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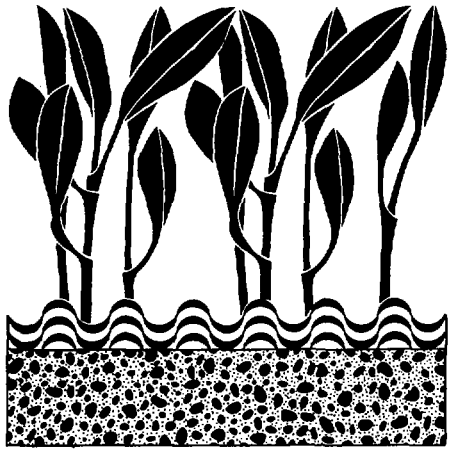

Soils Newsletter

JOINT FAO/IAEA DIVISION
OF ATOMIC ENERGY
IN FOOD AND AGRICULTURE

INTERNATIONAL
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CONTENTS

TO OUR READERS

We are glad to present this issue of the Soils Newsletter which enters the second year of its publication. It is heartening to note the excellent response and appreciation received from the continually enlarging readership of the Newsletter which is now distributed to over 400 institutions and scientists in Member States of FAO and IAEA.

The present issue starts with a brief account of new technical assistance projects to be implemented in ten Member States in Africa, Asia, and Europe in 1979, and summary reports on three projects executed during the latter half of the past year in Member States in Africa and Asia. Reports on research coordination meetings on the Use of Radiation and Isotope Techniques in Studies of Soil-Water Regimes (11-16 September 1978, Ghent, Belgium), and on Isotope-Aided Micronutrient Studies in Rice Production with Special Reference to Zinc Deficiency (11-15 September 1978, Bogor, Indonesia) are presented. Resumés of consultants meetings of newly initiated coordinated research programmes on Isotope and Radiation Techniques for Efficient Water and Fertilizer Use in Semi-Arid Regions (4-8 September 1978, Vienna, Austria), and on Potential Use of Isotopes in the Study of Biological Dinitrogen Fixation (16-20 October 1978, Vienna, Austria) are also included. These are followed by a summary report on the FAO/IAEA International Symposium on the Use of Isotopes and Radiation in Research on Soil-Plant Relationships (11-15 December 1978, Colombo, Sri Lanka). An account of the current activities at the Agricultural Section, Seibersdorf Laboratory is included. We conclude this issue with a report on the interregional training course held at Moscow, U.S.S.R. during September-November 1978, and announcements of two forthcoming interregional training courses to be held in Leipzig, German Democratic Republic, and IAEA Laboratory, Seibersdorf, Austria during April-June 1979.

We hope you find this material of interest. We request you to contribute relevant material on recent advances in isotope-and-radiation-techniques-aided research into soil-water-plant relationships in Member States of FAO and IAEA for publication in the Newsletter.

We thank you for your encouragement and cooperation and wish you every success in your activities for 1979.

SOIL FERTILITY, IRRIGATION
AND CROP PRODUCTION SECTION

CHANGES IN STAFF

Prof. F.E. Broadbent returned to the University of California, Davis, U.S.A. in June 1978 after spending a sabbatical year with the Soil Fertility, Irrigation and Crop Production Section. Dr. R.J. Rennie left the Agricultural Section, Seibersdorf Laboratory in June 1978 to take up an assignment with Agriculture Canada.

Prof. G.H. Wagner, University of Missouri, Columbia, U.S.A. and Prof. R.V. Olson, Kansas State University, Manhatten, Kansas, U.S.A. joined the Soil Fertility, Irrigation and Crop Production Section during January 1979. Prof. Wagner will spend one year with the Section on a sabbatical leave arrangement. Prof. Olson will spend four months with the Section.

TECHNICAL ASSISTANCE PROJECTS

A. New Projects - 1979

Ten new technical assistance projects dealing with the application of isotope and radiation techniques to solve specific problems of soil fertility, fertilizer usage, plant nutrition, soil moisture and water management in Member States in Africa, Asia, and Europe will be implemented during 1979. The Soil Fertility, Irrigation and Crop Production Section has the technical responsibility for the implementation of these projects. A brief account of the technical programme of these projects and the nature of assistance provided by the Agency is presented here.

I. Africa

1. Egypt

Assistance will be provided to the Department of Agriculture, Soils and Water Research, Atomic Energy Establishment, Cairo, for establishing a central facility for ^{15}N-analyses of plant and soil samples and initiating a programme on efficient nitrogen fertilization of major cereal crops of the country including transformation and losses of applied nitrogen. The provision of an emission spectrometer for ^{15}N analysis, labelled fertilizers and expert services for six man-months and awards of training fellowships and travel grants for scientific visits is envisaged. This project, which was approved in principle during 1978, was not implemented in the past year due to non-availability of funds.

2. Ivory Coast

The Agency is continuing its assistance to the Institut des Savanes, Bouake. During 1979, the Institut will receive three man-months of expert services in the field of soil physics and irrigation research, neutron moisture probes with accessories, instruments for recording meteorological data, and ancillary equipment for a research programme aimed at developing adequate soil management and water conservation practices for rational utilization of water by maize and rice crops.

3. Kenya

In continuation of the aid provided by the Agency over the past year, the Radioisotope Laboratory, Coffee Research Station, Ruiru will receive an automatic liquid scintillation counting system. Provision of this equipment would inter alia facilitate the radioassay of soil and plant samples arising out of the on-going isotope-aided investigations on root activity and timing and placement of fertilizer associated with newly introduced close-spaced planting of coffee.

4. Mauritius

The Agency is providing two man-months of expert services to the Mauritius Sugar Industry Research Institute, Reduit, to assist in the planning of specific isotope-and-radiation-techniques-aided research programmes aimed at improving the water and fertilizer use efficiency for sugarcane crop which occupies over 90 percent of the total cultivated area in the country. The Institute will be advised on the equipment and facili-

ties required, and future needs for expert services and training of local scientists for implementing these research programmes.

5. Niger

The Agency is assisting the Institut Nacional de Recherches Agronomiques, Niamey to implement nuclear-techniques-aided research programmes aimed at obtaining improved knowledge of the physical and hydraulic properties of the sand-dune type and terraced soils in the Niger, and determination of water requirements and root system development of major field crops in these soil types. These programmes are expected to develop adequate management practices under rain-fed and irrigated conditions for these soils and lead to enhanced crop production. The Agency's assistance is in the form of six man-months of expert services, neutron moisture and density probes, beta-gamma counting assembly and ancillary equipment, and labelled fertilizers. Awards of training fellowships are also envisaged.

6. Zaire

The Agency will provide assistance to the Regional Nuclear Research Centre, Kinshasa for nitrogen-15-aided studies aimed at improving biological dinitrogen fixation in legumes and non-legumes so as to reduce the need for nitrogen fertilizer application to these in crops in Zaire and minimize potential ground water pollution by nitrogen fertilizers. An emission spectrometer with accessories for N-15 analysis and four man-months of expert services are being provided for this project.

7. Zambia

As a follow-up of a consultancy mission by a Staff Member of the Agency during the past year, the Central Agricultural Research Station, Chilanga is being assisted in implementing isotope-aided research programmes of greenhouse and field experiments aimed at evaluating the efficiency of locally available rock phosphate as a phosphatic fertilizer for major field crops of Zambia and developing optimum methods of timing and placement of rock phosphate and nitrogen fertilizer applications for these crops on principal soil types of the country. Basic radiation detection and measuring instruments, glove-box and ancillary equipment required for the radioisotope laboratory and six man-months of expert services will be provided under this project.

II. Asia and the Pacific

1. Sri Lanka

The assistance to be provided by the Agency during 1979 is a follow-up of the earlier Agency-sponsored projects on evaluation of local Eppawela apatite as a phosphatic fertilizer for coconuts at the Coconut Research Institute of Sri Lanka, Lunuwila, and on water use efficiency studies on rubber at the Rubber Research Institute of Sri Lanka, Agalawatte. Beta counting assembly with accessories and labelled fertilizers will be supplied to the Coconut Research Institute of Sri Lanka. The Rubber Research Institute of Sri Lanka will receive a neutron moisture probe with accessories, tensiometers and plant water stress module. Awards of training fellowships are also envisaged under the current assistance programme.

2. Thailand

In continuation of the aid provided by the Agency over the past two years to the Isotope Laboratory, Division of Agricultural Chemistry, Department of Agriculture, Bangkok, the Agency will, subject to the availability of funds, provide an automatic liquid scintillation counting system. The provision of this equipment would greatly facilitate the analytical work of the on-going isotope-aided research programme aimed at comparing the effectiveness of ammonium chloride and ammonium sulphate as sources of nitrogen for lowland rice and assessing the possible adverse effects of long-term usage of ammonium chloride fertilizer, which is the cheapest nitrogen source in Thailand, on root activity of rice and the quality of subsequent upland crops grown in rotation with rice.

III. Europe and the Middle East

1. Albania

The Agency is assisting the Institute of Nuclear Physics, Tirana to initiate an isotope-techniques-aided research programme aimed at increasing crop yields through optimum use of phosphate fertilizers, and amelioration of possible micronutrient deficiencies which would be implemented in collaboration with agricultural research institutions in the country. The assistance will be in the form of one man-month of expert services, beta-gamma counting equipment, radiation detection equipment and related accessories.

B. Reports of Projects Executed in 1978

In continuation of the reports on technical assistance projects described in the previous issue of the Newsletter (Vol. 1, No. 2), summaries of final reports of field experts assigned to three projects in Member States in Africa and Asia are included here.

I. Africa

1. Ivory Coast

Project: IVC/5B/06

Institution: Institut de Recherches Agronomiques Tropicales, Bouake

Expert: Dr. M. Vauclin

Duration of Assignment: June - August 1978

During the period from 28 June to 17 August 1978 Dr. Michel Vauclin served as an Agency technical assistance expert at the Institut de Recherches Agronomiques Tropicales, Bouake, Ivory Coast. This assignment was a follow-up for previous missions carried out by Dr. G. Vachaud in February 1978 and by Dr. Vauclin in November 1977.

The purpose of Dr. Vauclin's visit was to cooperate with his counterparts in (1) evaluating the results of research carried out on

water-soil-plant-relationships; (2) planning applied research programme aiming at increasing yields of upland rice using isotope techniques.

The main achievements of the expert are summarized below:

1) Based on the available data (from Cadarache, Orstom and field calibration) as well as additional measurements, and taking into consideration the variation in the properties of different soil profile horizons, a reliable calibration curve for the neutron moisture meter (Lepaute H.P. 310) was established.

2) The data collected from internal drainage experiments carried out on plots B1, B2, and A6 were processed and interpreted and a new internal drainage experiment was performed on plot A5. These experiments provided valuable information on the hydraulic conductivity as a function of moisture content. The information gained was essential for evaluating and making use of the results of research work obtained since 1975.

3) The available information on the hydraulic characteristics of certain field plots, the tensiometer readings and soil moisture measurements performed with the neutron moisture meter were used to estimate the total water consumption and the contribution of each soil layer throughout the rooting zone for two upland rice varieties (IRAT 13 and Moroberekan) during a period of drought which prevailed from 22 June to 20 July 1978. The method was precise enough to allow for evaluating the difference between the two rice varieties in their behaviour under water stress.

4) Suggestions for future studies:

   a) Water balance studies should be carried out systematically for promising upland rice varieties on different soil types. As the performed root system development studies has shown that practically no roots are active below the depth of 80 cm, it is enough to place a tensiometer at 90 and another at 110 cm depth and to measure periodically the moisture content at 100 cm depth to be able to determine the flux of water at the 100 cm level (loss of water through percolation below the root zone). This, of course, assumes that the relation between hydraulic conductivity and moisture content has been studied before. Such a study will allow for determining the water requirements of a given rice variety when grown under well-defined conditions.

   b) In 1976 studies were initiated to compare the ability of different upland rice varieties to resist drought. The plants were subjected to varying degrees of water stress while a control site was maintained throughout the growth season under a maximum evapotranspiration regime. This very important study should be continued and the data obtained since 1976 should be urgently processed. The study should cover the whole growth season and combine the main hydraulic and agronomic aspects, especially the effects of water stress at certain stages of growth on the grain yield.

c) Because the determination of the hydraulic conductivity as a function of moisture content involves a lot of hard work, is costly and time consuming, it is not possible to repeat such a study in a given field often enough to take into consideration the commonly encountered spatial variability. It is therefore suggested to follow the following procedure:

i) Take undisturbed soil samples at different depths and different locations;

ii) Determine at the laboratory the water characteristic curve for each soil sample;

iii) Study the infiltration rate with the aid of a double ring infiltrometer at each sampling site;

iv) Based on the above information and the knowledge of the relation between hydraulic conductivity and moisture content at a limited number of locations, an attempt should be made to determine the hydraulic conductivity as a function of moisture content for all other locations, making use of established relations between hydraulic conductivity and the properties determined under ii) and iii).

2. Morocco

Project: MOR/5B/11

Institution: Station Centrale des Radioelements, Tangiers

Expert: Dr. M.R. Hamissa

Duration of Assignment: March - October 1978

For the duration of eight months starting March 1978 Dr. M.R. Hamissa served as an IAEA expert in the use of radioisotopes in soil fertility studies at the Central Radioisotope Station of the Directorate of Agricultural Research in Tangier, Morocco.

The main objectives of his assignment were:

1) To plan and initiate research programmes aiming at increasing yields through more efficient use of fertilizers;

2) To cooperate in processing and interpreting the data obtained from previous investigations on N balance studies in a four-year crop rotation using ^{15}N.

The achievements of the expert are summarized below:

1) Four field experiments were planned and initiated on sugarcane. The investigations aimed at improving the efficiency of nitrogenous fertilizer use through determining the best placement method, the most appropriate time of application and the choice of the most suitable fertilizer form. Due consideration was given to studying the residual effect of the applied labelled fertilizers.

2) The staff members of the duty station were familiarized with the different aspects of experimental work, and especially the following:

   a) Selecting experimental sites

   b) Collecting representative soil samples

   c) Determining of certain chemical and physical properties of the soils

   d) Laying out and planting experiments

   e) Applying fertilizer using various methods including foliar spray of micronutrients

   f) Collecting plant samples for analysis.

3) A brief summary of the main results of the N balance studies of a four-year crop rotation is given below:

   a) Yields of crops were significantly increased as a result of nitrogen application at the recommenced rates. In comparison to the yields of non-fertilized plots yields of sugarbeets, wheat grain, cotton lint, and maize grain were increased by 80, 86, 38 and 155%, respectively.

   b) Fertilizer application also caused an increase in total nitrogen uptake by the whole components of sugarbeet, wheat, cotton and maize amounting to 72, 100, 74, and 149%, respectively over the corresponding uptake of control treatments.

   c) Nitrogen application not only increased wheat and sugarbeet production, but also improved the quality of wheat grain through raising its protein content and increased the sucrose percent and yield of sugar obtained from sugarbeet.

   d) The residual effect of fertilizer nitrogen was detected in wheat grain and straw and in the seeds of cotton after the second and the third season from tracer application, respectively. However, the amount of nitrogen derived from the fertilizer during the second and third season after application was very small compared with that taken up by the crop to which the fertilizer was applied.

   e) The carry-over effect of tracer nitrogen was higher in the subsequent crop to which no fertilizer was applied. This is in accordance with previous findings indicating that increasing the fertility level of the soil results in decreasing the percent of nutrient derived from fertilizer.

   f) When N-15-enriched fertilizer was applied in the preceding season to fallow plots, the carry-over of tracer nitrogen was higher than when it was applied to cropped plots. As a result of the absence of a crop which would have utilized some of the fertilizer added, the amount of tracer remaining in the fallow plots was higher.

   g) Nitrogen balance sheet for wheat broke down as follows: 37.4% taken up by the crop, 24.9% retained in the soil, and 37.7% was not accounted for. This experimental data is in accordance with results published in the Agency's Publication STI/PUB/278 (1971) entitled "N-15 in Soil-Plant Studies."

h) Fate and distribution of nitrogen applied to fallow plots showed that 83% of the tracer nitrogen was lost after 11 months, while 94% was not accounted for 20 months after application. It was observed that most of the retained nitrogen was accumulated in the top soil layers.

i) Loss of nitrogen added to fallow plots was higher than that applied to cropped plots.

j) Total nitrogen content in soil was increased as a result of clover "berseem" cultivation. This is probably due to the amount of nitrogen symbiotically fixed by the root nodules of the crop. This indicated that legume crops constitute an important factor in the crop sequence for maintaining soil fertility and saving some of the fertilizer nitrogen required.

II. Asia and the Pacific

1. Malaysia

Project: MAL/5B/03

Institution: Malaysian Agricultural Research and Development Institute, Serdang

Expert: Dr. M.G. Huck

Duration of Assignment: October 1977 - February 1978

The project objectives related to isotope-aided studies to establish root activity patterns of cocoa and coconut trees grown in interculture in contrasting soil groups of Malaysia. During the assignment, techniques of soil injection of ^{32}P- and ^{33}P-labelled phosphates, sampling of leaves of cocoa trees and extraction of leaf tissue for radioassay through liquid scintillation counting were developed. These techniques were subsequently employed in a well-replicated field trial aimed at studying the root activity pattern of cocoa-coconut interculture laid out on a plantation in Perak. Results indicated that the cocoa trees are shallow rooted and greatest uptake occurred from labelled phosphate placed on or near the soil surface during the period when new flushes of growth appear on the trees. The local counterpart staff were trained to continue the programme initiated under the project and develop recommendations on optimum methods of fertilizer placement for these intercultures.

Report on the FAO/IAEA RESEARCH COORDINATION MEETING ON THE USE OF RADIATION AND ISOTOPE TECHNIQUES IN STUDIES OF SOIL WATER REGIMES

Ghent, Belgium

11-16 September 1978

The final Research Coordination Meeting on the Use of Radiation and Isotope Techniques in Studies of Soil Water Regimes was held at the premises of the State University of Ghent, in Ghent, Belgium from 11 to 16 Semptember

1978. The meeting was attended by 15 cooperators and consultants from Belgium, Brazil, Chile, Cyprus, France, Israel, Japan, Nigeria, Syria, and the U.S.A. The contractor from Madagascar was unable to attend owing to illness.

The data obtained by all participants throughout the duration of the programme were thoroughly discussed. Valuable information of great practical importance was obtained by each of the cooperators.

The reports presented indicated very good agreement between the experimental field calibrations of the neutrom moisture meters as performed by each of the cooperators and the semi-emperical calibrations based on certain chemical and physical properties of the soils and the characteristics of the equipment, which were carried out in Cadarache by Drs. Marcesse and Couchat at the Commissariat à l'Energie Atomique, Département de Biologie, Saint-Paul-lez-Durance, France. As the calibration of neutron moisture meters is very tedious and time consuming, this finding is of great importance and will make the use of the equipment easier and more reliable for the determination of absolute values of moisture content and will encourage many scientists to use it in their research in the near future.

The data discussed in the meeting confirmed the important spatial variability commonly encountered when determining the hydraulic conductivity as a function of moisture content at various locations. Variations in values of hydraulic conductivities corresponding to the same moisture content amounting to one or even two orders of magnitude were not usual. To improve the practical value of the wealth of data available on soil properties at various locations and the hydraulic conductivity as a function of moisture content, the hydraulic conductivity values will be scaled, statistically treated, and efforts will be made to establish correlations between the hydraulic conductivity and other soil properties which are much easier to determine.

Several of the cooperators reported on water balance studies, investigations on the amounts and frequencies of irrigation, movement of ions by mass-flow in soil profiles and established correlations between evapotranspiration and evaporation from an open pan and/or the potential evaporation estimated after Penman with the aid of daily recorded meteorological data. These studies make use of the values of hydraulic conductivity determined as a function of moisture content at various locations and would lead to an appreciable improvement in water use efficiency.

The participants recommended that the Agency publishes a summary of the important data obtained in the form of a technical report. This technical report would be composed of the following parts:

1. Introduction

2. Comparison between the experimental field calibrations of the neutrom moisture meters as performed by each of the cooperators and the semi-theoretical calibrations carried out in Cadarache based on certain properties of the soils and the characteristics of the equipment used.

3. The basic common investigations dealing with the study of the hydraulic conductivity as a function of soil moisture content, its spatial variability, and how best the data can be processed so that meaningful average values of

practical use could be obtained. This represents the main part of the report.

4. Practical applications—this part of the report will deal with the studies performed by each cooperator separately, as the work differed a great deal from one cooperator to another to take into consideration the ecosystems prevailing at the various locations.

4. The general conclusions that can be drawn, especially in connection with Parts 2 and 3 common to all cooperators.

Report on the

FAO/IAEA RESEARCH COORDINATION MEETING ON ISOTOPE-AIDED MICRONUTRIENT STUDIES IN RICE PRODUCTION WITH SPECIAL REFERENCE TO ZINC DEFICIENCY

Bogor, Indonesia

11-15 September 1978

The third meeting of participants in the FAO/IAEA Coordinated Research Programme on Isotope-Aided Micronutrient Studies in Rice Production with Special Reference to Zinc Deficiency was held at the Bogor Agricultural University, Bogor, Indonesia during 11-15 September 1978. The meeting was attended by 10 participants from Australia, Bangladesh, Egypt, India, Indonesia, Korea, Philippines, Thailand, Turkey, and the U.S.A. Representatives of the International Rice Research Institute, the Pasar Jumat Research Centre, Jakarta and the Bogor Agricultural University, Bogor also participated. Dr. K.B. Mistry served as the Scientific Secretary to the meeting.

Detailed progress reports were presented by the Chief Scientific Investigators of eight research contracts and two research agreements on the work carried out since the last coordination meeting of the programme held in Manila during May 1976. Substantial progress was reported in the establishment of soil analytical methods for identifying zinc deficiency in contrasting soil types on which lowland rice is cultivated. The participants presented results of Zn-65-aided field experiments on the comparative efficiency of various methods and sources of zinc fertilizer application to flooded rice grown on zinc-deficient soils. Useful data on factors affecting zinc nutrition of the rice plant from greenhouse experiments were also reported. A review of recent research at the International Rice Research Institute on zinc deficiency problems in lowland rice was presented by a representative of the Institute. The reports were critically discussed by the participants and Work Plans for 1978/79 were formulated to consolidate the progress achieved so far. The agreed Work Plans aim at: (i) Intensification of the survey of zinc status of rice soils in participating Member States through continuing analyses of soil and rice plant samples collected from locations representative of major soil types and geographical areas under rice cultivation, and greenhouse experiments to evaluate the response of rice to zinc application on as many soils as feasible. The regions covered by the survey should be classified as Very Likely Deficient; Likely Deficient; Potentially Deficient; or Adequate in zinc status, and this information incorporated into soil maps of the regions; (ii) Evaluation of the residual value of different sources and methods of zinc fertilizer appli-

cation using Zn-65-labelled fertilizers; and (iii) Continuation of the inter-laboratory comparison of analytical procedures for determination of zinc, copper, manganese, and iron in soils and rice plants through analyses of reference samples to be distributed by the Soil Fertility, Irrigation and Crop Production Section.

Report on the

FAO/IAEA CONSULTANTS MEETING ON ISOTOPE AND RADIATION TECHNIQUES FOR EFFICIENT WATER AND FERTILIZER USE IN SEMI-ARID REGIONS

Vienna, Austria

4-8 September 1978

The Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture convened a Consultants' Meeting on Isotope and Radiation Techniques for Efficient Water and Fertilizer Use in Semi-Arid Regions in Vienna during 4-8 September 1978. The meeting was attended by four consultants from Belgium, France, Israel, and the U.S.A. and a representative of the Land and Water Development Division of the F.A.O. Dr. Y. Barrada served as Scientific Secretary to the meeting. The meeting recommended detailed guidelines for the Joint FAO/IAEA Division's new Coordinated Research Programme on Isotope and Radiation Techniques for Efficient Water and Fertilizer Use in Semi-Arid Regions. A summary of these recommendations is included here:

Introduction

Deficiency of soil water is a primary factor that limits plant growth and crop yield in semi-arid regions where the amounts, frequency, and duration of rainfall are inadequate. In addition to the inherently unfavourable climatic conditions, the commonly encountered low yields are often related to inappropriate management for water conservation and utilization of the limited rainfall. Proper management to ensure the availability of the necessary plant nutrients in adequate amounts can significantly affect water use efficiency and total food and fiber production under dryland farming in the semi-arid region.

The aims of the proposed programme are to utilize isotope techniques to help develop practices providing more favourable soil water and fertility conditions by modification of the soil water and nutrient dynamics. Examples of possible procedures are:

1. Increasing input of water to the soil and improving its storage efficiency by enhancing infiltration and limiting evaporation losses by means of land shaping, tillage, and mulching.

2. Adjusting the initiation and length of the growing season so as to increase the probability of growing a successful crop.

3. Improving water and nitrogen use efficiency by fallowing, which may, under suitable climatic conditions, increase stored water available for crop growth sufficiently to

compensate for the absence of a yield during the fallow season.

4. Application of nutrients in sufficient amounts and at the appropriate time to ensure a better crop utilization of available water.

Because crop production under semi-arid conditions is dependent on both rainfall and stored soil water, it is necessary to understand and interpret the dynamics of soil water, nutrients, and organic matter in relation to the phenological stages of crop development, including the root system. Year-round measurements of soil water and plant processes, with due attention to both spatial and temporal variations are required for adequate evaluation of management alternatives.

In order to follow changes in soil water storage amount and to evaluate rate of water flow, a very large number of soil water determinations must be carried out. The only practical means of obtaining reliable information of this kind economically is by use of the neutron gauge and allied radiation equipment.

Manipulation of the soil water regime will, in many cases, affect the soil nitrogen balance as well as root system development, and thus, the ability of the crop to utilize the soil water and nutrient supply. This may call for initiating or increasing the use of chemical fertilizers to take better advantage of the enhanced water supply. Isotope-labelled fertilizers are essential to follow the fate of nutrients added to the native reserve in the soil, and to determine the optimal timing and method of fertilizer placement. Isotopes are also a particularly useful research tool for studying root system development under different management practices.

For these reasons, and to gain better understanding and solution of soil water and soil fertility problems in semi-arid areas of developing countries, the following guidelines for field research are suggested:

Fallow for Water Conservation

Fallow is a management practice where no crop is grown during a normal crop season and weeds (or other plant growth) are controlled to increase total available soil water for plant use the next growing season. Thus, production for one season is forfeited in anticipation that there will be at least partial compensation by increased crop production the next season. The increased production is mostly due to some increase in soil water and some increase in nitrate nitrogen. With the introduction of shorter cycle (shorter growing season or lower water requirements) varieties of locally adapted conventional crops, like standard millet compared to short-cycle millet, it may be possible to obtain a crop of good yield and fallow the rest of that growing season to conserve water for a different crop the next season. Also, it may be possible that instead of a fallow year, a leguminous plant can be grown for part of a growing season, the plant forage can be grazed or harvested, and then the rest of the season can be fallowed; or, such a plant might be plowed down at midseason as a green manure crop to add some organic material to the soil and possible gain a small amount of N resulting from nitrogen fixation.

If the water characteristics of a soil are not known, it is desirable to obtain this information before initiating any large field experiment with various cropping practices.

A technique that can be used to gain additional soil water information for practical use is to add different quantities of water to a soil to obtain different wetting depths. Then surface treatments can be imposed without a crop to gain information on the possible beneficial results of a given surface treatment, such as plowing or residues mulching, in terms of increased storage efficiency due to decreased evaporation or more favourable redistribution of water in the profile. It is assumed that some water supply is available to establish the desired soil water content.

For water studies without a crop involved, it is suggested that the minimum plot size should be approximately twice the depth of measurement. For example, if depth to be measured is 2 meters, the surface (horizontal) dimensions should be at least 4 by 4 meters, or 16 m^2 (2 meters in each direction from the location of the neutron access tube).

The number of access tubes for the neutron moisture meter measurements on a cropped plot depends on the type of crop (which determines the number of guard rows needed to protect the harvest rows), and soil variability of experimental field. The area of a plot would vary according to the type of crop, soil properties, and the treatments involved, but should not smaller than about 40 m^2.

If experiments including fallow are conducted, it must be recognized that yield data for the first crop year will probably not be counted for those plots which would have normally been planted on a plot which had been fallowed the previous year.

The following example sets of cropping patterns (or some other combination) can be considered as possible practices:

A. With Conventional Crops
   1. Conventional (prevailing cropping practice) (C-C-C)
   2. Conventional crop with fallow, i.e. fallow every other year (C-F)
   3. Two years conventional crop with fallow, i.e. fallow every third year (C-C-F)

B. With Conventional and Short-Cycle Crops
   1. Short cycle - conventional - fallow (SC-C-F)
   2. Two years conventional - one year short cycle (C-C-SC)

C. With Short-Cycle Crops
   1. Annual short-cycle crop (SC-SC)
   2. Short-cycle crop with fallow (SC-F)
   3. Two years short cycle with fallow (SC-SC-F)

D. With Green Manure in Place of Fallow
   1. Conventional - green manure, i.e. alternate years (C-M)
   2. Two years conventional and green manure, (C-C-M)
   3. Short cycle - conventional - green manure (SC-C-M)

Mulching

Most farmers in developing areas gather all crop residues as part of the total harvest. However, plant residues (particularly small grain straw at levels of 2.5 T/ha or more) can be managed as a soil mulch for reducing evaporation loss and increasing water infiltration. It is recognized that coarse stalk residues are not highly effective in reducing evaporation except at fairly high quantities, and that high rates of residue may encourage vermin or host pathogens. On the other hand, use of mulches may increase soil organic levels and will assist in preventing soil degradation by erosion. The following treatments should be considered for research:

A. Residue of preceding crop spread evenly on soil surface.

B. Same as A. except residue incorporated by disking to no greater than 10 cm tillage depth.

C. Residue removed and soil plowed to 10 cm depth.

These treatments should be established within two weeks after harvest. The purpose is to have a plant or soil mulch to increase water conservation, and to reduce weed or volunteer crop growth and measure this change with the neutron meter.

Weed Control

Control of weeds by herbicides, tillage, or hand methods will be needed because weeds consume significant amounts of water and nutrients. However, the intent is not to develop a weed control programme but to keep weeds from being a random variable. It may be desirable to count weeds or otherwise identify which treatments tend to be most weedy.

Tillage

Where specified, the suggested tillage does not mean to imply that such specified tillage is necessarily recommended as a universal method for all areas, but rather it is a treatment to aid in accomplishing water conservation. There are data which show that shallow tillage (< 10 cm) can create a soil clod mulch to benefit water conservation by reducing evaporation losses from the soil profile and by improving infiltration of rain. In no case should tillage or any other treatment create a condition such as a "dust" mulch that is susceptible to, or will increase, wind or water erosion. Also where tillage or fallow practices are used, consideration should be given to putting such treatments in strips preferably on the contour. Large, continuous areas of unprotected land surface should be avoided.

Water Harvesting

Practices like terracing, level pans, or level benches should be considered for experiments on slopes between 2 to 8% if there is potential for collecting water to increase soil water storage or to decrease soil degradation due to erosion. If such practices are used, it is suggested that special care be taken to establish permanent grass on the dike to prevent dikes from eroding. Depending on the extent of water deficiency in a given rainfall area, consideration can be given to using a contributing area for collecting and providing water to a cropped area. The ratio of

contributing area to cropped area probably should not exceed about 4:1. Treatment of the contributing area, such as compacting to encourage surface runoff, will depend on slope and soil type.

Water harvesting for the purpose of providing supplementary irrigation will not be considered in this programme.

Soil Fertility

Best water use efficiency cannot be obtained without adequate plant nutrition, and best fertilizer efficiency cannot be obtained without some adequacy of soil water. Also, good research plots are difficult to establish and maintain, and are expensive. Therefore, appropriate expertise will be included at locations where possible to simultaneously investigate soil water and soil fertility problems. Particular attention should be given to N, P, and micronutrients (either deficient or toxic). For example, the N cycle is not sufficiently well understood, and more complete information is needed, including denitrification and nitrogen fixation.

Under dry farming conditions, often little or no fertilizer is applied, and there is a lack of information with respect to the potential for plant use of soil nutrients. Therefore, at least three levels of N fertilization should be used as treatments:

A. A zero rate or control

B. A high rate which would be near optimum for maximum yields considering soil water gain anticipated from water conservation practices, and

C. A rate about 50% of B.

Criteria for the high rate will differ for various locations, soils, crops, and water conservation methods. In areas of lower rainfall, it may be possible to estimate "optimum levels" by using information from locations in higher rainfall areas. ^{15}N-enriched fertilizer will be applied so that information on the fertilizer use under the different treatments and its residual effect for the following crop can be studied.

Climate

In semi-arid regions, wher rainfall is appreciably less than potential evapotranspiration and where the crops are subjected to stress because of limited water supply, transition from dry to the rainy season is characterized by variability and uncertainty of rainfall and climatological conditions.

Information about intensity, frequency, and amount of rainfall is badly needed to utilize in an optimal way the limited water supply, to reduce crop failure, and/or to increase production appreciably under dry farming conditions. It is suggested that standardized meteorological measurements be recorded at a simple Met-Station in the vicinity of the experimental fields.

Other climatological data necessary for the calculation of the potential evapotranspiration also need to be regularly recorded.

Suggested Measurements

Detailed specifications were worked out for optional and minimum required measurements to be carried out on water regime, soil, plant, and atmosphere in connection with the proposed guidelines for research. These specifications are available in the Section's office and can be provided upon request.

Action has already been initiated to award research contracts and research agreements to institutes in Member States for implementation of the coordinated research programme based on the above-mentioned guidelines.

Report on the FAO/IAEA CONSULTANTS MEETING ON THE POTENTIAL USE OF ISOTOPES IN THE STUDY OF BIOLOGICAL DINITROGEN FIXATION

Vienna, Austria
16-20 October 1978

On the basis of findings of a previous FAO/IAEA Joint Division coordinated research programme entitled "Use of Isotopes in Fertilizer Efficiency Studies in Grain Legumes" (scheduled to be published in 1979), the FAO/IAEA Joint Division held a consultants meeting in Vienna during 16-20 October 1978 to expand its efforts by coordinating and assisting in research on the application of isotopic tracer techniques to the quantification of biological nitrogen fixation by leguminous plants. The new programme currently involves 19 agricultural institutes in Member States of the FAO and IAEA with financial support from SIDA (Swedish International Development Authority).

The main concern of the first year of research in the coordinated programme is to develop and uitlize quantitative measurements of the amount of N_2 fixed by legumes grown in the field. The use of isotopic nitrogen to quantitatively measure N_2 fixation under field conditions appears to be the most promising technique. Although it is not practical to label N_2 in the atmosphere under field conditions and measure $^{15}N_2$ fixation directly, a viable alternative exists in the addition of a labelled N source to the soil and measuring N_2 fixation by dilution of the labelled nitrogen taken up by the plant from the soil and labelled source by the unlabelled atmospheric N_2 that becomes fixed. This requires a non-fixing plant as a control to determine the isotopic composition of the nitrogen taken up from the labelled source and from the soil without dilution by atmospheric N_2. The major assumptions are that the sources of N in the soil are absorbed by the fixing and non-fixing plants in the same ratio, therefore the same isotopic composition, and that fixation by the legume does not alter the chemistry and availability of the soil nitrogen. When the same rate of addition of the labelled N source is given to both the control and legume, the fraction of N_2 fixed by the legume (N_f) is determined by the formula:

$$N_f = 1 - \frac{\%\ ^{15}N \text{ atomic excess (of fixing plant)}}{\%\ ^{15}N \text{ atomic excess (of non-fixing plant)}}$$

On the other hand, when the rate of application of labelled N source differs between the control and the legume, the "A" value transformation must be used to determine the amount of N fixed.

Objectives

Immediate and long-term objectives of the coordinated research programme were delineated in the consultants meeting. The major objective of immediate concern is the improvement of methodology for measuring N_2 fixation by legumes, using isotopic nitrogen techniques. This will be accomplished by the examination of a number of factors, including:

1. Design of experiments to improve precision.
2. Suitability of various non-fixing plants for the determination of the ratio of soil-derived nitrogen to ^{15}N derived from the N in the added labelled source.
3. Amounts of available nitrogen in the soil that may influence the growth of both the legume and non-fixing plant, and the consequent effect on nitrogen fixation.
4. Influence of agronomic practices that are important to cooperating members on the precision of N_2 fixation measurements and the amounts of N fixed.

Another objective is to measure the amounts of nitrogen fixed by the leguminous plants grown in different ecological situations. The associated errors will be determined.

After the methodology has been successfully established, further objectives will be outlined that will deal primarily with agronomic management practices with the aim of increasing biological nitrogen fixation and crop yields.

Regional Crops of Interest in Participating Countries

High yielding locally adapted varieties of nodulating crops will be used in the participating Member States. Soybean (*Glycine max.*), cowpea (*Vigna sinensia*), broadbean (*Vicia faba*), chickpea (*Cicer arietinum*), pigeon pea (*Cajanus cajan*), groundnut (*Arachis hypogaea*), lentil (*Lens esculenta*), common bean (*Phaseolus vulgaris*), and alfalfa (*Medicago sativa*) will be tested in symbiosis with local competitive and effective strains of *Rhizobia* and/or a supplied *Rhizobium* inoculant.

Sudan grass will be used as a non-nodulating control crop by all of the participants in the coordinated research programme. Another non-nodulating species will be employed as a second control. This second control species is selected by the programme participant on the basis of its physiological similarity to the legume crop of interest. The second non-nodulating species is selected on the basis of the following similarities to the legume crop:

1. Growth period (It is essential that the control crop has a growth period ideally equal to, but must not be shorter than the legume crop of interest).
2. Root distribution pattern.

3. Total N uptake.

4. Climatic adaptation.

5. Pattern of N uptake.

6. Plant height.

These characteristics are used as criteria in the selection of a non-nodulating control crop although the selected crop will usually not have all of the characteristics listed.

Experimental Plans

Detailed experimental treatments, plot layouts, and general procedures were defined during the consultants meeting as guidelines for the first year's experiment to be executed by participants in Member States directly associated with the coordinated research programme. These detailed experimental guidelines can be obtained from the Soil Fertility, Irrigation and Crop Production Section upon request.

Report on the

FAO/IAEA INTERNATIONAL SYMPOSIUM ON THE USE OF ISOTOPES AND RADIATION IN RESEARCH ON SOIL-PLANT RELATIONSHIPS

Colombo, Sri Lanka

11-15 December 1978

The FAO/IAEA International Symposium on the Use of Isotopes and Radiation in Research on Soil-Plant Relationships was held in Colombo, Sri Lanka during 11-15 December 1978. Sixty-six participants from 19 Member States and representatives of the International Rice Research Institute and the United Nations Development Programme attended the symposium. Dr. Y. Barrada and Dr. C. Ofori (FAO) served as Scientific Secretaries to the symposium. Forty-two papers were presented under seven technical sessions which covered Fertilizer Use and Efficiency, Water Relationships and Ion Movement, Organic Residues in Soil Management, Micronutrients, Nutrient Availability, and Techniques and Analytical Methods. A summary report of the technical sessions of the symposium, which is based on a report prepared by Prof. R.A. Olson, University of Nebraska, U.S.A. for the Atomic Energy Review, is included here.

The technical sessions began with papers on the topic of fertilizer use and efficiency. These included reviews of isotope studies on soil and fertilizer nitrogen (N), of N losses, and of N fertilization results in Romania. Specific studies were presented on the utilization of N by maize in the Ivory Coast and by sorghum in North Cameroon. Negative effects of foliarly applied nutrients at the grain-filling stage of common bean and soybean in Greece were elaborated, and a paper on N_2 fixation by associative symbiosis in temperate regions was presented. The associative N_2 fixation studies in Belgium revealed a distinct genotype by bacterial strain interac-

tion as well as major influence of soil texture and moisture on bacterial performance, further a stimulative effect of starter N fertilization on the symbiosis.

Of particular interest was the commonality of results from Nebraska (USA) and Romania showing enhanced utilization efficiency of N applied as a delayed sidedressing for summer grain crops over planting time application. Isotopic tracer methods indicated this to be at least in part due to more direct translocation of the N to grain with less vegetative entrapment. Results with spring topdressing of winter sheat in the GDR were comparable in noting that the proportion of absorbed fertilizer N recovered in the grain is greater the later the N is incorporated into the plant. The very important function served by ^{15}N-enriched as well as ^{15}N-depleted fertilizer materials in N economy studies was elaborated. Recognized isotopic effects were expressed to be of insufficient magnitude to invalidate crop uptake measurements in a given year but are so variable due to the many transformations to which N in soil is subject as to make this natural variation ($\Delta^{15}N$) unreliable for predicting source of nitrate contaminants in ground- or surface-waters. The tag has been indispensable to the study of residual fertilizer nitrate impact on yields of subsequent crops and in the determination of symbiotic and non-symbiotic N fixation in soils.

A further major point of interest brought out in the fertilizer use session was the extreme fixation of fertilizer phosphorus (P) and low fertilizer utilization efficiency achieved in tea production on Andosols of Sri Lanka, emphasizing the need for repetitive basic nutritional studies on the different soils of the world under their respective environmental conditions.

Sophisticated studies of soil water and solute movement in California (USA) demonstrated the essentiality of estimating the spatial variability of soil water properties for any given field. It was emphasized that water and solute observations should be taken along transects across a field of study for estimating necessary sampling intervals, for obtaining average values, and for extrapolation purposes. Prediction of unsaturated hydraulic conductivity can be accomplished by an elaborated new method employing the suction curve and the measured cumulative infiltration of a soil. The method developed in Senegal is characterized by accuracy, simplicity and rapidity and has been derived through major assistance of a coordinated research project of the IAEA.

In the sessions concerned with water relationships and ion movement and with organic residues in soil management, studies in Senegal with varied tillage systems and residue treatments evidenced substantially greater yields with plowing than minimum tillage, which was attributed to the creation of a dust mulch at the surface and consequent moisture conservation due to reduced evaporation. Millet was noted to be more capable than ground nut of utilizing water stored at depth in the soil, thus the 90-day millet is generally accepted as a very effective crop for dry regions. The moisture efficiency findings are somewhat in contrast with those reported in temperate regions, the disparity being attributed to the very sandy character of the Senegal experimental site. Tensiometers and the neutrom moisture meter were recognized as essential instruments for following moisture flux of the soil profile and the ultimate crop utilization of stored soil moisture, granting the disturbed soil homogeneity and essentially irrigation source that the tensiometer presents. Discussion brought out the need in moisture shortage situations for selecting crop varieties capable of high root activity in soil horizons where moisture exists, however deep. Evidence was presented of substantial root activity for absorbing N from depths of at least two meters by summer grain crops like maize so long as moisture exists there and if N

is largely depleted from soil horizons above. Tagged N measurements have confirmed this fact, a matter of major significance in programming measures for controlling ground water pollution with nitrate.

The associated problem of salinity control in irrigated dry regions was also discussed. A unique system was reported for evaluating the dynamics of soil salinization and desalinization involving ^{22}Na in plexiglass columns as developed in Iraq. The findings demonstrate a companion role of mass-flow and diffusion in the process of salinization, whereas mass-flow accounts for virtually all of the salt movement in desalinization.

A series of papers reported isotope studies on the synthesis and degradation of organic matter in soils. Fundamental to these measurements are the identification of the organic compounds produced in the various transformations and the interaction of these with the essential elements of plant nutrition and with the physical character of soil as detailed by studies in France. Animal manure was identified as one of the most beneficial organic amendments for soil improvement in Senegal with its capacity for supplying nutrients, ameliorating soil structure and alleviating fixation by P fixing soils. An investigation of the impact of added phenolic substances, which are very high in tea residues, did not significantly reduce the tea soil's P fixation capacity in Sri Lanka, and rather those organic residues of low degradability were most effective for reducing fixation and increasing the utilization of applied fertilizer P. In the equatorial rain forest of Guadeloupe the annual fall of leaves reaches 4-6 tons with genesis of fulvic and humic acids at a rapid rate during the fallow phase of shifting cultivation such that the soil organic fraction cannot be distinguished from that of the primeval forest in 30 years. Degradation and disappearance is much more rapid during the short cultivation phase.

In the session on micronutrients in plant nutrition and the availability of different forms of P to crops, the importance of soil "buffer power" was recognized in a review paper from Australia as evaluation is made of a soil's micronutrient status. Measurement of E and L values for zinc (Zn) proved in good agreement with soils having pH of less than 7, but there was no agreement with alkaline soils of high Zn fixing capacity. The L value on the latter soils was effective only when determined with a carrier-free Zn tag. A useful technique elaborated was that of uniformly labelling the soil for comparing different chemical sources of Zn as fertilizer, thereby eliminating the difficult problem of uniformly labelling the different sources. Described further was the use of optical density of autoradiographs for identifying micronutrient absorption sites on plant roots and the translocation and zones of utilization in the plant whether applied to the soil or foliarly.

A study was reported on the impact of radionuclides that are waste products of nuclear reactors, but also essential plant nutrients, on the soil-plant system. Differences were noted in plant uptake of these nuclides with different soils of India and different crop management practices. With submerged rice culture compared with non-flooded production there was a reduction in uptake of ^{59}Fe (iron) but an increased uptake of ^{58}Co (cobalt), ^{54}Mn (manganese), and ^{65}Zn on the two soil types investigated. The addition of organic residue generally reduced plant uptake of the nuclides. All four of the elements proved completely immobile and non-leachable by rain or irrigation.

Selenium (Se) has been recognized as very deficient for animals in the forage crops of Denmark and means are needed for correcting the problem in the grasses and cereals of the country. The element was noted to be readily

absorbed by the roots of maize and translocated to the tops when supplied as $^{*}SeO_3^{=}$ with incorporation primarily into the amino acid fraction, but absorbed and translocated largely as $^{*}SeO_4^{=}$ when applied in that chemical form. Both applied N and sulfur (S) decreased the translocation of Se to the plant tops while increasing the conversion to amino acid form of that translocated.

Substantial differences were expressed in the various papers on nutrient availability depending on region where the work was done as related to variations in the attendant soil conditions. Reported results from temperate regions generally indicated the low solubility forms of P fertilizers to be less available to plants than the water soluble types by whatever isotopic dilution measurement employed, soil pH being a prime determinant of carrier effectiveness. On the other hand, with some of the very acid tropical soils of high P fixing capacity as in Sri Lanka, Madagascar and Ivory Coast rock phosphates prove superior to superphosphate. Here was further expression of the limited transferability of soil-plant research results from one soil region to another.

Measurements of available soil P by isotopic dilution technique revealed the substantial difference that exists among crop species for extracting soil P. Among the four species studied in Denmark, buckwheat and lupin were most efficient in taking up soil P showing no yield response to applied fertilizer on the soil employed. Barley and peas expressed the lowest L values and responded positively to fertilizer application. The differences registered were explained in terms of differential root extension and of changed chemical conditions in the rhizosphere soil (immediately adjacent to the roots). Barley, for example, maintained the pH and exchangeable Ca (calcium) of the rhizosphere soil at a notably higher level than the other crops.

During the sessions concerned with analytical methods and with the nutritional problems of flooded rice production, an interesting technique was described from a cooperative Australian-USA study for observing the growth of young plant roots in soil by neutrom radiography using Indium collector foils and a neutrom beam of 10^7n $cm^{-2}s^{-1}$. No effects on germination were noted with varied seed orientation and surface crusts, and rate of shoot growth was constant irrespective of seed placement depth to the maximum employed of 80 mm. Especially noteworthy is the pictured orientation of soybean cotyledons, irrespective of seed orientation, that affords a minimum plant area expressed at the soil surface allowing a maximum force per unit area for emergence. Ancillary observations in the research reported were the doubling of soybean seed size before germination while maize swelled to 1.25 times normal size, the lack of any difference in germination of irradiated and non-irradiated seed, and demonstration that maize seedlings could penetrate a crust of 5.4 bars strength but not of 6.9 bars.

The development of an automated ^{15}N analyzer in the GDR and techniques for its effective use give promise of eliminating much of the tedium involved in ^{15}N tracer investigations. The system is rapid, permits a high degree of accuracy in isotope determination at relatively high levels of atom % excess ^{15}N, and allows the simultaneous measurement of inorganic N by isotope dilution technique.

Several papers reported investigations on root activity of trees using isotopic tracer methods. In one study in the GDR, ^{131}I (iodine) was injected into the rooting zone for defining the physiological capacity of roots under fruit trees. After four days leaves from the tree and roots

from the soil were collected and evaluated. General findings were: the more root tips/500 cm^3 of soil, the greater the isotope activity in the leaves; the more branches in the tree, the greater the activity of the root tip; and the more root tips per unit volume, the less the physiological activity of the individual root tip. Root activity of rubber trees was studied in Sri Lanka by injection of a ^{32}P-tagged fertilizer into the soil at varied depths and distances from the tree. Root activity as registered in the latex was greater with a shallow 15-cm depth of fertilizer placement and with a distance of 0.75 m from the tree. Rather similar results were found for coconut by an investigation in India where with different depths and distances of fertilizer placement the greatest uptake occurred with a 10-cm depth of placement and 0.5 m distance from the tree. The soil at this site for this crop also evidenced superiority of rock phosphate over superphosphate as fertilizer P source.

The range of isotopic methods currently employed in soil fertility investigations on flooded rice soils in India was elaborated. It was noted that N losses associated with flooded culture can be minimized by either placement of N fertilizer in the reduced zone or by the addition of rice straw to foster rapid immobilization of the applied N. Best results from fertilizer N accrued from fertilizer carriers containing ammonium or urea and with about 3/4 of the N applied during the vegetative growth stage and 1/4 top-dressed at panicle initiation. Low solubility phosphate carriers could be made equivalent in effectiveness to water soluble carriers if applied to the moist aerobic soil a few weeks prior to flooding and transplanting of the rice. A laboratory study on addition of $(^{15}NH_4)_2SO_4$ to flooded soil in the USA revealed a reduction in $^{15}NH_4^+$ and an increase in NO_3^- and NO_2^- with increasing pH, and greatest losses of NH_4^+ at the higher pH values due to volatilization under oxidized conditions and volatilization plus denitrification under reduced conditions. A study on rice root growth employing ^{32}P as tracer in Ivory Coast revealed that mass of roots and the absorption of nutrient from a given zone were not well related. Moisture, temperature and other factors can result in a very small part of the root system accomplishing the major portion of nutrient uptake during a given period of growth.

Nitrogen fixation by heterotrophic organisms in rice soil of India was enhanced by soil submergence and by addition of cellulose materials, but was completely suppressed by increasing amounts of added fertilizer N. The addition of certain pesticides at conventional field rates caused a stimulation of N fixation. Noted variations of $^{15}N_2$ incorporation by Azospirillum lipoferum from roots of different rice cultivars suggested the possibility of greatly improving this associative fixation by selection/breeding efforts for lines of rice harboring the organism with high nitrogenase activity. Magnitude of fixation was estimated in the range of 5-10 kg N/ha with possible potential for increasing this 3-4 fold by appropriate amendments, genotype selection and cultural practices.

One of the symposium statements was a testimonial on the benefits derived by Romania from isotope studies that have been made on the major crops of that country. Cited was the extra yield of maize, wheat and soybean resulting from modified fertilization practices prompted by experimental results from tracer experiments. Impact on the economy of the country has been substantial.

SOILS RESEARCH AT AGRICULTURAL SECTION, SEIBERSDORF LABORATORY

Symbiotic nitrogen fixation by legume crops under field conditions

Field experiments were carried out by the staff of the Seibersdorf Laboratory with a view to determine the precision with which the determination of the amount of nitrogen fixed by a legume crop can be made in the field using ^{15}N.

Vicia faba was grown on an area where ^{15}N had been incorporated the previous year and compared with several non-fixing standards such as barley, non-nodulating soybeans and soybeans inoculated with an ineffective Rhizobium strain. It was found that the % ^{15}N atom excess was not statistically different among the standard crops. About 50% of the nitrogen in the Vicia faba crop was derived from symbiotic fixation. A similar experiment carried out in the same area in which the ^{15}N was applied at seeding time in the form of a solution of $(NH_4)_2SO_4$ gave the same results indicating no advantage to incorporating the ^{15}N in the previous year.

It was found that the precision with which symbiotic N fixation by Vicia faba in the field was determined, depended greatly on the experimental design. In principle, the plots with the non-fixing standard crops have to be replicated more than the legume plots. Preferably, standards should be grown in every legume plot to enable the calculation of fixed amount of symtiotic nitrogen in every plot. In this way it was possible to determine the standard deviation directly in %N symbiotically fixed.

Great care should be taken to ensure regular distribution of small rates of application of ^{15}N-labelled nitrogen (10-20 kg N/ha) to the plot. This was accomplished by application of the nitrogen in solution using watering cans with small nozzles.

Fertilizer N efficiency and residual fertilizer N

During the years 1975-78, we cooperated in a series of field experiments in Austria to use labelled fertilizer to determine amount of residual fertilizer N in the soil at harvest time as affected by cultural practices such as irrigation and fertilizer placement.

Extensive soil N analyses were made at seeding time and harvest time of a series of sugarbeet experiments to evaluate the relationship between soil N components and the actual availability of soil N as "seen" by the sugarbeets (A_N values) and determine the amount of residual fertilizer N in the soil after harvest.

A series of 45 field experiments with sugarbeets in farmers' fields in Lower Austria showed that actually very little of the ^{15}N-labelled fertilizer nitrogen was exported with the sugarbeets, i.e. 2-5%. The remainder of the fertilizer N was found in the leaves (which are returned to the field), in the roots and as residual soil N. Unfortunately, the dilution of residual fertilizer N with soil N is so great that it was not possible to detect ^{15}N in a large number of soil samples. In the soil samples in which residual fertilizer N could be detected, the amounts were correlated with the total inorganic soil N content at harvest time, i.e. the higher the soil nitrogen, the more residual fertilizer N is found back.

Soil nitrogen extracted with water, KCl or with acid hydrolysis was not related to the availability of soil N as determined by the sugar beets (A_N values).

The amounts of fertilizer N taken up by the sugarbeet could be drastically increased by a combination of irrigation and band application of the fertilizer.

In another series of experiments using maize as a test crop, it was found that late application of fertilizer N, shortly before tasseling time, combined with irrigation, greatly increased the fertilizer utilization of the maize crop as compared with application of nitrogen at seeding time in the absence of irrigation.

TRAINING COURSES

Report on the Interregional Training Course on the Application of Nuclear Techniques in Agriculture

Moscow, USSR

1 September - 30 November 1978

The Interregional Training Course on the Application of Nuclear Techniques in Agriculture was held during 1 September to 30 November 1978 at the Timiryazev Agricultural Academy, Moscow, USSR.

The object of the course was to provide intensive training on the use of radioactive and stable isotopes and radiation techniques in the different fields of agricultural research to scientists from developing countries.

Fifteen participants were selected from Afghanistan, Bulgaria, Czechoslovakia, India, Poland, Romania, and Yugoslavia.

Dr. V. Ladonin, staff member of the Joint FAO/IAEA Division; Prof. V. Rachinskij, Director of the Course; and staff members of the Host Academy delivered lectures according to the programme of the course. The programme of the course included lectures (144 hours), laboratory experiments (300 hours), time for discussion, scientific visits and excursions.

The lectures and laboratory exercises placed particular emphasis on the theoretical and experimental aspects of the use of nuclear techniques in research into soil science, plant nutrition, plant physiology, fertilizer management practices and irrigation. The syllabus also covered radiation safety techniques, use of radiochemical and nuclear physics methods in chemical analysis, use of isotopic tracers in biological research and agricultural radiobiology.

During the course participants had an opportunity to discuss their future work and possible cooperation with IAEA in the different fields of agricultural research. The participants visited different departments of the Timiryazev Agricultural Academy and several agricultural research institutes in Moscow and Uzbekistan.

Announcement of the FAO/IAEA Interregional Training Course on the Use of Isotope and Radiation Techniques in Studies on Soil/Plant Relationships

Place:	IAEA Laboratory, Seibersdorf, Austria
Time:	23 April - 8 June 1979
Organizers:	International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations. Financed by the Swedish International Development Authority (SIDA).
Language:	English
Purpose:	The objective of the course is to provide intensive training on the use of both stable and radioactive isotopes and radiation equipment to scientists in developing countries who are actively engaged in research in soil science including plant nutrition, fixation of atmospheric nitrogen and fertilizer and water management practices. The course, which will deal with the basic principles and practical aspects of the subject, will help developing countries to build up adequately trained personnel who would be able to effectively uitlize isotope and radiation techniques in sound applied research aiming at increasing crop production.
Nature of the Course:	The course will deal with the principles involved in the use of both stable and radioactive isotopes and radiation equipment in research in soil chemistry, soil physics, plant nutrition, and fertilizer and water management practices. Through lectures, laboratory, greenhouse and field experiments, films and discussion groups, the course will provide information and practical experience to participants on how nuclear methods can be effectively used for increasing crop production economically through a better understanding of the soil-water-plant system. The first three weeks of the course will be devoted to training in the basic principles of isotope and radiation methodology. Greater emphasis will be placed on those topics of direct relevance to the practical application of isotope and radiation techniques. Laboratory exercises will be designed to familiarize the participants with the principles involved, use of equipment, and laboratory discipline pertaining to the safe handling of radioactive materials and minimizing contamination risks. During the latter four weeks, emphasis will be placed on the application of nuclear methods to research on soil science and plant nutrition problems of practical

importance to developing countries. The practical exercises will be designed to allow the students to carry through to completion short-term research-type projects. This would include planning, execution, sample preparation, analysis, interpretation and presentation of results.

Announcement of the FAO/IAEA Interregional Training Course on the Use of N-15 in Soil Science and Plant Nutrition

Place:	Zentralinstitut für Isotopen- und Strahlenforschung, Leipzig, German Democratic Republic
Time:	21 May - 22 June 1979
Organizers:	The International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations, in cooperation with the Government of the German Democratic Republic.
Language:	English
Purpose:	The object of the course is to train scientists from developing countries in all aspects of the use of nitrogen-15-enriched and depleted compounds in soil and plant nutrition studies. Particular emphasis will be placed on laboratory exercises and studies directed towards improving the techniques of N-15 determination and the efficiency of the use of nitrogenous fertilizers.
Nature of the Course:	The programme of the course will include lectures, discussion periods, laboratory exercises with soils and plants and scientific visits. The subject matter of the lectures will include the properties of isotopes of nitrogen, availability of stable isotopes N-15 and N-14, and principles of their separation, determination of N-15/N-14 ratios by mass- and emission-spectrometry, N-15-density labelling experiments, isotope effects, tracer kinetics, N-balance studies in the soil-plant system, use of N-15 in research into atmospheric nitrogen fixation, nitrogen transformation, improvement of nitrogen fertilizer management practices, and efficient use of herbicides. The laboratory work will include determination of total N and N-containing fractions in soils and plants, sample preparation for isotope ratio analysis, sources of error, isotope dilution chemistry, isotope ratio determination by mass- and emission-spectrometry, N-15 density labelling and positional N-15 isotope analysis by H nuclear

magnitude resonance, plant uptake of labelled fertilizer nitrogen, and losses of nitrogen by leaching and volatalization. Design of field experiments, plant, soil and soil-water sampling from field experiments and factors influencing the N-15 enrichment required for field experiments will be included.

COMING EVENTS

FAO/IAEA Advisory Group Meeting on Nuclear Techniques in Development of Fertilizer and Water Management Practices for Different Cropping Systems

Ankara, Turkey
September/October 1979
(provisional)

FAO/IAEA Research Coordination Meeting on Isotope-Aided Micronutrient Studies in Rice Production with Special Reference to Zinc Deficiency

Vienna, Austria
10-14 September 1979

FAO/IAEA Regional Seminar on the Use of Isotope and Radiation Techniques in Soil and Water Conservation Studies for Developing Countries in the African Region

Khartoum, Sudan
29 October - 3 November 1979
(provisional)

FORTHCOMING PUBLICATIONS

"Use of Isotopes and Radiation in Research on Soil-Plant Relationships" (Proceedings of the FAO/IAEA International Symposium on the Use of Isotopes and Radiation in Research on Soil-Plant Relationships held in Colombo, Sri Lanka from 11-15 December 1978).

"Use of Isotopes in Fertilizer Efficiency Studies on Grain Legumes" (Results of a Five-Year Coordinated Research Programme of Experiments Using Isotopically Labelled Fertilizers Carried out in Eleven Countries and Sponsored by the Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture).

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