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Report

an update on the work & progress at the International Fertilizer Development Center

Headquarters—

Fertilizer Technologist "Builds" Rotary Dryers on a Computer

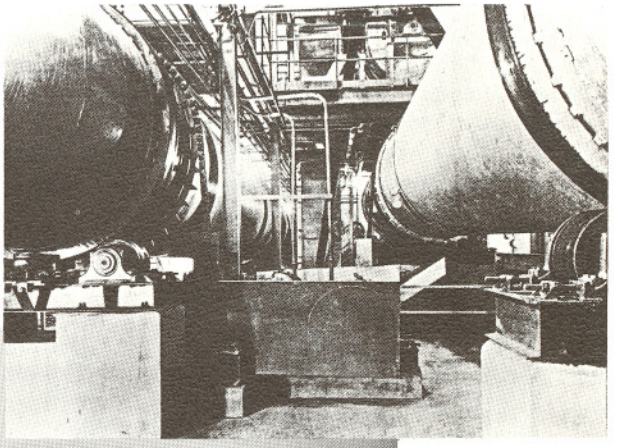
When fertilizer manufacturers produce urea-based NPK fertilizers in their conventional granular NPK fertilizer plants, they encounter problems. Conventional drying temperatures cannot be used because of the delicate nature of fertilizer containing relatively high levels of urea. Lower temperatures and longer drying periods must be used; otherwise, the sticky material that results will plug the plant equipment, form deposits, and force a shutdown.

An IFDC fertilizer technologist has arrived at a solution, that is, computer-aided design of rotary dryers. Using a computer program written in FORTRAN 77 language, Math H.G. Jennekens, Special Project Engineer, can provide fertilizer manufacturers with the information they need on the requirements and cost-effectiveness of producing urea-based NPKs. He can tell them the necessary modifications that they must implement prior to producing the material and also the cost involved in making the changeover from conventional to urea-based NPKs.

The program—Rotary Dryer—can be run on a Vax or IBM personal computer. He feeds data on the dryer conditions into the program. The program calculates the heat and material balances simultaneously; if one or both balances cannot be calculated, error messages are displayed on the computer screen so that the user can validate and correct the input data. For example, if the relative humidity of the air leaving the dryer exceeds the critical relative humidity of the product, an error message is displayed. After the material and heat balance calculations have been performed, the required size of the necessary drying equipment can be calculated. In this case also the user is made aware of excessive equipment size or ratios.

Using data from developing-country fertilizer plants, Jennekens and Jorge R. Polo, Deputy Engineering Coordinator, tested the program and achieved very satisfactory results. This program is available to fertilizer manufacturers; interested parties should contact O. W. Livingston, Director of IFDC's Fertilizer Technology Division. ■

An IFDC fertilizer technologist has arrived at a solution, that is, computer-aided design of rotary dryers.



Jorge R. Polo (left), Deputy Engineering Coordinator, and Math H.G. Jennekens, Special Project Engineer, examine a printout of the "Rotary Dryer" program. (Inset photo: a rotary dryer and cooler in a granulation plant; photo, courtesy Feeco International.)

Mali—

Potential Breadbasket Receives Added Boost

A potential "breadbasket" for the entire country of Mali exists in the southern part of that country, according to IFDC Biometrician, Dr. Julio Henao. That section of Mali has good soils, well-distributed rainfall, and good farm-to-market roads.

Judging from recent findings of the Mali Phosphate Project, farmers in southern Mali can have an additional advantage by using fertilizer produced from their country's indigenous phosphate resources. Recent farm-level results from a cotton/maize cropping system have shown a 100% increase over the average yields of the check plots when 60 kg of P_2O_5/ha as phosphate rock was applied and other nutrients were used in optional amounts. In order to achieve these results, crops must be planted as soon as possible, when adequate soil moisture is available. Under Malian conditions, it is generally accepted that the soil moisture level is sufficient after the first 25 mm of rain in June.

Since 1981 IFDC, with funding from the International Development Research Centre, has been assisting the Institut d'Economie Rurale (IER) in Mali in finding ways to use its indigenous phosphate resource located in the Tilemsi Valley. Additional funding has been provided by the World Bank for verifying the research results on farmers' fields in cotton-growing areas.

According to Henao, one of the key achievements of the project has been the refinement of both the approach and methodology in fertilizer research. "In collaboration with national and international institutions, such as IER, the Compagnie Malienne Pour le Developpement des Textiles, the International Institute of Tropical Agriculture, and the International Crops Research Institute for the Semi-Arid Tropics, IFDC has developed a strategy for research, including experimentation on experimental stations and in farmers' fields supervised by national counterparts. Information resulting from experiments is shared by participating institutions, and results are tested on farmers' fields and extrapolated to regions with similar environments.

"Thus we are making this research viable; it is being tested over a whole range of environmental conditions and management factors, including various cropping systems."
—Dr. Julio Henao

"Thus we are making this research viable; it is being tested over a whole range of environmental conditions and management factors, including various cropping systems.

"The project is a key model for the development of other national programs. It is strengthening the linkage between research and the extension service. After only 4 years the project is already producing specific recommendations for the use of phosphate rock to replace the soluble phosphate component of the conventional fertilizer."

According to Pierre Rosseau, Tropical Agronomist, who manages the fieldwork, specific recommendations must be made for each cropping system. For example, when using a cotton/maize system, phosphate rock should be basally applied (400 kg of Tilemsi rock/ha) at the beginning of the rotation on the cotton. The next application would only occur at the beginning of the fourth crop in the rotation (maize). If the rotation starts with maize, the first year's maize would also require a small amount of soluble phosphate (50 kg of TSP/ha) and small amounts of phosphate rock (100 kg of Tilemsi rock/ha) should later be applied every other year on the maize.

For maize/groundnut systems, phosphate fertilizer should be applied at planting time to the maize only.

In arid areas, where sorghum/millet systems are prevalent, the dryness affects the performance of phosphate rock. In dry areas, more soluble phosphate sources may give the best results, but phosphate rock has a residual, long-term beneficial effect. It provides real security.

For example, if a farmer applies TSP and it fails to rain, there is no benefit from the soluble and more expensive phosphate fertilizer. In addition, superphosphate will revert into less soluble forms. The residual effects of phosphate rock over years will equal the effect of annual applications of TSP.

With such a valuable indigenous resource available to Mali, that country should take full advantage of it. At present, only 4,000 tons of Tilemsi phosphate rock is being produced per year; however, Mali has the capacity of producing 60,000 tons of phosphate rock per year. More work needs to be done on developing an effective marketing system that will make phosphate rock available to farmers in time and at minimal cost.

Since it has been shown that phosphate rock can be used as an effective source of phosphorus, this material should replace the expensive imported phosphate. The next phase of the project should look at the requirements for other nutrients and adjust fertilizer management and recommendations using phosphate rock as the basis for fertilization. ■

Malian laborers apply phosphate fertilizer to experimental plots.

Headquarters—

Marriage Between Bacteria and Plants Studied

The symbiotic relationship between nitrogen-fixing bacteria (Rhizobium) and the roots of legumes is being studied in a collaborative project between the Boyce Thompson Institute for Plant Research (BTI) at Cornell University, the International Center for Tropical Agriculture (CIAT), the Microbiological Resources Center in Rhizobium, and IFDC, under sponsorship of the United Nations Development Programme.

By capitalizing on this mutually beneficial relationship, developing-country farmers can have a partial substitution of the nitrogen fertilizer that they are presently using.

This mutually beneficial relationship between Rhizobium and plant roots has enormous potential for the farmers of developing countries. Under this arrangement, the host plant provides the Rhizobium with the nutrients that it needs; in return this parasite supplies the plant with nitrogen that it draws from the air. By capitalizing on this mutually beneficial relationship, developing-country farmers can have a partial substitution of the nitrogen fertilizer that they are presently using.

The overall objectives of the project are to develop a fertilizer-Rhizobium or seed-Rhizobium combination that can withstand exposure to humid tropical conditions, to provide one package of fertilizer nutrients needed for plant growth, and to make small quantities of the material available for greenhouse screening.

In work conducted by IFDC since 1982, it was determined that phosphate rock would be a suitable carrier for Rhizobium (see *IFDC Report*, Volume 7, No. 2).

According to the IFDC coordinator, Dr. Amit H. Roy, Special Project Engineer, the first step in the project was the selection by BTI/CIAT of the Rhizobium that would have a good survivability rate. Then IFDC's technologists sprayed the freeze-dried Rhizobium that had been suspended in oil onto granulated phosphate rock and granulated fused magnesium phosphate.

Next, BTI conducted survivability tests and identified some of the constraints that affect the survivability of Rhizobium. They are also studying the effect of time and temperature on the survivability of Rhizobium.

Some results are already available from BTI's portion of the work. "We have found that it is extremely important to keep the granules under very dry conditions after the material has been sprayed," Roy says.

The oil that is used in the suspension must be one that is locally available in Colombia—a light paraffin, heavy mineral, commercial corn oil.

In the next phase of work, BTI will try to find different strains of Rhizobium that are appropriate for the legumes grown in Colombia and combinations of oils that can be used and still have a high survivability rate.

CIAT's part to play in the project is that of field testing, which will come later.

According to Roy, the project has enormous potential and possibilities. "The next step and an outgrowth of the project will be to try to combine seed, fertilizer, and Rhizobium into one granule. We must first try to combine seed and fertilizer and then add the Rhizobium. This will simplify application for developing-country farmers; all of the necessary inputs will be in one package."

Some developing countries are presently using similar technology; however, they apply the Rhizobium to peat moss or lignin instead of fertilizer. This method of application presents a problem as far as survivability is concerned.

If the tripartite project between BTI, CIAT, and IFDC continues to progress favorably, perhaps this technology can soon be transferred to other countries in the developing world. ■

Chile—

BAHIA INGLESA DEPOSIT TRANSLATES INTO SAVINGS IN FOREIGN EXCHANGE

A recently conducted technical assistance project with the National Research Institute of Chile (INTEC) on the development of an indigenous phosphate rock deposit should provide that country with the means to save valuable foreign exchange through reduced imports of phosphate fertilizer.

When the Bahia Inglesa deposit is developed, the country will have phosphate fertilizer produced from its own resources.

During 1983/84 IFDC conducted laboratory-scale tests on the beneficiation of Bahia Inglesa phosphate rock for CORFO (the Chilean bureau of mines). During Phase II of the project Dr. Talaat A.B. Lawendy, Minerals Engineer, visited Chile to instruct INTEC personnel on the beneficiation of the ore in their laboratories and pilot plants.

The deposit consists of two main areas, located in northern Chile. They are: the principal area, which contains 4-5 million tons of 18% P_2O_5 and the extension area, which contains 13-15 million tons of 7% P_2O_5.

Lawendy made several recommendations regarding the Bahia Inglesa deposit. For example, he recommended a complete geological survey of the deposit to determine the extent of the reserves before conducting any further beneficiation tests. In addition, beneficiation of the low-grade ore to remove feldspars and silica was recommended so that a suitable concentrate could be obtained for subsequent chemical processing.

Until now, Chile has not had a national phosphate fertilizer industry. When the Bahia Inglesa deposit is developed, the country will have phosphate fertilizer produced from its own resources. ■

Headquarters—

Australian Company Requests Final Opinion on Its Phosphate Rock

While evaluating pilot-plant test results on the production of phosphoric acid from its phosphate rock resources from several process licensors in various parts of the world, an Australian company has selected IFDC to conduct a series of tests and give its opinion on the most efficient use of the phosphoric acid for fertilizer production. When this phase of the project is completed in early 1986, the company will have gained the information base necessary for engineering companies to design, construct, and guarantee the necessary manufacturing plant.

A significant portion of IFDC's phosphate research program is devoted to collecting technical data on phosphate rocks from around the world. The compilation and interpretation of this information enhances the Center's ability to evaluate or test such rocks and provide advice on their effective use in fertilizer production.

A project currently being conducted is studying the processing characteristics of phosphate rock from the Duchess deposit for Queensland Phosphate Limited (QPL) of Australia. Because the QPL rock has a high silica content, the experience gained from this research will help the Center deal with similar rocks from developing countries.

The Duchess deposit, containing 1,400 million tons of phosphate rock, is located in the Georgina Basin in the northeastern Australian state of Queensland. Following the discovery of the deposit in 1966, a mine was developed and operated for several years during the 1970s. Some of the phosphate rock was used domestically, and some was shipped to Taiwan, the Philippines, Korea, and Japan. In the late 1970s the mine was closed for economic reasons.

QPL is now considering a plan to build at Phosphate Hill in the Duchess deposit a phosphoric acid plant, which would use byproduct sulfuric acid from a nearby copper smelter at Mount Isa. The phosphoric acid produced probably would be concentrated to about 60% P_2O_5 before being railed to a fertilizer plant on the coast. At the fertilizer plant this acid would be converted to granular triple superphosphate by reacting it with additional rock or to ammonium phosphates by reacting it with ammonia. These products would then be available for shipping to Australian ports and to Asia. This plan is pending approval by the QPL Board of Directors.

Pilot-plant tests on the performance of QPL phosphate rock in the production of phosphoric acid have been performed in Japan, England, and the U.S.A. (Florida). Part of the phosphoric acid product from the Florida tests was sent to IFDC for additional testing and conversion into granular triple superphosphate, monoammonium phosphate, and diammonium phosphate.

Gordon K. Bell, Consultant to QPL, recently visited Headquarters to review the progress on this project. During an interview, Bell summarized IFDC's role in the QPL project.

"IFDC's role in all of this is extremely involved, of course. All phosphate rocks are totally different mineralogically and chemically. From each rock is made a different phosphoric acid as far as all the trace elements are concerned. When you convert that to solid fertilizers, you have to investigate all aspects of the process. That's the objective of this exercise—to evaluate the acid here and learn the chemical grade and physical quality of fertilizers produced from our deposit."

Dr. G. H. McClellan, Research Coordinator, and Dr. A. H. Roy, Special Projects Engineer, are coordinating the work at Headquarters. In addition to the objectives of the work pointed out by Bell, Roy noted that studies were also being conducted on the behavior of the acid during concentration.

Bell has only praises for his collaborators at IFDC. "We have been very pleased with the work of the IFDC engineers," he says. "They have been very thorough and efficient, and the facilities in their pilot plant are some of the best that we have seen." ■

Workers mine phosphate rock at Phosphate Hill in the Duchess deposit. *Inset Photo:* Gordon Bell (left), Consultant to QPL, and Marshall E. Goode, Technical Aide, examine granular TSP produced by using QPL phosphate rock and phosphoric acid.

Profile—

Dr. Amir Muhammed Lends New Flavor to Board

The newest member of the IFDC Board of Directors fixes you with clear brown eyes that suggest sincerity as he reminisces about the journey that has brought him to his present position. His slightly graying hair shows evidence of his many maturing experiences along the way and the many challenging jobs he has not only accepted but also completed admirably.

For some 30 years, Dr. Muhammed has played various roles in agricultural research with the most recent being Chairman of the Pakistan Agricultural Research Council (PARC) and Secretary of the Agricultural Research Division, the Government of Pakistan, since 1978. During his professional life, he has held many interesting and challenging positions, including president of a major agricultural university; Pakistan's Federal Minister for Food, Agriculture, and Cooperatives; and a board member of numerous international organizations. In studying Muhammed's career one may decide that the most striking element is the fact that he has established four major institutions in his native Pakistan.

The journey for Muhammed began in Udaipur, India, where he was born. Not wanting to venture too far away from home, as a young man he enrolled in Punjab University where he obtained both the B.S. and M.S. degrees in chemistry with specialization in biochemistry. Next he journeyed to Oxford University (United Kingdom) to receive his Ph.D. degree in biochemistry and microbiology.

"I was trained earlier as a chemist," Muhammed says. "But biochemistry has always fascinated me. When I went to Oxford, Professor Krebs, who had just received the Nobel Prize for his work in intermediary metabolism, was head of the department and had established a very vigorous and stimulating research group. This attracted me a great deal."

His enthusiasm for this exciting work shows in his voice as Muhammed describes his early career. "When I was doing research for my doctorate, studies on DNA had already entered a very exciting phase. I went to Oak Ridge National Laboratory, Oak Ridge, Tennessee, U.S.A., as a post-doctoral research associate and there studied the mechanism of reactivation of DNA damaged by ultraviolet radiation through photoreactivation. To determine the biological activity of DNA, we used genetic transformation of com-

Dr. Amir Muhammed
Chairman
Pakistan Agricultural Research Council

petent recipient cells as an indicator. Studies on genetic transformation in bacteria with pure DNA of known genetic makeup afforded a mechanism for modifying the genetics of a host organism to the desired characteristics by integrating DNA from another organism with somewhat different traits. Studies on transformation could be considered the foundation of modern genetic engineering, and we used to talk about the possibilities of bringing about genetic changes in the higher organisms including plants, animals, and possibly human beings through the use of a similar technique."

After some 10 years in molecular genetics, Muhammed ventured in a slightly different direction. "I then got into ordinary 'bread and butter' research," he says. "I was asked to organize from scratch a new institute in Pakistan—the Nuclear Institute for Agriculture and Biology at Faisalabad. That was quite an experience; I was told to develop an institute to work on the more important problems of food production and agriculture. The experience of developing an institute carries with it an excitement similar to that of getting your first child."

After that Muhammed was appointed Vice Chancellor (or president) of the University of Agriculture at Faisalabad. This proved to be another challenging assignment for him.

Due to a change in the Government of Pakistan, Muhammed was asked to serve as Advisor to the Chief Martial Law Administrator (Federal Minister) for Food and Agriculture of his country. The fact that he only remained in that position for 1 year attests to his one true dedication —to agricultural research.

"Because I was really not a politician, I requested a transfer to a position in my own profession—agricultural research. At that time in Pakistan the population was increasing rapidly, and the problems of agriculture were mounting as pressures on the land built up. I recommended to the government that a quality agricultural research program be established. As a result, I was appointed Chairman of the Pakistan Agricultural Research Council, which I reorganized and made into an autonomous organization to plan, coordinate, and finance all agricultural research in the country."

Carrying his endeavor a step further, in 1984 Muhammed established the National Agricultural Research Centre (NARC) in Islamabad. NARC is a well-equipped national-level research institute with facilities for laboratory and field-oriented research and consists of institutes on crops, animals, social sciences, and farm machinery research and a separate training institute.

In 1981 Muhammed was elected to represent the South Asia and Pacific Region on the Consultative Group for International Agricultural Research (CGIAR). It was in this connection that he first learned of IFDC.

"Prior to becoming a member of the Board, my knowledge of IFDC primarily related to the Center's training programs, which have greatly benefited our people, and the research on nitrogen fertilizer efficiency, with which I am very impressed." he says.

Muhammed was also a member of the Board of Directors of the International Centre for Agricultural Research in the Dry Areas from 1979 to 1985 and is a former board member of the International Potato Centre, and at present, he is Vice-Chairman of the Governing Board and Member of the Executive Committee of the International Irrigation Management Institute.

With all of these credentials and more than 100 professional publications to his credit, Dr. Amir Muhammed is indeed a welcome member to the IFDC Board of Directors.■

Singapore—

Marketers Draft Plan for Utopia

During the sixth Asian Region Fertilizer Marketing Training Program, conducted December 9-20, 1985, a unique and innovative instructional method was used to help marketing managers grasp the real significance of fertilizer marketing management. Specifically, the group was given the task of developing a plan to help a fictitious country, Utopia, achieve self-sufficiency in rice production. In addition, they prepared a budget to support the marketing plan and recommended a pricing policy and credit plan.

Participating in this true-to-life case study were 22 marketing managers from 8 countries—India, Indonesia, Jordan, Malaysia, Pakistan, Philippines, Saudi Arabia, and Sri Lanka. With the garden city of Singapore as the locale of their learning environment, the group focused their attention on the various facets of fertilizer marketing—integrated marketing concepts, marketing planning, and marketing systems development.

An interesting and lively discussion occurred during one segment of the program. "The members of the group made presentations on the fertilizer marketing system in their countries," said R. S. Giroti, Program Comanager.

Two field trips—one to the Jurong port in Singapore and the second to Pasir Gudang in Malaysia—added a practical aspect to the program. At Jurong the participants toured the facilities and the fertilizer warehouse of Orient Bulk Terminal Pte., Ltd. In the l-day field trip to Pasir Gudang, Malaysia, the group visited the FPM Sendirian Berhad fertilizer plant where they saw the bagging and shipping operations. They visited the Bukit Besar oil palm scheme of Federal Land Development Authority (FELDA). At the plantations they learned how inputs including fertilizer reached the growers. They saw an oil mill operated by FELDA.

The non-IFDC speakers in the program were from the Southern Petrochemical Industries Corporation, Ltd., India; Fertilizer Advisory Development and Information Network for Asia and the Pacific/Economic and Social Commission for Asia and the Pacific, Thailand; Transcontinental Fertilizer Company, Singapore; Jurong Port, Singapore; and the International Potash Institute/Potash and Phosphate Institute, Singapore. Their participation in the program as faculty and their interaction with the group proved to be very useful.■

A unique and innovative instructional method was used to help marketing managers grasp the real significance of fertilizer marketing management.

Participants in the Asian marketing program examine the results of their efforts in a computer simulation of fertilizer marketing.

Indonesia—

Agronomists Given "One to Grow On"

How do you learn to conduct fertilizer efficiency research? The most practical way is to first design and plant an experiment; next, harvest the experiment; and finally, analyze and report the data on your resulting yield.

Simply stated, these are the steps that 28 agronomists/soil scientists followed during the Fertilizer Efficiency Research in the Tropics (FERITT) Training Program for the Asian Region, held November 18-December 6, 1985, in Puncak, Indonesia.

Approximately one-half of the time was devoted to classroom sessions and the other half to practical activities and field work. Emphasis was placed on (1) specific procedures for conducting fertilizer trials with new or improved fertilizer materials and application techniques and (2) agronomic, statistical, and economic analysis of results.

The program included over 40 formal presentations, 2 panel discussions, 1 case study, and 5 field trips.

To gain a practical insight, the group visited the fertilizer complex, P.T. Pupuk Kujang; research stations in the Bogor area; the Centre for Soil Research, and the Bogor Research Institute for Food Crops.

In addition, two films were viewed —"Making the Most of a Miracle" and "One to Grow On." The film, "One to Grow On," takes a credible news approach to the story of modern fertilizer production and use.■

FERITT participants view the facilities at the Kujang fertilizer plant.

Upcoming Training Programs

Program	Location	Dates
Headquarters		
Fertilizer Marketing		
Fertilizer Marketing Management Training Program	IFDC	August 11-September 19, 1986
Fertilizer Quality Control	IFDC	September 22-October 10, 1986
Fertilizer Production and Technology		
Fertilizer Process Economics Training Program	IFDC	June 2-20, 1986
Maintenance and Production Management Training Program	IFDC	October 13-31, 1986
Fertilizer Sector		
African Workshop on Fertilizer Sector Development	IFDC	June 16-17, 1986
Regional Programs		
Statistics and Economics of Fertilizer Use (in Spanish)	Colombia	November 3-21, 1986
Fertilizer Marketing Training Program for Asia	Indonesia	December 8-19, 1986
Fertilizer Efficiency Research in the Tropics—Africa (in French)	West Africa	October 20-31, 1986

NOTE: Dates are subject to change.

For further information on these training programs, please contact the Director, IFDC Outreach Division.

Recent IFDC Publications

SULFURIC ACID-BASED PARTIALLY ACIDULATED PHOSPHATE ROCK: ITS PRODUCTION, COST, AND USE

Phosphate deposits are located in many tropical countries. Many of these deposits have had little commercial significance in the past because they were either too low in grade, too unreactive, or associated with excessive quantities of unwanted impurities. One means of utilizing these indigenous phosphates to the benefit of countries having such deposits is to increase the plant-available phosphate by chemical conversion to a partially acidulated phosphate rock (PAPR) product. The partial acidulation concept, indicating the use of less acid than that needed to convert the rock to superphosphate, often makes it possible to process problem ores into useful fertilizer products when the use of conventional processing methods is not feasible. The PAPR products may be especially attractive to producers who rely upon imported sulfur or sulfuric acid because less acid is used and a significant saving in foreign exchange can be realized.

The process technology, production cost estimates, and agronomic performance of a number of sulfuric acid-based PAPR (SAB-PAPR) products described in this bulletin often compare favorably with those of conventional superphosphate fertilizers.

To order this publication, please request Technical Bulletin IFDC-T-31. The cost of the publication is $4.00 for U.S. addresses and $7.50 for overseas addresses. All orders should be directed to the IFDC Purchasing Department.

IFDC TRAINING PROGRAMS

An updated catalog of IFDC Training Programs is now available. The 32-page booklet gives details on the 14 different training programs that the Center offers. To order this free publication (IFDC-G-3), please write to the IFDC Outreach Division, P.O. Box 2040, Muscle Shoals, Alabama 35662.

IFDC Report

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IFDC is a public, nonprofit organization dedicated to increasing food production through the development of new and improved fertilizers and fertilizer know-how for developing countries.

Marie Thompson
Editor
P.O. Box 2040
Muscle Shoals, AL 35662, U.S.A.
Phone No. (205) 381-6600
TWX-810-731-3970 IFDEC MCHL