

Nitrogen Research— IFDC-IRRI Update

IFDC's collaborative research project with the International Rice Research Institute (IRRI) to improve the efficiency of nitrogen fertilizers applied to rice has completed an initial phase. The first phase of research focused on irrigated rice and on determining the magnitude of fertilizer nitrogen losses. Three separate major experiments with the isotope ^{15}N were conducted in the field at IRRI. Data from these experiments are still being processed, but the research has been extended through a network of ^{15}N experiments. These experiments are being conducted in India, Thailand, and Korea during 1980.

Other work on losses done at IRRI has shown that fertilizers which produce high concentrations of dissolved ammonium in floodwater are inefficiently utilized by the plant. The ammonium is commonly supplied in the form of either urea or ammonium sulfate fertilizer. Results have shown that there is a high potential for loss by ammonia volatilization. That portion of the total losses due to volatilization was as high as 10% from broadcast ammonium sulfate in tests using micro-meteorological techniques conducted in cooperation with Dr. John Freney from the Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia. Total losses from all modes may be as high as 70% in the case of broadcast urea and as much as 50% when broadcast as ammonium sulfate.

The farmer's traditional method of broadcasting the first application of fertilizer on paddy floodwater 2-3 weeks after transplanting was compared in field studies with the "best split" method developed at IRRI. In the best split system, two-thirds of the fertilizer is broadcast and harrowed into the soil before transplanting and one-third is broadcast at the panicle initiation stage of crop growth. Methods with one-time deep placement of supergranules and broadcast and incorporation of the slow-release fertilizer sulfur-coated urea were also compared.



Dr. I.R.P. Fillery, IFDC Soil Scientist, continues research project at IRRI.

The effectiveness of the different times and modes of applying the nitrogen varied widely between wet and dry season crops. Deep placement and slow-release urea fertilizers produce relatively low concentrations of dissolved nitrogen in the floodwater. Low concentrations in the wet season corresponded with the high crop recovery of broadcast nitrogen. In both seasons, root-zone placement of urea supergranules was the most effective method of nitrogen application.

Measurements of small nitrous oxide fluxes have shown that nitrification-denitrification occurs in tropical soils. Since nitrous oxide is only a minor product of this process, the relatively low rates of evolution do not represent the total loss due to denitrification, thus the practical significance of this loss mechanism has yet to be determined.

Other field experiments at IRRI have shown that, unlike traditional broadcast

fertilizers, deep-placed urea supergranules do not disturb the nitrogen-fixing blue-green algae in rice paddies and therefore provide a bonus of nitrogen to the soil. This has led to the concept of integrated nitrogen management for rice-growing soils, which combines maximum biological nitrogen fixation with efficient nitrogen fertilizer use.

Other agronomic research has shown that polymer-coated urea, produced by the Korean Institute of Science and Technology (KIST) under a contract from IFDC, is a slow-release fertilizer that is as effective as sulfur-coated urea. Preliminary trials conducted at IRRI with briquetting and fertilizer placement equipment from Fukien Province in the People's Republic of China have also shown promising results.

Fertilizer Equity Study

(from page 1)

IFDC and IRRI have developed a training program for cooperators in the International Network on Soil Fertility and Fertilizer Evaluation for Rice (INSFFER). The first program, held in February-May 1979, at IRRI Headquarters, covered theoretical and practical aspects of research on fertilizer efficiency for rice. There were 22 participants from 9 countries who took part in this program that included practical work to conduct an INSFFER experiment in the field.

Dr. E. T. Craswell, IFDC Soil Scientist, has returned from a 2-year assignment at IRRI. Dr. I.R.P. Fillery, IFDC Soil Scientist, began work at IRRI in January to continue the research project and begin a series of new experiments. The initial focus of the experiments to be conducted by Dr. Fillery is on measuring ammonia volatilization from broadcast urea under field conditions. He will also use ^{15}N balance techniques to measure losses, as well as measure nitrous oxide fluxes from soils subjected to intermittent flooding as part of a major reorientation of the program to the fertilization of rainfed rice.

IFDC-DITH— Eppawala Phosphate from Sri Lanka

Under contract with the Dienst Internationale Technische Hulp (DITH) of the Netherlands, IFDC recently completed a laboratory and greenhouse study of potential routes for utilization of the Eppawala phosphate. Technical results are to be made available by DITH to the State Mining and Mineral Development Corporation of Sri Lanka. This organization has responsibility for project implementation for the deposit. A number of products was made in small quantities, such as MAP, DAP, SSP, TSP, Rhenania-type phosphate, and fused calcium-magnesium phosphate for agronomic evaluation. Direct application potential of the phosphate was also investigated. Further studies of technical-economic factors will be needed to complement work by IFDC and others. Inquiries regarding project details should be directed to DITH.

Like all developing countries, Bangladesh strives to narrow the gap between food supply and demand. In the last decade annual increase in food grain production has been approximately 1.5%, while population has increased annually at the rate of approximately 3%. The resultant food grain shortfall has been averted through food imports, but the Bangladesh Government hopes to reach self-sufficiency in food production by 1985 and to ensure equality for farmers and laborers. Although rates of fertilizer use are still very low, improvements in total cereal production in accordance with 1985 government plans may be possible. Therefore, the Bangladesh Agricultural Development Corporation (BADC) requested that IFDC, in cooperation with the Bangladesh Agricultural Research Council (BARC), undertake a Fertilizer Equity Study under the IFDC-BADC-USAID financial technical assistance contract.

The aim of the study was to determine (1) the degree to which fertilizer and other agricultural inputs reached and benefited small farmers and sharecroppers and (2) the effect of fertilizer and agricultural inputs on employment in Bangladesh, particularly concerning the landless work force. Data for 1,053 farms from 10 representative thanas (political administrative division)—which included owner-cultivators of various farm sizes, tenant cultivators, and hired agricultural labor—were collected for the 1979 Aman (growing season) rice crop and fertilizer equity was studied with regard to the following variables: (1) intensity of use of fertilizer among those farmers of the sample using fertilizer; (2) fertilizer prices; (3) use of credit, water, High-Yielding Variety (HYV) seed, and other inputs complementary to fertilizer use; (4) changes in output and employment

due to fertilizer use; and (5) changes in income and returns to labor from crop production arising from fertilizer use.

Findings indicate that all farmers in the sample have access to fertilizer, with 65% actually using it in crop production. Urea, with 64% use, is the most commonly applied fertilizer, and the average N:P₂O₅:K₂O ratio of use is 7.2:4.3:1. Small farmers reaped the largest incremental benefits from fertilizer since they used it with greater intensity. Those who used fertilizer were more disposed towards other inputs such as HYV, irrigation, pesticides, and hired labor, than nonusers. The addition of these complementary inputs greatly increased crop yields; e.g., HYV in conjunction with irrigation more than doubled the rate of return to the cost of fertilizer under average sample conditions.

The data collected in this study show that net benefits of fertilizer use to Bangladesh after meeting fertilizer costs would be \$24M. Similarly, fertilizer use would increase employment wages by another \$24M. Fertilizer use and a general increase in agricultural efficiency become even more important when their benefits are coupled to the fact that there is almost no additional land available for cultivation in Bangladesh.

The professional staff involved in this study were Dr. S. S. Sidhu (Project Leader), Dr. C. A. Baanante from IFDC, and Dr. Ekramul Ahsan from BARC. In addition, Mr. P. R. Parker from IFDC contributed to the report. Members of the Coordination Committee for the Fertilizer Equity Study were Mr. A. Zaman Khan (BADC), Mr. Richmond Allen (USAID/Dacca), Dr. S. S. Sidhu (IFDC), Mr. J. M. Hill (IFDC/Dacca), Mr. M. A. Hashem (BADC), and Dr. Ekramul Ahsan (BARC).

IFDC Staff Update

Arrivals

Mr. Bhaurao M. Bhujbal—Soil Scientist—from the Bhabha Atomic Research Centre, Bombay, India—with the Fertilizer Technology Division as an International Atomic Energy Agency Fellow to do research on phosphate rocks used directly as fertilizer on acid soils for 6 months.

Dr. Roland J. Buresh—Soil Scientist—from Louisiana State University—now with the Agro-Economic Division to do research for the Upland Nitrogen Research Program.

Dr. John T. Moraghan—Soil Scientist—from the Department of Soils, North Dakota State University—now with the Agro-Economic Division—stationed at ICRISAT Headquarters where he will be involved in the Upland Nitrogen Research Program.

Miss Henriette van Gijn—Student—from the State Agricultural University, Department of Soils and Fertilizers, Wageningen, The Netherlands—with the Agro-Economic Division to do research on nitrogen fertilizers and plant nutrition studies for 9 months.

Mr. Uday Mohan—Communications Trainee—with the Office of the Managing Director for 1 year.

Collaborative Research Project

As a result of a contractual agreement between IFDC and the United Nations Development Program (UNDP), IFDC will expand its present Nitrogen Research Program to include research on upland crops. A program dealing with the fate and efficiency of nitrogenous fertilizers in arid and semi-arid agriculture is being initiated based on interactions among IFDC, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), and the International Centre for Agricultural Research in the Dry Areas (ICARDA). First emphasis will be given to the semi-arid tropics through collaboration with ICRISAT, with similar research planned for ICARDA.

Dr. J. T. Moraghan, IFDC Soil Scientist, is on a 2-year assignment to ICRISAT as part of the collaborative research project between IFDC and ICRISAT. The project is a study on the role, fate, and efficiency of nitrogenous fertilizers in relation to fertilizer source and management in the semi-arid tropics.

The research of the ICRISAT's Farming Systems Research Program (FSRP) will aim at improving fertilizer efficiency by the introduction of improved fertilizer use and management practices; improved crop, soil, and water management practices; inexpensive fertilizer modifications that reduce nitrogen losses caused by volatilization, denitrification, and leaching; and improved nitrogen utiliza-

tion by the crop. Preference will be given to the fertilizer and management practices that do not depress biological nitrogen fixation by intercropped legumes. ^{15}N -labeled materials will be used in a complex series of experiments to help assess the fate of nitrogen. Numerous fertilizer experiments conducted on soils at the ICRISAT site have demonstrated that dramatic nitrogen-response can be obtained, particularly with simultaneously improved water management and crop varieties.

Collaboration with ICARDA is expected to phase-in over a period of time. The project between IFDC and ICARDA will coincide with the development of a soil-chemistry/fertility program at ICARDA. It is expected that the initial ^{15}N -fertilizer experiments will concentrate on assessing the fate of fertilizer N in selected cropping systems of dryland farming in five Mediterranean environments with rainfall ranging from 200 to 500 mm/year.

Proposed workplans are broadly structured into three phases: (1) problem identification, (2) search for solutions, and (3) the generation of a region-wide awareness of the role and limitations of nitrogen fertilizer in semi-arid and arid agriculture. The activities within these work areas will phase-in as the need arises.

Kenya—

Training Course on Fertilizer Efficiency Research in the Tropics (FERITT)

IFDC, the International Institute of Tropical Agriculture (IITA), and the University of Nairobi will conduct a training course on fertilizer efficiency research in the tropics. The course will be held at the University of Nairobi, College of Agriculture, Kabete Campus, Nairobi, Kenya, from November 24 through December 11.

The course is designed for agriculture research workers engaged in fertilizer efficiency research. Objectives are to (1) develop and improve skills of research workers in conducting fertilizer trials at experiment stations and in farmers' fields, (2) impart the necessary techniques to process, analyze, and interpret data generated from trials, and (3) improve participants' ability to test new and conventional fertilizer materials using the latest procedures in field research situations.

The course content will deal with both theoretical and practical aspects of fertil-

izer efficiency research. Emphasis will be placed on (1) specific procedures for conducting fertilizer trials with new or improved fertilizer materials and application techniques and (2) agronomic, economic, and statistical analysis of results. One half of the time will be devoted to classroom instruction and the other half to practical field situations.

A team of scientists from IFDC, IITA, and the University of Nairobi will form the core faculty. Experts from FAO, USAID, and crop institutes will supplement the core faculty.

Additional information can be obtained from Dr. B. T. Kang, IITA—PMB 5320, Ibadan, Nigeria; Dr. V.P.X. D'Costa, Department of Soil Science, University of Nairobi, P.O. Box 30197, Nairobi, Kenya; or Mr. Carl R. Amstrup, Training Coordinator, IFDC, P.O. Box 2040, Muscle Shoals, Alabama 35660, USA.

Indonesia—

Fertilizer Efficiency Program

A program aimed at increasing agricultural production in Indonesia through more efficient use of fertilizers has been initiated. The program includes research and development activities that are essential to identifying ways to more efficiently utilize fertilizer-related resources in the agricultural and rural development of Indonesia. The research and development activities consist of various research and action-related programs in product and marketing development; basic, applied, and adaptive research on fertilizer efficiency in lowland and upland cropping systems; and the development of a wide range of socioeconomic information essential for the development of policies and programs that will facilitate efficient utilization of fertilizers as a developmental resource at both the farm and national levels. This program is expected to provide the Government of Indonesia with an information base which can lead to more effectively utilizing fertilizer-related resources in Indonesia's efforts to accelerate food and agricultural production, strengthen the overall Indonesian economy, and increase the nutrition and income levels of Indonesian farmers.

Scientists from Indonesia, the International Rice Research Institute (IRRI), and IFDC met at IFDC Headquarters in September 1979 to establish a strategy and planning document for the fertilizer efficiency program. In April 1980, after the program's approval by the Government of Indonesia, the Agency for Agricultural Research and Development, Ministry of Agriculture, in cooperation with the Directorate General of Food Crops, Ministry of Agriculture, the Directorate General of Basic Chemical Industry, Ministry of Industry, and P.T. Pupuk Sriwidjaja hosted a National Workshop on the Efficiency of Fertilizer in Jakarta and discussed ways to properly implement the program.

An interministerial technical committee was established at the workshop to coordinate the development of a 5-year plan and to suggest priorities of work in fertilizer production, marketing, and use. The committee will work through four workgroups—lowland rice, upland crops, socioeconomic, and fertilizer production and marketing—to develop detailed workplans and budgets, monitor activities, and evaluate and report the results of each activity area.

IFDC Publications

- "Granular Urea—Advantages and Processes," T-1.
 "The Potential for Regional Cooperation in Fertilizer—A Methodology Study of the ASEAN Group," T-2.
 "West Africa Fertilizer Study (Volumes I-VII)."
 Volume I—Regional Overview, T-3
 Volume II—Senegal, T-4
 Volume III—Mali, T-5
 Volume IV—Upper Volta, T-6
 Volume V—Niger, T-7
 Volume VI—Chad, T-8
 Volume VII—Mauritania, T-9
 "Suggested Fertilizer-Related Policies for Governments & International Agencies," T-10.
 "The Bangladesh Fertilizer Sector, 1978," T-11.
 "Sulfur in the Tropics," T-12.
 "World Fertilizer Situation and Outlook—1978-85," T-13.
 "Organic Nitrogen Compounds for Use as Fertilizers," T-14.
 "Bolivia Fertilizer Situation and Recommendations," T-15.
 "Mexico: The Fertilizer Industry," T-16.
 "Fertilizer Manual," R-1, Price—US \$15.00.
 "Progress Report, 1976-1977."
 "Annual Report 1978."

Papers and Reprints

- "Kinetics of Dissolution of Phosphate Rocks in Soils," S. H. Chien, W. R. Clayton, and G. H. McClellan, *Soil Science Society of America Journal*, Vol. 44, No. 2, March-April 1980.
 "Application of Elovich Equation to the Kinetics of Phosphate Release and Sorption in Soils," S. H. Chien and W. R. Clayton, *Soil Science Society of America Journal*, Vol. 44, No. 2, March-April 1980.
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 "Transportation and Storage of Ammonia," Travis P. Hignett, to be published in the proceedings of the Fertilizer Industry Round Table, Washington, D.C., October 30-November 1, 1979.
 "Technology of Production of Fertilizers Containing Ca, Mg, and S," Travis P. Hignett, to be published in the proceedings of the Colombian

Soil Science Society, Colloquium on Saline Soils and Secondary Elements in Colombian Agriculture, Palmira, Colombia, September 19-21, 1979.

"An Analysis of N Nutrition on Yield and Yield Components for the Improvement of Rice Fertilization in Korea," P.L.G. Vlek, C. W. Hong, and L. J. Youngdahl, *Agronomy Journal*, Vol. 71, September-October 1979.

"Impact of a Training Program on Participant's Mastery of Fertilizer-Related Subject Matter: An Evaluation of a Fertilizer Marketing and Distribution Course," K. J. Byrnes, presented at the Annual Meeting of the Rural Sociological Society, Burlington, Vermont, August 24-25, 1979.

"Dissolution of Phosphate Rock in Acid Soils as Influenced by Nitrogen and Potassium Fertilizers," S. H. Chien, *Soil Science*, Vol. 127, No. 6, 1979.

"Effect of Nitrogen Source and Management on Ammonia Volatilization Losses from Flooded Rice-Soil Systems," P.L.G. Vlek and E. T. Craswell, *Soil Science Society of America Journal*, Vol. 43, No. 2, March-April 1979.

"Possibilities for the Improvement of Nitrogen Fertilizer Efficiency and Rice Production," D. H. Parish, Proceedings of Division of Chemical Marketing and Economics of American Chemical Society Conference, pp. 99-115, Honolulu, Hawaii, April 2, 1979.

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"Needed Information and Economic Analysis for Fertilizer Policy Formulation," M. S. Mudahar, Presented at FAO/FIAC Seminar on Fertilizer Pricing Policies and Subsidies, Bangkok, Thailand, 1978.

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