

# Report

Bangladesh—

## Phosphogypsum Represents Sizable Foreign Exchange Savings and Satisfies Sulfur Needs



An IFDC technical assistance project has provided additional momentum to ensuring that a white powder-like waste product of the fertilizer industry will continue to be turned into takas (Bangladesh currency) and more food for the Bangladesh people. IFDC's findings on a phosphogypsum study should ensure that Bangladesh will continue to save foreign exchange which is likely to amount to 18 million takas (US \$750,000) during 1983 alone.

Bangladesh has no indigenous sources of sulfur. The phosphogypsum produced by the triple superphosphate (TSP) complex at Chittagong is a byproduct of the TSP process derived from imported sulfur and phosphate rock. Interest in reclaiming the phosphogypsum has long existed and other institutions have long encouraged use of this resource, but the most cost-effective way of using the gypsum was not clearly defined.

At the request of the Bangladesh Agricultural Development Corporation (BADC), an IFDC Chemical Engineer, Mr. M. T. Frederick, conducted a study in January to show the economic feasibility of using by-product phosphogypsum as a source of agricultural sulfur.

"Agronomic research in Bangladesh has identified an acute sulfur deficiency in various cropped areas," Mr. Frederick said. "Sulfur is becoming a limiting factor in Bangladesh agriculture. Some sources estimate that lost production for the 1981/82 crop year due to sulfur deficiency was in excess of 350,000 tons of milled rice. This loss is equivalent to 1.75 billion takas (US \$73 million) at the farmer level."

Phosphogypsum or calcium sulfate dihydrate results from the digestion of phosphate rock with sulfuric acid in the production of phosphoric acid by the so-called wet process. The phosphogypsum, a white powder-like material produced by this process, is normally discarded as

having no value, especially in areas having sources of natural gypsum. By reclaiming the phosphogypsum, Bangladesh receives a credit for use of sulfur—not only the phosphate production (for TSP) value but also its agronomic value (increased yields).

The IFDC engineer recommended that the Bangladesh Government continue to use the phosphogypsum and that it be moved in bulk to central distribution points using either BADC or the Bangladesh Chemical Industries Corporation (BCIC) as a coordinating agency. The dealers and farmers can lift the gypsum in any quantity. The Ministry of Agriculture, BADC, and BCIC can develop a distribution program using truck, barge, and rail transport.

"Assuming an annual sulfur requirement of 18,000 tons, Bangladesh could realize possible foreign exchange savings of 60 million takas (US \$2.5 million) per year by using phosphogypsum as compared with importing and using elemental sulfur even though phosphogypsum could be an expensive source of sulfur if transported great distances," Mr. Frederick said.

The current level of usage is 2,000 to 2,500 tons of phosphogypsum per month, which is being lifted from the Chittagong factory and distributed to the farmer, according to Mr. Robert Benton, IFDC Distribution Consultant, USAID/Dhaka. As a result of this assistance, this usage is likely to increase significantly in the future. ■



A Bangladesh worker loads phosphogypsum at the Chittagong factory.

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Headquarters—

## Project Uses Rubber to Save Money in Rubber Production



How can rubber be used to save money in rubber production? Leaders of a current IFDC project are looking for the answer.

IFDC, the Rubber Research Institute of Malaysia (RRIM), and Petroliam Nasional Berhad (PETRONAS) are cooperating on a project that is using rubber that will eventually be used to improve the efficiency of urea and urea-based NPK fertilizer on plantation crops, such as rubber, in Malaysia. The three organizations are studying the technical and economic feasibilities of rubber coating granules of urea and urea-based NPK fertilizer to control the release rate of nitrogen.

Dr. Amitava H. Roy, IFDC Special Project Engineer, is the project's group leader, while Mr. Jerry Clemmons, IFDC

Chemist, is supervising the laboratory research. Dr. N. K. Savant, IFDC Soil Chemist, is conducting the nutrient-release component of the project.

PETRONAS staff are working alongside IFDC staff throughout the project. At IFDC Headquarters Mr. Samin B. Ahmad, PETRONAS Chemical Engineer, is working with an IFDC counterpart on process evaluation. Mr. Paimin Kasimon, PETRONAS Soil Scientist, is conducting research on the nutrient-release aspect of the project; Mr. Yeoh Choon Seng, a polymer chemist with RRIM, is in charge of preparing different natural rubber formulations being evaluated as coating material.

PETRONAS, in conjunction with RRIM, previously conducted experiments with natural rubber coating of granular and

prilled urea; their results were encouraging. Since PETRONAS is scheduled to start up a new urea plant in 1985, they are interested in developing a rubber-coated urea using this substrate. In addition, PETRONAS wants to evaluate the coating on granular urea and urea-based NPK fertilizer.

Because of IFDC's recognition in coating research, PETRONAS contracted with the Center to conduct studies on the production of coated products using natural rubber and the evaluation of nutrient release and physical properties of rubber-coated products.

Phase I of the project began on September 1, 1982, and will continue through November 1983. At the completion of Phase I, PETRONAS will determine if it desires IFDC to conduct pilot-plant studies as Phase II of the project.

For most developing countries sulfur is an expensive coating to use on fertilizers; it is difficult to handle and requires special handling equipment and techniques. Since Malaysia has an abundant supply of natural rubber, it is the most practical coating material for that country to use on urea and urea-based fertilizer.

Besides studying the process development, the researchers are studying nutrient-release rates and physical properties of selected products by using laboratory procedures. The technical and economic aspects of the product are also being studied.

"We are evaluating two basic processes for coating the fertilizers, that is, using a fluidized bed and a modified rotary drum," Dr. Roy said. "Our final objective is to recommend to PETRONAS the most cost-effective process to be adopted." ■



Mr. Paimin Kasimon, PETRONAS Chemist, and Ms. Angie James, IFDC Chemical Analyst, conduct nutrient-release studies.

Indonesia—

## INSFFER Studies Efficiency of Fertilizers for Rice



The Chinese give a second meaning to the word "rice": it is "all of agriculture." The origin of this meaning is easy to understand when one considers that in much of Asia rice is the basis of nutritional survival. Without rice, many of the world's people would perish.

The work of an international fertilizer network should help to place more rice on the tables of Asian people. In 1975 the International Rice Research Institute (IRRI) and IFDC organized a network of scientists based at national institutions ultimately aimed toward developing and sharing new

technology to increase rice production. That network, the International Network on Soil Fertility and Fertilizer Evaluation for Rice (INSFFER), conducts experiments in developing countries to improve fertilizer efficiency on rice.

To review the results of INSFFER research, IRRI and IFDC organized a workshop and tour of the INSFFER experiments in Indonesia. Eleven sites were included on the tour, which was conducted February 13-22. Subsequently, the workshop was held in Jakarta, February 23-24.

The tour provided the first opportunity for the Indonesians to exhibit and explain

their National Fertilizer Efficiency Program to an international audience. During the tour the participants visited the National Rice Research Station at Sukamandi where Dr. Robbert Wetselaar, IFDC Soil Scientist, showed the Agency for Agricultural Research and Development/IFDC cooperative experiment being conducted on novel nitrogen fertilizers for rice using urease inhibitors. Everyone agreed that supergranules as well as sulfur-coated urea appeared to outperform broadcast urea.

Thirty-one participants from seven developing countries attended the workshop and tour. They were from Bangladesh, Burma, the People's Republic of China, the Philippines, Sri Lanka, Thailand, and Vietnam.

Indonesia's representatives at the workshop included Dr. D. Muljadi, Director of the Center for Soils Research in Bogor and the National Coordinator of the Indonesian National Fertilizer Efficiency Program and Dr. M. Sudjadi, Coordinator of INSFFER activities in Indonesia. Other representatives of Indonesian fertilizer industries and research organizations were present.

IRRI was well represented at the tour and workshop. IRRI representatives included Dr. Dennis Greenland, Deputy Managing Director; Dr. C. Mamaril, the INSFFER Coordinator and organizer of the workshop; and Dr. J. Ritchie Cowan, the IRRI representative in Indonesia.

IFDC's representatives included Dr. D. L. McCune, Managing Director; Dr. E. T. Craswell, Soil Scientist; Dr. R. B. Diamond, Coordinator—Fertilizer Evaluations; Dr. I.R.P. Fillery, Soil Scientist; Dr. Dennis O'Brien, Soil Scientist; Dr. Brian Palmer, Soil Scientist; and Dr. Robbert Wetselaar, Soil Scientist.

According to Dr. Craswell, there were three major highlights of the workshop. First, the participants discussed the practical implementation of deep-placement technology and the possibility that the fertilizer industry in Indonesia produce



Dr. N. Bhuiyan of the Bangladesh Rice Research Institute presents a paper on results from Bangladesh during the INSFFER workshop.

either urea supergranules or briquettes for testing in Indonesia. Second, they resolved to strengthen the economic analysis of data from INSFFER experiments on

nitrogen fertilizer for rice. Third, Dr. I.R.P. Fillery presented recent data on ammonia volatilization and data on the use of urease inhibitors to reduce nitrogen losses. ■

#### Headquarters—

### Program Review Committee Convenes at Third Meeting

Economics research was the primary topic considered at the third meeting of the Program Review Committee, held at Headquarters, April 4-6. The Committee members are Dr. Ola Heide (Chairman), IFDC Board member and Rector of the Agricultural University of Norway; Dr. George W. Cooke, former IFDC Board member and now Honorary Scientist, Rothamsted Experimental Station, England; Dr. S. K. Mukherjee, Consultant and former IFDC Board member, New Delhi, India; and Dr. Richard Reidinger, Economist, the World Bank, Washington, D.C., U.S.A.

At its third meeting, the work in progress on IFDC's economics research program was presented by senior staff members. The four primary areas of discussion were economic evaluation of new fertilizer production technology, the world fertilizer market situation, farm-level economics, and fertilizer-related government policies.

#### Economic Evaluation of New Fertilizer Production Technology



Mr. N. D. Le, Chemical Engineer, described how the engineers developed a new product and assessed it economically; he gave examples from the work on

partially acidulated phosphate rock and urea fertilizers.

To provide examples of the costs of engineering work involved, Dr. A. H. Roy, Special Project Engineer, discussed mini-granulation, partial acidulation, and other processes for using local phosphate rocks.

To illustrate the economic analyses that are conducted on new processes, Dr. M. S. Lupin, Research Chemist, used conversion cost estimates for the briquetting and compaction processes to produce urea supergranules and large granules of NPK fertilizers.

Dr. C. A. Baanante, Economist, discussed the economic evaluation of using modified fertilizers and of the management technology involved. The main objective of this work is to identify fertilizer products and management technologies that have the potential of increasing economically the efficiency and/or use of fertilizers in developing countries.

#### Planning of Transport and Distribution Systems



Dr. W. E. Clayton, Transportation Distribution Specialist, discussed the significance of distribution system costs and described recent studies on costs and

efficiencies in distributing and handling fertilizers in developing countries.

#### Fertilizer-Related Government Policies



Dr. M. S. Mudahar, Economist, discussed progress and plans in fertilizer-policy research. The economic importance of such studies, the identification of the important issues, and the location of the information needed were discussed.

#### World Fertilizer Market Situation



Mr. G. T. Harris, Economist, discussed the world fertilizer situation and described the collection of data made by IFDC. The difficulties in securing accurate and reliable data were described. The information is used for many purposes, e.g., answering requests from developing countries, use in technical assistance programs, supplementing other economic studies and research, as well as for presentation in courses and at meetings.

Dr. Y. H. Chuang, Market Development Economist, described the collection and analysis of fertilizer prices. The recent historical changes were described and discussed.

## Farm-Level Economics



Dr. S. S. Sidhu, Economist, gave an account of adoption and demand studies on the use of fertilizers, with special reference to the work being done in Bangladesh.

Dr. Y. H. Chuang, Market Development Economist, described how economic incentives to fertilizer use were assessed and how surveys were used to produce information on fertilizer use in practice on farms.

Dr. J. A. Ashby, Sociologist, gave an account of socioeconomic studies that are being conducted on Colombian farmers' practices of phosphate fertilizer application.

## Country Studies



Dr. E. C. Kapusta, Regional Coordinator—Asia, described the comprehensive program in Bangladesh, which has been in progress since 1979. Its purpose is to assist the Bangladesh Agricultural Development Corporation (BADC) in overcoming the fertilizer marketing- and distribution-related constraints that impede the expanded and more efficient use of fertilizer needed to produce more food.

Mr. L. B. Williams, Regional Coordinator—Africa, described the work done in Nigeria to assist in the establishment of a plan and structure for marketing fertilizer from a new fertilizer plant.

The strengths of IFDC in economics research were praised by the Committee; in particular they commended the multidisciplinary nature of all activities of economics research. "Equally important is the unbiased nature of IFDC. Impartial advice is given, and no other consulting organization is in this unique position," summarized one Committee member.

The Committee strongly approved of the work done to assess the world fertilizer



Mr. Gene T. Harris, IFDC Economist, (third from left) points out interesting data on a computer printout of world fertilizer consumption to Program Review Committee members, (from left) Dr. George Cooke, Dr. Ola Heide, Dr. Richard Reidinger, and Dr. S. K. Mukherjee.

situation and considered that, if resources were limited, this project should have priority. The Committee suggested that about 20 countries where important developments in fertilizer use were occurring might be selected for detailed studies.

The Committee considered that selected candidates from these countries might be brought to IFDC for periodic conferences on data collection at national levels. A network of regular correspondents could be created to provide information regularly on the supply/demand situation in their countries. The publications resulting from this work would be freely available to policymakers and others in developing countries.

The Committee stressed the need to disseminate the information and research results acquired by IFDC as widely as possible. All aspects of communications, both of IFDC with outside institutions and within IFDC, should be considered. Regarding the latter, the merits of holding regular

seminars when staff members describe their work to their colleagues and visitors were pointed out.

During its October 1982 meeting, the Board of Directors accepted the Committee's recommendations for increased research on six topics that were accorded the highest priority. These six topics are (1) improving the efficiency of urea fertilizers, (2) development of partially acidulated phosphate rock, (3) sulfur research, (4) work on multinutrient fertilizers, (5) foliar application of nutrients, and (6) biological fixation of nitrogen. At the April meeting IFDC staff members reported on the efforts made to implement these recommendations.

Three priority topics will be considered later in greater detail by the Committee; they are: (1) micronutrient studies; (2) work on potassium, calcium, and magnesium; and (3) the interactions between nutrients and water supplies to crops. ■

Mali—

## Phosphate Project Progressing Toward Evaluation on Farmers' Fields



"The IFDC phosphate project in Mali will help to ensure a richer, healthier life for many of my people," said Mr. Amadou Gakou, Agronomist, Institut D'Economie Rurale (Institute of Rural Economics), Malian Ministry of Agriculture.

Mr. Gakou completed a 3-month training program at Headquarters on February 15. As part of the Mali phosphate project,

Mr. Gakou's training concerned laboratory techniques used in evaluating phosphate sources. Specifically, it involved the evaluation of the influence of composted farmyard manure and different phosphate sources on the properties of two soils with different textures.

The objective of the Mali phosphate project, which began in 1981 with funds from the International Development Research Centre (IDRC), is to select the

most efficient and economical source of phosphate for Mali's farmers. IFDC is studying the benefits to Mali of using its indigenous phosphate from the Tilemsi deposit.

IFDC has assisted with the establishment of experiments in 11 research stations that represent the major soils, climatic patterns, and cropping sequences of Mali. All experiments are providing information on comparative responses to

Tilemsi ground phosphate rock, granular and powdered forms of partially acidulated phosphate rock, and totally water-soluble superphosphate. In 1982 IFDC supplied about 2 tons of experimental materials for the field trials, including both powdered and granulated forms of partially acidulated phosphate rock from Mali.

Mr. Gakou is responsible for supervising the experiments in the southern zone, which is devoted primarily to cotton and maize production. Mr. Minamba Bagayoko, who participated in a training program at Headquarters during 1982, supervises the northern zone, which is primarily a cereal-producing zone. The cereals produced include millet, sorghum, maize, and rice. Dr. Zana Sanogo, Director for Research of the Institut D'Economie Rurale, Bamako, Mali, is the leader of the phosphate project in Mali. Mr. Pierre Rosseau, Tropical Agronomist, is the IFDC coordinator.

During 1982, 3,400 experimental plots were harvested. Data on the first cropping season provided interesting information for the Malian extension service.

Basal application of phosphate rock proved beneficial and gave a yield increase of 30% as of the first year. Partially acidulated phosphate rock applied solely gave similar or even slightly higher yield response than superphosphate. With maize, for instance, yield increase can be as high as 75% more than the check yield.

Regarding ground phosphate rock, yield response was also good the first year. After the first year, application rates of

20-30 kg of  $P_2O_5$  per hectare and 60 kg of  $P_2O_5$  per hectare may be suggested for soluble or partially soluble phosphates and phosphate rock, respectively.

Recommendations on basal application rates cannot be given at this point of the project. Regarding phosphate rock, however, previous research has shown basal application to be very beneficial.

A socioeconomic study was also initiated and will be divided into two major phases. These include a preliminary survey of 150 farmers representative of most of the agricultural environments in Mali and an in-depth study involving 20-30 farmers in five major agricultural zones of Mali.



Mr. Minamba Bagayoko, Agronomist; Mr. Amadou Gakou, Agronomist; and Mr. Mamadou Bagayoko, Research Technician, visit a sorghum experiment in Northern Mali, which is part of the IFDC Mali Phosphate Project.

Several of Mali's extension departments recently undertook actions to promote the use of Tilemsi phosphate rock. Farmers are now using phosphate rock because it is cheap and effective. Therefore, IFDC will initiate trials on farmers' fields during 1983 and make an accurate economic evaluation of phosphate rock use on farmers' fields.

"The working relationship that IFDC has enjoyed with the Malians is extraordinary," Mr. Rosseau said. "Under the guidance of the Director, Mr. Fatogoma Traoré, the Institut D'Economie Rurale has been very helpful to IFDC in the project by coordinating the work in a very systematic, effective manner." ■

Yugoslavia—

## Soil Scientist Examines Primary Production Component of Agricultural Sector



As part of a World Bank consultancy mission to evaluate World Bank-assisted agricultural development projects in Yugoslavia, an IFDC Soil Scientist, Dr. Dawit Deguefu, recently examined primary agricultural production projects financed in that country by the World Bank.

(Another segment of this mission was discussed in the March 1983 issue [p. 4] of the *IFDC Report*.)

With two other World Bank counterparts, Dr. Deguefu visited two project areas in the provinces of Bosnia—Herzegovina and Kosovo.

The primary objectives of the project were to evaluate the overall implementation progress, identify major problems in implementation, and make recommendations for the solution of problems identified.

"My portion of the mission focused primarily on the organizational and technical aspects of the primary production component of the Yugoslav agricultural sector," Dr. Deguefu said. "On the technical side, the progress made in the implementation of projects dealing with land reclamation components, including irrigation-drainage, fertilizer use efficiency and other cultural practices, livestock production practices, and related subprojects, was evaluated, and recommendations were made. On the organizational side, the structure and role of the extension service system, its operational efficiency, and working relationship with farmers and subject-matter specialist institutions were evaluated. The mission had the opportunity to interact with farmers both in the private and social sectors, extension agents, subject-matter specialists, and administrators."

Recommendations were made for improvement in extension services and cultural practices. The cultural practices that were examined included such factors as fertilizer use; irrigation-drainage; natural methods of increasing the soil fertility by using legumes, green manuring, and mulching; livestock production; horticultural crops; and land reclamation.

Specifically, for both project areas, the mission recommended that the number of extension agents be increased to adequately meet the need for more extension agent service in the private sector. Also the mission recommended that an increased number of progressive farmers be involved in order to enhance the transfer of improved methods of farming in the private sector. Since farmers are known to believe more from what they see than from what they hear, the farm education methods that the

extension agents employ should include visual aids, films, slide presentations, and field demonstrations.

Besides including green manuring and inoculated legumes in the cropping pat-

tern, the mission also recommended terracing, strip cropping, crop rotation, windbreakers, and plowing along the contour to curb the depletion of soil fertility through the removal of top soil by erosion.

The mission made suggestions to the extension agents on efficient methods to be used to ensure the timely distribution of fertilizers, seeds, herbicides, and livestock feeds. ■

*Headquarters; Nashville, Tennessee; Washington, D.C.—*

## **Program Produces Data Analyzers**



"We are drowning in information but starved for knowledge," says John Naisbitt, author of *Megatrends*.

In the 1980s we are entering a global information age, but we are learning that unorganized information is not a resource, but an enemy in an information society. Information technology brings order to the chaos of information pollution and therefore gives value to data that would otherwise be useless.

Recognizing the value of properly collected and analyzed data, IFDC organized its first training program on "Data Collection and Analysis for National Fertilizer Sector Studies." Twenty-one participants from 13 countries received this training during March 21-April 3 at IFDC Headquarters; Nashville, Tennessee; and Washington, D.C. Mr. G. T. Harris, IFDC Economist, was the program manager.

The participants traveled from Bangladesh, Burma, the Dominican Republic, Egypt, India, Indonesia, Nigeria, Pakistan, Rwanda, Sri Lanka, Sudan, Thailand, and Upper Volta. By participating in this 2-week program, they gained information that will be helpful to their organizations in planning and implementing policies and programs for their respective fertilizer sectors.

The program included 1 week of classroom exercises at IFDC Headquarters designed to acquaint the participant with what should be included in a national fertilizer sector study and data analysis needed for the production, marketing, policy, and projection components of these studies. IFDC staff members who have developed sector studies for such countries as Bangladesh, Bolivia, Indonesia, Mexico, Nigeria, and Thailand discussed their experiences.

Presentations on the use of personal computers, computer graphics, and writing technical reports proved to be popular segments of the course. Participants learned ways to collect, analyze, and present statistics to avoid being dazzled with mountains of unorganized data.

A "hands-on" computer exercise was a practical part of the course. The participants were given exercises to complete using the IFDC computer facilities.



**Miss Serifunnessa, Research Officer, Food and Fertilizer Planning and Monitoring Section, Planning Commission, Dhaka, Bangladesh, enters data on an IFDC computer terminal for a class exercise while Mr. Gene T. Harris, Program Manager, looks on.**

For participants like Mr. R. C. Gupta, Deputy Manager of Marketing Services, Indian Farmers' Fertiliser Cooperative, Ltd., this exercise was invaluable. "This was my first exposure to computers, and the experience will be very helpful to me in my work," he said.

In fact Mr. Gupta hopes that IFDC will develop an in-depth course on computer applications. "I would like to see IFDC offer another program in which more time could be allowed for working on the computers and the graphics terminal," Mr. Gupta said.

Parts of 2 days were devoted to how India collects and analyzes fertilizer-related statistics. Mr. Gopal Sohbt, Chief Executive of the Fertiliser Association of India, presented this information.

During the second week participants traveled to Nashville, Tennessee, where they learned how the state office of Statistical Reporting Service collects statistics. In Washington, D.C., they learned how U.S. Government agencies analyze fertilizer-related data collected from fertilizer producers and farmers. Representatives of the Bureau of Mines, Bureau of Census, Economic Research Service, U. S. Department of Agriculture (ERS-USDA), and Statistical Research Service, U.S. Department of Agriculture (SRS-USDA) made presentations

during the last week. Representatives of the Fertilizer Institute, Potash and Phosphate Institute, the World Bank, and the Food and Agriculture Organization of the United Nations also made presentations.

Some of the procedures for collecting and analyzing data that were presented during the 2-week course included sampling, regression analysis, short-range and long-range projection methods, benefit:cost analysis, trend extrapolation, developing sampling frames, aerial photography, point samples, and modeling.

In presenting this training program, IFDC responded to a growing demand for people at the national level having expertise in collecting and analyzing data. The value of collecting accurate data for use in making the best management decisions was stressed throughout the program. Properly analyzed data is vital to the development of viable fertilizer sectors in developing countries and ultimately to increased agricultural production.

Voicing an opinion that IFDC is making a strong contribution toward this end was Mr. Sohbt. "With the development of its training program, IFDC's reputation is expanding and developing; the Center has great potential of helping developing countries," he said. ■

Malaysia—

## FERITT Program Includes Plantation Crops for First Time



Oil palm, coconut, and rubber plantations provided a picturesque backdrop for IFDC's recent Fertilizer Efficiency Research in the Tropics Training (FERITT) Program in Malaysia. This fourth FERITT program was cosponsored by and held at the Universiti Pertanian Malaysia (UPM), Serdang, May 2-20.

Twenty-nine practicing agronomists/soil scientists from 10 countries—Bangladesh, Burma, Egypt, India, Indonesia, Malaysia, Pakistan, Philippines, Sri Lanka, and Thailand—attended the Malaysian program.

A team of scientists from IFDC and UPM formed the core faculty. Specialists from national and international institutions supplemented this group. Dr. Adolfo Martinez, IFDC Fertilizer-Use Economist, guided the progress of the 3-week training program.

The classroom lectures focused on experimental design, statistical analysis

of experimental data, economic evaluation of fertilizer materials, soil fertility management and evaluation, soil chemistry, new developments in fertilizer technology and nutrient deficiencies.

"The FERITT programs require a different kind of planning and preparation from the other training programs," Dr. Martinez said. "In February a maize crop had to be planted at UPM so that it could be harvested and evaluated during the program."

This experiment plays a very important role in the program. It provides the participants with a hands-on experience not only in the field but also in the classroom. Participants learn to (1) design experiments, (2) establish the experiments in the field, (3) determine the amount of fertilizer materials for each plot, (4) harvest the field trials and process the samples, (5) conduct statistical and economic evaluation of the fertilizers tested, (6) prepare a technical report on the experiment, and (7) make a presentation

on the experiment. The participants were divided into four working groups during the program; at the conclusion of the program each group prepared and presented a report on the maize experiment.

Field trips to the Rubber Research Institute of Malaysia, the Oil Palm Research Station, and Chemical Company of Malaysia (CCM—a private fertilizer company) enhanced the program activities.

"Through FERITT programs, IFDC attempts to improve the technical knowledge of agronomists/soil scientists from developing countries so that better fertilizer recommendations to farmers are made," Dr. Martinez said. "We emphasize that the only way to have good fertilizer recommendations that are acceptable to farmers is to derive them from the statistical and economic analyses of well-designed experiments." ■

## Recent IFDC Publications

### Compaction—Alternative Approach for Granular Fertilizers

This bulletin describes a relatively simple process—compaction—in which granular fertilizer is made by a dry process without the necessity for a liquid phase such as water, steam, or melt to form the granules. The process does not require energy for drying and cooling but only electricity for equipment operation. It is considered an alternative to water/steam granulation of solid dry materials. Preliminary estimates of the investment and conversion costs indicate that the compaction/granulation process compares very favorably with the steam-granulation process. The suitability of various raw materials for use in this dry granulation process is discussed. This bulletin will be helpful in evaluating compaction for fertilizer granulation in comparison with liquid granulation processes.

The authors of this publication are Dr. M. S. Lupin, IFDC Research Chemist, and Mr. N. D. Le, IFDC Chemical Engineer.

To purchase this publication, please request Technical Bulletin T-25. The price for U.S. addresses is US \$4.00 and for international addresses, US \$7.50.

### Agronomic and Economic Evaluation of Urea Placement and Sulfur-Coated Urea for Irrigated Paddy in Farmers' Fields in Eastern India

This paper presents an analysis of the agronomic and economic efficiency of different placement practices of urea and sulfur-coated urea fertilizer. In six states of eastern India, 162 fertilizer trials were conducted to evaluate the agronomic response of wetland paddy and the economic benefits to farmers.

Results of the analysis indicated that the agronomic efficiencies of urea supergranules and sulfur-coated urea are equivalent and that both are greater than the efficiency of prilled urea. It was determined that the nitrogen required to obtain an increase of 1 metric ton of paddy yield was approximately 25%-45%

less with urea supergranules and sulfur-coated urea than with prilled urea.

The authors of this publication are Dr. Adolfo Martinez, IFDC Fertilizer-Use Economist; Dr. Ray B. Diamond, IFDC Coordinator—Fertilizer Evaluations (now outposted to the International Rice Research Institute in the Philippines); and Dr. Sakti P. Dhua, General Marketing Manager, Hindustan Fertilizer Corporation.

To purchase this publication, please request Paper Series P-4. The price for U.S. addresses is US \$4.00 and for international addresses, US \$7.50. ■

## Future IFDC Training Programs

Soil Testing and Fertility Management; June 15-August 5; Auburn University, Auburn, Alabama. (One week of this course will be conducted at IFDC. For more information contact Professor J. T. Cope, Auburn University, Auburn, Alabama 36849 U.S.A.)

Regional NPK Fertilizer Production Training Program; July 10-16; Bangkok, Thailand.

Fertilizer Marketing Management Training Program; August 15-September 23; Headquarters.

Maintenance and Production Management Training for Fertilizer Producers; October 3-21; Headquarters.

Fertilizer Process Economics Training Program; October 24-November 4; Headquarters.

Regional Fertilizer Marketing Training Program for Asia; December 4-16; Manila, Philippines.

For information on these training programs, contact the IFDC Training Coordinator.



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Marie Thompson  
Editor  
P.O. Box 2040  
Muscle Shoals, AL 35660, U.S.A.  
Phone No. (205)381-6600  
TWX-810-731-3970 IFDEC MCHL  
DONALD L. McCUNE, Managing Director  
BOARD OF DIRECTORS, JOHN A. HANNAH,  
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