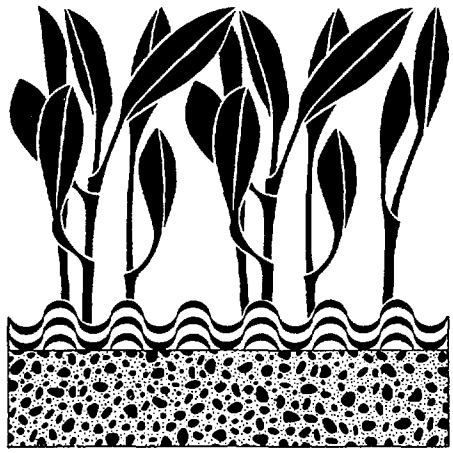

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Soils Newsletter

JOINT FAO/IAEA DIVISION
OF ISOTOPE AND RADIATION APPLICATIONS
OF ATOMIC ENERGY
FOR FOOD AND AGRICULTURAL DEVELOPMENT
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA

Vol. 10, No. 2 December 1987

CONTENTS

1. TO OUR READERS

One year has finished and another has started, so it is perhaps a good time to look back briefly and to look forward somewhat.

The year 1987 has been a very full one with many developments. We were pleased to welcome N. Sanginga at Seibersdorf (tree nitrogen fixation) and also Eric Craswell (sabbatical from ACIAR, Australia working on N-fixation by Azolla), as well as several fellows in training. At Headquarters, we welcomed Cevat Kirda (soil physics) and Bogdan Astvatsatrian (visiting professor). We have been delighted to have Saliya Kumarasinghe as our African Regional Expert, serving the African Biological Nitrogen Fixation Network, and Mohan Saxena (sabbatical from ICARDA, legume nitrogen fixation). We now have a strong professional staff at full strength, but the continuing worry is the lack of support staff combined with the general shortage of money to ensure more of this important need.

As well as involvement in three training courses/workshops, three co-ordination research meetings, several missions to developing countries, technical officers for some 70 TC projects and operating 6 Co-ordination Research Programmes, the Headquarters/Seibersdorf groups produced some 18 refereed publications/chapters for books. Helga Axmann and her analytical group, as well as developing software for computers links with analytical equipment and performing some expert missions, performed over 10,000 ^{15}N analyses. These outstanding performances would have been impossible without the high professionalism and dedication of staff at all levels. I personally thank them all, and I know I speak for all professionals when I say thank you to our support staff: Martina Golbs, Jose Arrillaga, Leo Mayr, Aldo Sebastianelli, the clerical/typing staff: Marina Kneissl, Ruth Rossi, Mehrnaz Tadjbakhsh and all M+O Staff.

Our new programmes on measurement and management of nitrogen fixation by trees, and on root biology and the efficient use of soil resources are becoming established. Two of our fellows in training, Victor Martin (Uruguay) and Yong-Moon Jin (Republic of Korea), have been examining genotypic differences in phosphate uptake. As well as having increased glasshouse facilities (a donation from the USA Government), we are constructing temperature tanks (to reproduce field soil temperatures in our studies) and a biosynthesis chamber for $^{14}CO_2$ labelling of plants to examine carbon physiology in nitrogen fixation and in nutrient relations/root function. Recently, we held a consultants meeting on Roots and Plant Productivity, focussing on plant root genetic factors to increase productivity and to overcome soil physical, chemical and biological constraints - this meeting is reported in more detail later in this Newsletter.

Looking to the year ahead, we want to consolidate our new activities. Shortly, we will be commencing a Co-ordinated Research Programme on the measurement and management of nitrogen fixation by trees (and their role in maintaining soil fertility and in soil conservation). In May/June 1988 a training course will be conducted at the Seibersdorf Lab on the use of isotope and radiation techniques in studies on soil/plant productivity with emphasis on root studies. We feel excited about this - it will be one of the few courses (if not the only course) focussing on various aspects of roots. The need for such a course has been expressed several times in different countries - both developed and developing - for root studies which are fundamental to the effective use (and conservation) of soil resources. In accordance with the desire to strengthen regional training

courses, we will be holding an African Regional Training Course on nitrogen fixation and soil/plant relations in Ghana in September. More details of these and how to apply appear in this Newsletter. Finally, we are pleased to announce that our Technical Co-operation activities in Latin America will have much more cohesion by the inclusion of our Technical Co-operation activities in ARCAL (Regional Co-operative Arrangements for the Promotion of Nuclear Sciences and Technology in Latin America) of a programme on "Improvement of Fertilizer and Water Management Practices through Nuclear Techniques". Not only will this assist in the development of soil fertility studies in Latin America but it will help in forming "symbioses" between soil scientists in Latin American countries.

Glynn Bowen

All of the staff at Headquarters and Seibersdorf wish you all the very best for 1988.

2. STAFF

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3. CO-ORDINATED RESEARCH PROGRAMMES

A. Isotopic studies of nitrogen fixation and nitrogen cycling by blue-green algae and Azolla

(Project Officer: David L. Eskew)

The major objectives of this CRP involve the use of isotopic techniques to assess N_2 fixed by the Azolla-Anabaena symbiosis, and the quantitative evaluation of the available N from Azolla biofertilizer to flooded rice under various management conditions. The CRP is funded by the Swedish International Development Authority.

The third research co-ordination meeting was held November 2-6, 1987, at the Fujian Academy of Agricultural Sciences, People's Republic of China. Details of this meeting are given later in the Newsletter.

B. The use of isotopes in studies to improve yield and N_2 fixation of Phaseolus vulgaris in Latin America.

(Project Officer: Gudni Hardarson)

This programme has presently seven contractors from Brazil (2), Chile, Guatemala, Mexico (2), and Peru as well as two agreement holders from CIAT and the University of Wisconsin, USA. The first Research Coordination Meeting of the above programme was held 23-27 November 1987 at CIAT, Colombia. During the past year, participants have been investigating the potential of various lines of common beans for effectiveness in N_2 fixation by the use of ^{15}N methodology. Preliminary results have shown great differences between germplasms as well as the effect of environmental factors. The information which has been collected will be used to enhance symbiotic nitrogen fixation in common bean. Screening of rhizobial strains for effectiveness in nitrogen fixation is being done in a parallel study.

C. The use of nuclear and isotopic techniques to improve crop production on salt affected soils.

(Project Officer: Cevat Kirda)

Reports which have been received to date from participants of this programme showed good progress. The next research co-ordination meeting is scheduled in fall 1988, Vienna, Austria. The participants are expected to present results on screening of salt tolerant genotypes of different plant species, having potential benefit to the local farmers. The genotypes of high salt tolerance will be used in subsequent years to study biological amelioration of salt affected soils. Some studies on the mechanism of tolerance may also take place.

D. Evaluation and calibration of nuclear techniques as compared to traditional methods.

(Project Officer: Cevat Kirda)

This programme was implemented to compare nuclear and non-nuclear traditional methods to measure field soil water content. Due to financial restrictions, the number of participants to the programme was kept at minimum and therefore there are only 7 participants with 4 research contracts and 3 agreements. The first Research Coordination Meeting of this programme was held November 2-4, 1987, in Vienna. A more detailed report of the meeting is given later in the Newsletter.

E. The use of nuclear techniques in pasture management
(Project Officer: Seth Danso)

The final research coordination meeting planned for September 1987 could not, however, be held due to financial constraints. Final reports for many of the participants have already been received, and some are still awaited. With the N-15 analysis for most participants completed and mailed recently, it is anticipated that all the reports would come soon, and that an attempt would be made to compile all the data obtained in the CRP, whose major aim was to improve the contribution of nitrogen fixed in legumes to increased pasture yields into a valuable reference document.

F. Improvement of yield and nitrogen fixation of grain legumes with the aim of increasing food production and saving N-fertilizer in the tropics and sub-tropics of Asia. A joint programme of the Soils Section and the Plant Breeding Section.
(Project Officers: Seth Danso, Nobuos Murata)

The objective of the CRP is to increase the contribution of biologically fixed nitrogen (rather than fertilizer or soil nitrogen) to the increased yield of major grain legume crops in Asia. Funding for this project, as part of a UNDP/FAO/TCDC project expired this year, and efforts are being made to secure funding for the project for 1988. Participants of the project are, however, continuing with the identification of superior Rhizobium and plant genotypes, which will be assessed later for nitrogen fixing ability, or incorporated into breeding strategies.

4. BIOLOGICAL NITROGEN FIXATION RESEARCH WORK AT SEIBERSDORF

The facilities of the IAEA Laboratory at Seibersdorf improved considerably last year as the Soils Unit moved into a new Agriculture Building. A specialized laboratory in soil microbiology was set up for Rhizobium work which will be used both for research and training. The main objective of this laboratory is to give support fo various FAO/IAEA Coordinated Research Programmes (CRP) on biological nitrogen fixation. Presently we have two CRPs and one Regional Technical Co-operation Project (Africa) on the use of nuclear techniques to enhance nitrogen fixation in grain legumes. In particular the new laboratory has facilitated improved assistance to programmes using ^{15}N methodologies to quantify N_2 fixation, a major emphasis in CRPs of the Soils Section during the last decade.

Within the frame of the Regional Africa Project on biological nitrogen fixation, a workshop was held from 6-10 July 1987 at the University of Ghana, Legon-Accra, which was designed to discuss future research activities and areas of focus on biological nitrogen fixation in Africa. Training of fellows in the field of ^{15}N methodology and ecology of rhizobia, as well as research in support of CRP and Technical Co-operation programmes are continuing. The research has mainly involved further development of the ^{15}N methodology to measure N_2 fixation under field and greenhouse conditions as well as the study of movement of rhizobia in the rhizosphere of grain legumes. A list of experiments as well as persons involved will indicate the type of work being conducted at the laboratory:

^{15}N methodology, (1) Quantification of N_2 fixation by three ^{15}N isotope approaches. (Hardarson). (2) Use of various ^{15}N labelled formulations on N_2 fixation measurements (Zapata, Danso and

Cervenansky). (3) Effect of N carrier and selection of reference crop in estimation of N_2 fixation by field grown fababeans (Kirda, Zapata, Axmann and Danso).

Inoculation methods (1) The effect of inoculation treatments on the movement of rhizobia in the rhizosphere, nodule formation, and N_2 fixation of soybean and common bean (Hardarson, Danso, Wadisirisuk and Golbs). (2) Effect of delayed inoculation on nodule formation and nitrogen fixation of soybean under greenhouse conditions (Danso, Wadisirisuk and Hardarson). (3) Field study on the placement of inoculum on soybean nodule formation and N_2 fixation (Hardarson).

Genotypic and physiological aspects (1) N_2 fixation potential of thirty lines of common beans under field conditions (Hardarson). (2) Effect of cotyledon N on nodulation and N_2 fixation in soybean (Kumarasinghe and Danso). (3) Effect of combined N on N_2 fixation of super nodulating soybean mutant (Kapuya, Eskew and Danso). (4) Physiology of super nodulating soybean mutant (Kapuya, Eskew and Danso).

Competitive ability of rhizobial strains. Selection of alfalfa for reference for rhizobial strains (Hardarson).

Stress effects. (1) Effect of supplementary irrigation on N_2 fixation by field grown fababeans (Kirda, Zapata and Danso). (2) Influence of water stress regimes on N_2 fixation of soybean (Kirda and Danso).

In the future we will continue training fellows and expand our research efforts on the use of nuclear techniques in studies of symbiotic nitrogen fixation in tree crops. We will also be expanding our research on roots and the use of soil resources. This covers a wide range of interests from agronomy to the physiology of genotypic differences in nutrient, water uptake and use.

5. TECHNICAL CO-OPERATION PROGRAMMES

The section continues to handle over 70 Technical Co-operation programmes in Africa, Asia, Latin America and Middle East and Europe. For the general terms of subjects implemented within the frame of technical co-operation projects, see Soils Newsletter, December 1986. In this issue, highlights of Technical co-operation programmes in Latin America and Africa Regions are given. Other areas will similarly be covered in the following issues.

Regional Latin America project on the improvement of fertilizer and water management practices through the use of nuclear techniques.

As previously reported, one innovation to implement technical co-operation programmes more effectively is, where appropriate, to organize these projects on a regional basis. For instance, the Regional Africa Project on biological nitrogen fixation was started within this context in 1987.

A first attempt to establish some relationship between the ongoing projects in Latin America was made by organizing a regional workshop among four Andean countries (Bolivia, Ecuador, Colombia and Peru) in Bogota from 24 to 28 November 1986 in collaboration with the Institute of Nuclear Affairs (IAN) of Colombia. The workshop was designed to review the research results obtained so far using nuclear techniques in soil/plant

relationship studies, to exchange ideas about methodologies and to prepare guidelines for further research activities. One recommendation of this regional workshop was to co-ordinate national relevant projects at the Latin America level. Accordingly a project proposal on "The improvement of fertilizer and water management practices through nuclear techniques" was prepared and submitted for consideration to the Fourth Planning and Technical Co-ordination Meeting of the ARCAL Programme (Nuclear Science and Technology Development RLA/0/006). The country co-ordinators participating in this meeting which was held in Santiago, Chile, from 11 to 15 May 1987, analysed and included our project as ARCAL XI within the ARCAL programme.

At present the IAEA has already prepared a working paper to be used for seeking outside contributions. As soon as sufficient funds will become available, the project will start to be implemented.

Further information on this matter can be provided by the Head, Soil Fertility, Irrigation and Crop production Section upon request.

Research news from the Andean region

One of the project-related activities planned within the ARCAL XI project is the dissemination and exchange of scientific information at the regional level. This was also one of the recommendations given by the participants of the workshop held in Colombia for the Andean region. Extensive summaries of previous research work carried out within the framework of Technical Co-operation Projects (TCP) have been already prepared. The following is a list of contributions so far received by us:

ECU/5/009: (a) Varietal response of quinoa (Chenopodium quinoa) to NPK fertilization levels and soil water utilization. (A. Gómez, I. Piedra. M. Calvache, J. Flor and E. Basantes) (b) Fertilizer N use efficiency of three improved wheat (Triticum aestivum) cultivars. (M. Calvache, G. Bernal, D. Gangotena and E. Basantes). (c) The hydrodynamic characteristics of a soil cropped to wheat. (M. Calvache, A. Guerrero, and M. Paredes).

COL/5/007: (a) Influence of time of application and chemical carrier (N-15 labelled urea and ammonium sulphate) on fertilizer N utilization of rice cv CICA 8 under greenhouse conditions. (O. Bastidas, R.L. Victoria, S. Urquiaga, A.L. Alvarez and T. Muraoka), in Spanish, NUCLEARES* 1(1): 9-17, En-Jun, 1986) (b) Influence of time of application of ^{32}P-labelled triple superphosphate on fertilizer P utilization and yield of potato. (O. Bastidas, S. Uruquiaga and A.L. Alvarez), in Spanish, NUCLEARES* 1(2); 11-18, Jun-Dec, 1986). (c) Assessment of available plant-P from different commercial phosphatic fertilizers using ^{33}P as a tracer. (O. Bastidas and H. Broeshart, in Spanish NUCLEARES* 1(2): 19-23, Jun-Dec, 1986).

* NUCLEARES is a technical-scientific journal of the Institute of Nuclear Affairs (IAN) of Colombia. For more information please write to Dr. E. Villareal, Chairman Publication Committee, Institute of Nuclear Affairs, P.O.Box 8595, Bogotá, D.E. Colombia.

BOL/5/004: A draft document (Spanish version) intended to serve as training manual on the use of nuclear techniques in soil-plant-fertilizer relationships has been prepared by Mr. J. Pascuali. It is a compilation of methods and techniques used in the experimental plans carried out within the framework of the TC project BOL/5/004

Regional Africa Project on biological nitrogen fixation

With the addition of two more countries (Morocco and Niger) to this project (RAF/5/010), the total number of countries has now increased to eight. The counterparts/collaborators responsible for the execution of research in the respective countries are: Dr. M.S.A. Safwat and Dr. T.M.M. Moharram (Egypt); Dr. F.K. Kunaga, Dr. S. Duah-Yentuni, Dr. E. Owusu-Bennoah and Dr. A. Dzietror (Ghana); Ms. C. R'Kiek (Morocco); Mr. M.G. Goube (Niger); Dr. K.O. Awonaike and Dr. G.U. Okereke (Nigeria); Ms. A. Badiane and Dr. B. Sougoufara (Senegal); Dr. N. Hafedh and Dr. N. Rejeb (Tunisia); and Dr. N. Luyindula and Dr. N. Mbaya (Zaire). Tunisia will work on N-fixing trees while Senegal and Ghana are to work on both N-fixing trees and grain legumes. Other five countries will concentrate mainly on grain legumes. This year Egypt, Morocco, Nigeria, Senegal and Tunisia have taken the lead in establishing their field experiments while the other three counties will initiate their studies in early 1988. The findings from these preliminary experiments are expected to be presented at a regional research co-ordination meeting to be held in Tunisia in November 1988.

6. TRAINING COURSES IN 1988

(1) The use of isotopes and nuclear techniques in soil/plant productivity with emphasis on root studies, Agency's Laboratories, Seibersdorf May 24-July 1, 1988.

The objective of this course is to give scientists from developing countries a sound working knowledge of the relevant nuclear techniques in soil fertility and plant nutrition research and their appropriate integration with non-isotope related techniques. The course aims at training personnel to enable them to carry out isotope-aided experiments as part of national programmes on plant nutrition for increasing agricultural production. This course has special emphasis on root studies and the use of soil resources, the relationships between root activity and plant productivity, and the scope for management of roots and associated symbioses to enhance yield.

Participants must have a university degree and should have special interest in the fields of soil fertility and plant nutrition or root biology (including physiology and symbiotic associations). Preference will be given to those who are actively involved in FAO/IAEA Co-ordinated Research and/or Technical Co-operation Programmes on the above topics. They will be expected to have an active, personal involvement in research.

The official announcement of the course has already been issued to the relevant government authorities (in each country) in November 1987. Nominations should be submitted in duplicate on the standard IAEA nomination form for training courses. Completed forms must be endorsed by and returned through the official channels established (the Ministry of Foreign Affairs, the National Atomic Energy Authority, the Office of the United Nations Development Programme or the Ministry of Agriculture). They must be received by the International Atomic Energy Agency, P.O. Box 100, A-1400 Vienna, Austria, not later than 26 February 1988. Nominations received after that date or applications sent directly by individuals or by private institutions cannot be considered.

For additional enquiries, please write to Dr. G. Bowen, Head, Soil Fertility, Irrigation and Crop Production Section, Joint FAO/IAEA Division, Wagramerstr. 5, P.O. Box 100, A 1400 Vienna.

(2) Regional Africa Training Course on the use of isotope and radiation techniques in studies of biological nitrogen fixation and soil/plant nutrition, University of Ghana, 5-30 September 1988

This is scheduled to be held at the University of Ghana, Legon-Accra, Ghana, in collaboration with the Ghana Atomic Energy Commission, Kwabenya, from 5 - 30 September 1988. The objective of this training course is to equip scientists from African countries with a sound working knowledge of the relevant isotope and nuclear techniques used in studies of biological nitrogen fixation and soil fertility, the correct field experimental study and design, and data interpretation so that the knowledge and skills acquired can be put to practical use in research aimed at increasing crop production and soil fertility. Emphasis will also be placed on phenomena related to root biology and physiology.

The official announcement of this training course will be issued to the relevant Government authorities (in each country) responsible for IAEA matters, by about January 1988. Information may also be obtained from Dr. K.S.Kumarasinghe, Soil Fertility, Irrigation & Crop Production Section, Joint FAO/IAEA Division, Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna, Austria. The prospective participants should have at least a University degree or an equivalent with substantial research experience in the field of soil/plant studies. Preference will be given to those involved with the FAO/IAEA Regional Africa Project on Biological Nitrogen Fixation (RAF/5/010) or other IAEA projects related to increasing crop productivity and soil fertility.

7. REPORTS OF MEETINGS

(1) The first Research Co-ordination Meeting on "Evaluation and calibration of nuclear techniques as compared to traditional methods in soil water studies", 2-4 November 1987, IAEA Headquarters, Vienna, Austria.

Inadequate water is the most important constraint in agriculture production, in many parts of the world. The measurement and management of soil water is therefore of great importance in meeting the food demands for an ever increasing human population. The neutron moisture gauge has now gained wide acceptance among scientists as an indirect method of measuring soil water content, as an alternative method to traditionally used non-nuclear methods, including gravimetric sampling, tensiometers, resistance blocks and the like. This programme will compare different methods of calibration of neutron moisture gauges, including field, laboratory and theoretical calibrations. Participants of the programme are also requested to evaluate nuclear methods, namely neutron moisture and gamma density gauges, to determine if they have worthy advantages over other, traditional, non-nuclear methods in measuring soil water content.

Excerpts from progress reports, in the order of their presentation, during the meeting:

D.R. Nielsen, et al., USA. University of California, Davis, California. Evaluation and calibration of neutron moisture meters under different field conditions. A method was presented to decide number and location of neutron access tubes to estimate average soil water storage in root zone of almond trees irrigated with drip system. It was shown that water storage estimated with measurements from only two access tubes was the same as that with 25 access tubes. Results were discussed with "time-invariance" of water content measurements made with neutron gauges,

which is a concept previously introduced by Vachaud et al., (1985, Soil Sci. Soc. Am J. 49:822-827).

P.L. Libardi, et al., Brazil. Centre de Energia Nuclear na Agricultura, Piracicaba (S.P.) Comparison of different methods to calibrate a neutron moisture meter and to measure soil-water content in studies of spatial variability. Calibration of a neutron gauge, using a field transect, was discussed. Slopes of linear calibration curves of different soil layers were increased with increase of soil bulk density.

P. Mountonnet, et al., France. CEN de Cadarache, St.Paul-les-Durance, CEDEX. Application of neutronic soil analysis to the neutron moisture gauge calibration. Theoretical calibration method of neutron gauges, developed at the Cadarache Nuclear Research Centre, requires measurement of soil neutron parameters: Thermal neutron absorption (Σ_a) and diffusion (Σ_d) cross sections of the soil samples. The calibration curve is computed with a computer simulation model describing neutron scattering in soils. The most probable values of soil neutronic parameters and their expected influence on neutron gauge calibration curves were disccussed.

T. Zhangxiong, et al., China (P.R.). Chinese Academy of Agricultural Sciences, Beijing. Evaluation and calibration of neutron moisture meter as compared to resistance, tensiometer and weighing methods. They compared field calibration of neutron gauges with laboratory and manufacturer's calibration. Their results showed that field and laboratory calibration curves were quite similar; however, manufacturer's calibration was significantly different when it was compared with that of field calibration curve.

K.S. Ryu, et al., Republic of Korea. Agricultural Sciences Institute, Office of Rural Development. Suweon. Evaluation and calibration of neutron probe as compared to traditional methods of soil water content measurement. Different error components contributing to total variance of water content measurments, made with neutron gauges were discussed. The results indicated that plant root activity may contribute to field soil heterogenity, which inturn increases total variance of measurements.

J. Salgado, et al., Portugal. Laboratória Nacional de Engeharia e Tecnologiá Industrial, Sacavèm. Nuclear methods in agronomical studies. Design and calibration of a transmission gamma probe were discussed. Results of calibration of a neutron gauge, in swelling and shrinking soils, were presented. Theoretical base for dual-gamma-sources-gamma-ray attenuation technique was discussed and it was indicated that a major source of error in simultaneous measurement of soil water content and bulk density arises from errors made in measurement of gamma attenuation coefficients.

B. Cevik, et al., Turkey. University of Cukurova, Adana. Evaluation and calibration neutron moisture probe as compared to gravimetric sampling and other traditional methods in soil water studies. The influence of soil texture, lime content and soil salinity on field calibration of a neutron gauge were discussed. The slope of the linear calibration curve, decreased with increase of soil clay content (when neutron count ratio being the independent variable). Similarly, increased soil salinity caused decrease of the slope. Soil lime content did not show an appreciable influence on the calibration.

J. MacIntyre, USA, University of California, Davis, California. Calibration of a Neutron Moisture Meter in Vertisols and Salt Affected Soils. Preparatory work for field calibration of a neutron moisture meter in vertisol soils was described.

It was agreed that the main core of activity in the next year's work will be elaboration of field calibration procedures of the neutron gauges. The calibration will be made for large fields. Questions of interests are: (1) What is the maximum distance away from neutron access tubes to take soil samples, in field calibration of neutron moisture gauges (2) Can the size of soil samples influence calibration? (3) Are "measuring domains" of neutron moisture meter and gravimetric sampling the same? Soil salinity, soil cracking, presence of gravels and influence of other soil chemical constituents on the calibration will also be considered. Each participant will at least choose one factor which would influence calibration. Laboratory calibration of the neutron gauges will be compared with field calibration. Theoretical calibration of the neutron gauges, at least for one soil in each participant's country, will be made if funds can be alloted for this purpose. All participants will at least compare neutron gauge measurements with gravimetric sampling. Participants will compare tensiometers and/or gypsum resistance blocks with the neutron data. Basic statistics and/or geostatistic methods will be used in the comparison.

(2) The third research coordination meeting of the FAO/IAEA/SIDA programme on "Isotopic studies of nitrogen fixation and nitrogen cycling by blue-green algae and Azolla" 2-6 November, 1987. The Fujian Academy of Agricultural Sciences, Fuzhou, People's Republic of China.

The programme is now in the fourth year of a planned 5 year duration. Results were presented on experiments comparing rice yield responses and ^{15}N recovery from applications of azolla green manures in comparison to urea when added as a basal fertilizer at transplanting or as a top dressing at maximum tillering. Residual effects on a second rice crop were also measured. Other experiments compared the effects of different azolla species and strains, and preliminary results were presented which indicated that the presence of an azolla cover may prevent losses by ammonia volatilization.

In most cases, rice yield responses to azolla green manures were similar to an equivalent application of urea with a split of 30 kg N/ha applied at transplanting and 30 kg N/ha applied at maximum tillering. Growth analysis showed that tiller production was significantly delayed in the early stages of rice growth in plots treated with azolla in comparison to urea but that later in the season tiller number was greater in the azolla plots.

Recovery of ^{15}N in the above-ground portions of the rice plants was lower from azolla than from urea in 5 experiments, and in 3 others it was similar. The ^{15}N recovery from azolla applied at transplanting was higher than that from applications at maximum tillering. For urea applications ^{15}N recovery was higher from applications at maximum tillering.

When a second crop of rice was grown in the same plots without further N fertilizer applications a residual yield response was observed in 3 experiments. In 2 experiments the residual yield response was greater in the azolla treated plots. Recovery of ^{15}N by the second rice crop was low in all experiments ranging from 2-8% of that applied and was similar for both urea and azolla. A ^{15}N balance study showed that N losses from

azolla applications were less than from urea, and 35% more ^{15}N from azolla remained in the soil after 2 crops.

Comparisons of the ^{15}N recovery from different species or strains of azolla gave conflicting results in different experiments. In a field experiment the ^{15}N recovery was greater from A. caroliniana than from A. microphylla and 2 strains of A. pinnata. Whereas, in a pot experiment in Beijing, China the results showed that ^{15}N recovery by rice was in the order A. microphylla > A. caroliniana > A. filiculoides. A comparison of the ability of 99 strains of azolla to fix atmospheric N_2 in the presence of 40 mg/l of $(NH_4)_2SO_4$-N showed large differences between strains within the different species of azolla, but that differences between species also occurred, with the general ranking A. filiculoides > A. caroliniana > A. pinnata imbricata > A. pinnata pinnata. For 3 selected strains these differences were consistent over a range of NH_4^+-N concentrations and temperatures.

Preliminary results were presented which indicated that the presence of an azolla cover can have significant effects on the dynamics of N added into the floodwater. In one experiment one third of the ^{15}N from urea added as a topdressing was taken up by A. pinnata pinnata, although no effect on ^{15}N recovery by rice was observed. Another experiment showed that an azolla cover can reduce the pH in the floodwater by 0.5 pH units which could result in significant reduction in N losses by NH_3 volatilization. A new set of experimental plans was developed to determine the effects of azolla on N fertilizer losses and to measure ^{15}N balances in the rice-soil system.

The participants at the meeting were: A. Ruschel, Brazil; G. Kovacs, Hungary; S. Ali, Pakistan; M. Mian, Bangladesh; P. Swatdee, Thailand; E. Sisworo, Indonesia; J. Bunoan, Philippines; You Chong-biao, China; Liu Chung-chu, China; W. Zimmerman, U.S.A.; C. Van Hove, Belgium; A. Gunatilaka, Austria; I. Watanabe, IRRI (Philippines); D. Eskew (served as Scientific Secretary) and U. Granhall (representing the Swedish International Development Authority).

(3) Consultants Meeting on "Roots and plant productivity", 9-12 November 1987, IAEA Headquarters, Vienna, Austria.

From time to time we invite a limited number of leading scientists in a particular area to a consultants meeting to discuss the present status of a field of research, further research needs, and the possible role of isotope and nuclear related methods in these. From November 9 - 12, we had one such meeting on "Roots and Plant Productivity" at which the following topics were discussed, with particular (not exclusive) reference to genotypic variation within plant species, and the effective use of soil resources. Those invited to the meeting were:

Ann Hamblin, (Australia) Soil physical constraints on root-growth and the use of soil resources; Betty Klepper, (USA) Modelling root growth; Peter Gregory, (UK) (i) Root systems in plant communities; (ii) Water use efficiency; Peter Vose, (U.K.) Genetic variation in nutrient uptake by roots; Ralph Clark, (USA) Intraspecific variation in nutrient uptake and distribution in the plant; Walter Horst, (FRG) The physiology of nutrient uptake and use; screening for genetic variation; Alvin Smucker, (USA) The carbon relations of the plant and root dynamics; Avnel Carmi, (Israel) Roots as producers of growth compounds; James MacKey, (Sweden) Root/Shoot relations, and genetic variation in roots; Gudni Hardarson, (IAEA) Genetic variation in Rhizobium nodulation, competition

and nitrogen fixation; Glynn Bowen, (IAEA) Mycorrhiza, rhizosphere organisms, soil biological constraints to productivity.

The papers will be published by the Agency. A summary of the main conclusions has been prepared and is currently with participants for confirmation. A selection of some of the points is given below.

1. In most soils in the world, plant productivity is limited by soil factors. Especially in low input systems actions such as the addition of fertilizer, the use of legumes for fixing atmospheric nitrogen must be integrated with the use of plant genotypes selected for high efficiency in production on minimal input. Genotypic differences within species in nutrient content and distribution of nutrients in plant parts have been reported for every nutrient studied and heritability of these differences has been demonstrated in many cases. In many cases these nutritional differences have been reflected in yield differences. Marked genotypic differences within species have also been demonstrated in tolerance of deleterious factors associated with acid soils and saline/sodic soils.

The most immediate needs in developing this area further are (1) Field screening and (2) detailed plant/soil studies of variations in major processes in (a) uptake and (b) use of nutrients in the plants.

In field screening and especially in studies at the mechanism levels, isotope techniques will be of particular value.

2. The rhizosphere is a vital area deserving more collaborative study between soil scientists, microbiologists and plant physiologists and in which isotopes are particularly useful.

3. Although the importance of the dynamic of shoot/root/soil is generally acknowledged, there is a great paucity of quantitative information. Broadly speaking, shoot (assimilate source)/root (an assimilate sink) ratios are under genetic control with modification by the climate and the soil climatic, physical, chemical and biological environment.

4. Studies of root biomass and root/shoot ratios have been almost entirely limited to dry weights. This parameter, however, ignores root turnover, respiratory losses of carbon and spatial and temporal dynamics of root systems. There is a need both for a more precise understanding of the energy requirements of roots and to describe root dynamics in terms recognized as more meaningful for the use of soil resources.

5. Over the last five years there has been increasing recognition that particularly for perennials, but also with annuals, fine roots are continually being lost and replaced. Considering only net changes in root growth can therefore be quite misleading, both in estimation of the assimilate allocation to roots and in the volume of soil used by roots, especially for poorly diffusible nutrients such as phosphate. There is a particularly pressing need to develop good methods to measure (quantatively) root turnover in the field, and possible genotype differences in this. Non isotope methods such as ingrowth of roots into a soil core, or direct observation with minirhizotrons have been developed. Both of these, while extremely useful, can present logistic problems. There are indications from published work that ^{14}C studies may be developed to provide an acceptable method to examine root turnover.

6. Most reports of root turnover and factors effecting this are anecdotal. This is a need to examine factors leading to root death and genetic variation in this, under controlled experimental conditions.

We note there are considerable genotypic differences in root regeneration and that soil temperature interacts with this.

7. Much of the "traditional wisdom" on uptake of water and nutrients along roots has been derived from laboratory studies, often is solution culture, and often under unrealistic conditions, for example patterns of uptake of phosphate at soil temperatures of 10°C can differ markedly from those at 20°C. There is a need for more study of the uptake of water and different nutrients by different parts of roots in soil. Several isotopic methods are available for this, and for relating activity to assimilate distribution in the root.

8. The production of plant growth regulators by plant roots is well known e.g. giberellins and abscissic acid (to some extent) but particularly cytokinins, which are produced almost exclusively by the root apices for translocation to the shoots. The role of cytokinins in leaf longevity - a major component of total assimilation - the demonstrations of genotypic differences in cytokinin production and a reduction of cytokinin production in some nutrient deficiency conditions, focus attention on this as an area worthy of much more study.

9. While marked reduction of productivity by root pests and diseases is recognized in some developed countries, generally there has been little evaluation of the occurrence and importance of soil biological constraints in many developed countries as well as in most developing countries. Regardless of the apparent health of the plant, an indication of the probable importance of root diseases should be obtained with major crops and major soils by examining the plant growth response to fumigation against diseases and pests. Such simple evaluations are necessary to define the problems before an economical solution can be attempted.

10. Many non-infective rhizosphere organisms have been shown to have the ability to increase plant yield, sometimes by up to some 30%, but often about 10-15% and sometimes not at all. There are two broad modes of operation (i) partial control of root disease (the most common), (ii) Stimulation of root growth, and of earlier flowering; the production of plant growth regulators appears to occur. This is a rich area for future research and there are several areas in which isotopic methods could help.

11. Marked genotypic variations associated with root characters occur with relation to the most common soil physical constraints to productivity - in water uptake, (both spatially and temporarily) with soil aeration, mechanical impedance, and high or low soil temperatures. Although the neutron moisture meter is of major benefit in studying water uptake with depth (and root activity) there is a need to develop a similar instrument of much finer resolution, to examine water potential variation near individual roots.

8. PUBLICATIONS, 1987

Afza, R., G. Hardarson, F. Zapata, S.K.A. Danso (1987) Effects of delayed soil and foliar N fertilization on yield and N_2 fixation of soybean. Plant and Soil, 97:361-368, (1987)

Bowen, G.D. and S.K.A. Danso (1987) Nitrogen nutrition of perennials. IAEA Bulletin, Vol. 29:5-8

Danso, S.K.A., C. Hera, C. Douka (1987) Nitrogen fixation in soybean as influenced by cultivar and Rhizobium stain. Plant and Soil 99:163-174.

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Danso, S.K.A., C. Labandera, D. Pastorini and S. Curbelo (1987) Nitrogen fixation in a two-year old white clover - fescue pasture: influence of nitrogen fertilization. Soil Biol. & Biochem.

Danso, S.K.A., G. Hardarson, F. Zapata (1987). Nitrogen fixation estimates in alfalfa-ryegrass swards using different N-15 labelling approaches. Crop Science.

Danso, S.K.A. and J.D. Owiredu (1987) Competitiveness of introduced and indigenious cowpea rhizobium strains for nodule formation in three soils. Soil Biol. & Biochem.

Owiredu J.D. and S.K.A. Danso (1987) Response of soybean (Glycine max (L) Merrill) to Bradyrhizobium japonicum inoculation in three soils in Ghana. Soil Biol. & Biochem.

Hardarson, G., S.K.A. Danso, F. Zapata (1987) Nitrogen fixation measurements in alfalfa-ryegrass swards using nitrogen-15: Influence of the reference crop. Crop Science.

Danso, S.K.A. (1987) Nodulation of soybean in an acid soil: The influence of Bradyrhizobium inoculation and seed pelleting with lime and rock phosphate. Soil Biol. & Biochem.

Labandera, C., S.K.A. Danso, D. Pastorini, S. Curbelo and V. Martin (1987) Nitrogen fixation in a white clover - fescue pasture using three methods of nitrogen 15 uptake. Agronomy Journal.

For further information on the above publications, please write to any of the individuals concerned, or to the Head, Soil Fertility, Irrigation and Crop Production Section.

9. PLEASE NOTE PLEASE NOTE PLEASE NOTE PLEASE NOTE

1. International Symposia

The use of stable isotopes in plant nutrition, soil fertility and environmental studies.

The general theme of this symposium was described in the last issue of the Newsletter, July 1987. It is going to be held by the Joint FAO/IAEA Division in Vienna, 1989. The exact date has yet to be decided.

2. A new CRP on the management of nitrogen fixing trees for restoring and maintaining soil fertility.

As it was mentioned in the last issue of the Newsletter, July 1987, this programme had been approved and we were hoping to find funds for its implementation. We are happy to inform you now that the Italian Government has provided the needed funds for starting this project. The programme will mainly focus on the measurement of biological nitrogen fixation by trees in agricultural - pastoral ecosystems. It will have an agroforestry emphasis but studies relating to soil conservation and anti-desertification will not be excluded. The programme will also seek to examine the effects of: (i) soil chemical status, especially the effect of adding small amounts of phosphate and trace elements. (ii) season and age of the tree, and different management systems such as times and intensity of cutting of foliage or stems for green manure, fodder, and fuel. (iii) soil moisture (and its interactions with soil nutrient); and (iv) genetic variation in nitrogen fixation within species.

It will be important to measure also the rate of increase of soil fertility in response to management of nitrogen fixation, and the benefit derived by cropping systems associated with the tree stands, e.g., in alley cropping.

Submission of contract applications for this co-ordinated research programme (CRP) are now being accepted. The co-ordination programme normally lasts for 5 years and two or three research co-ordination meetings are held and attended by all contract holders (usually 12 per programme) and a number of agreement holders. Agreement holders are scientists from more advanced countries/laboratories working on topics relevant to the activity of the particular CRP. At these research co-ordination meetings, results of previous experiments are discussed extensively, and follow-up experiments to be conducted by the group and the appropriate research strategy are arrived at. The Agency normally provides up to approximately $5000 per annum for equipment and labelled fertilizer for contract holders.

If you do not have contract application forms, please telex Dr. G.D. Bowen, Joint FAO/IAEA, Telex 1-12645, and send air mail information on (i) title of your project proposal and objectives, (ii) your curriculum vitae and publications within the past two years, (iii) related research work already underway at your institute, (iv) first year work plan of your research proposal, including proposed experimental methods and techniques and (v) laboratory facilities and available equipment at your institute. We hope to select the contracts soon after February 29, 1988.

For additional enquiries on the above announcements, please write to: The Head, Soil Fertility, Irrigation and Crop Production Section, Joint FAO/IAEA Division, P.O.Box 100, Wagramerstrasse 5, A-1400 Vienna, Austria.

Notes for readers for consideration for the next issue of Soils Newsletter should reach the above by May 1, 1988.

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