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INTERNATIONAL FERTILIZER DEVELOPMENT CENTER

PROGRESS REPORT

1975-1976

The International Fertilizer Development Center (IFDC) is dedicated to the goal of increasing agricultural productivity in developing countries through the use of improved fertilizers and fertilizer know-how. Program objectives include the development of new fertilizers, as well as expanding the use of current or modified fertilizer materials. Special emphasis is placed on developing more effective fertilizers for food crops grown under tropical and subtropical conditions using, where technically or economically feasible, indigenous raw materials and production capacities.

IFDC

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PROGRESS REPORT

1975-1976

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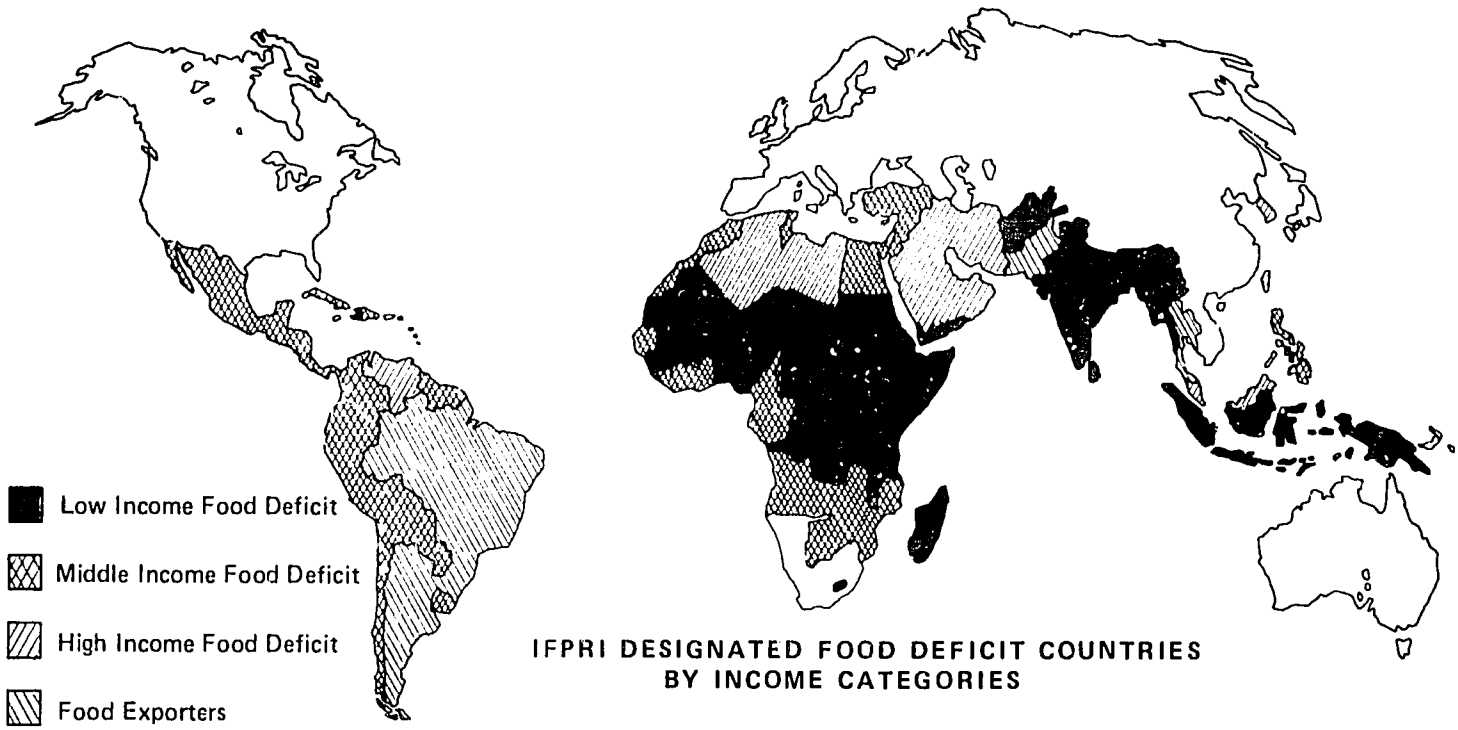
Role of Fertilizer in World Food Production



IFPRI DESIGNATED FOOD DEFICIT COUNTRIES BY INCOME CATEGORIES

Historically, at least up until recent times, food production in the LDC's has been increased more by bringing new lands under cultivation than by increasing yields on existing farmland. In the Near and Far East, land is becoming a severely limiting factor although in Africa and Latin America considerable potential still exists to expand the land area under cultivation. While potentially arable lands must continue to be brought into production, it must be recognized that land colonization is a difficult, slow, and costly process. Furthermore, increasing areas of good agricultural land are being transferred from agricultural production to urban and industrial use.

In order to avoid the food deficits projected by 1985, agricultural development strategies need to be concentrated on increasing yields on existing croplands. Yields per unit of land must be greatly increased to meet future demands. Such yield increases will require significant improvements in plant nutrition.

Developing countries are only now beginning to recognize the key role fertilizer must play in overall agricultural development. As recently as 1974/75, only 26% of the total fertilizer used in the world was consumed by the developing countries where two-thirds of the world's population resides. Recent fertilizer use estimates by the United Nations Industrial Development Organization (UNIDO) suggest that total nutrient consumption in the world will increase from the 1975 level of 81.7 million mt to 307 million mt by the year 2000, an increase of 375%.

Using the Lima Declaration of December 1975 as a guideline for Third World development strategies, UNIDO estimates that 40% of world fertilizer consumption and production by the year 2000 should be located in the developing countries. Although the accuracy of these projections can be debated, the need to increase efforts in developing countries to produce, distribute, and use more fertilizers seems beyond question.

At present, serious constraints exist that frustrate efforts to increase fertilizer use in many developing countries. The relationship between the prices of agricultural inputs and those of farm output has not been conducive to get farmers, particularly small farmers, to adopt and use large quantities of fertilizer. In many developing countries, farmers perceive too great a risk in using recommended quantities of fertilizer, particularly on food crops where water availability is unpredictable, response to fertilizer is uncertain, credit is expensive and/or unavailable, and the remuneration the farmer receives for his labor is uncertain and often disappointingly low.

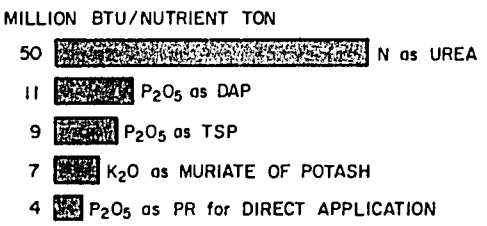
There are indications that the cost of fertilizer will increase sharply in the years ahead. This increase is due to the energy intensiveness of fertilizer manufacturing and the rising cost of raw materials (attributable to the growing scarcity of natural gas and oil and the increasing difficulty of mining phosphate rock); the sharp increases in the investment costs of

nitrogen and phosphate fertilizer production facilities; and finally the rapidly rising cost of transporting and distributing fertilizer.

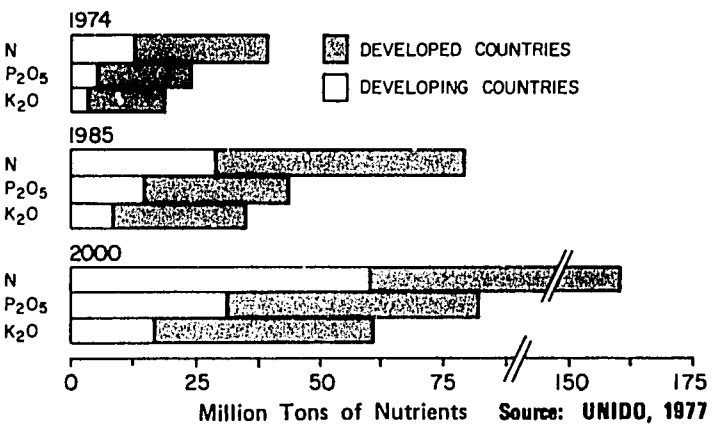
Up to now, developing countries have relied on fertilizer technology developed for the conditions in temperate zone agriculture. Such technology and resultant fertilizer materials have not proven entirely adequate for the climate, crops, soils, raw materials, and economic conditions found in much of the developing world. Without technology better adapted to developing country conditions and more effective fertilizer materials, it is doubtful that sufficient fertilizer will be produced and used in the tropical and subtropical regions of the world to improve, or even sustain, per capita levels of food production.

The human and physical capital requirements in fertilizer production and distribution facilities to meet developing country fertilizer demand will require an investment of billions of dollars over the next 25 years.

FERTILIZER PRODUCTION ENERGY REQUIREMENTS

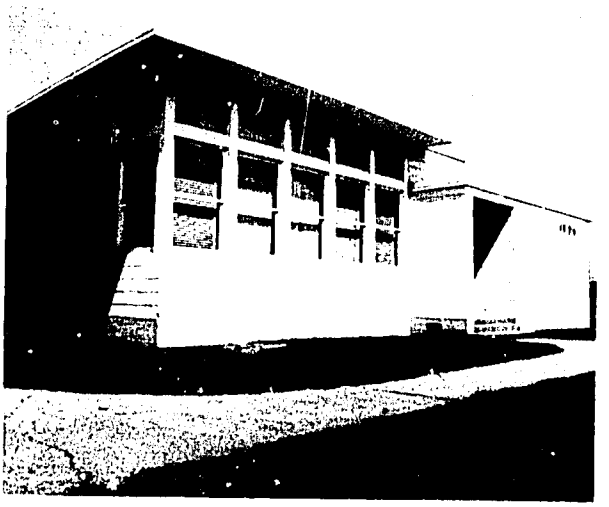


PROJECTIONS WORLD FERTILIZER CONSUMPTION TRENDS



Source: UNIDO, 1977

Administrative Report



IFDC began program activities in rented facilities. Plans for permanent facilities were approved by the Board of Directors in early 1975. By the end of 1976, the Agro-Economic Research Wing was in use and the Engineering Research Building was nearing completion.

Creating IFDC

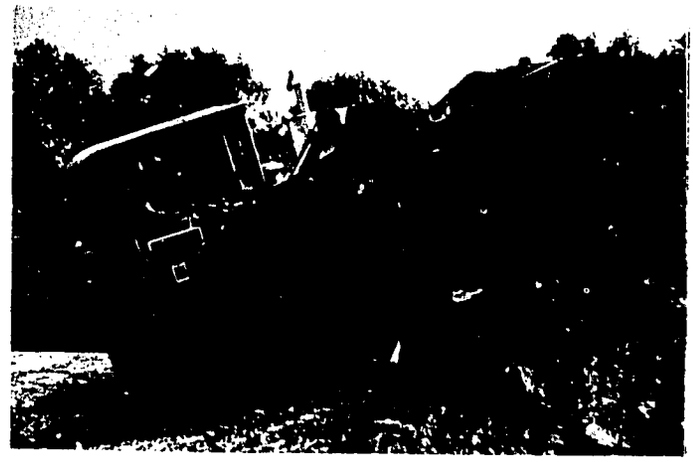
Grasping the significance of new fertilizer technology and materials tailored to the tropics in overcoming the world food crisis, the United States Secretary of State, in a speech before the UN General Assembly in 1974, urged the establishment of an international fertilizer research center to focus on improving the effectiveness of chemical fertilizers in tropical agriculture and on new methods to produce fertilizers less dependent on petroleum resources.

The United States Agency for International Development (USAID) was called upon to develop a proposal to address this problem. USAID responded with a proposal that had three major areas of emphasis: chemical fertilizers; biological fixation and solubilization of nutrients; and recycling of nutrients from plant, animal, and human wastes. To keep this effort in the international arena, USAID presented the proposal to the Consultative Group for International Agricultural Research (CGIAR) and its Technical Advisory Committee (TAC).

The CGIAR and TAC studied the proposal and recommended that work on chemical fertilizer research and development be implemented but asked for more time to study what research should be done on biological fixation and recycling of nutrients. These findings led to the decision by USAID to establish a plant nutrition research center focusing, for the time being, on chemical fertilizers.

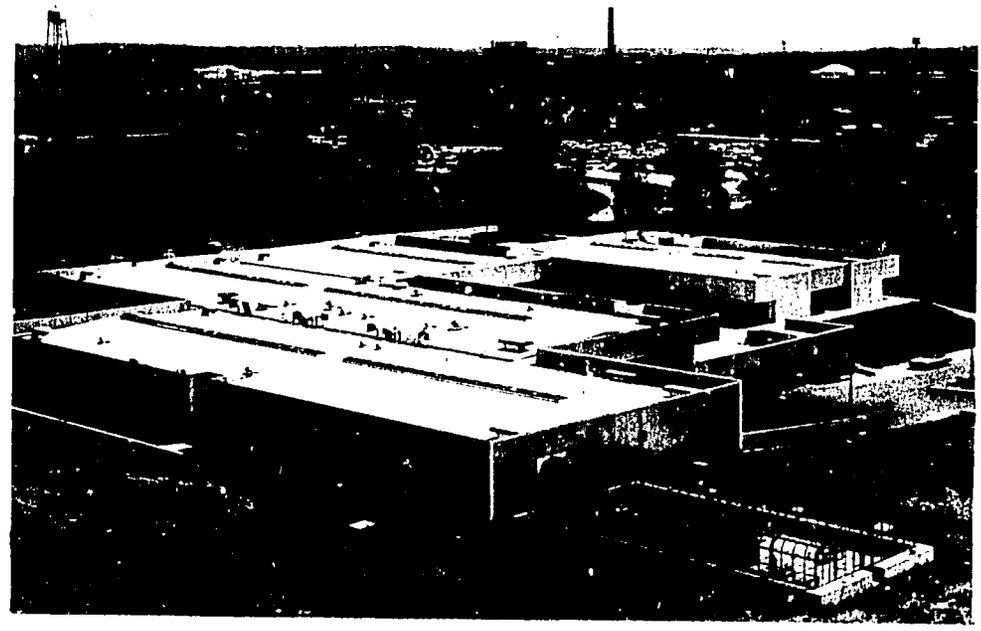
The first step was to determine where such a chemical fertilizer research and development center should be located. It was felt that such a center should be basic in the production of the so-called intermediates or building blocks of fertilizer–ammonia, nitric acid, phosphoric

acid, sulfuric acid, urea, etc. To build such facilities in a developing country would take years, cost an estimated $100-200 million, and require a staff of 100 or more technicians just to operate and maintain these facilities.



Talks with the Tennessee Valley Authority (TVA) Board of Directors determined that the international center could be located on the TVA Muscle Shoals Reservation, in Alabama, adjacent to the National Fertilizer Development Center (NFDC), and that many of the necessary fertilizer intermediates could be purchased at cost from TVA.

On October 7, 1974, IFDC was officially registered in the State of Alabama as a private, nonprofit corporation. Planning funds came from USAID and Canada's International Development Research Centre (IDRC). An additional grant came from USAID to build and equip facilities and to partially finance core research and outreach activities for 3 years. Following a planning and organizational period of 7 months, IFDC became operational from a program standpoint in July 1975 when developing country programs, formerly managed by the International Fertilizer Development Staff of TVA, were officially taken over.



International Status

From the time of the original proposal by the U.S. Government and all through the various steps of creation of IFDC, the concept of international support has been pursued. USAID has stated its intention to contribute to core budget support for IFDC for 10 years but has encouraged the Center to seek additional support for other basic research and direct assistance activities carried out for developing countries. (The budget for these special

projects for 1975/76 is contained in the Financial Report Section.)

IFDC has expanded its Board of Directors to nine members to include nominations made by CGIAR and the U.S. Government. This was an important step toward achieving U.S. recognition as an international organization and to more fully conform to other centers that are under the CGIAR. (Note: On March 14, 1977, President Carter signed an executive order whereby IFDC was "- - - designated as a public international organization entitled to enjoy the privileges, exemptions, and immunizations conferred by the International Organization Immunities Act.")

Organization and Staffing

IFDC is organized into an administrative group and three Divisions: Fertilizer Technology, Agro-Economic, and Outreach. Additional detail on the functional relationships among divisions, in terms of program responsibilities, is given in subsequent sections of the report.

Early activities at the Center have focused on program development, staffing, furnishing temporary office and laboratory space, and planning and constructing permanent headquarters, located on a 30-acre tract of land made available by TVA on a permanent easement. The completed facility will house over 100 employees with approximately half at the professional level. At the end of 1976, the total staff had reached 60, of which 35 were at the professional level.

Program Development and Activity

Laboratory research activities at IFDC at the end of 1976 awaited the completion of permanent facilities to get into full swing. In broad terms, IFDC research programs have been identified and outlined. Initial laboratory research in phosphorus was initiated in the Center's temporary facilities, with the overflow being contracted out to other institutions, including TVA. Linkages were established abroad with such international centers as International Rice Research Institute (IRRI), International Center of Tropical Agriculture (CIAT), and International Institute of Tropical Agriculture (IITA), as well as with a number of national institutions.

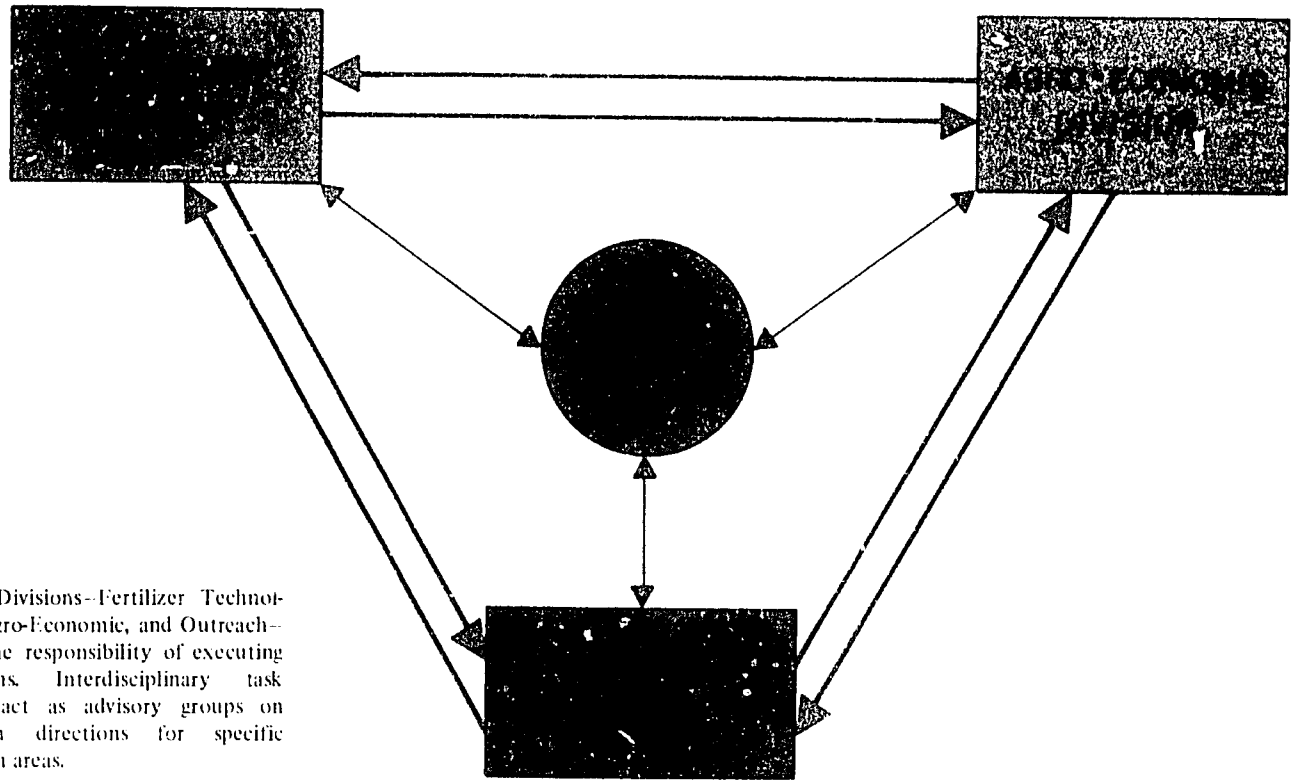
Through December 1976, IFDC responded to over 500 technical inquiries from over 40 countries, and over 200 international visitors have traveled to IFDC for technical consultation and orientation to programs. Staff members participated in numerous seminars and conferences related to the role of fertilizers in developing countries.

Technical assistance projects were carried out in a number of countries for private and public sector institutions. During 1975/76 staff members traveled to 30 countries in Africa, Asia, and Latin America at the request of USAID and other organizations to carry out technical assistance assignments. Training programs in fertilizer production, marketing, and use were extended to 37 individuals representing 12 countries.

PROGRAM OVERVIEW

In establishing research programs, the Task Team approach has been used. IFDC Task Teams include selected personnel from each Division, as well as invited special consultants from outside IFDC. The following broad problem areas have been identified to guide program development:

1. Technology to improve efficiency of nutrient use by crops grown on soils in the tropics and subtropics.
2. Technology to assure adequate and low-cost sources of nitrogen for use in fertilizers.
3. Technology to improve recovery and



IFDC Divisions—Fertilizer Technology, Agro-Economic, and Outreach—have the responsibility of executing programs. Interdisciplinary task teams act as advisory groups on research directions for specific program areas.

utilization of indigenous fertilizer raw materials, particularly phosphate ores.

4. An improved understanding of the economics of fertilizer supply, demand, pricing, government policy, distribution, adoption, and use in developing countries.

Regional Priorities

Since fertilizer problems encountered in developing countries vary from region to region, IFDC has established regional priorities for research and market development assistance based on specific problems identified in Asia, Latin America, and Africa.

IFDC Regional Coordinators for Asia, Latin America, and Africa are responsible for orchestrating IFDC program activities in each region. Regional Coordinators can call upon individuals from any Division and even from outside IFDC to meet program objectives.

Asia

Urea, the major nitrogen fertilizer used by Asian farmers, suffers large nitrogen losses when used in rice cultivation, especially under conditions of poor water management. A variety of modified physical forms of urea—supergranules, briquettes, and time-release coatings—offer potential improvements in nutrient efficiency when used at the farm level.

IFDC is pursuing cooperative agreements with international and national agricultural institutions for farm-level testing of modified urea materials. If the gains in efficiency offered by such materials prove to offset added production and application costs, particularly for the small farmer, IFDC is prepared to assist in the development and transfer of technology related to the commercial production and distribution of these materials in Asia.

Despite the existence of phosphorus deficiencies over large areas of tropical Asia, current farm-level use of phosphorus fertilizer is low, and research on phosphorus problems in Asia will be a second order priority. IFDC is interested in working with Asian countries to improve the benefit:cost ratio of phosphorus fertilizers through market development and, where it is economically advantageous, to develop indigenous phosphate ore deposits for use in chemical fertilizer processes and for possible use in direct application.

Latin America

The main immediate thrust of IFDC activities in Latin America will be in fertilizer market development. Technical assistance is available in fertilizer market development so that regional producers can manufacture quality grades desired by consumers at competitive prices, reduce dependence on imported fertilizer materials, and operate production facilities closer to design capacity. Increased and more efficient utilization of indigenous raw material deposits, particularly phosphate rock, is receiving considerable research attention.

Africa

Per capita fertilizer use in Africa is much lower than in Asia or Latin America. Fertilizer production in many countries is either low or nonexistent. Thus, IFDC program emphasis in Africa stresses basic planning assistance in fertilizer development programs.

A total development plan must include systems for supply and distribution of all agricultural inputs (including fertilizer) as well as development of research and extension education programs. A flexible fertilizer supply model is suggested, consisting of a progression of phases with increasing capital and technology inputs as fertilizer consumption increases. In addition, research on ways to utilize African raw material resources for fertilizer production is receiving considerable attention.

Fertilizer Research & Development

IFDC fertilizer research is directed toward the development of efficient, low-cost fertilizers suited to physical and other conditions found in developing countries. Much of the research and development work in fertilizer production technology will be conducted by the Technology Division at headquarters in the Engineering Research/Pilot-Plant Building and in more basic research laboratories.

Research begins in laboratory-scale equipment. If laboratory research proves promising, pilot-plant testing is carried out as needed. Some research activities will never reach pilot-stage testing, while others will carry through pilot-plant scale to preliminary determinations for commercial-scale manufacturing. However, the scaling of technology to commercial-sized units takes place outside IFDC in the public or private sector of developing countries.

IFDC will acquire public patents so that our newly developed technical know-how can be made available at limited costs to developing countries. Primary responsibility in transferring technology lies with the Outreach Division, with assistance as required, from the Agro-Economic and Fertilizer Technology Divisions.

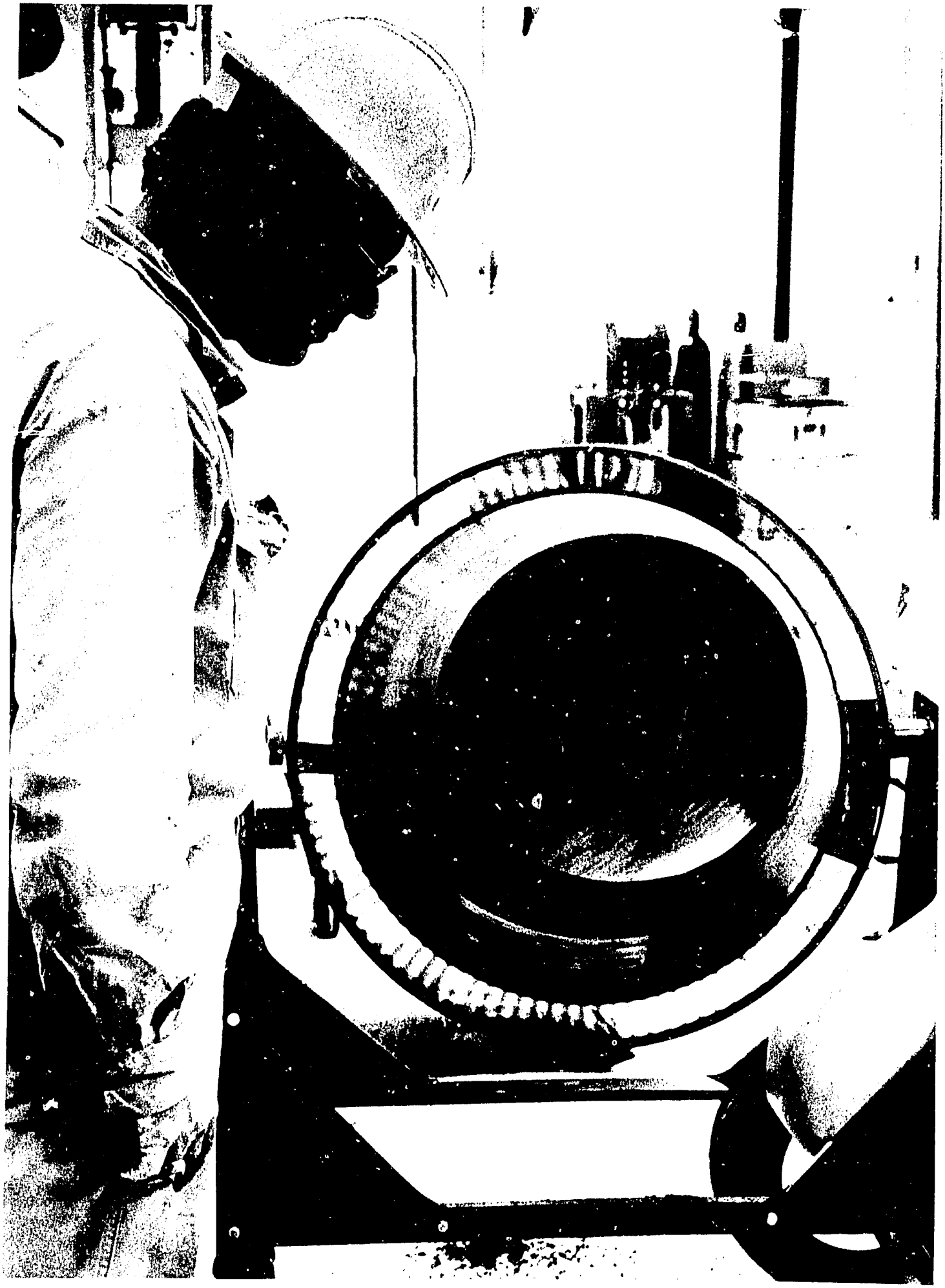
Since IFDC is not an engineering design group, close cooperation is expected with commercial engineering design organizations to translate research data into commercial operations.

As part of the overall IFDC fertilizer research program, the Agro-Economic Division is responsible for agronomic and economic research activities. Agronomic research facilities are available at headquarters for preliminary evaluations up through the growth chamber and greenhouse level. The agronomic program will provide backstopping to technology research programs and will help to suggest relevant field-plot and on-farm fertilizer testing programs carried out under the direction of the Outreach Division.

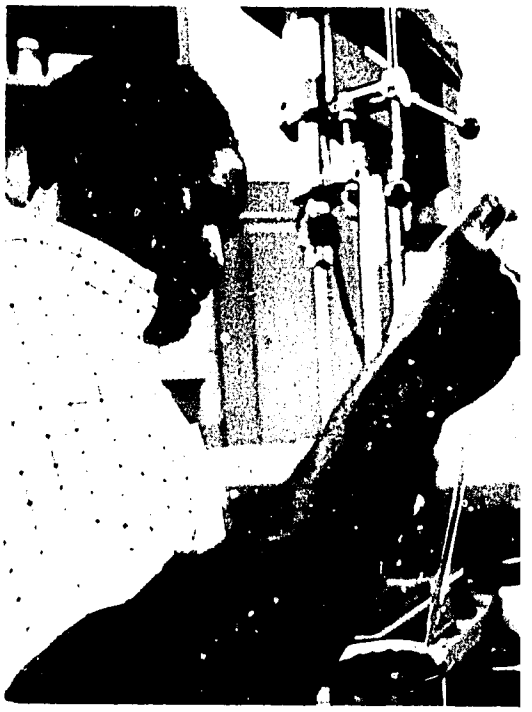
Basic fertilizer/soil/plant/water interactions under various tropical and subtropical environmental conditions are being investigated. It is hoped that these studies will help establish criteria for the manufacture of new or modified fertilizer materials with greater use efficiency in developing country agriculture.

Agronomic research facilities are being used to test new and modified products under simulated tropical and subtropical conditions. Field testing capabilities come through cooperative projects with other international centers and certain national institutions to verify research findings obtained at headquarters.

The general focus of economic research related to fertilizer technology will be on economic and financial analysis of investment and production costs, production methods and facilities, as well as feasibility studies for new or modified fertilizers. The initial research emphasis has been placed on the cost of producing modified urea nitrogen fertilizer materials, such as sulfur-coated urea (SCU) and supergranules, and selected phosphorus fertilizers including rock phosphate for direct application.



IFDC is evaluating the relative reactivity and potential utilization of phosphate ores found in developing countries, either for direct application or use in fertilizer processes.



PHOSPHORUS RESEARCH

The primary purpose of IFDC phosphorus research is to assist developing countries in meeting their phosphate needs, using, wherever economical, local resources. To the extent possible, research will focus on simplified, low-capital technology, appropriate to the agricultural needs found in a particular country. While the emphasis will be on utilizing indigenous phosphate raw materials for fertilizers, other useful byproducts may result from fertilizer development work which could contribute to industrial growth and even be the basis for the development of an export industry.

Raw Materials Datafile

Since improved utilization of phosphate rocks found in developing countries must begin with a better understanding of the fundamental nature of the deposit, IFDC has begun working on a data package on known phosphate rock deposits. This data package will contain information on the location, extent, and quality of deposits; current or applicable exploitation methods and uses; published literature references; and where possible, a technical evaluation of the deposit. Once rock characterization studies have been carried out, preliminary recommendations can be made to guide research on the enrichment and utilization of a particular ore. This information will be available through the World Fertilizer Information System, described in greater detail later in the report.

Phosphate Rock for Direct Application

The direct use of fine-ground phosphate ore as a source of phosphorus fertilizer represents the least sophisticated production technology and lowest capital investment option in phosphorus fertilization. In view of accumulating evidence that the direct application of highly reactive fine-ground rock is a suitable source of phosphorus fertilizer in acidic tropical soils, a portion of the research program is directed toward evaluating phosphate rock for direct application.

Laboratory and greenhouse experiments have been designed to evaluate the initial and residual effectiveness of phosphate rock for either direct application or application after partial treatment. A variety of phosphorus sources, soil types, and crops are included in this research. Greenhouse and laboratory experiments are underway at IFDC headquarters and in developing countries.

Treatment of Ground Phosphate Rock—For phosphate rock to be agronomically effective (even the reactive rocks), it is necessary to fine-grind the material. This produces a dusty, hard-to-manage type of product which is not easily shipped and handled in bulk and which suffers losses during application. Studies were initiated on ways to treat the rock to improve its physical properties yet retain good agronomic characteristics.

Despite the interest by manufacturers in granulation of phosphate rock, agronomic research has almost universally shown that such granulation decreases the effectiveness of phosphate rock in the soil, at least during the first crop after application.

Exploratory tests were made by TVA early in the IFDC program on methods of granulating phosphate rock that will retain suitable agronomic use characteristics. Numerous binders such as magnesium chloride, magnesium sulfate, ammonia polyphosphate, ferric sulfide, monoammonium phosphate, and urea phosphate were tested. Variations in granule size down to minigranules were made so that particle-size effect could be determined. Work accomplished to date has provided some promising preliminary results. Studies on the granulation of phosphate rock are continuing.

Another approach to improving the handling properties of fine-ground rock phosphate for direct application is to add a surfactant to the material which will form a suspension-type fertilizer when water is added. The suspension or slurry can then be applied to the soil. Research has shown the technical feasibility of

suspension-phosphate fertilizers. In a developing country, unground rock could be received or mined locally in the country (if a suitable type is available where an additive is mixed in during or subsequent to the grinding operation. The rock (plus additive) could then be transported to the farm in bags and suspended in water at the farm. The feasibility of suspension methods, in terms of profitability and market acceptance, is still under study.

Crop Response to Phosphate Rock— Considerable emphasis is being placed upon the agronomic evaluation of various sources of phosphate rock for direct application and on establishing criteria for determining the feasibility of using various sources for direct application. While plant growth is being used as a measure of effectiveness in all studies, a special emphasis is being placed upon measurements of the rate and degree of dissolution of the different phosphate rocks as related to their mineralogical composition. Some trends are developing that may be of interest, even though further substantiation is still needed.

Preliminary results from greenhouse and field studies confirm that the potential effectiveness for direct application of a given source of phosphate rock is closely related to laboratory measurements of the citrate soluble P_2O_5 content of the rock. Depending in part on the apatite structure and resulting solubility, a raw phosphate rock is capable of providing a characteristic level of phosphorus to the soil solution. The relationship between soil solution phosphorus concentration and plant uptake of phosphorus is being studied in search of a means of prediction of crop response to the levels of P which can be sustained by phosphate rocks. Yield data to date show the highly reactive sources of phosphate rock were 80% to 100% as effective as soluble P for initial response; whereas, the more unreactive rocks were in the range of 27% to 66% of relative agronomic effectiveness. Measurements of the effect of residual phosphorus from raw phosphate rock are also in progress.

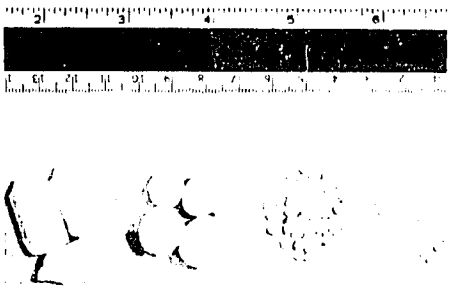
The liming effect of phosphate rocks on soil pH has frequently been cited as beneficial, although supporting data have been sparse. In both field and greenhouse experiments in Colombia and in greenhouse experiments in Israel, soil pH was increased when finely ground phosphate rocks were mixed with the soil. The indications are that at practical rates of application, expected soil pH changes would be too small to be of significance but may be beneficial in counteracting the effects of other acidifying fertilizers.

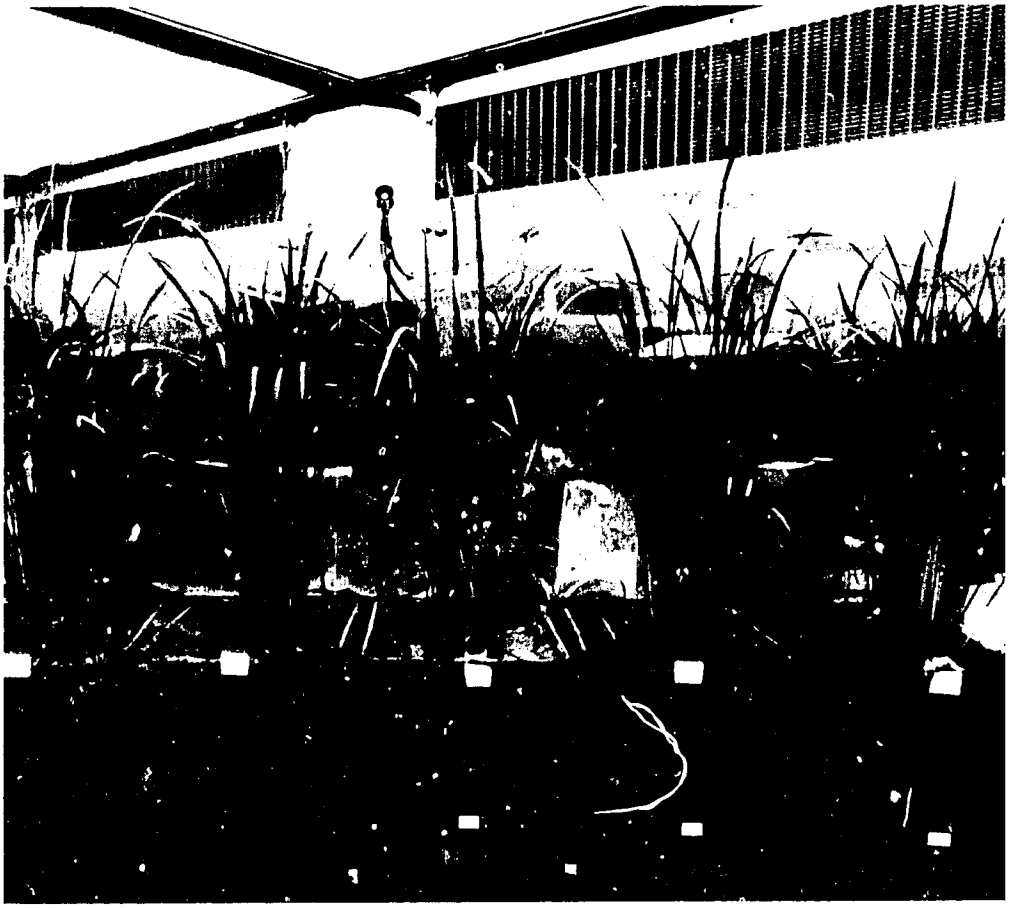
Upgrading Indigenous Ore Through Physical-Chemical Means— When an indigenous ore is not suitable for direct use as a fertilizer, it must be upgraded. Many of the ores known to exist in developing countries have impurity problems such as high chloride, high calcium carbonate, high silica, high iron and aluminum, and other impurities which create challenging technical problems in ore utilization.

IFDC is carrying out fundamental and applied research with the objective of upgrading ores to produce a wide range of fertilizers. This includes common products such as single and triple superphosphate, ammonium phosphate via wet-process acid, as well as less common forms such as nitric phosphates, magnesium and sodium phosphates, and other thermally and chemically altered materials.

Several raw material evaluation studies were carried out for individual organizations on particular ores. Technical data were provided to make decisions on potential beneficiation and processing techniques for the production of phosphoric acid, triple superphosphate, and intermediate and other finished phosphate products from indigenous ores. Companies receiving characterization and evaluation reports during 1975/76 were:

FONADE, Colombia
NATRON, Brazil
National Fertilizer Corporation, Pakistan
Companhia Uniao Fabril, Portugal
Roca Fosforica Mexicana, Mexico





Ways to improve the nitrogen efficiency of urea by producing materials for deep placement and through coatings to control nutrient release are being investigated under growth chamber and greenhouse conditions at IFDC, and under field conditions at IRRI and various national institutes.

NITROGEN RESEARCH

Full initiation of the nitrogen research program awaits the completion of permanent research facilities at headquarters. IFDC hopes it can make a substantial contribution toward improving the efficiency of use of nitrogen fertilizer in the tropics and subtropics. Problems in fertilizer efficiency on rice, the world's major cereal food grain, have slowed the rate of fertilizer adoption and use among farmers. Nitrogen recovery is rarely above 60% on rice, even under good water management. It is lowest on intermittently flooded or rainfed rice fields where recovery is often below 30%.

It is unlikely that a new nitrogen material will be developed over the next 20 years that will replace the major materials–urea, ammonia sulfate, and ammonium nitrate–now being used in developing countries. Thus, initial IFDC research on nitrogen will be heavily oriented toward improving the uptake efficiency of current materials.

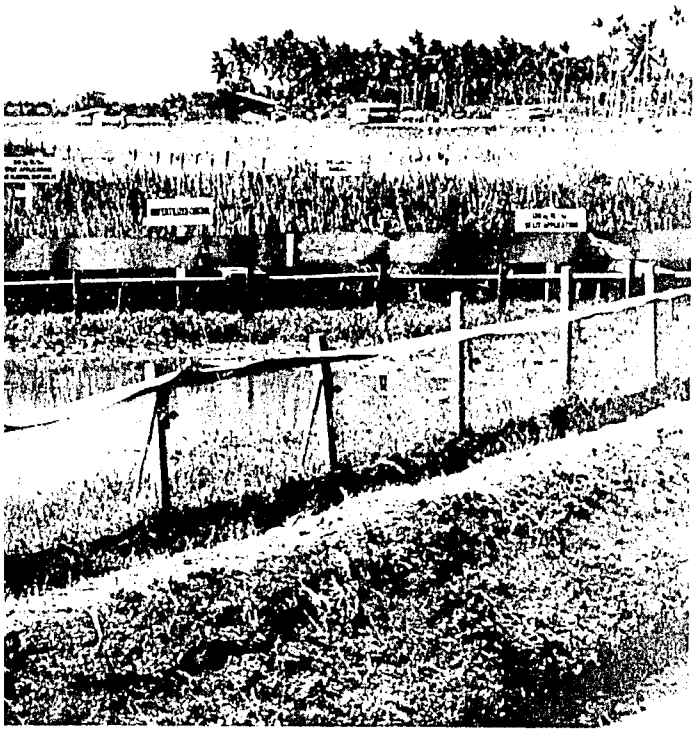
Soil scientists are studying the mechanisms of nitrogen loss from flooded soils and the factors influencing crop recovery of fertilizer. This information will guide fertilizer engineering research concerned with the ways and relative costs of producing new or modified fertilizer materials.

IFDC, in conjunction with IRRI, is monitoring agronomic studies of deep placement of urea in the form of large granules referred to as "supergranules" (each granule weighs 1-3 grams). By placing the granules in the active rooting zone of rice, the transformations of nitrogen leading to losses are retarded, thus allowing the ammonium form to remain longer for plant utilization. The idea originally came from the "mudball," which involved deep placement of a mudball containing fertilizer; this method, however, is extremely labor intensive.

Although the use of supergranules may offer a more economical alternative, no commercial process is now available for the production. Several methods appear to be technically possible, such as the pan granulator, modified spray-drum granulator, briquetting, or even a fluidized bed granulator. Very little technical data exist even at the bench-scale level for making large granules. Exploratory tests using a modified spray-drum granulator indicate that the method is worthy of further study. Data are being gathered comparing the cost of supergranules by pan granulation and briquetting versus the cost of conventional urea by prilling. If the results of the study appear promising, additional technical information will be obtained in larger-scale equipment.

In addition, researchers will continue to study the benefits and costs of controlled-release fertilizers such as sulfur-coated urea (SCU) developed by TVA. IFDC will attempt to improve the physical and chemical properties of this product as well as gather farm-level data on the effectiveness of SCU under varying fertilizer and water management practices. Some studies will also be made on the use of indigenous material in SCU production.

IFDC is formulating research programs to go more basic, even to the point of making new nitrogen compounds for testing. Long-range research programs can

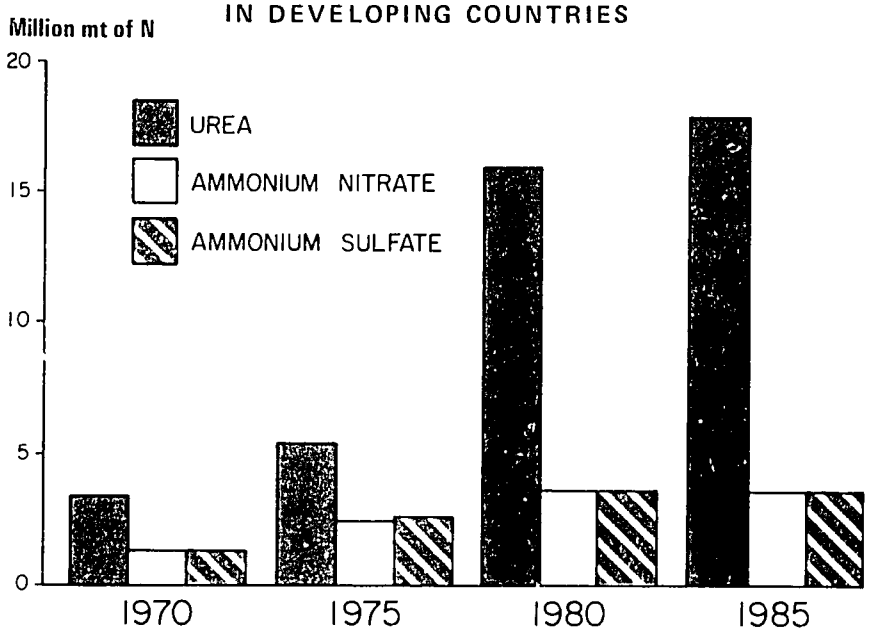


begin by late 1977 when the construction and equipping of the research laboratories and facilities in the new headquarters are completed. These facilities have been designed and equipped to provide the flexibility needed in the research program.

RESEARCH ON OTHER NUTRIENTS

The IFDC staff recognizes the need for research and development on potash, calcium, magnesium, sulfur, and certain micronutrients such as zinc and iron. Much current technology is available for formulation of multi-nutrient fertilizers. The principles of direct soil and plant treatments with a single nutrient are well understood. Thus, outreach activity could prove immediately valuable for certain areas. For long-term research, however, specific IFDC activities will be deferred until the nitrogen and phosphorus programs become better developed. Work on potash and sulfur will begin with a better definition of the problem and an assessment on whether improvements in technology are likely to solve these problems.

TREND IN NITROGEN PRODUCTION CAPACITY IN DEVELOPING COUNTRIES



Market Development Assistance

At IFDC, market development programs cover a wide range of research, technical assistance, and training activities in fertilizer production, marketing, and use. Programs are directed toward ways to facilitate the expansion of economically sound fertilizer usage among low-income farmers through the design and implementation of sound fertilizer public policies and market development strategies. Market development activities are an integral part of the Agro-Economic and Outreach Division programs and draw on the technical expertise and research capabilities of all IFDC Divisions, as well as consultants in specialized areas from other organizations.

RESEARCH ACTIVITIES

Economic research programs have been established to generate information useful in public policy formulation of fertilizer production, marketing, and use strategies. This program is being carried out by a team of economists, sociologists, and agronomists centered in the Agro-Economic Division. In addition to country-specific information, the expected output from this program includes the development and transfer of research methods appropriate to the research capabilities of developing countries. Such analytical tools can aid policymakers in the design of more effective fertilizer development programs. Further, the research will be closely integrated with related research and development in the areas of fertilizer technology, technology transfer, technical assistance, and training.

Adoption/Demand Research

This research, being carried out principally by staff in the Agro-Economic Division, will identify and quantify the impact of the key variables influencing fertilizer demand. The development of such information will also support IFDC efforts to improve fertilizer forecasting techniques.

Public Policy Research

This research is oriented toward evaluating the relative effectiveness and implications of alternative public policies, with initial emphasis on pricing, subsidy, and credit policies to determine the likely economic impact and distribution of social benefits and costs associated with various policy alternatives.

Fertilizer Marketing Research

This research involves short-term economic analysis of specific marketing problems identified through technical assistance and technology transfer programs. One research project on marketing efficiency is now underway in Colombia. The project utilizes a systems simulation approach to identify profitable ways to improve marketing efficiency.

SERVICE UNITS

Three service units, each with specific responsibilities in engineering, training, and fertilizer information and analysis, support market development assistance in developing countries.

Engineering Unit

The Engineering Unit helps identify production and distribution problems associated with the transfer and use of improved fertilizer technology in the developing countries; works on solutions to short-term problems and bottlenecks; and transmits information back to the Technology and Agro-Economic Divisions on problems requiring longer-term research and development to provide solutions.

Engineering assistance can be provided in determining design parameters for production and distribution systems, process flowsheets, specifications for equipment, and estimation of investment and production costs. Assistance can also be provided during the installation and startup phases of fertilizer production facilities, as well as in fertilizer handling and distribution.

Training and Development Unit

The Training and Development Unit has the primary responsibility of ensuring that adequate training programs exist in developing countries to utilize the fertilizer technology transferred by IFDC. In addition, the unit coordinates a variety of training and development programs for groups and individuals from organizations concerned with the principles of fertilizer production, marketing, and use.

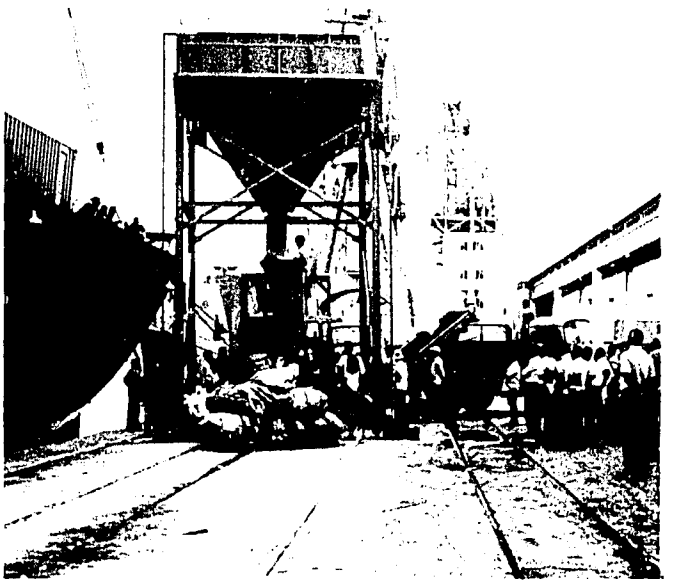
Training programs can be carried out at headquarters and in developing countries. A variety of educational activities are offered including formal training courses, attendance at specialized schools, consultation with fertilizer specialists at other institutions, and visits to commercial fertilizer facilities—all arranged and coordinated through IFDC.

World Fertilizer Information Unit

The World Fertilizer Information Unit, if planned developments materialize, will be a cornerstone of IFDC Outreach activities. This unit collects key information on fertilizer raw materials, plant investment costs, production and distribution costs, and the economics of fertilizer use. These data will be analyzed in cooperation with specialists from other Divisions and put into forms that policymakers can utilize to make fertilizer development decisions.

Highlights of Program Activities

Recovering industrial byproduct material for use in fertilizers, the operating efficiency in fertilizer plants, and lowering the cost of fertilizers delivered to the farmer are major themes in IFDC outreach activities.



During 1975/76, fertilizer development assistance was provided to a number of public and private organizations. In carrying out these activities, considerable program support was provided by TVA's National Fertilizer Development Center.

Technical Assistance

Specific technical assistance activities carried out by IFDC in 1975/76 include the following:

Latin America

MONOMEROS, Colombia—IFDC has an ongoing contract with MONOMEROS to provide technical assistance in fertilizer production and distribution. In 1975, assistance was provided in developing a preliminary strategy for the expansion of fertilizer manufacturing facilities in connection with the proposed expansion of caprolactam production at Barranquilla, Colombia. The scope of work focused on engineering and marketing alternatives for utilizing and marketing byproduct ammonium sulfate as straight ammonium sulfate, NP or NPK fertilizer, or a combination of these alternatives.

Ways to increase operating efficiency in an NPK production facility in Barranquilla were also studied. Several IFDC recommendations were initiated and the plant is now operating much nearer to design capacity. Analytical procedures used in the manufacturing quality control program were reviewed and training in key areas of quality control was provided to a MONOMEROS chemist.

NITROVEN, Venezuela—Under a continuing technical assistance contract, IFDC provided information on ways to increase the efficiency of production units, pollution control, and market intelligence.

ARAFERTIL, Brazil—Technical assistance was provided in 1976 to evaluate an existing electric furnace to determine the possibility of renovation and modification for pilot production of phosphoric acid from indigenous phosphate rock deposits.

INTER-UHDE, Brazil—Assistance was given in 1976 on the design criteria for new fertilizer plants using melt-type granulation and on the adaptation of an existing plant to use the pipe reactor.

Africa

GHANA FERTILIZER COMPANY (GFC), Ghana—An IFDC chemical engineer assisted GFC in coordinating and training personnel for the first unloading and bagging of bulk fertilizers. Expertise was also extended in the design of a plant layout for a mixing facility and in the preparation of bid specifications for a storage building conveyor system and mixing equipment.

SODEVA, Senegal—A 3-year technical assistance project began in 1975 to periodically review and evaluate data on peanuts and millet fertilization and to assist in the formulation of a field trial program to identify the most economical fertilizer use practices.

Asia

P.T. PUSRI, Indonesia—Technical assistance was provided in preliminary calculations on capital investment and production costs of an ammonia-urea complex at several alternative locations. Preliminary data were provided on fertilizer nitrogen demand. Also, granular urea was sent for testing in Indonesia to assess handling properties and farmer acceptance of this new material.

TAIWAN FERTILIZER COMPANY (TFC), Taiwan—TFC has a continuing technical assistance contract with IFDC. In 1976, two engineers served as advisors during the startup of an NPK granulation plant.

Training

During 1975/76, IFDC organized and carried out a variety of group and individual training programs. Considerable program support was again supplied by TVA's National Fertilizer Development Center.

Individualized Training

A variety of individualized training programs were carried out during 1975/76.

Agronomic Training—A postdoctoral fellow of the International Research Institute, Dr. Jose Rubio Delgado from the Instituto de Agroquimica y Tecnologia de Alimientos, Spain, completed a 1-year program of study of the various properties of controlled-release fertilizers. Dr. Rubio's research was carried out in cooperation with TVA Soil Scientist Dr. Roland Hauck of the Soils and Fertilizer Research Branch.

Mr. Rafael Perez from the Centro Nacional de Investigaciones Agropecuarias, Venezuela, spent 7 months at IFDC and TVA during 1975/76 studying the agronomic aspects of sulfur-coated urea (SCU), phosphate rock, and micronutrients.

Fertilizer Production and Distribution—Two programs in fertilizer production quality control were conducted during 1975/76. Mr. Jacinto Yepez of the Instituto Nacional de Investigaciones Agropecuarios (INIAP), Ecuador, spent 5 weeks studying fertilizer quality control laboratories at TVA and at other organizations in the United States.

Mr. E. N. Mandler of Companhia Souza Cruz, Brazil, participated in a similar program in fertilizer quality control during 1976.

Phosphate Technology—Mr. Angel Calvo of the Ministerio de Industria y Turismo, Peru, spent 4 months at IFDC and TVA studying engineering processes related to phosphorus fertilizer manufacture.

Nitrogen Technology—Mr. Naser Ali Alnaser and Mr. Talot Anbar from the Saudia Arabia Fertilizer Company (SAFCO) spent 4 weeks at IFDC and TVA studying the operation of ammonia and urea plants. Instrumentation, preventive maintenance programs, laboratory control work, and pollution control programs were studied. In addition, the production process for SCU was studied, as well as principles of organizational development and management by objective.

Transportation Systems—Mr. Ivan Dario Parra from NITROVEN, a nitrogen fertilizer industry of Venezuela, completed a 1-year training program in late 1976 in management studies of fertilizer transportation and distribution. Mr. Parra also worked with IFDC staff members on plans for an Andean region fertilizer technology center to be located in Venezuela.

Organizational Development—Several seminar programs in organizational development and management were carried out in 1976.

Mr. Henrique Hopkins, Mr. Tito Livio Parra, and Mr. Vicente Rossi from NITROVEN, Venezuela, spent 7 weeks studying management by objectives, ways to improve organizational effectiveness through improved communications, better interdepartmental cooperation, and human resource management.

Numerous short-term training and development programs were conducted during 1975/76. Such programs are usually less than 2 weeks in length and cover very specific topics.

Fertilizer Factory Maintenance Course

A team of nine Bangladesh engineers, financed by USAID and coordinated by the U.S. Department of Agriculture, arrived in mid-1976 to participate in the first IFDC Fertilizer Factory Maintenance Course. The Bangladeshis are studying with IFDC and TVA personnel in all phases of fertilizer plant maintenance, inventory control, and repair. An important component of the program is the planning of future training programs in factory maintenance and spare parts inventories to be implemented at factories in Bangladesh.

At the end of 1976, the Bangladeshi engineers had completed their general study of the maintenance function, including critical path planning, preventive maintenance, and scheduling of daily maintenance activities. Specific subjects such as vibration analysis, new welding techniques, spare parts fabrication, and corrosion testing and control were also covered. In addition, the engineers attended various short courses on instrumentation and valve engineering at specialized private industry schools. Study tours to various foundries, fertilizer factories, and machining and plating companies were also arranged.

The final phase of the program which includes a short course in organizational development and formulation of a training program, (complete with manuals) to be used in the fertilizer factories of Bangladesh, is scheduled for completion in 1977.

Development Planning Assistance

IFDC has begun to gather country profile information through a number of regional and national feasibility studies carried out in 1975/76 related to fertilizer demand, supply alternatives, and distribution systems. These studies were coordinated by the Outreach Division but involved staff members from all three Divisions, as well as outside consultants.

The ASEAN Study

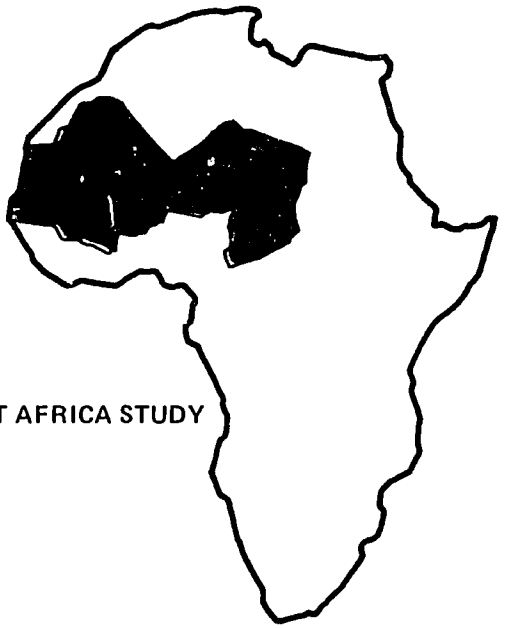
A study was conducted to measure the potential gain that would accrue to ASEAN members from a regionally coordinated expansion program of fertilizer production capacity. This study, requested by the Consultative Group on Food Production and Investment (CGFPI) was carried out in collaboration with the World Bank.

A mathematical programming model developed by the World Bank was used to determine the least cost investment, production, importation, and transportation patterns needed to meet projected 1985 fertilizer requirements. Six different scenarios, corresponding to varying degrees of regional cooperation in production and raw materials, were described in the study. The optimum product mix for the region includes urea and monoammonium phosphate (MAP), although the dominance of MAP over diammonium phosphate (DAP) is marginal.

The preliminary analysis indicates that there are significant economic benefits to be realized from a regionally harmonized program to expand total capacity. Economic benefits come through efficient utilization of the region's relatively low-cost sulfuric acid byproduct, abundant natural gas supply, capitalization on the physical geography, and integration of markets to permit economies of size in fertilizer production facilities. For example, full regional cooperation, as compared with severely restricted cooperation, could save as much as $180 million in total initial investment and another $117 million in annual operating costs.

While full regional cooperation maximizes total savings, substantial gains can still be made with limited degrees of cooperation. For example, the members of the ASEAN may agree that each country should be 75% self-sufficient in nitrogen but open to free trade for the remaining market share. This arrangement would still save $112 million in initial investment and $8 million in annual operating costs.

It should be noted that, in all cases, increased regional cooperation requires a considerable expansion in inter-country transportation systems. For example, under the "full cooperation" scenario, 543 vessel loads of 7,000 tons each would be required annually. This is an approximate loading rate of 1.5 ships per day.



Due to time and financial limitation, the analysis conducted did not determine the optimal timing of investment between 1975 and 1985 and looked at only a limited number of regional economic integration and trade relationships. Further, the foreign exchange implications of various programs were not studied. Work in this area will be continued in 1977.

West Africa Fertilizer Study

USAID requested IFDC to determine the current and potential capacity to produce, market, and use fertilizer in six west African countries--Senegal, Mali, Upper Volta, Niger, Chad, and Mauritania.

Currently, fertilizer use is low in all six countries, although use in Senegal is greater than the other five countries combined. Almost all of the fertilizer currently used is applied to export crops, principally peanuts and cotton. Most of the fertilizer used in these countries is imported. Senegal is the only country with fertilizer production facilities, and here, the processed fertilizers (DAP, superphosphates, and mixed NPK grades) rely somewhat on imported intermediates.

Various fertilizer supply alternatives were reviewed and analyzed by IFDC. For example in Mali, it is estimated that the use of indigenous phosphate rock can meet 50% of the projected 1985 phosphorus fertilizer demand. In addition to phosphate rock, soluble phosphorus and NPK grade fertilizers will be needed. This demand must be supplied by imported fertilizers.

The installations of simplified bulk-blending operations in Chad, Mali, and Upper Volta to receive imported fertilizers (common on world market) could result in savings of up to $80 per mt over the current system of importing small quantities of special fertilizer grades in 50-kg sacks.

IFDC estimates that with a proper fertilizer development program, cereal production on existing cropland can be increased by 590,000 mt by 1985. This would reduce the projected 1985 food deficit by 27%. The remaining potential food deficit would have to be reduced through increased land under cultivation. This study will serve as a basis upon which IFDC will develop future programs in west Africa. The results of this study are contained in a regional overview report and six individual country reports.

Nigerian Fertilizer Distribution Study

Technical assistance was provided to the International Institute of Tropical Agriculture (IITA) in 1975 in a study entitled, "Fertilizers and Plant Protection Chemicals in Nigeria" done for the National Accelerated Food Production Program (NAFPP). The purpose of this study was to advise the NAFPP on how to improve the delivery system for farm inputs in Nigeria.

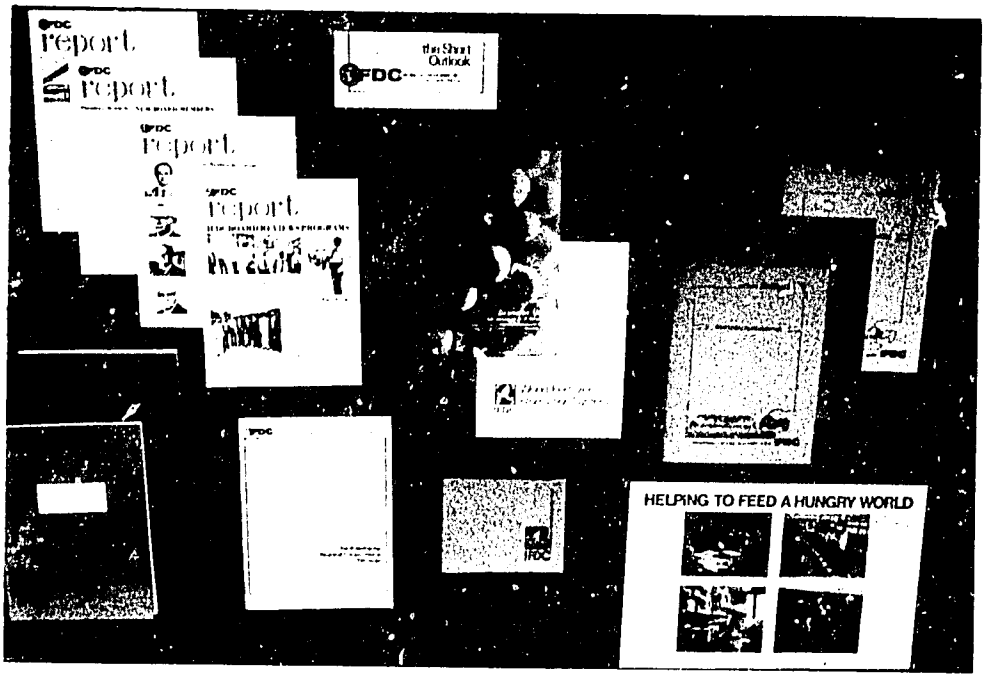
Nigeria depends upon fertilizer imports to satisfy demand, except in the case of single superphosphate which is now produced in Nigeria. The continued importation of nitrogen fertilizers will be necessary until 1980/81 when newly constructed nitrogen facilities come on stream. Potash and micronutrients will continue to be imported unless new discoveries are made.

Fertilizer costs are relatively high in Nigeria due to port congestion and a high cost of internal distribution. In addition, the present distribution system is plagued with some serious operational problems such as unsuitable and untimely arrival of supplies, inadequate stock control, transportation bottlenecks, insufficient incentive to encourage private sector participation, and inadequate credit programs.

The IITA-IFDC-NAFPP study team analyzed the current distribution system and drafted a suggested model for an improved fertilizer delivery system. The model included institutional recommendations to improve fertilizer procurement as well as operational techniques to remove some of the bottlenecks affecting fertilizers and other agricultural inputs.

Communications

IFDC's innovative word processing center (WPC) serves the entire staff in the typing of correspondence and reports. In addition, the WPC staff assists in the editing and preparation of IFDC publications and maintains IFDC mailing lists.



The effective and timely communication of accurate scientific information on fertilizer production, marketing, and use to audiences with diverse languages and professional backgrounds represents the communications goal of IFDC. In order to serve such a diverse clientele, numerous communication methods and techniques are being employed.

World Fertilizer Information System

Efforts are underway to gather and maintain current and reliable information on fertilizer production, marketing, and use as part of the World Fertilizer Information System.

Market intelligence reports summarizing recent supply, demand, price, and inventory data eventually will be published on a quarterly basis, when the full data collection network is operative. In addition to the storage of basic data, the system includes a variety of analytical programs which can be used to carry out many types of economic analyses.

Specific computer data packages, either available or planned, include:

1. plant investment
2. quarterly market intelligence
3. raw materials
4. country profiles
5. physical distribution
6. agronomic indicators

Newsletter

IFDC publishes a newsletter (*IFDC Report*) on a quarterly basis in English and Spanish to report the work and progress at the Center. The newsletter is available to any interested individual or organization.

Technical Reports

Technical reports on IFDC research and outreach activities will be published and available upon request, providing that the activity was not done for a specific organization and is proprietary in nature. Publications available for external distribution are listed in the newsletter.

Reprints, Circulars, and Training Materials

Reprints are available upon request of technical papers, speeches, and articles by IFDC staff or consultants under contract to IFDC. These reprints either appeared in professional journals and publications or were unpublished work identified by IFDC for external distribution.

A variety of popular materials (brochures, pamphlets, progress reports) describing IFDC programs and activities will also be published on a regular basis to provide a continuing flow of information to administrators and development practitioners.

Training materials with a strong emphasis on audio-visual communications are being developed. Slide/tape and filmstrip programs, videotape productions, correspondence courses, and manuals related to fertilizer production, marketing, and use will be produced and available for developing country audiences.

Financial Report

Price Waterhouse & Co.

1200 FIRST NATIONAL-SOUTHERN NATURAL BUILDING
BIRMINGHAM, ALABAMA 35203
205-328-8700

March 16, 1977

To the Board of Directors of
International Fertilizer Development Center

In our opinion, the accompanying balance sheets and the related statements of revenue and expenses and changes in fund balances and of functional expenses present fairly the financial position of International Fertilizer Development Center (IFDC) at December 31, 1976 and 1975, and the results of its operations and changes in fund balances for the year ended December 31, 1976 and for the period October 7, 1974 through December 31, 1975, in conformity with generally accepted accounting principles consistently applied. Our examinations of these statements were made in accordance with generally accepted auditing standards and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

Price Waterhouse & Co.

INTERNATIONAL FERTILIZER DEVELOPMENT CENTER

BALANCE SHEETS

Assets

CURRENT FUND (unrestricted)

	December 31, 1976	December 31, 1975
Cash	$ 400,403	$ 150,909
U. S. Treasury bills, at cost		39,753
Accounts receivable from donors (Note 2)	4,874,512	3,171,332
Other accounts receivable	153,826	71,733
Advances to employees	8,164	2,654
Prepaid expenses	5,397	14,933
	$5,442,302	$3,451,314

PROPERTY AND EQUIPMENT FUND (Notes 1 and 4)

	December 31, 1976	December 31, 1975
Equipment	$ 192,656	$ 59,540
Leasehold improvements	60,587	55,268
Construction-in-progress	3,825,036	50,934
Less - accumulated depreciation	(47,603)	(12,188)
	$4,030,676	$ 153,554

Liabilities and Fund Balances

CURRENT FUND

	December 31, 1976	December 31, 1975
Accounts payable	$ 178,374	$ 150,795
Accrued annual and sick leave	92,552	32,247
Deferred revenue (Notes 1 and 3)	4,874,512	3,171,332
Total liabilities and deferred revenue	5,145,438	3,354,374
Fund balance	296,864	96,940
	$5,442,302	$3,451,314

PROPERTY AND EQUIPMENT FUND

	December 31, 1976	December 31, 1975
Accounts payable	$ 315,620	
Contract retainage	177,220	
Total liabilities	492,840	
Fund balance	3,537,836	$ 153,554
	$4,030,676	$ 153,554

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INTERNATIONAL FERTILIZER DEVELOPMENT CENTER

STATEMENT OF FUNCTIONAL EXPENSES

	Year ended December 31, 1976				October 7, 1974 through December 31, 1975
	Research	Outreach	General and Administrative	Total expenses	Total expenses
Personnel compensation (Note 3)	$370,861	$270,077	$297,204	$ 938,142	$395,190
Personnel benefits (Note 3)	64,166	55,952	65,771	185,889	79,112
Travel and transportation	76,316	106,909	32,503	215,728	78,191
Occupancy (Note 4)	25,506	5,305	13,800	44,611	19,960
Telephone and telegraph	13,517	8,351	26,975	48,843	20,623
Rental of equipment	5,677	31,100	24,380	61,157	22,533
Contractual research and development	226,431	2,172		228,603	101,936
Other contractual services	33,165	106,543	30,425	170,133	50,195
Institute of International Education fee (Note 3)			25,000	25,000	15,650
Materials and supplies	29,434	15,764	33,088	78,286	37,847
Postage			3,781	3,781	1,817
Insurance			2,520	2,520	2,536
Miscellaneous	616		370	986	6,191
Total expenses before depreciation and amortization	845,689	602,173	555,817	2,003,679	831,781
Depreciation of furniture and equipment and amortization of leasehold improvements	24,227	8,191	2,997	35,415	12,188
Total expenses	$869,916	$610,364	$558,814	$2,039,094	$843,969

INTERNATIONAL FERTILIZER DEVELOPMENT CENTER

STATEMENT OF REVENUE AND EXPENSES AND CHANGES IN FUND BALANCES

	Year ended December 31, 1976			October 7, 1974 through December 31, 1975
	Current Fund	Property and Equipment Fund	Total All Funds	Total All Funds
Revenue:				
Grants received (Note 2)	$5,225,731		$5,225,731	$ 979,247
Recovered project costs	394,139		394,139	112,237
Other	3,430		3,430	2,979
Total revenue	5,623,300		5,623,300	1,094,463
Expenses:				
Research	845,689	$ 24,227	869,916	279,034
Outreach	602,173	8,191	610,364	169,580
General and administrative	555,817	2,997	558,814	395,355
Total expenses	2,003,679	35,415	2,039,094	843,969
Excess (deficiency) of revenue over expenses	3,619,621	(35,415)	$3,584,206	$ 250,494
Other changes in fund balances:				
Property and equipment acquisitions from unrestricted funds	(3,419,697)	3,419,697		
Fund balances, beginning of period	96,940	153,554		
Fund balances, end of period	$ 296,864	$3,537,836		

INTERNATIONAL FERTILIZER DEVELOPMENT CENTER

NOTES TO THE FINANCIAL STATEMENTS

DECEMBER 31, 1976 AND 1975

NOTE 1 - ORGANIZATION AND ACCOUNTING POLICIES.

The International Fertilizer Development Center (IFDC) is a non-profit organization incorporated October 7, 1974 under the state laws of Alabama. On March 14, 1977, IFDC was designated as a public international organization by executive order of the President of the United States. The purpose of the organization is to improve fertilizers and fertilizer know-how in developing countries through research and development, technical assistance and training and communications.

In the event of dissolution, the articles of incorporation provide that the residual assets of the organization will be turned over to one or more tax exempt organizations or to the federal, state or local government for exclusive public purpose.

The following is a summary of significant accounting policies:

A. Property and equipment is stated at cost. Depreciation and amortization is computed on the straight-line method over estimated useful lives ranging from three to ten years.

B. Revenue and expenses are accounted for on an accrual basis. In particular, grants of the United States Agency for International Development (AID) are recorded as receivable for the full amount at the date of the grant. Amounts not clearly designated for a specified program period are deferred in the balance sheet and reflected in revenue when received. Contributions for reimbursable costs are recognized as project costs are incurred.

Revenue is restricted only to the extent it is to be used in accordance with the purpose of the organization unless otherwise indicated.

NOTE 2 - GRANTS.-

Grants received are summarized as follows:

	Year ended December 31, 1976	October 7, 1974 through December 31, 1975
United States Agency for International Development (AID)		$ 255,000
International Development Research Center (IDRC)		50,579
United States Agency for International Development (AID)	$ 6,900,000	3,845,000
Rockefeller Foundation	28,911	
	6,928,911	4,150,579
Amounts deferred during prior year	3,171,332	
	10,100,243	4,150,579
Less - Amounts deferred to future periods	(4,874,512)	(3,171,332)
Revenue recognized in current period	$ 5,225,731	$ 979,247

The current grant from AID was amended to provide additional funds of $6,900,000 and to extend the grant period from June 29, 1977 to December 31, 1978. The amounts of $4,860,112 and $3,171,332 had not been received at December 31, 1976 and 1975, respectively, and were not clearly designated for a specified program period and, accordingly, were deferred. The amendment to the grant provides funds for the construction of new office and research facilities and equipment. The use of funds by area is unrestricted except that equipment purchases may not exceed $1,122,000. Funds not legally committed at the grant expiration date will revert to AID.

The amount of $14,400 from the Rockefeller Foundation grant is for the period January 1, 1977 through July 31, 1977 and was deferred at December 31, 1976.

NOTE 3 - INSTITUTE OF INTERNATIONAL EDUCATION:

IFDC has a contract with the Institute of International Education (IIE) relating to the employment of personnel of IFDC. All payroll administrative functions are performed by IIE; IFDC makes advances quarterly to fund salaries, employment taxes and fringe benefits.

NOTE 4 - FACILITIES:

The building used for the research and development and outreach programs is leased for a three year period at an annual rate of $2,900. Administrative office space and additional space for outreach programs is leased on a month-to-month basis; rental expense was $17,700 for the year ended December 31, 1976 and $12,850 for the period October 7, 1974 through December 31, 1975.

Architectural plans and specifications for the construction of new facilities have been completed and construction begun. The project is funded by a grant from AID.

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Manuel Sanchez-Nelson, Special Assistant to the Managing Director
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G. Edward Schuh, Consultant
Surjit S. Sidhu, Economist
John M. Stumpe, Analytical Chemist
Paul L.G. Vlek, Soil Scientist

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Ray B. Diamond, Regional Coordinator–Africa
M. Terry Frederick, Chemical Engineer
Terry Hudgens, Part-Time Office Assistant
Kham Thanh Pham, Economist
Dennis H. Parish, Regional Coordinator–Asia
Robert T. Smith, Regional Coordinator–Latin America

*Left during 1976.

As of December 31, 1976.

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Dr. Robert Wagner
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*Left during 1976.

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