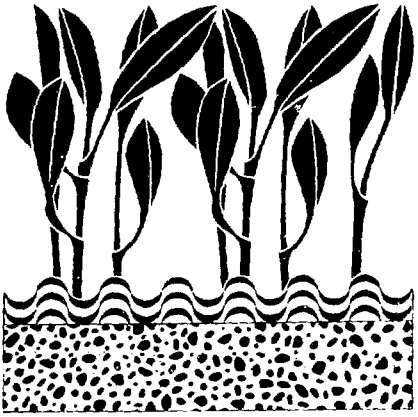

Soils Newsletter

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

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CONTENTS

TO OUR READERS

The past six months turned out to be a particularly busy period for myself and for all the colleagues in the Soil Fertility, Irrigation and Crop Production Section.

Preparations are well advanced now for the FAO/IAEA International Symposium on "Nuclear and Related Techniques in Soil/Plant Studies on Sustainable Agriculture and Environmental Preservation" planned to be held in Vienna, Austria from 17-21 October 1994. The symposium is expected to provide a forum for scientists conducting research on soil/plant relationships in sustainable agricultural systems, and associated environmental pollution problems. The programme has been finalized but one could still register to attend as an observer - earlier the better in order to facilitate accommodation arrangements - Vienna, as you know, is generally full of tourists, be it Spring or Autumn. Preparations have also been finalized for 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, to be held in Acapulco, Mexico, from 10-16 July. This will form part of the XV International Congress of Soil Science Society. As in previous years, only a limited number of invited speakers have been selected for this Symposium.

At the time of writing this, an FAO/IAEA Regional Training Course on the Use of Isotopes and Radiation Techniques in Soil Fertility and Plant Nutrition is in progress in Nairobi, Kenya. Twenty-one participants from 12 Member States of the IAEA and FAO have been selected. In addition, an FAO/IAEA Advanced Fellowship Group Training on Modern Techniques in Soil-Plant Research for Sustainable Agriculture Development and Environmental Conservation is planned to be held at the IAEA Laboratories in Seibersdorf from 26 September - 21 October 1994. The main objective of this special course is to update the knowledge of local counterparts of the IAEA Technical Co-operation projects on the on-going and future project areas as well as specific aspects of the use of nuclear techniques in soil/plant relationship studies. Participants from eleven Member States of the IAEA and FAO have been selected.

In October this year, the FAO/IAEA/SIDA Co-ordinated Research Programme (CRP) on "Increasing and Stabilizing Plant Productivity in Low Phosphate and Semi-arid and Sub-humid Soils of the Tropics and Sub-tropics" will come to an end. The participants of this CRP will also have the opportunity to attend the Symposium scheduled for the week immediately following the Research Co-ordination Meeting (RCM). The third RCM of the FAO/IAEA CRP on "Enhancing Soil Fertility and Crop Production by Better Management of *Rhizobium*" is planned for 15-19 August. Prof. W.J. Broughton has kindly offered to host the RCM at the University of Geneva in Switzerland. Also, the final RCM of the FAO/IAEA/UNDP CRP on "The Use of Isotopes in Studies to Improve Yield and N Fixation of Grain Legumes with the Aim of Increasing Food Production and Saving N-fertilizer in the Tropics and Sub-tropics of Asia" is due to be held in Patancheru, India. Dr. O.P. Rupela of ICRISAT will be our host.

At the beginning of 1995 we will start a new Co-ordinated Research Programme on "The use of

nuclear techniques on radiation processing of sewage sludge and its use to increase crop yields, and to preserve the environment". The Consultants Meeting will be organized in November 1994 and any suggestions on this subject will be very much appreciated.

In our Newsletters of 1992 and 1993 we highlighted the activities of the IAEA Technical Co-operation (TC) projects in Latin America, Africa, and the Middle East and Europe. In this issue, you will find the highlights of the TC projects implemented in Asia and the Pacific Region.

I warmly would like to welcome Pierre Moutonnet, a specialist in soil physics and water studies who joined our Section at the beginning of this year. I wish him great success especially in the co-ordination of two CRPs on interaction between fertilizers and irrigation which I have been handling as project officer until now.

We value very much the comments we often receive from our readers on the information disseminated through this Newsletter. As always, we will endeavour to continue to do our best. This issue of the Soils Newsletter was compiled and edited by Saliya Kumarasinghe and myself with contributions from our colleagues from the Soils Section at the Headquarters and Soils Unit at the Seibersdorf Laboratory. The manuscript was typed by Ms. Ruth Rossi.

Christian Hera
Head, Soil Fertility, Irrigation
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3. **Staff Changes**

In January this year, we welcomed Pierre Moutonnet who succeeded Cevat Kirda as our specialist in soil water studies. Pierre comes from the Nuclear Research Centre in Cadarache, France, where he has worked for the past 20 years concentrating mainly on soil/plant/atmosphere continuum in relation to water and nitrate nitrogen leaching. He is an expert in the use of the neutron moisture gauge and the gamma density probes.

Angela Sessitsch left the post as a laboratory technician of the Seibersdorf Laboratory in February this year. She is expected to re-join the Laboratory as an FAO Associate Professional Officer (APO) funded by the Austrian Government.

William Quist, the FAO APO funded by the Netherlands, left Seibersdorf laboratory in May 1994. William was involved with studies of soil erosion and nutrient dynamics in agroforestry systems. He has been a methodical and a conscientious research officer. We wish him success in his future endeavours.

Louise Taylor from the United Kingdom joined us on 27th June 1994 as our Section Secretary. All our staff wishes her a very warm welcome and all the best.

A new APO, Silke Eckert funded by Germany assumed duties in June. Silke is trained in soil/plant water studies. She will be working closely with Pierre Moutonnet in the Joint Divisions' programmes on irrigation and crop water studies.

After bidding us "Adieu", we would like to take this opportunity to express our thanks to Ingrid Puschnig (2 years) and Angela Peake (3 months) for the invaluable contributions done during their stay.

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 (D1-50.02)

(Project Officer: K. Saliya Kumarasinghe)

This CRP, funded by the Swedish International Development Authority (SIDA) is now in 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), B.A. Ogunbodede (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). The programme is being implemented as scheduled and the last RCM is planned to be held in Vienna from 10 - 14 October 1994. Official invitations to participants will be dispatched in the near future.

2. FAO/IAEA/UNDP CRP on The Use of Isotopes in Studies to Improve Yield and N_2 Fixation in Grain Legumes with the Aim of Increasing Food Production and Saving N-Fertilizer in the Tropics and Sub-tropics of Asia (D1-40.04)

(Project Officer: Seth K.A. Danso)

This CRP is in its last year, with a final Research Co-ordination Meeting scheduled for 7-11 November at ICRISAT, Hyderabad, India. In conjunction with the RCM, a tripartite mission consisting of three to four scientists, a UNDP officer and the technical officer would have to review achievements of the CRP and submit a report to UNDP. In addition to the original aim of the project, that of selecting, breeding or using induced mutation to increase yield and biological nitrogen fixation in grain legumes, participants are conducting experiments to [illegible] the residual value of rotating legumes and cereal crops on the same plot, compared with a cereal-cereal rotation.

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 (D1-40.05)

(Project Officer: Seth K.A. Danso)

The CRP is still going on, and will now proceed to 7 years instead of 5 years. This is because trees grow for longer periods and a CRP on nitrogen fixing trees does not have to be terminated based on the periods used for shorter duration crops. Participants are continuing with their studies on the use

of ^{15}N techniques to measure N_2 fixation in various trees, and efforts are being made to overcome problems with the selection of reference trees. Genotypic variation among trees for N_2 fixation has been demonstrated and remains one of the achievements of this project. Studies on the management of nitrogen fixing trees for greater nitrogen fixation and the role of nitrogen fixing trees as sources of organic matter for soil fertility improvement are going on alongside. The only unfortunate news is, that the CRP planned for this year had to be postponed to next year (June 26-30 1995) due to financial constraints.

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 (D1-20.05).**

(Project Officer: Pierre Moutonnet)

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

The second RCM was held from 24 - 28 August 1993 in Fundulea, Romania. The final RCM will be held in Morocco in March/April 1995. The results will be published as an IAEA-TECDOC.

5. **FAO/IAEA CRP on The use of Nuclear Techniques for Optimizing Fertilizer Applications under Irrigated Wheat to Increase the Efficient Use of Fertilizers and Consequently Reduce Environmental Pollution (D1-40.07)**

(Project Officer: Pierre Moutonnet)

This programme presently includes twelve participants, four agreements holders: R. Rennie (Canada), G. Vachaud (France), R.A. Fisher, and W. Baethgen (USA) and eight contract holders: X. Wen (People's Republic of China), M.A.S. Abdel Monen (Egypt), M.S. Sachdev (India), and J.M. Sanchez-Yañez (Mexico), B. Soudi / M. Bazza (Morocco), G. Cioban (Romania), A. Arslan (Syria), Ç. Kirda (Turkey). Two to four more contractors are expected. A Consultants Meeting on this theme was held in Vienna from 29 November to 2 December 1993. It was devoted to establishing the goals and objectives of this new CRP, initiated in co-operation with CIMMYT, Mexico, and IFDC, USA. The first RCM will be held in Vienna. The exact date will be announced in due course. So far several technical documents have been sent to the contractors, to be used as a guideline during the current winter wheat cropping campaign.

6. **FAO/IAEA CRP on Enhancing Soil Fertility and Crop Production by better Management of *Rhizobium* (D1-40.06)**

(Project Officer: Gudni Hardarson)

At the present there are 14 participants collaborating in this programme. The third RCM is planned to be held from 15 to 19 August 1994. Prof. W.J. Broughton has kindly offered to host the meeting at this institute at the University of Geneva, Switzerland. A full report of the meeting will be published in an upcoming Newsletter.

7. **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 (D1-50.03)**

(Project Officer: Felipe Zapata)

This CRP, funded by the French Government, has just started its second year of operation. The programme is being implemented as recommended by the Consultants Meeting held in Vienna, 10-12 May 1993. The overall goal of this CRP is to develop through the use of nuclear and related techniques an effective and economic phosphate management programme for increasing productivity of food crops while protecting the environment. The first RCM of this CRP cum Workshop was held in Vienna, Austria from 1 - 5 November 1993. Excerpts from this meeting are given elsewhere in this Newsletter. The second RCM of this CRP is planned to be held in March/April 1995.

The present contractors (12) are: 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 (Vietnam). The agreement holders (6) are: T. McLaughlin (Australia), J.C. Fardeau (France), Truong Binh (France), J.M. Barea (Spain), S.H. Chien (USA) and F. Sikora (USA).

FAO/IAEA TRAINING COURSES

In progress

1 **FAO/IAEA Regional Training Course on the Use of Nuclear Techniques in Soil Fertility and Plant Nutrition Studies (RAF/5/030), 6 June - 8 July 1994, Nairobi, Kenya.**

Technical Officer: Seth K.A. Danso, Course Director: F. Muchena

The course was organized by IAEA and FAO in co-operation with the Government of Kenya through the Kenya Agricultural Research Institute in Nairobi, Kenya. Twenty-one participants from 12 Member States of IAEA and FAO were selected. More details will be given in the next Newsletter.

Planned

1 **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 (near Vienna), Austria**

Technical Officer: Christian Hera, Course Director: Felipe Zapata

The main objective of this group training is to update the knowledge of local counterparts of IAEA Technical Co-operation projects and or former participants of FAO/IAEA Training Courses on the ongoing and future projects areas as well as specific aspects of the use of nuclear techniques in soil plant relationship studies. Eleven participants have been selected to take part in this training. In addition to IAEA staff, invited specialists will participate as key-lecturers to provide overview lectures, assist in the design of isotope aided experiments and interpretation of isotopic data, and lead group discussions on selected topics of soil-plant research.

2 **The FAO/IAEA Interregional Training Course on the Use of Isotope and Radiation Techniques in Studies of Soil Plant Relationship with emphasis on better Nutrient Utilization to improve Crop Production, 29 May - 7 July 1995, Seibersdorf (near Vienna), Austria**

Technical Officer: Christian Hera, Course Director: Felipe Zapata

The objective of this six-week training course is to give scientists from developing countries a sound working knowledge of the use of isotope and radiation techniques in soil plant relationship studies. The course also aims at training local personal to develop capability to carry-out isotope-aided experiments as part of national programmes for increasing sustainable agricultural productivity. The course will cover the relevant isotope and nuclear techniques in soil fertility and plant nutrition studies. Broad coverage of techniques will be given through lectures, laboratory sessions, greenhouse field experiments, films and discussion groups. Emphasis will be placed on application of these techniques to solve practical problems.

from their own experience. Please note that the language of the course is English. A written certificate of English proficiency is required.

The circular announcement and prospectus will be dispatched to the National Atomic Energy Authority or Government Office responsible for nuclear matters in the respective Member States during the last quarter of 1994. For additional information, please contact the Technical Officer Christian Hera, Head, Soil Fertility, Irrigation and Crop Production Section, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna, Austria.

3. **FAO/IAEA Regional Training Course on the Use of Isotopes and Radiation Techniques in Studies of Soil/Plant Relationships with Emphasis on Nutrient and Water Use Efficiency to Increase Crop Production on Acid Soils, 6 March - 7 April 1995, Bangkok, Thailand.**

Technical Officer: Saliya Kumarasinghe; Course Director: Patoom Snitwongse

The objective of the course is to train scientists in Asia and the Pacific region on the use of relevant isotope and radiation techniques in research to find ways by which soil fertility, nutrient uptake and water use efficiency of crops could be increased on acid soils. The course also aims at training personnel to enable them to carry out isotope aided research as part of their national research programmes for increasing and sustaining soil fertility and food production. The course will provide both theoretical and practical knowledge on the use of radioactive and stable isotopes as well as radiation techniques in research on fertilizer and water use efficiency, plant nutrition, biological nitrogen fixation, carbon metabolism, soil chemistry and soil physics. Broad coverage of the techniques will be given through lectures, laboratory sessions, field/greenhouse experiments, calculation exercises, films and discussion groups. The participants will be required to present a research proposal which will provide the opportunity to learn the methods of applying the techniques and concepts described during the course to solve practical problems in their own countries. The language of the course is English.

The announcement and prospectus will be dispatched to the National Atomic Energy Authority or Government Office responsible for nuclear matters in the respective Member States around September 1994. All applications should be forwarded through official channels. For additional enquiries, please contact the Technical Officer, Saliya Kumarasinghe, Soil Fertility, Irrigation and Crop Production Section, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna, Austria.

MEETINGS/WORKSHOPS

Corrigendum: *Soils Newsletter, Vol. 16, No. 2, December 1993, page 24, last paragraph. Please note that the report from Syria was presented by Dr. M. Janat and not by Drs. Asfari and Khalifa as was published in the above Newsletter.*

1 **The First Research Coordination Meeting of the FAO/IAEA French funded CRP on The Use of Nuclear and Related Techniques for Evaluating the Agronomic Effectiveness of Phosphate Fertilizers, in particular Rock Phosphates** (D1-RC-542.1)
1 - 5 November 1993, Vienna, Austria

Scientific Secretary: Felipe Zapata

The meeting was attended by 17 scientists from as many participating Member States and staff members of the Soil Fertility, Irrigation and Crop Production Section of the Joint FAO/IAEA Division and the Soil Science Unit of the IAEA Agriculture Laboratory. The participants presented reports on their past experiences on phosphate research and on preliminary experiments already conducted in connection with this programme. A one-day workshop on the use of ^{32}P techniques in phosphate research and practical demonstrations on the use of ^{32}P in laboratory and greenhouse experiments was held at the IAEA Laboratories in Seibersdorf. This was followed by discussions on the networking of the research programme and future experimental plans.

From the presented reports and the discussion on future experiments it was clearly demonstrated that the objectives of this CRP are highly relevant to tackle the main limitations of a phosphate management programme i.e.,: to assess the availability to plants in soils amended with indigenous and modified phosphate rock products and water-soluble P fertilizers, and to enhance the agronomic effectiveness of phosphate rock-based products tested in diverse soil and climatic conditions. A full report on this meeting is available upon request.

Excerpts from presented reports:

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Development of Soil Tests for Assessing P Availability in Soils Fertilized with Rock Phosphates and Suitability of Soils for Fertilization with Rock Phosphates.

A national series of field trials has been established in Australia and is co-ordinated through La Trobe University in Melbourne. These trials are evaluating various RPR fertilizers and triple superphosphate in a range of environments and soils. Soils from these trials are currently being analyzed by various soil test methods to evaluate the most effective soil test procedure to determine response of pasture plants to both water-soluble and RPR fertilizers. Methods being evaluated are water-extractable P, 0.01M $CaCl_2$-extractable P, Bray-1 P, Colwell-P (0.5M $NaHCO_3$), isotopically exchangeable P, P desorbed to iron-oxide impregnated filter paper, mixed resin extractable P, exchangeable Ca, isotopically exchangeable Ca and pH buffer capacity. Preliminary glasshouse experiments running in parallel to the above field trials, and using five different types of P fertilizer, have indicated that the mixed-resin soil

P test is the most appropriate test tried to date. Further P tests on these soils are currently underway

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Fate of Fluid and Solid Fertilizers P in the Soil

Maize seeds were sown in pots containing 1 kg of two latosols with different P retention capacities. The P fertilizer were applied at rates of 0 (control), 70, 140 and 210 mg P_2O_5/kg of soil. Plants were grown three times (30 days each period). Two laboratory experiments were also conducted to evaluate the fate of phosphatic fertilizers and the availability of native and added P in the soils. The method used was soil P fractionation (Chang & Jackson, 1957) associated with isotopic dilution technique (^{32}P) (Baker, 1964; Dumbar & Baker, 1965).

The agronomic efficiency of both fluid and solid phosphatic fertilizers were equivalent, indicating that the use of fluid P sources to short cycle crops, such as maize is agronomically viable. The majority of P applied to the soil was recovered in the Al-P and Fe-P fractions. Only small quantity of P were found in H_2O-P, Ca-P and occluded-P fractions. The colorimetric method was less precise than isotopic method for the determination of P fate in the soils. The calcination method was used for the evaluation of soil organic P fraction, but the method was inadequate to analyze the organic P fraction in these two latosols. The availability of native and formed phosphates was greater in low P fixing capacity soils compared to soils with high P retention potential.

In another experiment, four methods for soil phosphorus availability (Bray 1, Mehlich 1, resin and $E_{1/2}$ value) were compared in soil which received 0, 50 and 100 ppm P as TSP (Triple super- phosphates); 50 and 100 ppm P as fused magnesium phosphate (Yoorin); and 50, 100 and 500 ppm P as Patos rock phosphate. The results were correlated with rice dry matter weight and absorbed P.
Soils with fertilizers were also incubated for 1 and 30 days, to evaluate effect of incubation time on the P availability (measured by Bray 1 method).

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Use of Isotopic Techniques in the Kinetics of Phosphorus Efficiency in Volcanic Ash Soils of Chile

In Chile, the 60% of the total arable land is volcanic ash soils. The high P retention and the

different response to P fertilizers showed by the soils make essential the applications of increasing amounts of this nutrient to obtain higher yields. Several studies with volcanic ash soils were carried out in order to determine the sorption and desorption of P, using conventional and isotopic methods. At the same time, some greenhouse experiments were conducted in order to evaluate the efficiency, rates and forms of application of Triple Superphosphate labelled with ^{32}P (TSP-^{32}P) with the direct isotopic method, using wheat, oat and rye grass as standard crops. Furthermore the direct use of natural phosphoric rock, as a source of P has been studied in the past years.

The greenhouse and field studies show a better response of TSP-^{32}P with high yields of crops such as wheat, but differing according to the cultivars. So, the direct application of phosphoric rock will depend upon the level of productivity present in each farming system. In long term studies (three years) it is possible to obtain a better behavior from the phosphate rock specially in acid soils. However, there are inverse relationships between P retention in the soils (80-99%) and the efficiency of the phosphate rock. This methodology allows an assessment of the effectiveness of different treatments with phosphate rock in both field and greenhouse trials aimed at studying the residual effects.

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Academia Sinica
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P.R. of China

Agronomic Potential of Partially Acidulated Rock Phosphates in Acid Soils of Subtropical China

The agronomic potentials of four partially acidulated rock phosphates (PARP) manufactured from a moderate reactive phosphate rock were compared with those of the unacidulated phosphate rock (RP) and monocalcium phosphate (MCP) in a glasshouse experiment on three acid soils from subtropical China. Plant dry matter and P accumulation of six successive cuttings of ryegrass were recorded. Results indicated that the effectiveness of various phosphates was determined both by the solubility of the phosphates and by the acidity and P fixation ability of the soils. The higher the water soluble P content, the better was the effect of the fertilizers. Although P accumulation by plant of PARP treatments was constantly lower than that of MCP treatment, some PARPs could still get a similar dry matter production as MCP. SP60 of the highest soluble P content had the same effectiveness as MCP in terms of dry matter production on all the soils. S-60 and C-1 had above 80% effectiveness as MCP. RP's effectiveness increased with increase in soil acidity. It was suggested from the study that some of these PARPs could be expected to have a comparable agronomic efficiency as soluble P fertilizers in acid soils in the test region.

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Agronomic Effectiveness of Phosphate Fertilizers in Tropical Red Soils

An efficient use of different sources of P in the agricultural areas is a challenge, mostly nowadays when the prices of selling and exportation of the agricultural products are low and the cost of the inputs are high. In Cuba, the P fertility of soils is a serious constraint to obtain high crop yields in the central and eastern region of the country. In 1980, a research program based on long-term field experiments and studies of the transformation of phosphate in red tropical soils was started at the Higher Agricultural Institute of Ciego de Avila.

The most outstanding results are related to high P dressings applied to the first crop in the rotation (potatoes or beans) and to take advantage of the residual effect of the fertilizer in subsequent less demanding crops. Preliminary trials have demonstrated that animal manures, rock phosphate and filter cake are feasible options when the sources are close to the cultivation areas. Recently, inoculation of VAM and PSO have given promising results with soybean

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Use of an Isotopic Method to Predict P Fertilizers Efficiency in Soil-Plant Ecosystems. Application to Some Phosphate Rocks and Related P Fertilizers

A laboratory method using $^{32}PO_4$ ions and based on isotopic exchange between phosphate ions of the soil solution and mobile phosphate ions of the solid phase of the soil, was developed to (i) characterize available soil P by status parameters and kinetic parameters; (ii) predict the contribution of a P fertilizer to the P nutrition of crops, i.e., the efficiency of a P fertilizer. The status parameters are the intensity, quantity and capacity factors. The kinetic factors are the size of four P pools that can leave the solid phase of the soil to enter in a given time into the soil solution, the mean residence time of phosphate ions in the soil solution and the mean exchange time of phosphate ions between ions of the solution and mobile ions of the solid phase. Experiments were carried out in soils from Venezuela, Viet Nam, China, Senegal, Côte d'Ivoire and France using phosphate rocks (PR), partially acidulated phosphate rocks (PAPR), basic slag and water soluble P fertilizers. A general policy for PR and PAPR recommendation is inferred from the results. The recommendations depend on soil P status, soil pH, fixing capacity of soil for phosphate ions and type of PR.

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Agronomic Evaluation of Phosphate Rocks.

Rock phosphates and partially solubilized rock phosphates may have variable solubilities in water and standard reagents, and consecutively different availability to plants. Their reaction depends first on their intrinsic characteristics, and to a second degree, on the environment with which they react.

An agronomic evaluation of phosphatic rock would involve several steps:

- Phosphate characterization
- Preliminary evaluation in controlled conditions
- Evaluation in the field, at a representative scale
- Economic consideration of production and use of various P fertilizers

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Greenhouse Evaluation of Agronomic Potential of Different Sources of Phosphate Fertilizer in a Typical Concretionary Soil of Northern Ghana

The concretionary soils are known to adsorb significant amounts of water-soluble fertilizer phosphate because of the high levels of ferruginous nodules contained in them. The use of less expensive indigenous P sources offers a possible management option for these soils. The objective of this research is to evaluate direct and residual effects of three P sources and their transformation in a typical concretionary soil in the greenhouse and laboratory studies. Maize (*Zea mays*) var *Dobidi* was grown in plastic pots in the greenhouse containing the concretionary soil treated with the following phosphorus sources: single superphosphate, partially acidulated (50%) Togo phosphate rock ("APR-50) and Togo phosphate rock, at 26.4 kg P/ha for 28 days. After harvesting subsequent cropping was carried out to evaluate the effects of the residual P in the pots. The results showed that increase in dry matter yield of shoot and total P uptake followed the trend SSP > PAPR-50 > PR > control. The relative agronomic efficiency (RAE) of PAPR was 58% that of commercial SSP in increasing growth of the crop, while PR was only 23%. The residual effect of either PAPR-50 or PR on dry matter yield and total P uptake was found to be negligible compared with SSP, suggesting that applications of apatitic P do not improve P efficiency on a near neutral soil. The P fractionation results confirmed that the untreated PR and PAPR did not significantly increase any of the P fractions in either the soil fines or nodules after first crop. On the other hand, the application of SSP increased all extractable P_i fractions, most of the P added being recovered from the nodules in forms associated with Fe (hydroxide and residual P_i).
It may be inferred from the results that transformation of residual P from the indigenous PAPR-50 and PR sources may not be of significant agronomic use in sustaining plant production in the concretionary soils over the short term.

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Prospects of Rock Phosphate Utilization in Lowland and Upland Soils to Meet P Requirement of Crops

In Indonesia phosphorus fertilization is an expensive practice because of the raw materials all of which must be still imported. Recently, research showed that cost of P-fertilizers could be minimized by directly using rock phosphate as a fertilizer, rather than the expensive acidulating and processing required for TSP. The possibility of directly using rock phosphate as fertilizer is based on the fact that in Indonesia soils are predominantly acidic and there are locally available phosphate rock deposits. Studies showed that rock phosphate and partially acidulated rock phosphate (PARP) although not water soluble could still supply P to upland crops. For lowland soils, rock phosphate might be even more attractive to farmers because of the recent increases of fertilizer prices. Another advantage is the potential residual effect of rock phosphate.

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The Use of P-32 in Screening Effectiveness of Phosphate Rocks in Malaysian Soils

Phosphate rocks have been shown to be an effective source of P for perennial crops in Malaysia. The primary type used was from Christmas Island. Since the closure of the PR mine in Christmas Island in 1987, Malaysia began importing PR from Jordan, Morocco, Algeria, Tunisia, China and recently North Carolina, USA. Field trials on the effectiveness of these PR are being carried out by various plantation sectors, but results are slow. Thus, the use of ^{32}P in screening these PR sources were initiated. Pot experiments using soils of varying pH have shown that PR are effective only on soils with pH below 6.0. Among the PR tested, the reactive NCPR, JPR and APR were equally as good as the water soluble triple superphosphate (TSP). The unreactive PR (China and Christmas Island) were not as effective as the reactive PR in the first crop, but increased in the subsequent crop. Utilization of PR by legumes was found to be 50% higher than corn grown on the same soil. Under field conditions where NCPR and CPR and TSP were tested, NCPR was as good as TSP in providing P to the first crop. But in the second crop, NCPR surpass the TSP in its P supplying power. The unreactive CPR also showed some P made available to the crop. Very little from all the three sources remain available in the third crop.

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Some unconventional possibilities of enhancing the productive use of soil and fertilizer phosphorus in increasing crop yields

Theoretical considerations and some experimental support are given for colloid protonation in base saturated soils, supplementary leaf applied fertilization, special foliar fertilization to increase the productive nutrient content in seeds, especially in seeds of hybrid cultivars (maize and sunflower) for increased crop yields. While conventional procedures are well established, both theoretically and experimentally, the unconventional ones are yet in the state of development, requiring further elaboration through adequate research, including the use of radioisotope techniques.

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The Use of Mycorrhizas and Phosphate Solubilizing Rhizobacteria to Improve the Agronomic Effectiveness of Natural and Modified Sources of Rock Phosphate

In a recent FAO/IAEA Consultants Meeting we discussed the feasibility of the management of microbiologically-mediated processes to improve the efficiency of rock phosphate under field conditions. Recent interest on these studies is based on the role of certain mycorrhizal fungi (AMF), which colonize the soil extensively, improve soil structure and stimulate soil microbiota. In addition, some Phosphate Solubilizing Bacteria (PSB) are able to solubilize rock phosphate in vitro, have been characterized as rhizobacteria because of their "aggressiveness" in colonizing the root region. They can even improve mycorrhiza formation. Therefore, the plant can be furnished with an active mycorrhizosphere which could be tailored to improve rock phosphate efficiency. A work plan has been proposed to develop laboratory/greenhouse experiments for selecting an appropriate mycorrhizal fungi bacteria combination which is able to improve the use of several rock phosphate sources whose first stage is as follows:

a) Isolation, selection and labelling (double antibiotic marking) of rhizobacteria (PGPR), efficient solubilizers of rock phosphate.
b) Isolation and selection of mycorrhizal fungi able to produce both an active external mycelium and efficient symbiotic structures in the host roots.
c) Selection of mycorrhizal fungi/PGPR combinations for "functional compatibility" with the host plants (genotype selectivity).

d) Selection for their ability to improve colonization by each other in order to develop an active mycorrhizosphere.

e) Development of appropriate methodologies for applying ^{32}P (and ^{15}N for legume crops) for the evaluation of the efficiency of the biological processes involved in improving the use of rock phosphates by the crop plants.

Experiments under a,b,c and d are already being done in this Department and accordingly, some PSB (PGPR) and AMF have been selected. Some experiments will now be carried out (for e) to ascertain the role of microbiologically-mediated processes to improve the use of natural and modified sources of RP. These will include:

(i) Bioassays using standard test plants

(ii) Isotope techniques using ^{32}P

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Efficiency of Use of Phosphorus from Rock Phosphate with a Cassava - Food Legume Rotation Using Nuclear Techniques

Rock phosphate is an alternative to TSP for dryland cropping in Thailand. The objective of this experiment was to evaluate a Thai rock phosphate for a rotation of cassava and food legumes in terms of initial and residual response over 4 years. The field trial commenced in 1989 at Rayong Research Centre. Rock phosphate (applied once only) and TSP (applied in each crop) were compared with zero P. Treatment 1 was a rotation of cassava in year 1, and mungbean followed by peanut in year 2; Treatment 2 was a rotation of mungbean followed by peanut in year 1 and cassava in year 2. Four years of data are available. In the first year more phosphorus was taken up by cassava and mungbean from TSP. In the 2nd year (the first year of residual effect) with cassava and peanut, there were no significant differences. In the 3rd and 4th years the same trends were observed.

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Liming Potential of Phosphate Rock

Phosphate rock has been reported to increase soil pH. Just a little increase in soil pH can reduce toxic Al levels and help establish vegetative growth in very acidic environments where soils have been

affected by mining operations. A 3-year field study is currently under progress to evaluate North Carolina phosphate rock as a P source and liming agent for reclaiming denuded land in Copper Basin, Tennessee. The study reported on here is an evaluation of the liming potential of phosphate rock. Theoretical calculations were conducted to determine % calcium carbonate equivalents (% CCE) of phosphate rock.

A laboratory incubation study was conducted to determine the actual % CCE of North Carolina and Idaho phosphate rocks. A granulated Idaho phosphate rock was included in the study. Because 100 % dissolution of phosphate rock is rarely achieved, the 60% CCE from phosphate rock application to soil does not occur. The % CCE from phosphate rock increases linearly with increased % P dissolution. Phosphorus dissolution is also dependent on P application rate, with high dissolution at low rates and low dissolution at high rates. Therefore, a high % CCE may be obtained at low P application rates but the rate would be too low to have any effect on soil pH. At 20 to 40% P dissolution, % CCE ranges from 12 to 22%. The use of % CCE value to represent the liming potential of phosphate rock would not appear to have any value because % CCE changes with the amount of phosphate rock dissolved. A more appropriate labelling of CCE of phosphate rocks may be the slope of the % CCE vs % P dissolution function so one could predict liming potential from expected % P dissolution.

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Estimation of Phosphorus Availability from Phosphate Rock in Soil as Enhanced by Water-Soluble Phosphorus

One practice that has been observed to increase the phosphorus (P) availability from unacidulated phosphate rock (PR) is to add to the PR some water-soluble P fertilizers. This can be achieved by the following methods: (1) surface broadcast and incorporation of finely ground PR into the soil followed by banding of water-soluble P fertilizers, (2) partial acidulation of PR with H_2SO_4 or H_3PO_4, and (3) dry compaction or wet cogranulation of PR with water-soluble P fertilizers. The objective of the present study is to estimate quantitatively the possible enhancement effect of water-soluble P on the P availability to maize from a PR (central Florida rock) with medium reactivity applied to an acid soil (pH 4.8). Water-soluble TSP was tagged with radioactive ^{32}P to distinguish P sources from TSP and PR or soil.

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The Use of Nuclear and Related Techniques for Evaluating the Agronomic Effectiveness of Phosphate Fertilizers in Venezuela

The objectives of this research were to evaluate methods to determine soil P availability and to conduct agronomic evaluations of natural and modified phosphate rocks at greenhouse and field experimental level. The E value, A value, and fixation Index are some of the isotopic parameters measured in the experiments using soils with different chemical and physical characteristics. The results showed that the soils can be classified according to the adsorption capacity index (r_1/r_∞) <0.2, 0.2-0.7 and >0.7 which shows a good relation to the P fixing capacity of these soils. In the greenhouse experiments using *Agrostis communis* it was also shown that plant P uptake was also related to the E values and the P fixation capacity. The application of P fertilizers locally or uniformly using partially acidulated phosphate rock gave different responses on P uptake when compared with a highly soluble source like triple superphosphate.

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Preliminary Results on the Efficiency of Different Phosphate Sources to Rice Growing on Acid Sulphate Soils of the Mekong Delta, South Viet Nam

Phosphorus is an element which severely restricts yield of crops growing on acid sulphate soils of Viet Nam. Many studies on the efficiency of different P fertilizers including rock phosphates have been conducted to improve their efficacy as well as bringing down the price of fertilizer investment. In case of rock phosphate (RP), the efficiency is very low when solely applied to the acid sulphate soils. Efficiency of partial acidulated rock phosphate is as high as the water soluble phosphate fertilizers and in addition, they are lower in price. A combination of both nuclear and non-nuclear methods in research work on the dynamics of available P of the soils and plants in the field, greenhouse and laboratory experiments is needed.

2. Fourth FAO/IAEA Research Workshop of the Regional Africa Project on Biological Nitrogen Fixation (RAF/5/010)

14 - 25 March 1994, Nairobi, Kenya

Technical Officer: M.P. Salema

This was the final of the series of workshops that have been held since the project started in 1987. The workshop was locally organized by the National Agricultural Research Laboratories (NARL) of the Kenya Agricultural Research Institute (KARI) in Nairobi. It brought together project Chief Counterparts or their representatives from Egypt (M.S.A. Safwat), Ethiopia (B. Tulema), Ghana (F.K. Kumaga), Kenya (G. Ayaga, C. Kibunja, V. Sijali, P. Kathuli), Niger (F. Seyni), Nigeria (G. Okereke, D. Daramola),

Senegal (A. Badiane), Sierra Leone (D. Amara), Uganda (A. Kintukwonka representing P. Ijemba), United Republic of Tanzania (H. Mansoor representing A. Nyaki), Zaire (N. Luyindula), Zambia (C. Malama) and Zimbabwe (J. Fundire representing L. Mukurumbira). Algeria and Tunisia were not represented.

The workshop lasted for two weeks. The first week was devoted to discussing results obtained since the previous workshop held in 1992 in Morocco, reviewing the work carried out since the beginning of the project, and discussing future strategy for isotope aided research in soil/plant relationships. The second week was devoted to writing up the results obtained under the project in individual Member States since the beginning of the project. The contributions from individual Member States will be compiled, edited and published in a monograph form and distributed to Member States. The monograph is expected to be published in 1995.

The workshop discussed soil related problems facing food production in Africa. It was acknowledged that one of the root causes of the decline in yields per unit area of land in most parts of Africa is the degradation of the soil resource base, especially soil fertility. In many countries "nutrient mining" was taking place, i.e. the quantity of nutrients removed through crop harvests and losses was greater than the quantity brought in through fertilizer application, nitrogen fixation, manures, etc. It was considered that Integrated Nutrient Management, where the little chemical fertilizer available to the farmers is supplemented with as many as possible of the other sources, was the best strategy to tackle the problem. The indispensable role of isotopes in determining nutrient balances which are essential in formulating the strategy in any farming system, was discussed.

TECHNICAL CO-OPERATION PROGRAMMES

The Soil Fertility, Irrigation and Crop Production Section currently has the responsibility for 50 Technical Co-operation projects. In the December 1993 issue, we gave summaries of projects in Latin America. In this issue, we highlight the activities of TC projects in Asia and the Pacific Region..

Bangladesh

Nuclear Techniques to Improve Agricultural Production

(BDG/5/015)

Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh

Counterpart: **K.M.I. Ali**

This project was initiated in 1993 with the objective of strengthening research and development activities in the fields of soil science and mutation breeding through application of radioisotopes and radiation technology. Expert services were provided to initiate studies on zinc deficiency of rice using ^{65}Zn. Equipment, fellowship training and scientific visits were also provided. This year, the project's

emphasis is more on biofertilizer production for grain legumes (mainly lentil, chickpea and groundnut), a field in which BINA has shown promising results through previous projects executed by Dr. M A Sattar. 4000 trials are expected to be conducted in farmers fields this year. The project is expected to develop into a model project for semi-large scale production of biofertilizer through collaboration of public sector (BINA and the Department of Agricultural Extension) and private sector (Messrs A.K. Khan & Co., Ltd.). At the end of this model project in 1996/97, A.K. Khan & Co., Ltd. will commence commercial scale production of biofertilizer. The project is expected result in substantial increases of grain legume production in Bangladesh.

Democratic People's Republic of Korea

Isotope Techniques in Fertilizer Studies (DRK/5/004)

Research Institute of Agrobiology, Academy of Agricultural Sciences, Pyongyang

Counterpart: **Kim Se Gyang**

The project was initiated in 1993 with the objective of finding ways of increasing phosphate fertilizer use by plants (using ^{32}P) so that crop productivity could be increased. Up to now, a number of equipments including a scintillation counter have been provided for measurement of radioisotopes. An expert mission to advise counterparts on the applications and handling of ^{32}P in soil/plant studies has been arranged for 1994. Greenhouse and field experiments will be initiated this year if the expert mission is implemented as planned.

Indonesia

University Research and Teaching in Agriculture (INS/5/022)

Andalas University, Padang, West Sumatra

Brawijaya University, Malang, East Java

Hasanuddin University, Ujung Pandang, South Sulawesi

Counterparts: ***N. Hakim; S. Prijono; M. Syafiddin***

The project INS/5/022 is a multi-disciplinary, multi-institutional project and is a follow-up of project INS/0/011 completed in 1992. Both are footnote "a" projects funded by the USA. The project involves three Universities (Andalas University, Brawijaya University and Hasanuddin University). Through the first project, the three Universities received IAEA assistance for the establishment of basic laboratory facilities, training and development of a curriculum in fundamental radioisotope techniques necessary for research and teaching in agricultural sciences. Now, with the follow-up project the three Universities are concentrating on research in the different fields of soil science. Andalas University is concentrating on phosphate studies using ^{32}P and biological nitrogen fixation studies using ^{15}N, Brawijaya

University on nitrogen fertilizer studies using ^{15}N and Hasanuddin University on problems of sulphur deficiency using ^{35}S. In 1993 and 1994 several expert missions were provided in addition to supply of some equipment and isotopes. Fellowship training was also provided.

Malaysia

Nuclear Techniques to Improve Agricultural Production (MAL/5/020)

Nuclear Energy Unit (UTN), Bangi, Selangor

Malaysian Agricultural Research and Development Institute (MARDI), Kuala Lumpur

Rubber Research Institute of Malaysia (RRI), Kuala Lumpur

Universiti Pertanian Malaysia (UPM), Serdang

Counterpart: **M.N. Sudin**

The project MAL/5/020 initiated in 1989 is a multi-disciplinary, multi-institutional project with soil fertility and crop production as one of the components. This section includes studies on nitrogen fertilization, N_2 fixation, evaluation of rock phosphates and water use efficiency studies. Using ^{15}N as a tracer, it has been estimated that a ground cover of *Pueraria phaseloides* can fix as much as 150 kg N/ha/year and that oil palm grown with *Pueraria* as a ground cover produced an additional 1.7 tons of palm oil/ha. This means an additional income of US$ 54/ha/year for the farmer at a current market price of US$ 320/ton of oil. In addition, the legume cover also helps in building up a more stable soil, rich in organic matter while decreasing the chances of soil erosion. Recently, the project has placed greater emphasis on environmental aspects.

Mongolia

Nuclear Techniques in Agriculture (MON/5/006)

Agricultural Research Institute, Darhan

Counterpart: **G. Davaadorj/B. Badral**

The Agricultural Research Institute situated in Darhan, about 200 km from the capital, Ulan Bator, initiated this project in 1993 with the objective of utilizing isotope and nuclear techniques to increase agricultural production. The project involves two main disciplines; soil fertility and crop production, and plant breeding. The soils component involves nitrogen fertilizer studies of wheat and biological nitrogen fixation of grain legumes mainly soybean and peas. The institute has been provided with basic equipment and ^{15}N fertilizer in addition to expert missions on ^{15}N fertilizer studies. Another mission on biological nitrogen fixation will be fielded in September this year. The counterpart (Ms. Badral) received training at the IAEA Laboratory in Seibersdorf and is now back in Darhan organizing the project activities.

Myanmar

Isotopes and Nuclear Techniques in Crop Production (MYA 5/006)

Myanmar Agriculture Service, Ministry of Agriculture, Yangon

Counterpart: **T.T. Hlaing**

This project initiated in 1993 involves three areas of study: (i) nitrogen fertilizer studies (ii) biological nitrogen fixation, and (iii) soil plant water studies. Minor equipment and ^{15}N labelled has been supplied in addition to an expert service on nitrogen fertilizer studies. Three field experiments have already been completed and the ^{15}N soil and plant samples are being analysed at the IAEA laboratory in Seibersdorf. The results of these experiments are expected to lead to formulation of improved nitrogen fertilizer management practices in order to increase and sustain rice production in the country. An expert mission on biological nitrogen fixation is also expected to be fielded shortly. Fellowship training is already in progress.

Pakistan

Application of Biotechnology in Agriculture (PAK 5/031)

National Institute of Biotechnology and Genetic Engineering (NIBGE), Faisalabad

Counterpart: **K.A. Malik**

The objective of this project is to find applications of biotechnology for the restoration and utilization of saline soils in Pakistan which encompasses some 13 million acres. The neighbouring Nuclear Institute of Agriculture and Biology (NIAB) has been involved for several years in screening various plant species for salt tolerance and their potential for soil amelioration. In addition to food, the biomass that could be produced on such saline soils can be converted to useful products by various microbiological and biotechnological processes. In support of this project, the Agency has supplied a number of items of equipment and chemicals in addition to provision of expert services on molecular biology with special reference to DNA probes. Fellowship training has also been provided.

The Philippines

Biological Nitrogen Fixation (PHI/5/004)

The University of the Philippines, Los Baños, Laguna (UPLB)

The Philippine Nuclear Research Institute, Manila (PNRI)

The Bureau of Soils and Water Management, Manila (BSWM)

Counterparts: **E.S. Paterno, C. Rosales and M.J. Palis**

This is a footnote "a" project funded by the United Kingdom. It was initiated in 1993 with the objective of finding ways to enhance biological nitrogen fixation of grain legumes, especially mungbean in the marginal lands of the Philippines. Of particular interest are the experiments established near Mount Pinatubo to study crop production in Lahar soils formed from the newly deposited lava after the eruption of the volcano in 1991. Experiments with peanut, cowpea and mungbean have shown varying degrees of success of establishment indicating that *Rhizobium* studies are urgently needed to find answers to the problems. Equipment including ^{15}N labelled fertilizer and expert services have been provided. Fellowship training and scientific visits are also arranged.

Korea, Republic of

Isotopes and Radiation in Agricultural Research (ROK/5/028)

Agricultural Sciences Institute, Rural Development Administration, Suweon

Counterpart. **P. Moon**

This is a multi-disciplinary project involving soil fertility, plant breeding and agrochemicals, and initiated in 1991 with the objective of developing nuclear techniques for improving agricultural production. The soils component of this project is primarily concerned with increasing fertilizer use efficiency of crops and solving related environmental issues particularly those related to methane and nitrous oxide gas emission from paddy soils and high phosphate accumulation due to heavy applications of phosphate fertilizer. Some field studies have been conducted and the results are being analysed. Expert services were also provided in addition to provision of fellowship training and scientific visits.

Sri Lanka

Nitrogen-15 Fertilizer Studies (SRL/5/024)

Atomic Energy Authority, Colombo

Counterpart: **M.C.S. Seneviratne**

This project was initiated in 1989 with the objective of setting up a national ^{15}N analytical laboratory for studies of nitrogen uptake by plants. In support of this project, the Agency provided a number of spare parts for the ^{15}N analytical system, ^{15}N fertilizer, and expert services. Implementation of the project resulted in the strengthening of ^{15}N analytical capabilities in Sri Lanka thus making available, services to several Universities and Research Institutes involved in soil/plant research using ^{15}N. The project had several initial impediments due to change of counterparts and civil disturbances in the country. However, the activities were revived in 1991 and has made good progress since then. The project will be closed in August 1994.

Sri Lanka

Soil Moisture and Crop Productivity Studies (SRL/5/025)

Research Station, Department of Minor Export Crops, Matale

Counterpart: **H.A. Sumanasena**

This project was implemented at the Research Station of the Department of Minor Export Crops in Matale, Sri Lanka, with the objective of developing improved agronomic practices for increased production of minor export crops such as pepper and cocoa. In support of this project, the Agency supplied several items of equipment including neutron moisture meters and chemicals. The counterparts also received fellowsnip training. Expert services were provided which assisted the counterparts in the design and conduct of field experiments to find ways by which the limited resources of soil water available could be used more effectively to increase productivity of pepper and cocoa. In field studies using a run-off method together with coconut husk as a mulch, it has been possible to demonstrate a substantial retention of soil water at each planting point which can be beneficially utilized for the field establishment of pepper. The method has shown a significant reduction in early casualties of young pepper plants. If used in agriculture, the economic returns of these findings could be substantial. The project also assisted the counterparts in establishing a good laboratory for soil moisture studies in addition to developing capabilities for research using nuclear techniques. The project was closed in May 1994.

Sri Lanka

Increased Coconut Production through Improved Water Use (SRL/5/026)

Coconut Research Institute, Lunuwila

Counterpart: **C. Jayasekera**

This project was implemented at the Coconut Research Institute in Lunuwila, Sri Lanka, with the objective of identifying cultivars/genotypes of coconut that utilize water more efficiently so that they can be used for the national coconut planting programme in low rainfall areas. A number of equipment items including a scintillation counter and chemicals labelled with radioactive and stable isotopes have been provided, in addition to expert services and fellowship training. Field and greenhouse experiments were conducted to develop a new selection criteria for genotypes of coconut efficient in water use. The method based on the $^{13}C/^{12}C$ ratios of leaves of young coconut palms showed that ^{13}C discrimination is negatively correlated with water use efficiency and also with dry matter yield. Although the nut yield data are not available yet, preliminary studies indicate that the ^{13}C isotope discrimination could be used as a valuable tool to select coconut cultivars efficient in water use and high in yield so that they could be recommended for cultivation in areas with low water resources. The method also has the additional advantage in that long experimental periods commonly required for tree crops like coconuts can be substantially reduced

saving considerably on experimental inputs including labour. The project also assisted the counterparts in establishing good facilities for plant physiological studies using radioisotopes in addition to developing capability for research on water use efficiency of tree crops. The project was closed in May 1994.

Sri Lanka

Biological Nitrogen Fixation in Trees (SRL/5/028)

Research Station, Department of Minor Export Crops, Matale

Counterpart: **W.D.L. Gunaratne**

The project was initiated in 1993 with the objective of studying the nitrogen fixation capacity of leguminous trees grown in coffee, cocoa and pepper plantations so that agronomic practices could be improved to increase soil fertility and crop production. In support of this project, the Agency has supplied some basic equipment and chemicals including ^{15}N labelled fertilizer. The counterpart received fellowship training in tree crop studies in Australia and expert services have been provided to advise counterparts in agroforestry systems involving minor export crops.

Sri Lanka

Isotope Techniques in Sustainable Increased Tea Production (SRL/5/029)

Tea Research Institute, Talawakelle

Counterpart: **S. Krishnapillai**

Initiated in 1993, the project at the Tea Research Institute aims at identifying the possible causes of yield decline with ageing of tea plants and to identify cultivars of tea efficient in water use. Photosynthetic and other physiological parameters related to crop growth is being studied using ^{14}C and Infra Red Gas Analysis Techniques for which the Agency has assisted in providing the necessary equipment and chemicals. Expert services and fellowship training have also been provided. Follow-up missions are expected towards the end of 1994.

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 symposium is expected 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 he 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. Each session will have an invited speaker.

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. 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. Participants selected have now been informed.

Christian Hera, Head of Soil Fertility, Irrigation and Crop Production Section will be the Scientific Secretary and Saliya Kumarasinghe will be the Scientific Co-Secretary of the symposium.

(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 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.

Christian Hera, Head of Soil Fertility, Irrigation and Crop Production Section will be the convenor of the symposium at this congress