Green manuring is a common practice in some Asian countries but it has not been extensively used in South America. CENA has sufficient counterpart staff and facilities to implement the project. Other collaborating institutes are the Federal University of Pelotas, the State Agronomic Institute of Campinas, EMBRAPA in Goiania and the Sao Paulo University at Botucatu. The Agency will provide experts in nitrogen and sulphur turnover studies, equipment and labelled fertilizers. It is expected that the results will be transferred to other national and Latin American Institutes.

Chile

Management Systems in Crop Production (CHI/5/018)

National Research Institute for Agriculture and Livestock (INIA), Santiago
Counterpart: P. Baherle

Chilean Nuclear Energy Commission (CCHEN), Santiago
Counterpart: I. Pino

This new project is aiming at identifying suitable management systems leading to optimized crop production through improved utilization of soil, water and fertilizer resources. Under the past IAEA technical assistance, both co-operating institutes have set up excellent facilities for the use of ^{15}N and ^{32}P in agricultural research and contributed to a substantial increase in the efficient use of nitrogen and phosphate fertilizers. However, significant losses of fertilizer and soil nitrogen occur mainly by leaching, thus making it necessary to identify suitable soil management systems which would combine high crop productivity, efficient fertilizer use and protection of soil/water quality. INIA and CCHEN are proposing to compare various management systems related to the production of fruit trees, pastures and grain legumes. IAEA assistance will involve the provision of expert services covering fruit-tree nutrition, nitrogen fixation and crop management, equipment including labelled fertilizer and training. It is expected that this project will consolidate the transfer of nuclear technology to the agricultural sector. The improvement of fertilizer, soil and water resources utilization will contribute to reduce production costs and increase the quality of agricultural products while preserving soil and water resources.

Costa Rica

Nitrogen Dynamics (COS/5/016)

School of Agricultural Sciences, National University of Costa Rica (UNA), Heredia, San José
Counterpart: C. Cervantes

This is a new project which started in 1993. The main objective is to study the dynamics of nitrogen in traditional cropping systems involving grain crops (maize/bean) to assess nitrogen inputs from nitrogen fixation and green manuring. Cropping systems for the production of basic grain crops in Central America are very variable. When combined with large variations in climate and soils, the resulting dynamics of nutrient cycling is very complex. Nitrogen, an essential nutrient for ensuring high yields is exposed to severe losses due to various mechanisms. Knowledge about the significance and magnitude of these losses is not available and will be essential for developing improved fertilizer N practices, including the use of cover and green manure crops. Research aiming at determining the dynamics of nutrients in traditional cropping systems of small peasant farmers are underway in the southern region of Costa Rica and the approach to be adopted under this project will involve the use of ^{15}N isotope techniques to obtain reliable quantitative information on the major gen cycling processes. The IAEA assistance includes provision of expert services, equipment (mainly ^{15}N labelled fertilizers) and training of local staff. It is expected that the development of improved fertilizer N practices will contribute to increase basic grain production while reducing costs to the farmers. The results will be transferred to other countries of Central America with similar cropping systems.

Ecuador

Efficiency in the Use of Water and Fertilizer (ECU/5/018)

Ecuadorian Atomic Energy Commission (CEEA), Quito
Counterpart: M. Calvache

This project aims at developing fertilizer and water management practices of major export crops of Ecuador. Through previous IAEA Projects, the CEEA has set up facilities to conduct isotope-aided studies in soil/plant research. The CEEA has been working in close collaboration with the Faculty of Agriculture of the Central University and the National Research Institute of Agriculture and Livestock (INIAP) for developing improved water and fertilizer N and K practices of main food crops (potato and cereals) and measuring biological nitrogen fixation in grain legumes (common bean, pea and soybean). Relevant results have been reported in several technical and scientific publications. Ecuador is a country oriented to the production of export crops such as coffee, banana and oil palm and in recent years ornamental and horticultural crops have been gaining importance in the export market. Among the main limitations for commercial production are insufficient knowledge of the nutritional requirements of these species as well as appropriate water management practices, problems which will be investigated under this project. The IAEA inputs are expert services, equipment (labelled fertilizer and complementary equipment for isotope analysis), and fellowship training of staff. In the long term, it is expected that the development of improved fertilizer management practices for the crops under study will contribute to increasing the Ecuadorian agricultural export potential.

Mexico

Use of Nuclear Techniques in Agriculture (MEX/5/019)

Agricultural Research and Development Centre (CUIDA), University of Colima, Colima
Counterpart: M. Cigales-Rivero.

Centre for Investigation and Advanced Studies (CINVESTAV), National Polytechnic Institute, Irapuato, Gto.
Counterpart: J.J. Peña-Cabriales

This is a new project, initiated in 1993. The major objective is to introduce the use of N-15 techniques in soil/plant studies with respect to efficient use of fertilizer N (maize amaranthus and lemon) and biological nitrogen fixation (bean) for improving agricultural production of the most important crops of the Colima State. The CUIDA has already obtained selected genotypes of bean, amaranthus and maize with high yield potential. ^{15}N isotope techniques will be used to evaluate the performance of the selected genotypes under different ecological conditions. On the other hand, tests have been carried out on pruning and fertilizer N rates and timing in order to stagger the production period of lemon (potential export product). These studies will be continued using isotope techniques. IAEA assistance involves the provision of experts, equipment (^{15}N labelled materials and ancillary laboratory equipment) and fellowship training of local scientists. CINVESTAV will collaborate in this project with the provision of analytical services and expertise on the use of ^{15}N techniques. The establishment of a national network for the application of isotope techniques in agricultural research will contribute to the improvement of food production in Mexico.

Nicaragua

Improvement of Crop Yields (NIC/5/003)

Faculty of Agronomy, National Agrarian University (UNA), Managua
Counterpart: T. Talavera

This project initiated in the biennium 1991-92 was implemented with the objective of strengthening local research capability for studying soil/water/fertilizer relationships through the use of isotope techniques with a view to improving agricultural production. The project has been extended through the biennium 1993-94. Several experiments on fertilizer N use efficiency and effective use of irrigation water have been carried out. IAEA inputs involve expert assistance and equipment mainly isotopically labelled fertilizers. Transfer of the nuclear technology to local staff is done through the conduct of short training courses and workshops. Emphasis is being placed on the analysis and transfer of results of immediate practical relevance to agricultural production.

Uruguay

Nuclear Techniques in Soil Phosphate Dynamics and Fertilizer P Efficiency (URU/5/019)

National Directorate of Nuclear Technology (DNTN), Montevideo
Counterpart: R. Goyenola

National Institute for Agricultural Research (INIA), Montevideo
Counterpart: R. Rabuffetti

Faculty of Agronomy, University of the Republic, Montevideo
Counterpart: J. Zamalvide

This is a new project which started in 1993. The main objective is to establish a facility for use of ^{32}P radioisotope techniques on studies of soil P dynamics and fertilizer P use efficiency in various production systems. Agricultural productivity in Uruguay is often limited by low availability of nitrogen and phosphorus in soil. During the past ten years, extensive research using ^{15}N isotope techniques have been carried out on nitrogen dynamics and fertilizer N use efficiency with IAEA assistance through several TC projects. As a result, relevant information is available on the management of soil and fertilizer N in different crop systems. Also the country has trained manpower and excellent facilities for ^{15}N analysis. Phosphate research using conventional techniques has been already carried out in the country since 1980. Under present project, the three collaborating institutes will perform laboratory, greenhouse and field experiments using ^{32}P isotope techniques. IAEA is providing laboratory equipment and ^{32}P labelled materials as well as expert services. Training of staff is also foreseen. It is expected that the use of isotope techniques will contribute to the development of an economic and effective phosphate management programme.

Venezuela

Nuclear Techniques Applied to Soil Sciences - Phase II (VEN/5/016)

Faculty of Agronomy, Central University of Venezuela (UCV), Maracay
Counterpart: E. Casanova

National Fund for Agricultural and Livestock Research (FONAIAP), Maracay
Counterpart: J.L. Gil

This project is a continuation of the IAEA TC Project VEN/5/014, which started in 1991. The project was approved to further expand the research activities of these associated institutions. This project deals with two main subject areas: (i) studies on soil P availability and P fertilizer management including local rock phosphate utilization (UCV), and (ii) biological nitrogen fixation in tropical forage legumes (FONAIAP).

Facilities and staffing at both institutions are adequate and operational funds will continue to be provided from national resources. The IAEA assistance will consist of expert services and training of staff. Only minor pieces of equipment and labelled fertilizers required to perform the studies will be supplied. It is expected that both the inclusion of nitrogen fixing tropical legumes and the utilization of phosphate rock-based products will help to increase soil fertility (saving fertilizer costs and avoiding detrimental environmental effects) and improve the nutritional quality of pastures in the tropical savannah of Venezuela.

SYMPOSIA and SEMINARS

(a) The FAO/IAEA International Symposium on Nuclear and Related Techniques in Soil/Plant Studies on Sustainable Agriculture and Environmental Preservation, 17 - 21 October 1994, Vienna, Austria

This Vienna symposium is planned to provide a forum for scientists conducting research on soil/plant relationship studies in sustainable agricultural systems and associated environmental pollution problems, using isotope and related nuclear techniques. The scope of the symposium will be limited to soil fertility, plant nutrition, water management and crop production in sustainable agriculture where isotopes and related nuclear techniques have been used. Environmental aspects related to nutrient and water management in crop production studies will also form an important component.

The symposium will cover: (i) recent developments in analytical methods and equipment; (ii) soil organic matter studies and nutrient cycling; (iii) fertilizer use and management studies; (iv) water use and management studies; (v) biological nitrogen fixation in sustainable cropping systems; (vi) plant physiological aspects in crop production; (vii) environmental pollution; and (viii) soil conservation, soil erosion and desertification.

We expect participants to present papers which will highlight recent research on soil fertility, plant nutrition, agronomy and related aspects such as organic matter and nutrient cycling, dealing with sustainable agriculture and problems of environmental pollution caused by irrational use of fertilizers and water. Extensive discussions will allow an exchange of information which will lead to identification of future directions of research aimed at improving management practices that ensure sustainable agricultural productivity and environmental preservation. **All papers** - apart from invited review papers - **must present original work; they should not have been published elsewhere.**

A completed **Form for Submission of a Paper** (Form "B"), together with the **Participation Form** (Form "A") and six copies of an **extended synopsis** of 800 words (i.e. two A4 format pages of single spaced typing or the equivalent, including any tables or diagrams and a few pertinent references) must be sent to the competent offical authority for transmission to the Meeting Secretariat to reach it **by 10 April 1994**. The synopsis should give enough information on the contents of the proposed paper to enable the selection committee to evaluate it. Participants who order copies of the proceedings in advance during the meeting will be entitled to a 50 % discount. The prospectus and other relevant details pertaining to this symposium have now been dispatched to the Member States.

As a general rule, the sponsoring organizations do not pay the cost of attendance, i.e. travel and living expenses of participants. However, limited funds are available to help meet the cost of attendance of selected specialist mainly from developing countries with low economic resources. Generally, not more than one grant will be awarded to any one country.

For additional inquiries, please contact the scientific secretary of the symposium, Dr. Christian Hera, Head of Soil Fertility, Irrigation and Crop Production Section, Joint FAO/IAEA Division, Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna, Austria.

(b) **The FAO/IAEA Symposium on the Use of Nuclear and Related Techniques in Soil/Plant Studies with Special Emphasis on Environmental Preservation and Sustainable Agriculture, 10 - 16 July 1994, Acapulco, Mexico**

This symposium is being organized as part of the XV International Congress of Soil Science Society to be held in Acapulco, Mexico from 10 - 16 July 1994. The symposium will deal with the use of isotopes and related nuclear techniques and will cover:

1. Organic matter accumulation and decomposition in sustainable agriculture.
2. Biological nitrogen fixation - selection of genotypes to increase BNF and yield.
3. Fertilizer use and plant nutrition in different cropping systems.
4. Soil/plant water relationships.
5. Crop productivity in deleterious soils.

The limited number of invited speakers have already been selected. Dr. Christian Hera, Head of Soil Fertility, Irrigation and Crop Production Section will be the convenor of the symposium at this congress. Detailed information can be found in the Bulletin of the International Society of Soil Science No. 82/83, 1992/2, 1993/1 and No. 84, 1993/2.

FROM OUR READERS

Excerpts from the XXIIIrd Annual Meeting of ESNA, Sept. 5 - 9, 1993, Halle, Germany

Report of Working Group (WG-3) on Soil/Plant Relationships, prepared by the chairman of the group, Dr. Martin H. Gerzabek, Austria.

Session I - Use of ^{15}N and ^{13}N in plant nutrition studies:

Mr. Kovacheva from Bulgaria presented results from nutrient solution experiments with different labelled nitrogen forms. Ammonium added at low concentrations to nitrate medium significantly stimulated the protein synthesis in sunflower leaves.

Mr. Hahn, Germany, reported an advanced technqiue with ^{13}N to study the principles of nitrate influx and the role of potasium in NO_3^- uptake in order to verify or falsify the Ben Zioni model of co-uptake.

Two papers from Mr. Brohi and co-workers, Turkey, highlighted the nitrogen utilization of maize and wheat from tobacco waste using ^{15}N. Due to the slow release of nitrogen from this organic fertilizer, up to 55 % (maize) and 62 % (wheat) of total N-uptake came from the tobacco waste.

Ms. Ilieva, Bulgaria, showed in her paper that optical characteristics of plant leaves can be used as a rapid method for determining the effectiveness of nitrogen fixation by a mycorrhizal fungus (*Glamus fc.*).

Session II - Soil-to-plant transfer of radionuclides

This was jointly held with the IUR (International Union of Radioecologists) and was chaired by Mr. Martin Frissel. Nine lectures and one poster were presented. The session was opened with an introductory lecture by the session chairman Mr. Frissel, Netherlands. He highlighted a publication of the IAEA and IUR in which expected values for radioecological transfer parameters are listed. The publication is intended as an authoritative and convenient base for radioecological assessment studies. Values are based on the investigations of numerous scientists, part of them being ESNA members. The majority of the presentations discussed the transfer of ^{137}Cs and ^{89}Sr. There seems to be an increasing interest in natural ecosystems; four papers by Messrs. Schuller (Chile), Gerzabek (Austria), Salt (UK), and McGee (Ireland) as well as a poster by Ms. Nikolova (Bulgaria) discussed this topic. Mr. Schuller noticed that in some prairie soils in Chile, the ^{137}Cs concentration is much higher than in comparable areas of the South American sub-continent. The reason is the high rainfall. It is also possible that the area lies in the rain shade of the French nuclear weapon test sites in Micronesia.

Mr. Gerzabek showed that in alpine areas, the decrease in ^{137}Cs content is slow, the reason probably is that ^{137}Cs remains absorbed in the organic debris. After decomposition, the ^{137}Cs is immediately taken up by the growing vegetation. This limits leaching and fixation of ^{137}Cs by clay minerals. His findings are in agreement with observations in natural ecosystems and forest systems. Also, Ms. Nikolova's poster showed that an important part of ^{137}Cs is present in the upper litter layer. This indicates that ^{137}Cs is easily recycled in forest areas.

Messrs. Salt and McGee presented data on heather moorland in Scotland and Ireland. Results show that the ecology of heather moorlands differs significantly from the ecology of arable land. It is even difficult to apply the same units. The usual units: (Bq/kg dry crop)/(Bq/kg dry soil) have hardly a meaning. Moreover, it is difficult to define the entity "soil" in such an ecosystem.

Messrs. Skarlou (Greece), Nobeli (Greece) and Roca (Spain) reported on the transfer of radioactivity to food crops in Greece (2x) and Spain. Despite the fact that nowadays rather reliable estimates exist for the soil to plant transfer, many details are still unknown. In particular low pH values can result in relatively high uptake values, as was shown by Mr. Skarlou. There exists at the moment an increasing interest in homeostatic processes and homeostatic models. In such models it is assumed that Cs and K, and Sr and Ca behave identically. Data by Mr. Roca and Mr. Nobeli showed that equal behaviour does not exist. Plants discriminate between Cs and K and between Sr and Ca indeed. A key problem is that it is difficult to define and/or determine the "plant available" quantities. Different determination methods provide different resutls. The ascertainment of radioecological data required for homeostatic models may be a research topic for the near future.

Session III - Plant nutrition studies with special emphasis on the use of radioactive and stable isotopes

Mr. Aydeniz (Turkey), focussed on potassium nutrition on typical soils from Turkey. He used ^{86}Rb as a tracer to determine the potassium taken up from the fertilizer and to show the interactions between potassium, nitrogen and calcium nutrition. Mr. Aydeniz used autoradiographic methods for the confirmation of his results.

Mr. Serdinescu from Romania proposed in his presentation a new method for screening grapevine rootstocks with respect to iron absorption. Excised roots are exposed to $^{59}FeCl_3$ in alcaline solution, then dried and again exposed to $FeCl_3$, but without labelling. From the reduction of activity in the first solution and the increase in the second one, it is possible to calculate Fe taken up into the inner space and rank the rootstocks according to their Fe-absorption.

Mr. Ullah from Bangladesh elaborated on the heavy metal pollution around three factories (battery, pharmaceutical and tannery factory) in Dhaka. He showed very clearly the detrimental impact of the industrial wastes on the environment, causing heavy metal toxicity to plants, heavy metal concentrations in plants above toxic limits for feed and food and an extremely high input of nitrogen to the soil-plant-water system. Pot experiments showed that cowdung may diminish heavy metal toxicity to plants.

Mr. Roeb (Germany), presented an advanced technique using the short-lived isotope ^{11}C for in vivo measurements of assimilate translocation within plants. He discussed especially the feasibility of studying the short-term transport of assimilates.

The next ESNA-meeting will take place in Varna, Bulgaria, from 12 - 16 September, 1994.